

AFINA IN PROJEKTIVNA GEOMETRIJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|-----------------------------------|---------------------------------|
| Predmet: | Afina in projektivna geometrija |
| Course title: | Affine and Projective Geometry |
| Članica nosilka/UL Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039564 |
| Koda učne enote na članici/UL Member course code: | 27220 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: Aleš Vavpetič, Tomaž Košir

Vrsta predmeta/Course type: izbirni predmet/elective course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|----------------------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Opravljen predmet Linearna algebra. | Completed course Linear algebra. |

Vsebina:

Afina geometrija: afini prostori, affine transformacije, osnovni izrek affine geometrije.
Projektivna geometrija: projektivni prostori, dualnost, vložitev affine geometrije v projektivno, kolineacije in projektivnosti, osnovni izrek projektivne geometrije, projektivno ogrodje, dvorazmerje, harmonična četverka, perspektivnost.
Stožnice v projektivni ravnini: pol in polara, dvorazmerje na stožnici, Pascalov izrek, klasifikacija stožnic.
Izbirna vsebina: Klasifikacija izometrij v evklidski ravnini. Leonardov izrek, frize in tapetne grupe. Končne grupe izometrij v trirazsežnem evklidskem prostoru.

Content (Syllabus outline):

Affine Geometry: affine spaces, affine transformations, the fundamental theorem of affine geometry.
Projective Geometry: projective spaces, embedding of affine spaces into projective spaces, collineations and projectivities, the fundamental theorem of projective geometry, projective coordinates, cross-ratio, harmonic ratio, perspectivities.
Conics in projective plane: poles and polars, cross-ratios on a conic, Pascal's Theorem, classification of conics.
Additional topics: classification of isometries in the Euclidean plane, Leonardo's Theorem, frieze groups and wallpaper groups, finite groups of isometries in Euclidean 3-space.

Temeljna literatura in viri/Readings:

. Košir, B. Magajna: *Transformacije v geometriji*, DMFA-založništvo, Ljubljana, 1997.
 Vidav: *Afina in projektivna geometrija*, DMFA-založništvo, Ljubljana, 1981.
 M. Berger: *Geometry I*, Springer, Berlin, 2004.
 M. Berger: *Geometry II*, Springer, Berlin, 1996.
 E. G. Rees: *Notes on Geometry*, Springer, Berlin-New York, 2005.
 R. A. Rosenbaum: *Introduction to Projective Geometry and Modern Algebra*, Addison-Wesley, Reading, 1963.

Cilji in kompetence:

Študent spozna osnovne pojme afine in projektivne geometrije. Pri tem uporablja že znana orodja iz algebre in linearne algebre. Razvije geometrijsko intuicijo.

Objectives and competences:

The main objective is to introduce affine and projective geometry using the tools from algebra and linear algebra. The student develops geometric intuition.

Predvideni študijski rezultati:

Znanje in razumevanje: Razumevanje osnovnih pojmov afine in projektivne geometrije. Sposobnost povezovanja znanj iz algebre in analize v uporabi pri geometriji.
 Uporaba: Uporaba geometrijskih tehnik pri drugih predmetih in reševanju praktičnih problemov.
 Refleksija: Sposobnost povezovanja različnih pristopov: analitičnega, algebraičnega in geometričnega.
 Prenosljive spretnosti – niso vezane le na en predmet: Spretnost prenosa teorije v uporabo.

Intended learning outcomes:

Knowledge and understanding: The understanding of the fundamental notions of affine and projective geometry. The ability to apply the knowledge obtained in algebra and mathematical analysis courses in geometry.
 Application: The application of geometric techniques in other subjects and in practice.
 Reflection: The ability to connect different approaches: analytical, algebraic and geometric.
 Transferable skills: The ability to apply theoretical knowledge in practice.

Metode poučevanja in učenja:

Predavanja, vaje, konzultacije

Learning and teaching methods:

Lectures, exercises, consultations

Načini ocenjevanja:**Delež/Weight****Assessment:**

| | | |
|---|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj | 50,00 % | 2 midterm exams instead of written exam, written exam |
| izpit iz teorije | 50,00 % | oral exam |
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

Tomaž Košir:
 – KOŠIR, Tomaž. Root vectors for geometrically simple multiparameter eigenvalues. *Integral equations and operator theory*, ISSN 0378-620X, 2004, vol. 48, no. 3, str. 365-396 [COBISS.SI-ID 12895321]
 – BINDING, Paul, KOŠIR, Tomaž. Root vectors for geometrically simple two-parameter eigenvalues. *Transactions of the American Mathematical Society*, ISSN 0002-9947, 2004, vol. 356, no. 5, str. 1705-1726 [COBISS.SI-ID 13013081]
 – BUCKLEY, Anita, KOŠIR, Tomaž. Plane curves as Pfaffians. *Annali della Scuola normale superiore di Pisa, Classe di scienze*, ISSN 0391-173X, 2011, vol. 10, iss. 2, str. 363-388 [COBISS.SI-ID 15928409]
 Aleš Vavpetič:
 – VAVPETIČ, Aleš, VIRUEL, Antonio. Symplectic groups are N-determined 2-compact groups. *Fundamenta mathematicae*, ISSN 0016-2736, 2006, vol. 192, no. 2, str. 121-139 [COBISS.SI-ID 14185305]
 – CENCELJ, Matija, DYDAK, Jerzy, MITRA, Atish, VAVPETIČ, Aleš. Hurewicz-Serre theorem in extension theory. *Fundamenta mathematicae*, ISSN 0016-2736, 2008, vol. 198, no. 2, str. 113-123 [COBISS.SI-ID 14551385]

- VAVPETIČ, Aleš. Afina in projektivna geometrija. Ljubljana: samozal. A. Vavpetič, 2011. VI, 114 str., ilustr [COBISS.SI-ID 15994969]
- CENCELJ, Matija, DYDAK, Jerzy, VAVPETIČ, Aleš, VIRK, Žiga. A combinatorial approach to coarse geometry. *Topology and its Applications*, ISSN 0166-8641. [Print ed.], 2012, vol. 159, iss. 3, str. 646-658 [COBISS.SI-ID 16094809]

ALGEBRAIČNE KRIVULJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|----------------------|
| Predmet: | Algebraične krivulje |
| Course title: | Algebraic Curves |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039565 |
| Koda učne enote na članici/UL Member course code: | 27218 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: izr. prof. dr. Pavle Saksida, Jakob Cimprič, Tomaž Košir

Vrsta predmeta/Course type: izbirni predmet/elective course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|----------------------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Opravljen predmet Linearna algebra. | Completed course Linear algebra. |

| | |
|--|--|
| Vsebina: | Content (Syllabus outline): |
| Afine algebraične krivulje. Nerazcepnost in povezanost. Projektivno zaprtje. Presečna večkratnost med krivuljo in premico. Bezouteva lema. Tangente. Singularnosti. Polare in Hessove krivulje. Dualna krivulja. Plückerjeva formula. Racionalne krivulje. Stožnice. Kubične krivulje. Izrek o rodu in stopnji nesingularne krivulje. | Affine algebraic curves. Irreducibility and connectedness. Projectivization. Multiplicity of intersection between a line and a curve. Bezout lemma. Tangents. Singularity. Polars and Hess curves. Dual curve. Plücker formula. Rational curves, Conics. Cubic curves. Degree-genus formula for nonsingular curves. |

Temeljna literatura in viri/Readings:

G. Fisber: *Plane Algebraic Curves*, AMS, Providence, 2001.
C. G. Gibson: *Elementary Geometry of Algebraic Curves*, Cambridge Univ. Press, Cambridge, 1998.
M. Reid: *Undergraduate Algebraic Geometry*, Cambridge Univ. Press, Cambridge, 1988.
K. Hulek: *Elementary Algebraic Geometry*, AMS, Providence, 2003.
F. Kirwan: *Complex Algebraic Curves*, Cambridge Univ. Press, Cambridge, 1992.

| | |
|--|--|
| Cilji in kompetence: | Objectives and competences: |
| Je eden od treh osnovnih predmetov, pri katerem študent spozna geometrijski način razmišljanja. Osnovni cilj je spoznati temeljne pojme in lastnosti algebraičnih krivulj. | This is one of the three basic courses in which students learn to think geometrically. The basic goal is to understand the basic definitions and properties of algebraic curves. |

| | |
|---|--|
| Predvideni študijski rezultati: | Intended learning outcomes: |
| Znanje in razumevanje: Razumevanje povezave med algebraičnimi enačbami in geometrijskimi objekti. Sposobnost obravnave geometrijskih objektov s pomočjo orodij iz teorije polinomov. Poznavanje in razumevanje osnovnih pojmov in definicij iz teorije algebraičnih krivulj in algebraične geometrije. Uporaba: Algebraični opis objektov, ki se pojavljajo pri problemih v drugih vejah matematike in njene uporabe. Uporaba algebraično-geometrijskih sredstev pri obravnavi teh problemov. Refleksija: Dojemanje istih objektov (krivulj) z različnih aspektov. Razvijanje geometrijskega razmišljanja pri reševanju problemov iz prakse. Prenosljive spretnosti – niso vezane le na en predmet: Formulacija problemov v primernem jeziku, reševanje in analiza doseženega na primerih. Ker je za razumevanje predmeta potrebno solidno obvladovanje nekaterih vsebin iz analize in linearne algebre, se študent nauči uporabljati znanje, pridobljeno pri drugih predmetih. Nauči se tudi spretnosti uporabe tuje literature. | <p>Knowledge and understanding: Understanding the relation between the algebraic equations and the geometric objects. Ability of treating some geometric problems by means of tools, coming from the theory of polynomials. Knowledge and understanding of the fundamental concepts of the theory of algebraic curves and algebraic geometry.</p> <p>Application: Algebraic description of objects, appearing in problems from other areas of mathematics and its applications. Application of algebro-geometric methods in the treatment of such problems.</p> <p>Reflection: Ability of perceiving mathematical object from different points of view. Development of the geometric approach to solving problems in applicative mathematics.</p> <p>Transferable skills: Formulation of problems in suitable contexts, evaluation of developed tools in concrete examples. This course demands a firm knowledge of certain chapters from mathematical analysis and algebra. Therefore students learn how to use previously acquired knowledge in new situations. Students learn the use of study literature in foreign languages.</p> |

| | |
|-------------------------------------|---------------------------------------|
| Metode poučevanja in učenja: | Learning and teaching methods: |
| Predavanja, vaje, konzultacije | Lectures, exercises, consultations |

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|---|---------------------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj | 50,00 % | 2 midterm exams instead of written exam, written exam |
| izpit iz teorije | 50,00 % | oral exam |
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |

| |
|---|
| Reference nosilca/Lecturer's references: |
| <p>Tomaž Košir:</p> <ul style="list-style-type: none"> – GRUNENFELDER, Luzius, KOŠIR, Tomaž. Koszul cohomology for finite families of comodule maps and applications. Communications in algebra, ISSN 0092-7872, 1997, let. 25, št. 2, str. 459-479 [COBISS.SI-ID 7127641] – GRUNENFELDER, Luzius, KOŠIR, Tomaž. Coalgebras and spectral theory in one and several parameters. V: GOHBERG, I. (ur.), LANCASTER, P. (ur.), SHIVAKUMAR, P. N. (ur.). Recent developments in operator theory and its applications : International Conference in Winnipeg, October 2-6, |

1994, (Operator theory, ISSN 0255-0156, vol. 87). Basel, Boston, Berlin: Birkhäuser, cop. 1996, str. 177-192 [COBISS.SI-ID 7436889]

– GRUNENFELDER, Luzius, GURALNICK, Robert M., KOŠIR, Tomaž, RADJAVI, Heydar. Permutability of characters on algebras. Pacific journal of mathematics, ISSN 0030-8730, 1997, let. 178, št. 1, str. 63-70 [COBISS.SI-ID 7437145]

Pavle Saksida:

– SAKSIDA, Pavle. Nahm's equations and generalizations Neumann system. Proceedings of the London Mathematical Society, ISSN 0024-6115, 1999, let. 78, št. 3, str. 701-720 [COBISS.SI-ID 8853849]

– SAKSIDA, Pavle. Integrable anharmonic oscillators on spheres and hyperbolic spaces. Nonlinearity, ISSN 0951-7715, 2001, vol. 14, no. 5, str. 977-994 [COBISS.SI-ID 10942809]

– SAKSIDA, Pavle. Neumann system, spherical pendulum and magnetic fields. Journal of physics. A, Mathematical and general, ISSN 0305-4470, 2002, vol. 35, no. 25, str. 5237-5253 [COBISS.SI-ID 11920217]

Jakob Cimprič:

- CIMPRič, Jaka, HELTON, J. William, MCCULLOUGH, Scott, NELSON, Christopher. A noncommutative real nullstellensatz corresponds to a noncommutative real ideal: algorithms. Proceedings of the London Mathematical Society. 2013, vol. 106, iss. 5, str. 1060-1086. ISSN 0024-6115.

<http://dx.doi.org/10.1112/plms/pds060>. [COBISS.SI-ID 16636249]

- CIMPRič, Jaka. Prime and semiprime submodules of R^n and a related Nullstellensatz for $M_n(R)$. Journal of algebra and its applications. Nov. 2022, vol. 21, no. 11, art. 2250217 (11 str.). ISSN 0219- 4988.

<https://www.worldscientific.com/doi/10.1142/S0219498822502176>, DOI: 10.1142/S0219498822502176.

[COBISS.SI-ID 142463235]

- CIMPRič, Jaka. Matrix versions of real and quaternionic Nullstellensätze. Journal of algebra. Nov. 2022, vol. 610, str. 752-772. ISSN 0021-8693. <https://www.sciencedirect.com/science/article/pii/S0021869322003659>, DOI: 10.1016/j.jalgebra.2022.06.038. [COBISS.SI-ID 139324931]

ALGORITMI IN PODATKOVNE STRUKTURE 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-------------------------------------|
| Predmet: | Algoritmi in podatkovne strukture 1 |
| Course title: | Algorithms and data structures 1 |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 2. letnik | 1. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 2. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039586 |
| Koda učne enote na članici/UL Member course code: | 63279 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Tomaž Hočevar

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

| | |
|--|---------------------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Poznavanje osnov programiranja. | Knowledge of basic programming. |

| | |
|---|---|
| Vsebina: | Content (Syllabus outline): |
| Predavanja: <ul style="list-style-type: none">• modeli računanja, računska zahtevnost• urejanje• abstraktni podatkovni tipi• drevesne strukture• požrešni algoritmi• grafi, minimalna vpeta drevesa• najkrajše poti• deli in vladaj• dinamično programiranje• računska geometrija• reševanje težkih problemov Sprotno delo (vaje in domače naloge): | Lectures: <ul style="list-style-type: none">• models of computation, computational complexity• sorting• abstract data types• tree data structures• greedy algorithms• graphs, minimum spanning trees• shortest paths• divide and conquer• dynamic programming• computational geometry• solving hard problems Tutorials and homeworks: |

| | |
|--|--|
| Na vajah bodo študenti utrjevali snov, ki so jo obravnavali na predavanjih, tako da jo bodo uporabili pri reševanju praktičnih problemov. Pri tem bodo poudarki na samostojnem delu študentov ob pomoči asistentov. Na vajah bodo študenti implementirali rešitve kratkih nalog, s katerimi bodo opravili sprotno delo in pridobili pravico pristopa k izpitu. | Practical applications of the knowledge gained through lectures. The emphasis is on the autonomous work of students with the help of assistants. During tutorials, students will implement solutions of various short problems. With successful solutions they will pass their continuous study and can take the exam. |
|--|--|

Temeljna literatura in viri/Readings:

| |
|--|
| <ul style="list-style-type: none"> Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). Introduction to algorithms. MIT press. Sedgewick R. & Wayne K. (2011). Algorithms fourth edition. AddisonWesley Aho A. V. Hopcroft J. E. & Ullman J. D. (1983). Data structures and algorithms. AddisonWesley. Kononenko, I., Robnik Šikonja, M., & Bosnić, Z. (2008). Programiranje in algoritmi. Fakulteta za računalništvo in informatiko. |
|--|

Cilji in kompetence:

Cilj predmeta je spoznavanje osnovnih principov načrtovanja in analize algoritmov in podatkovnih struktur. Pri tem študenti razvijajo svoje zmožnosti analitičnega in kritičnega razmišljanja. V povezavi z obstoječim znanjem programiranja osvojijo potrebno znanje za učinkovito reševanje tehničnih in znanstvenih problemov v računalništvu in informatiki.

Objectives and competences:

The goal of the course is to learn the basic principles of design and analysis of algorithms and data structures. Students develop their analytical and critical thinking skills in the process. Combined with their prior knowledge of programming, they acquire the necessary knowledge for efficiently solving technical and scientific problems in computer and information science.

Predvideni študijski rezultati:

Po uspešno zaključenem predmetu naj bi bili študenti zmožni:

- Uporabiti osnovne podatkovne strukture in algoritme v razvoju programov.
- Prilagoditi znane algoritme in podatkovne strukture za reševanje podobnih problemov.
- Razlikovati med različno učinkovitimi rešitvami istega problema.
- Načrtovati učinkovite rešitve zastavljenega problema z uporabo primernih podatkovnih struktur in algoritmov.
- Utemeljiti in zagotoviti pravilnost ter učinkovitost razvitega algoritma.
- Uporabiti naučene algoritmične koncepte v poljubnem programskem jeziku.

Intended learning outcomes:

After successfully completing the course, students should be able to:

- Use the basic data structures and algorithms in the development of computer programs.
- Adapt wellknown algorithms and data structures for solving similar problems.
- Differentiate between solutions of a given problem with different efficiencies.
- Design efficient solutions with the use of appropriate data structures and algorithms.
- Justify and ensure the correctness and efficiency of a developed algorithm .
- Use the learned algorithmic concepts in an arbitrary programming language.

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge. Poudarek je na sprotne študiju in na samostojnem delu.

Learning and teaching methods:

Lectures, tutorials, homeworks,. The emphasis is on continuous study and on autonomous work.

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|---|--------------|---|
| Sprotne preverjanje (vaje, domače naloge) | 50,00 % | Continuing (tutorials, homeworks) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statuom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

- Hočevar, T., Brodnik, A., & Munro, J. I. (2018). Sosednost vozlišč v hipergrafih. *Elektrotehniški Vestnik*, 85(5), 224-228
- Hočevar, T. (2018). Counting small patterns in networks
- Hočevar, T., & Demšar, J. (2017). Combinatorial algorithm for counting small induced graphs and orbits. *PLoS one*, 12(2)
- Hočevar, T., & Demšar, J. (2016). Computation of graphlet orbits for nodes and edges in sparse graphs. *Journal of Statistical Software*, 71, 1-24
- Hočevar, T., & Demšar, J. (2014). A combinatorial approach to graphlet counting. *Bioinformatics*, 30(4), 559-565

ALGORITMI IN PODATKOVNE STRUKTURE 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-------------------------------------|
| Predmet: | Algoritmi in podatkovne strukture 2 |
| Course title: | Algorithms and data structures 2 |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 2. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039587 |
| Koda učne enote na članici/UL Member course code: | 63280 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Borut Robič

Vrsta predmeta/Course type: obvezni predmet / compulsory course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|-----------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| | |

Vsebina:

- Predavanja:**
- Uvod: splošno o metodah razvoja algoritmov, o analizi algoritmov, o računski zahtevnosti algoritmov in problemov
 - Deli in vladaj: opis metode, primeri problemov in algoritmov (glejte primere v točki 12 spodaj)
 - Požrešna metoda: opis metode, primeri
 - Postopno izboljševanje: opis, primeri
 - Dinamično programiranje: opis, primeri
 - Sestopanje: opis metode, primeri
 - Razveji in omeji: opis metode, primeri
 - Linearno programiranje: opis metode, simpleksni algoritem, primeri
 - Izbrane višje podatkovne strukture

Content (Syllabus outline):

- Lectures:**
- Intro: about methods of algorithm design, analysis of algorithms, and computational complexity of algorithms and problems
 - Divide-and-Conquer: description of the method, examples of problems and algorithms (see examples 12 below)
 - Greedy method: description, examples
 - Iterative improvement: descr., examples
 - Dynamic programming: descr., examples
 - Backtracking: description, examples
 - Branch&Bound: description, examples
 - Linear programming: descr., Simplex algorithm, examples
 - Selected advanced data structures

| | |
|--|---|
| <p>10. NP-težki računski problemi: spodnja meja časovne zahtevnosti, intuitivno o razredih P, NP in NP-težkih problemih</p> <p>11. Metode reševanja NP-težkih problemov: hevristični algoritmi, aproksimacijski algoritmi, verjetnostni algoritmi, parametrizirani algoritmi, eksaktni eksponentni algoritmi, primeri</p> <p>12. <i>Primeri problemov in algoritmov</i>: napredno urejanje & Heapsort, Quicksort; problem izbiranja & linearni algoritmi; matrično množenje & Strassenov alg.; diskretna Fourierova transformacija & FFT alg., iskanje v nizih & Knuth-Morris-Prattov algoritem; osnovni in zahtevnejši problemi in algoritmi na grafih (iskanje v grafu; topološko urejanje; maksimalni pretok & Ford-Fulkersonov alg.; najkrajše poti & Bellman-Fordov ter Floyd-Warshallov alg.); izbrani problemi iz računske geometrije.</p> <p>Vaje: Na vajah bodo študentje utrjevali snov, podano na predavanjih. Snov bodo uporabili za reševanje praktičnih problemov, pri čemer bo poudarek na samostojnem delu ob pomoči asistentov. Implementirali bodo več manjših programov (kot domače naloge) in obsežnejše programe (kot seminarske naloge), ki jih bodo zagovarjali na vajah.</p> <p>Domače in seminarske naloge: Namen domačih in seminarskih nalog je dati študentom priložnost za reševanje raznih računskih problemov s samostojnim razvojem algoritmov in njihovim programiranjem (in jih spodbuditi k sprotnemu študiju).</p> | <p>10. NP-hard computational problems: lower bounds on time complexity, informally about P, NP and NP-hard problems;</p> <p>11. Methods of solving NP-hard problems: heuristic algorithms, approximation algorithms, randomized algorithms, parameterized algorithms, exact exponential algorithms, examples</p> <p>12. <i>Example problems and algorithms</i>: advanced sorting & Heapsort, Quicksort; selection problem & linear algorithms; matrix multiplication & Strassen alg.; Discrete Fourier Transformation & FFT alg; string matching & Knuth-Morris-Pratt; elementary and other graph problems and algorithms (searching a graph; topological sort; maximum flow & Ford-Fulkerson alg.; shortest paths & algorithms of Bellman-Ford, and Floyd-Warshall); selected problems from computational geometry.</p> <p>Tutorial: Students will use the topics given during the lectures to independently solve practical problems (with the assistance of the TAs if needed). They will implement several smaller programs (home works) as well as larger programs (seminars), and present them at the tutorial.</p> <p>Home works and seminars: These are necessary for a student to independently practice the design and implementation of algorithms .</p> |
|--|---|

Temeljna literatura in viri/Readings:

B. Robič: *Algoritmi* (to appear, instead of 2. below)
 B. Vilfan: *Osnovni algoritmi*, Založba FE in FRI, 2002

Dodatna literatura:

T. Cormen et al. *Introduction to Algorithms*, McGraw-Hill, 3rd ed., 2009
 B. Robič: *Aproksimacijski algoritmi*, Založba FE in FRI, 2. izdaja, 2009

Cilji in kompetence:

Cilj predmeta je pridobiti poglobljeno znanje s področij načrtovanja algoritmov, analize algoritmov, uporabe podatkovnih struktur, izbranih problemov in algoritmov ter ob vsem tem utrjevati in poglobljati znanje programiranja.

Objectives and competences:

To gain deeper knowledge of algorithm design methods, analysis of algorithms, use of data structures, selected problems and algorithms, and at the same time, to improve and deepen programming skills.

Predvideni študijski rezultati:

Študent bo po opravljenem predmetu:

- poznal razvoj algoritmov, analizo algoritmov in osnovne razrede zahtevnosti;
- sposoben razvijati alg. z metodo deli in vladaj, s požrešno metodo, z metodo dinamičnega programiranja, z metodo sestopanja ter z metodo razveji in omeji;
- sposoben prepoznati probleme kot linearne programe, rešljive s simpleksnim algoritmom;

Intended learning outcomes:

After completing the course the student will:

- know how to design and analyse algorithms and understand the basic complexity classes;
- be able to design algorithms using the methods divide and conquer, greedy method, dynamic programming, backtracking, branch and bound;
- be able to recognize problems definable as linear programs and solvable with simplex alg.

| | |
|---|--|
| <p>-- poznal učinkovite alg. za probleme iskanja, linearne algebre, Fourierove transformacije, kombinatorične optimizacije in iskanja vzorcev.</p> <p>-- sposoben samostojnega načrtovanja alg. in ustreznih podatkovnih struktur, in analiziranja njihove zahtevnosti;</p> <p>-- poznal osnovne pojme o NP-težkih problemih in metodah njihovega reševanja.</p> <p>Uporaba: Uporaba naučenih principov pri načrtovanju algoritmov in njihovem programiranju.</p> <p>Refleksija: Razumevanje osnovnih principov načrtovanja algoritmov in razumevanje njihove vloge pri reševanju računskih problemov.</p> <p>Prenosljive spretnosti - niso vezane le na en predmet: Zmožnost načrtovanja učinkovite oz. primerne algoritmične rešitve različnih problemov, zmožnost uporabe naučenih principov pri programiranju rešitve (ne glede na izbrani programski jezik).</p> | <p>-- understand efficient algorithms for problems of searching, linear algebra, Fourier transform, combinatorial optimiz. and pattern matching;</p> <p>-- be capable to design algorithms and data structures for various problems and analyse their complexities;</p> <p>-- know the basics of NP-hard problems and the methods for solving them.</p> <p>Application: use of the principles and methods in algorithm design and implementation</p> <p>Reflection: understanding of the basic principles of algorithm design and their role in efficient solving of computational problems</p> <p>Transferable skills: there are many and useful in other subjects. For example, the ability to plan, design, and implement algorithmic solutions to various problems (regardless of the programming language used)</p> |
|---|--|

| | |
|--|---|
| <p>Metode poučevanja in učenja:</p> <p>Predavanja, domače naloge, seminarski način dela pri vajah. Poudarek je na sprotnem študiju in samostojnem delu pri vajah, seminarskih in domačih nalogah.</p> | <p>Learning and teaching methods:</p> <p>Lectures, tutorial, home works, seminars.</p> |
|--|---|

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|---|
| Način: pisni izpit, ustno izpraševanje, naloge, projekt | | Type: exam, oral, coursework, project |
| Sprotno preverjanje: domače naloge, projektno delo | 50,00 % | Continuing: homework, project work |
| Končno preverjanje: pisni in ustni izpit | 50,00 % | Final: written and oral exam |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

| |
|---|
| <p>Reference nosilca/Lecturer's references:</p> <p>ČIBEJ, U., SLIVNIK, B., ROBIČ, B. The complexity of static data replication in data grids. <i>Parallel comput.</i> 31(8/9):[900]-912, 2005.</p> <p>SULISTIO, A., ČIBEJ, U., VENUGOPAL, S., ROBIČ, B., BUYYA, R.. A toolkit for modelling and simulating data Grids : an extension to GridSim. <i>Concurr. comput.</i> 20(13):1591-1609, 2008.</p> <p>TROBEC, R., ŠTERK, M., ROBIČ, B. Computational complexity and parallelization of the meshless local Petrov-Galerkin methods. <i>Comput. struct.</i> 87(1/2):81-90, 2009.</p> <p>MIHELIČ, J., ROBIČ, B. Flexible-attribute problems. <i>Comput. Optimiz. appl.</i> 47(3):553-566, 2010.</p> <p>MIHELIČ, J., MAHJOUN, A., RAPINE, C., ROBIČ, B. Two-stage flexible-choice problems under uncertainty. <i>Eur. J. Oper. Res.</i> 201(2):399-403, 2010</p> <p>Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=5202.</p> |
|---|

ANALIZA 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|-----------------------------------|------------|
| Predmet: | Analiza 1 |
| Course title: | Analysis 1 |
| Članica nosilka/UL Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 1. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039511 |
| Koda učne enote na članici/UL Member course code: | 27201 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|----------------------|------------------|-----------------|-----------------------------------|--|--|------|
| 45 | | 45 | | | 120 | 7 |

Nosilec predmeta/Lecturer: Janez Mrčun, Oliver Dragičević, Sašo Strle

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

Uvod: naravna števila in matematična indukcija, realna števila, kompleksna števila, zaporedja, stekališča in limite.
Številске vrste: vrste realnih in kompleksnih števil, absolutna in pogojna konvergenca, testi za konvergenco, alternirajoče vrste.
Funkcije ene spremenljivke: zveznost in limita, lastnosti zveznih funkcij, elementarne funkcije.
Odvodi funkcij ene spremenljivke: definicija in geometrijski pomen odvoda, pravila za računanje, odvodi elementarnih funkcij, lastnosti odvedljivih funkcij, uporaba odvoda (risanje grafov, računanje limit, ekstremi), Taylorjev izrek, Taylorjeva vrsta.
Integral: nedoločeni integral, osnovna pravila za računanje, določeni integral, zveza med določenim in nedoločenim integralom, posplošeni integral, uporaba integrala.

Content (Syllabus outline):

Introduction: natural numbers and mathematical induction, real numbers, complex numbers, sequences, accumulation points and limits. Series: series of real and complex numbers, absolute and conditional convergence, convergence tests, alternating series.
Functions of one variable: continuity and the limit, properties of continuous functions, elementary functions.
Derivatives of functions of one variable: definition of the derivative and its geometric meaning, differentiation rules, derivatives of elementary functions, properties of differentiable functions, applications of the derivative (drawing graphs, calculating limits, extrema), Taylor's theorem, Taylor's series.

| | |
|--|---|
| | Integral: indefinite integral, basic rules for calculating integrals, definite integral, connection between a definite and an indefinite integral, generalized integrals, application of integrals. |
|--|---|

Temeljna literatura in viri/Readings:

| |
|--|
| <p>Ivan Vidar: <i>Višja matematika I</i>, Ljubljana: DMFA-založništvo, 1994.</p> <p>Gabrijel Tomšič, Bojan Orel, Neža Mramor Kosta: <i>Matematika I</i>, Ljubljana: Založba FE in FRI, 2001.</p> <p>Neža Mramor Kosta, Borut Jurčič Zlobec: <i>Zbirka nalog iz matematike I</i>, Ljubljana: Založba FE in FRI, 2001.</p> <p>Pavlina Mizori-Oblak: <i>Matematika za študente tehnike in naravoslovja, Del 1</i>. Ljubljana: Fakulteta za strojništvo, 1991.</p> <p>James Stuart: <i>Calculus</i>, Brooks/Cole Publishing Company, 1999.</p> <p>M. H. Protter, C. B. Morrey, <i>Intermediate Calculus</i>. Springer-Verlag, New York-Heidelberg, 1985.</p> <p>W. Rudin, <i>Principles of mathematical analysis</i>. McGraw-Hill, Auckland, 1976.</p> |
|--|

Cilji in kompetence:

| | |
|---|---|
| <p>Študent spozna osnovne pojme matematične analize, kot so limita zaporedja, številske vrste, zveznost, odvod funkcije ene realne spremenljivke, Taylorjeva vrsta, integral funkcije ene realne spremenljivke. Analiza 1 sodi med temeljne predmete pri študiju matematike in računalništva.</p> | <h3>Objectives and competences:</h3> <p>The student learns about the basic concepts of mathematical analysis, such as the limit of a sequence, numerical series, continuity, the derivative of a function of one real variable, Taylor series, an integral of a function of one real variable. Analysis 1 is one of the fundamental courses within the study of mathematics and computer science.</p> |
|---|---|

Predvideni študijski rezultati:

| | |
|--|--|
| <p>Znanje in razumevanje: Poznavanje in razumevanje osnovnih pojmov, definicij in izrekov.</p> <p>Uporaba: Analiza 1 sodi med temeljne predmete študijskega programa. Razumevanje snovi predmeta je nepogrešljivo pri mnogih drugih matematičnih in računalniških predmetih na programu.</p> <p>Refleksija: Razumevanje teorije na podlagi uporabe.</p> <p>Prenosljive spretnosti - niso vezane le na en predmet: Spretnosti uporabe domače in tuje literature in drugih virov, identifikacija in reševanje problemov, kritična analiza.</p> | <h3>Intended learning outcomes:</h3> <p>Knowledge and understanding: Knowledge and understanding of basic notions, definitions and theorems.</p> <p>Application: Analysis 1 is one of the fundamental courses of the program. Understanding of the material of this course is indispensable for many other mathematics and computer science courses of the program.</p> <p>Reflection: Understanding the theory from the applications.</p> <p>Transferable skills: Skills in using the literature and other sources, the ability to identify and solve the problem, critical analysis.</p> |
|--|--|

Metode poučevanja in učenja:

| | |
|------------------------------------|---|
| Predavanja in vaje, domače naloge. | Learning and teaching methods: Lectures and tutorial sessions, homework. |
|------------------------------------|---|

Načini ocenjevanja:

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|---|--------------|--|
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj, | 50,00 % | 2 midterm exams instead of written exam, written exam, |
| ustni izpit / izpit iz teorije. | 50,00 % | oral exam / theoretical test. |
| 6-10 (pozitivno), in 5 (negativno) (po Statutu UL). | | 6-10 (pass), 5 (fail) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

| |
|---|
| <p>Janez Mrčun: – MOERDIJK, Ieke, MRČUN, Janez. On integrability of infinitesimal actions. American journal of mathematics, ISSN 0002-9327, 2002, vol. 124, no. 3, str. 567-593 [COBISS.SI-ID 11700057]</p> |
|---|

- MRČUN, Janez. On isomorphisms of algebras of smooth functions. Proceedings of the American Mathematical Society, ISSN 0002-9939, 2005, vol. 133, no. 10, str. 3109-3113 [COBISS.SI-ID 13782361]
- MOERDIJK, Ieke, MRČUN, Janez. On the developability of Lie subalgebroids. Advances in mathematics, ISSN 0001-8708, 2007, vol. 210, no. 1, str.1-21 [COBISS.SI-ID 14209881]

Sašo Strle:

- CHA, Jae Choon, KIM, Taehee, RUBERMAN, Daniel, STRLE, Sašo. Smooth concordance of links topologically concordant to the Hopf link. Bulletin of the London Mathematical Society, ISSN 0024-6093, 2012, vol. 44, iss. 3, str. 443-450 [COBISS.SI-ID 16807769]
- OWENS, Brendan, STRLE, Sašo. Dehn surgeries and negative-definite four-manifolds. Selecta mathematica. New series, ISSN 1022-1824, 2012, vol. 18, iss. 4, str. 839-854 [COBISS.SI-ID 16808025]
- RUBERMAN, Daniel, STRLE, Sašo. Concordance properties of parallel links. Indiana University mathematics journal, ISSN 0022-2518, 2013, vol. 62, no. 3, str. 799-814 [COBISS.SI-ID 16946265]

Oliver Dragičević:

- DRAGIČEVIĆ, Oliver, VOLBERG, Alexander. Linear dimension-free estimates in the embedding theorem for Schrödinger operators. Journal of the London Mathematical Society, ISSN 0024-6107, 2012, vol. 85, p. 1, str. 191-222. [COBISS-SI-ID 16214873]
- DRAGIČEVIĆ, Oliver, VOLBERG, Alexander. Bilinear embedding for real elliptic differential operators in divergence form with potentials. Journal of functional analysis, ISSN 0022-1236, 2011, vol. 261, iss. 10, str. 2816-2828. [COBISS-SI-ID 16051545]
- DRAGIČEVIĆ, Oliver. Weighted estimates for powers of the Ahlfors-Beurling operator. Proceedings of the American Mathematical Society, ISSN 0002-9939, 2011, vol. 139, no. 6, str. 2113-2120. [COBISS-SI-ID 15876697]

ANALIZA 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------|
| Predmet: | Analiza 2 |
| Course title: | Analysis 2 |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 1. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039512 |
| Koda učne enote na članici/UL Member course code: | 27204 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 45 | | | 120 | 7 |

Nosilec predmeta/Lecturer: Barbara Drinovec Drnovšek, Janez Mrčun, Sašo Strle

Vrsta predmeta/Course type: obvezni predmet/compulsory course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|-----------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| | |

Vsebina:

Podmnožice v Evklidskih prostorih.
Funkcije več spremenljivk, nivojske krivulje in nivojske ploskve, zveznost.
Odvod funkcij več spremenljivk: parcialni odvodi, gradient in smerni odvod, totalni diferencial in tangenti prostor, Taylorjeva formula, lokalni ekstremi in vezani ekstremi, izrek o implicitni funkciji.
Osnove krivulj in ploskev: podajanje krivulj in ploskev (eksplicitno, implicitno, parametrično, polarno), tangenta na krivuljo, risanje krivulj, dolžina loka.
Funkcijske vrste, enakomerna konvergenca, odvajanje in integriranje vrst po členih, potenčne vrste, Taylorjeva vrsta.
Osnove diferencialnih enačb: diferencialne enačbe 1. reda (ločljive, eksaktne, linearne), linearne diferencialne enačbe višjih redov.

Content (Syllabus outline):

Subsets of Euclidean spaces.
Differential calculus of several variables: partial derivatives, gradient and directional derivative, total differential and tangent space, Taylor's formula, local extrema and constrained extrema, implicit function theorem.
Basics of curves and surfaces: descriptions of curves and surfaces (explicit, implicit, parametric, polar coordinates), tangent to a curve, drawing of curves, arc length.
Function series: uniform convergence, differentiation and integration of series of functions, power series, Taylor series.
Elementary differential equations: differential equations of first order (separable, exact, linear), linear differential equations of higher order.

| | |
|--|---|
| Sistemi diferencialnih enačb: obstoj in enoličnost rešitev, struktura prostora rešitev, linearni sistemi s konstantnimi koeficienti. | Systems of differential equations: existence and uniqueness of solutions, structure of the space of solutions, linear systems with constant coefficients. |
|--|---|

Temeljna literatura in viri/Readings:

| |
|---|
| <p>Ivan Vidav: Višja matematika I, Ljubljana: DMFA-založništvo, 1994. Sašo Strle: Analiza 1: za študente finančne matematike. DMFA - založništvo, 2021. Gabrijel Tomšič, Neža Mramor Kosta, Bojan Orel: Matematika II, Ljubljana: Založba FE in FRI, 2005. Neža Mramor Kosta, Borut Jurčič Zlobec: Zbirka nalog iz matematike II, Ljubljana: Založba FE in FRI, 2004. Pavlina Mizori-Oblak: Matematika za študente tehnike in naravoslovja, Del 2. Ljubljana: Fakulteta za strojništvo, 1997. James Stuart: Calculus, Brooks/Cole Publishing Company, 1999. Walter Rudin: Principles of mathematical analysis. McGraw-Hill, Auckland, 1976.</p> |
|---|

Cilji in kompetence:

| | |
|--|--|
| <p>Študent spozna osnovne pojme matematične analize, kot so funkcije več realnih spremenljivk in funkcijske vrste ter spozna osnovne metode reševanja diferencialnih enačb in sistemov linearnih diferencialnih enačb. Analiza 2 sodi med temeljne predmete pri študiju matematike in računalništva.</p> | <p>Objectives and competences: Student learns basic concepts of mathematical analysis such as functions of many real variables, function series, and the basic methods for solving differential equations and systems of linear differential equations. Analysis 2 is one of the fundamental courses of the study of mathematics and computer science.</p> |
|--|--|

Predvideni študijski rezultati:

| | |
|--|---|
| <p>Znanje in razumevanje: Poznavanje in razumevanje osnovnih pojmov, definicij in izrekov. Uporaba: Analiza 2 sodi med temeljne predmete študijskega programa. Razumevanje snovi predmeta je nepogrešljivo pri mnogih drugih matematičnih in računalniških predmetih na programu. Refleksija: Razumevanje teorije na podlagi uporabe. Prenosljive spretnosti - niso vezane le na en predmet: Spretnosti uporabe domače in tuje literature in drugih virov, identifikacija in reševanje problemov, kritična analiza.</p> | <p>Intended learning outcomes: Knowledge and understanding: Knowledge and understanding of basic notions, definitions and theorems. Application: Analysis 2 is one of the fundamental courses of the program. Understanding of the material of this course is indispensable for many other mathematics and computer science courses of the program. Reflection: Understanding the theory from the applications. Transferable skills: Skills in using the literature and other sources, the ability to identify and solve the problem, critical analysis.</p> |
|--|---|

Metode poučevanja in učenja:

| | |
|------------------------------------|--|
| Predavanja in vaje, domače naloge. | Learning and teaching methods: Lectures and tutorial sessions, homework. |
|------------------------------------|--|

Načini ocenjevanja:

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|---|--------------|--|
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj, | 50,00 % | 2 midterm exams instead of written exam, written exam, |
| ustni izpit / izpit iz teorije. | 50,00 % | oral exam / theoretical test. |
| 6-10 (pozitivno), in 5 (negativno) (po Statutu UL). | | 6-10 (pass), 5 (fail) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

| |
|---|
| <p>Janez Mrčun: – MOERDIJK, Ieke, MRČUN, Janez. On integrability of infinitesimal actions. American journal of mathematics, ISSN 0002-9327, 2002, vol. 124, no. 3, str. 567-593 [COBISS.SI-ID 11700057] – MRČUN, Janez. On isomorphisms of algebras of smooth functions. Proceedings of the American Mathematical Society, ISSN 0002-9939, 2005, vol. 133, no. 10, str. 3109-3113 [COBISS.SI-ID 13782361]</p> |
|---|

– MOERDIJK, Ieke, MRČUN, Janez. On the developability of Lie subalgebroids. *Advances in mathematics*, ISSN 0001-8708, 2007, vol. 210, no. 1, str.1-21 [COBISS.SI-ID 14209881]

Sašo Strle:

– CHA, Jae Choon, KIM, Taehee, RUBERMAN, Daniel, STRLE, Sašo. Smooth concordance of links topologically concordant to the Hopf link. *Bulletin of the London Mathematical Society*, ISSN 0024-6093, 2012, vol. 44, iss. 3, str. 443-450 [COBISS.SI-ID 16807769]

– OWENS, Brendan, STRLE, Sašo. Dehn surgeries and negative-definite four-manifolds. *Selecta mathematica. New series*, ISSN 1022-1824, 2012, vol. 18, iss. 4, str. 839-854 [COBISS.SI-ID 16808025]

– RUBERMAN, Daniel, STRLE, Sašo. Concordance properties of parallel links. *Indiana University mathematics journal*, ISSN 0022-2518, 2013, vol. 62, no. 3, str. 799-814 [COBISS.SI-ID 16946265]

Barbara Drinovec Drnovšek:

DRINOVEC-DRNOVŠEK, Barbara, FORSTNERIČ, Franc. Minimal hulls of compact sets in R^3 . *Transactions of the American Mathematical Society*. 2016, vol. 368, no. 10, str. 7477-7506. [COBISS.SI-ID 17543769]

ALARCÓN, Antonio, DRINOVEC-DRNOVŠEK, Barbara, FORSTNERIČ, Franc, LÓPEZ, Francisco J. Minimal surfaces in minimally convex domains. *Transactions of the American Mathematical Society*, ISSN 0002-9947, Feb. 2019, vol. 371, no. 3, str. 1735-1770. [COBISS.SI-ID 18379865]

DRINOVEC-DRNOVŠEK, Barbara, SLAPAR, Marko. Proper holomorphic curves attached to domains. *Complex variables and elliptic equations*. 2020, vol. 65, no. 3, str. 489-497. [COBISS.SI-ID 18647129]

ANALIZA 3

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------------------|------------|
| Predmet: | Analiza 3 |
| Course title: | Analysis 3 |
| Članica nosilka/UL Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039522 |
| Koda učne enote na članici/UL Member course code: | 27207 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: Aleš Vavpetič, Barbara Drinovec Drnovšek, izr. prof. dr. Pavle Saksida

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

Integrali s parametrom: zveznost in odvedljivost.
Večkratni integral: definicija in lastnosti, vpeljava nove spremenljivke, Fubinijev izrek. Dolžina krivulje in površina ploskve.
Funkcije kompleksne spremenljivke: elementarne funkcije kompleksne spremenljivke, Cauchyjev izrek, residui in računanje integralov, transformacije kompleksne ravnine.

Content (Syllabus outline):

Integrals with a parameter: continuity and differentiability.
Multiple integrals: definition and properties, change of variables, Fubini theorem. Length of a curve, area of a surface.
Functions of a complex variable: elementary functions of a complex variable, the Cauchy theorem, residues and evaluation of integrals, transformations of the complex plane.

Temeljna literatura in viri/Readings:

Ivan Vidav: *Višja matematika 2, Državna založba Slovenije, Ljubljana, 1979, 591 str.*
Erwin Kreyszig: *Advanced engineering mathematics, 9th ed., J.Wiley, Hoboken, 2006.*
Gabrijel Tomšič, Tomaž Slivnik: *Matematika III, Založba FE in FRI, Ljubljana, 2001, 175 str.*
Tomo Žitko: *Zbirka nalog iz matematike III, Založba FE in FRI, Ljubljana, 2002, 92 str.*
Serge Lang: *Calculus of several variables, Springer-Verlag, 1995.*

Cilji in kompetence:

Študent pri predmetu spozna nekaj novih pojmov in tehnik matematične analize, kot so dvojni in trojni integrali, kompleksna analiza. Te vsebine sodijo v uporabno matematiko in so nujno potrebne za razumevanje mnogih drugih predmetov, ki jih študent sreča pri študiju. Na predavanjih in vajah se študent uči matematičnega razmišljanja in strogosti, ter pridobiva praktično, delovno znanje obravnavanih področij.

Objectives and competences:

By attending the course students get acquainted with some new notions and techniques of mathematical analysis, such as the double and the triple integrals, complex analysis. These topics belong to the applied mathematics and are an essential component in the education of the students majoring in natural sciences or engineering. During the lectures and the classes students learn the mathematical rigor. They also acquire practical working knowledge of the topics, covered in the course.

Predvideni študijski rezultati:

Znanje in razumevanje:
Razumevanje in uporaba nekaterih zahtevnejših konceptov matematične analize.

Intended learning outcomes:

Knowledge and understanding:
Understanding of certain advanced topics of mathematical analysis.

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge, konzultacije.

Learning and teaching methods:

Lectures, classes, homework, consultations.

Načini ocenjevanja:**Delež/Weight****Assessment:**

| | | |
|---|---------|---|
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj, | 50,00 % | 2 midterm exams instead of written exam, written exam, |
| izpit iz teorije. | 50,00 % | theoretical exam. |
| 6-10 (pozitivno), in 5 (negativno) (po Statutu UL). | | 6-10 (pass), 5 (fail) (according to the Statute of UL). |

Reference nosilca/Lecturer's references:

Pavle Saksida:

- SAKSIDA, Pavle. Nahm's equations and generalizations Neumann system. Proceedings of the London Mathematical Society, ISSN 0024-6115, 1999, let. 78, št. 3, str. 701-720 [COBISS.SI-ID 8853849]
- SAKSIDA, Pavle. Integrable anharmonic oscillators on spheres and hyperbolic spaces. Nonlinearity, ISSN 0951-7715, 2001, vol. 14, no. 5, str. 977-994 [COBISS.SI-ID 10942809]
- SAKSIDA, Pavle. On the nonlinear Fourier transform associated with periodic AKNS-ZS systems and its inverse. Journal of physics. A, Mathematical and theoretical, ISSN 1751-8113, 2013, vol. 46, no. 46, 465204 (22 str.) [COBISS.SI-ID 16833369]

Aleš Vavpetič:

- CENCELJ, Matija, MRAMOR KOSTA, Neža, VAVPETIČ, Aleš. G-complexes with a compatible CW structure. Journal of mathematics of Kyoto University, ISSN 0023-608X, 2003, vol. 43, no. 3, str. 585-597 [COBISS.SI-ID 12807769]
- CENCELJ, Matija, DYDAK, Jerzy, MITRA, Atish, VAVPETIČ, Aleš. Hurewicz-Serre theorem in extension theory. Fundamenta mathematicae, ISSN 0016-2736, 2008, vol. 198, no. 2, str. 113-123 [COBISS.SI-ID 14551385]
- CENCELJ, Matija, DYDAK, Jerzy, VAVPETIČ, Aleš, VIRK, Žiga. A combinatorial approach to coarse geometry. Topology and its Applications, ISSN 0166-8641. [Print ed.], 2012, vol. 159, iss. 3, str. 646-658 [COBISS.SI-ID 16094809]

Barbara Drinovec Drnovšek:

- ALARCÓN, Antonio, DRINOVEC-DRNOVŠEK, Barbara, FORSTNERIČ, Franc, LÓPEZ, Francisco J. Minimal surfaces in minimally convex domains. Transactions of the American Mathematical Society, ISSN 0002-9947, Feb. 2019, vol. 371, no. 3, str. 1735-1770. [COBISS.SI-ID 18379865]
- DRINOVEC-DRNOVŠEK, Barbara, SIGURDSSON, Ragnar. A note on weighted homogeneous Siciak-Zaharyuta extremal functions. Indagationes mathematicae, ISSN 0019-3577, 2016, vol. 27, no. 1, str. 94-99. [COBISS.SI-ID 17434201]
- DRINOVEC-DRNOVŠEK, Barbara, FORSTNERIČ, Franc. Minimal hulls of compact sets in R^3 . Transactions of the American Mathematical Society, ISSN 0002-9947, 2016, vol. 368, no. 10, str. 7477-7506. [COBISS.SI-ID 17543769]

ANALIZA ALGORITMOV IN HEVRISTIČNO REŠEVANJE PROBLEMOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|---|
| Predmet: | Analiza algoritmov in hevristično reševanje problemov |
| Course title: | Analysis of Algorithms and Heuristic Problem Solving |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0100984 |
| Koda učne enote na članici/UL Member course code: | 63263 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

| | |
|-----------------------------------|----------------------|
| Nosilec predmeta/Lecturer: | Marko Robnik Šikonja |
|-----------------------------------|----------------------|

| | |
|------------------------------------|----------------------------------|
| Vrsta predmeta/Course type: | izbirni predmet /elective course |
|------------------------------------|----------------------------------|

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|--|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Poznavanje osnovnih algoritmov in podatkovnih struktur. | Knowledge of basic algorithms and data structures. |

| | |
|---|---|
| Vsebina: | Content (Syllabus outline): |
| Vsebina predmeta: Analiza rekurzivnih algoritmov: substitucijska metoda, rešitev za algoritme deli in vladaj, metoda Akra-Bazzi. Verjetnostna analiza: definicija, analiza stohastičnih algoritmov. Randomizacija algoritmov. Amortizirana analiza kompleksnosti algoritmov. Reševanje linearnih rekurzivnih enačb. Analiza večnitnih in vzporednih algoritmov. Aproksimacijski algoritmi. Kombinatorična optimizacija, lokalno preiskovanje, simulirano ohlajanje. Linearno programiranje za reševanje problemov. | Lecture topics: Analysis of recursive algorithms: substitution method, solution for divide and conquer approach, Akra-Bazzi method. Probabilistic analysis: definition, analysis of stochastic algorithms. Randomization of algorithms. Amortized analysis of algorithm complexity. Solving linear recurrences. Approximation algorithms. Analysis of multithreaded and parallel algorithms. Approximation algorithms. Combinatorial optimization, local search, simulated annealing. Linear programming for problem solving. |

| | |
|---|--|
| <p>Metahevrstike in stohastično preiskovanje: vodeno lokalno preiskovanje, preiskovanje s spremenljivo sosesčino, tabu preiskovanje.</p> <p>Populacijske metode: genetski algoritmi, optimizacija z rojem delcev, diferencialna evolucija.</p> <p>Strojno učenje v kombinatorični optimizaciji.</p> | <p>Metaheuristics and stochastic search: guided local search, variable neighbourhood search, and tabu search.</p> <p>Population methods: genetic algorithms, particle swarm optimization, differential evolution</p> <p>Machine learning in combinatorial optimization</p> |
|---|--|

Temeljna literatura in viri/Readings:

| |
|--|
| <p>T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein: <i>Introduction to Algorithms, 4th edition</i>. MIT Press, 2022</p> <p>R. Sedgwick, P. Flajolet: <i>An Introduction to the Analysis of Algorithms</i>. Addison-Wesley, 1995</p> <p>M. Gendreau, J.-Y. Potvin: <i>Handbook of Metaheuristics, 2nd Edition</i>. Springer, 2010.</p> <p>Dodatna literatura je na razpolago v obliki znanstvenih člankov.</p> <p>Additional literature is available in the form of scientific papers.</p> |
|--|

Cilji in kompetence:

| | |
|---|--|
| <p>Cilj predmeta je študente seznaniti z analizo algoritmov, računsko zahtevnostjo in učinkovitim reševanjem zahtevnih problemov, ki potrebujejo posebne pristope in optimizacijske tehnike.</p> <p>Splošne kompetence: sposobnost kritičnega razmišljanja, sposobnost definiranja, razumevanja in reševanja ustvarjalnih profesionalnih izzivov, sposobnost prenosa znanja in pisne komunikacije v domačem in tujem jeziku.</p> <p>Predmetno-specifične kompetence: uporaba metod za analizo rekurzivnih algoritmov: substitucijska metoda, drevesna metoda. metode za analizo algoritmov deli in vladaj: mojstrska metoda in metoda Akra-Bazzi verjetnostna analiza algoritmov, uporaba amortizirane analize algoritmov, poznavanje ideje aproksimacijskih tehnik, poznavanje hevrističnih pristopov in meta-hevristik za reševanje težkih problemov, uporaba populacijskih optimizacijskih metod in principov evolucijskega računanja.</p> | <p>Objectives and competences:</p> <p>The goal of the course is the students to become acquainted with the analysis of algorithms, computational complexity and techniques for efficient solving of difficult problems, requiring optimization techniques and approximations.</p> <p>General competences: ability of critical thinking, the ability to define, understand and solve creative professional challenges in computer and information science, the ability of knowledge transfer and writing skills in the native language as well as a foreign language.</p> <p>Subject-specific competences: use of methods for analysis of recursive algorithms; substitution method, recursive-tree method, use of methods for analysis of divide-and-conquer algorithms: master theorem and Akra-Bazzi method, probabilistic analysis of algorithms, use of amortized analysis of algorithms, use of heuristic methods and metaheuristics, for solving complex problems, use of population techniques and principles of evolutionary computation in optimization.</p> |
|---|--|

Predvideni študijski rezultati:

| | |
|---|---|
| <p>Po koncu predmeta bodo študente znali analizirati algoritme in njihovo računsko zahtevnost. Sposobni bodo ovrednotiti delovanje hevrističnih metod za reševanje zahtevnih problemov in bodo takšno analizo izvedli na realnem problemu. Konkretno bodo</p> <p>uporabljali splošne metode za analizo rekurzivnih algoritmov: substitucijsko metodo in drevesno metodo,</p> <p>uporabljali metode za analizo algoritmov deli in vladaj: mojstrsko metodo in metodo Akra-Bazzi verjetnostno analizirali programe</p> <p>uporabljali amortizirano analizo algoritmov, poznali ideje aproksimacijskih tehnik,</p> | <p>Intended learning outcomes:</p> <p>Upon passing the exam, the students will know how to analyze algorithms and their computational complexity. They will be capable to evaluate heuristic techniques for efficient solving of difficult problems and will be able to do such an analysis on real world problem. Specifically, they will</p> <p>use of methods for analysis of recursive algorithms: the substitution method and recursive-tree method, use methods for analysis of divide-and-conquer algorithms: master theorem and Akra-Bazzi method, probabilistically analyze the algorithms, use the amortized analysis of algorithms, knowing the ideas of approximation algorithms, use and evaluate of heuristic methods and metaheuristics for solving complex problems,</p> |
|---|---|

| | |
|--|---|
| uporabljali, razlikovali in vrednotili hevristične pristope in meta-hevristik za reševanje težkih problemov, uporabljali in primerjali populacijske optimizacijske metode in principe evolucijskega računanja. | use and compare population-based techniques and principles of evolutionary computation in optimization. |
|--|---|

Metode poučevanja in učenja:

| | |
|--|--|
| Predavanja, naloge s pisnimi poročili in z ustnimi nastopi in predstavitvami, seminarski način dela in domače naloge, ki stimulirajo sproten študij. Študenti bodo v manjših skupinah samostojno reševali in analizirali zahtevne optimizacijske probleme. Skupine bodo svoje naloge, analize in rešitve opisale v pisnem poročilu in predstavile ostalim v obliki kratke predstavitve, ki se ocenjuje skupaj s poročilom. | Learning and teaching methods: Lectures, assignments with written and oral demonstrations and presentations, seminar works and home works, which stimulate continuous learning. The emphasis is on the continuous study and on autonomous work on assignments and seminars. Students form small project teams and autonomously solve assignments based on real-life problems. The teams describe their solutions in written reports and prepare short oral presentations. Written reports and oral presentations are graded. |
|--|--|

Načini ocenjevanja:

Delež/Weight

Assessment:

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|---|--------------|---|
| Način: pisni in ustni izpit, domače naloge, predstavitev projekta, projekt. | | Type: oral and written examination, coursework, project presentation, project. |
| Sprotno preverjanje: domače naloge, projektno delo. | 50,00 % | Continuing: homework, project work. |
| Končno preverjanje: pisni in ustni izpit. | 50,00 % | Final: written and oral exam. |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

| |
|---|
| <ol style="list-style-type: none"> VREŠ, Domen, ROBNIK ŠIKONJA, Marko. Preventing deception with explanation methods using focused sampling. <i>Data mining and knowledge discovery</i>. 2023, vol. , no. , str. 1-46 MIOK, Kristian, ŠKRLJ, Blaž, ZAHARIE, Daniela, ROBNIK ŠIKONJA, Marko. To BAN or not to BAN: Bayesian attention networks for reliable hate speech detection. <i>Cognitive computation</i>. Jan. 2022, vol. 14, iss. 1, str. 353-371 LAVRAČ, Nada, ŠKRLJ, Blaž, ROBNIK ŠIKONJA, Marko. Propositionalization and embeddings: two sides of the same coin. <i>Machine learning</i>. 2020, vol. 109, no. 7, str. 1465-1507. KRANJC Janez, ORAČ, Roman, PODPEČAN, Vid, LAVRAČ, Nada, ROBNIK ŠIKONJA, Marko. ClowdFlows: online workflows for distributed big data mining. <i>FGCS</i>, 2017, vol. 68, pp. 38-58 ROBNIK ŠIKONJA, Marko. Data generators for learning systems based on RBF networks. <i>IEEE transactions on neural networks and learning systems</i>. May 2016, vol. 27, no. 5, str. 926-938 <p>Celotna bibliografija je dostopna na SICRISu https://cris.cobiss.net/ecris/si/sl/researcher/8741 Complete bibliography is available in SICRIS: https://cris.cobiss.net/ecris/si/en/researcher/8741</p> |
|---|

ARHITEKTURA RAČUNALNIŠKIH SISTEMOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------------|
| Predmet: | Arhitektura računalniških sistemov |
| Course title: | Computer Systems Architecture |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 1. letnik | 2. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 1. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039576 |
| Koda učne enote na članici/UL Member course code: | 63212 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Branko Šter

Vrsta predmeta/Course type: obvezni predmet/compulsory course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|---|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Poznavanje osnov digitalnih vezij. | Knowing the basics of digital circuits. |

| | |
|--|--|
| Vsebina: <p>Kako so narejeni računalniki in kako delujejo? Zakaj se princip delovanja od prvih računalnikov do danes skoraj ni spremenil? Kaj se dogaja v stroju med reševanjem problemov? To so samo nekatera od vprašanj, na katera odgovarja predmet Arhitektura računalniških sistemov.</p> <p>Pri predmetu bodo študenti v teoriji in na praktičnih primerih spoznali naslednje vsebine:</p> <p>Narava računanja, kompleksnost, omejitve, teoretični modeli računanja.</p> <p>Zgodovinski pregled dosedanjega razvoja strojev za računanje.</p> <p>Von Neumannov arhitekturni model, osnovni principi delovanja. Vhod in izhod, prekinitve, lokalnost pomnilniških dostopov, Amdahlov zakon, strojna in programska oprema.</p> | Content (Syllabus outline): <p>How are computers designed and how they work? Why has the principle of operation remained almost unchanged from the first computers to today? What is going on in the machine during problem solving? These are just some of the questions that are answered by the Computer Systems Architecture course.</p> <p>During the course the students will in theory and on practical examples study the following topics:</p> <p>Nature of computation, complexity, limitations, theoretical models of computation.</p> <p>Survey of historical development of computing machines.</p> <p>Von Neumann architecture model and basic principles of operation. Input and output, interrupts,</p> |
|--|--|

| | |
|---|---|
| <p>Predstavitev informacije in osnove računalniške aritmetike.</p> <p>Ukazi in strojni jezik: načini naslavljanja, operacije, formati, RISC-CISC</p> <p>Centralna procesna enota: podatkovna enota, aritmetično-logična enota, kontrolna enota.</p> <p>Analiza zgradbe in delovanja CPE na primeru RISC računalnika.</p> <p>Paralelizem na nivoju ukazov: cevovod, cevovodne nevarnosti, odpravljanje cevovodnih nevarnosti, dinamično razvrščanje, špekulativno izvrševanje, večizstavitveni procesorji. Paralelizem na nivoju niti, večjedrni procesorji.</p> <p>Glavni pomnilnik: tehnologija, organizacija, zaščita</p> <p>Predpomnilniki: princip delovanja, vrste zgrešitev, zgrešitvena kazni, problem skladnosti</p> <p>Navidezni pomnilnik</p> | <p>locality of memory references, Amdahl's law, hardware and software.</p> <p>Representation of information and basic computer arithmetic.</p> <p>Instructions and machine language: addressing modes, operations, formats, RISC-CISC.</p> <p>Central processing unit: datapath with arithmetic-logic unit, control unit.</p> <p>Analysis of CPU design and operation using a RISC computer as an example.</p> <p>Instruction level parallelism: pipeline, pipeline hazards. Pipeline hazard elimination, dynamic scheduling, register renaming, speculative execution, multiple-issue processors. Thread level parallelism, multi-core processors.</p> <p>Main memory: technology, organization, protection.</p> <p>Cache memories: principles of operation, types of cache misses, miss penalty, coherency problem.</p> <p>Virtual Memory</p> |
|---|---|

Temeljna literatura in viri/Readings:

- D. Kodek: *Arhitektura in organizacija računalniških sistemov*, Bi-Tim, Ljubljana 2008, poglavja 1 do 8.
- Dodatna literatura:
1. J. L. Hennessy, D. A. Patterson: *Computer Architecture: A Quantitative Approach*, 4. izdaja, Morgan Kaufmann, San Francisco 2007.
 2. D. A. Patterson, J. L. Hennessy: *Computer Organization and Design: The Hardware/Software Interface*, 4. izdaja, Morgan Kaufmann, Burlington 2009.

Cilji in kompetence:

Namen predmeta je predstaviti študentom področje arhitekture računalniških sistemov.

To področje je osnovnega pomena za vse študente računalništva, ker daje razumevanje o tem, kaj stroj za računanje je. Na koncu predmeta bo vsak študent poznal osnovne elemente računalnika, kako so ti deli med seboj povezani, razlikoval različne nivoje programiranja in razumel osnovno zgradbo strojev za računanje.

Kompetence:

Razvoj veščin kritičnega, analitičnega in sintetičnega mišljenja.

Zmožnost definiranja, razumevanja in reševanja ustvarjalnih profesionalnih izzivov v računalništvu in informatiki.

Osnovne veščine v računalništvu in informatiki.

Praktično znanje in veščine, potrebne za uspešno profesionalno delo v računalništvu in informatiki.

Objectives and competences:

The aim of the course is to introduce students to the field of computer systems architecture. This is a fundamental field for all computer science students since it gives understanding of what a computing machine is. At the end of this course the students will know the basic elements of a computer, comprehend how this elements link together, distinguish different levels of programming, and understand the basis of computing machines design.

Competences:

Developing skills in critical, analytical and synthetic thinking.

The ability to define, understand and solve creative professional challenges in computer and information science.

Basic skills in computer and information science.

Practical knowledge and skills necessary for successful professional work in computer and information science.

Predvideni študijski rezultati:

Po uspešno opravljenem predmetu naj bi bili študenti zmožni:

- razumeti osnovne koncepte računanja
- razložiti, kako deluje računalnik
- poznati omejitve računalnikov

Intended learning outcomes:

After the completion of the course a student will be able to:

- understand basic concepts of computation
- explain, how the computer works
- know limitations of computers

| | |
|---|---|
| <ul style="list-style-type: none"> - zapisovati in pretvarjati med številskimi zapisi, ki jih uporabljajo računalniki - razložiti arhitekturo konkretnega RISC računalnika - pisati programe v zbirnem jeziku - uporabiti kvantitativne metode za primerjavo in ocenjevanje različnih računalniških arhitektur - razumeti in vrednotiti pristope za povečanje učinkovitosti računalnikov (cevovod in drugi paralelizmi, predpomnilnik, itd.) - uporabiti znanje računalniške arhitekture pri razvijanju bolj učinkovite programske opreme | <ul style="list-style-type: none"> - write and convert between different number presentations used by computers - explain the architecture of a specific RISC computer - write programs in assembly language - apply quantitative methods for comparison and evaluation of different computer architectures - understand and evaluate techniques for improving efficiency of computers (pipeline and other parallelisms, cache memory, etc.) - apply knowledge of computer architecture in developing more efficient software |
|---|---|

| | |
|---|--|
| Metode poučevanja in učenja: | Learning and teaching methods: |
| Predavanja, laboratorijske vaje in domače naloge. | Lectures, laboratory work and homeworks. |

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|---|
| Sprotno delo poteka v obliki laboratorijskih vaj, domačih nalog in kolokvijev. | 33,00 % | Midterm work consists of laboratory exercises, homeworks and midterm exams. |
| Končno preverjanje (računski izpit) | 33,00 % | Final exam (written exam) |
| Končno preverjanje (teoretični izpit) | 33,00 % | Final exam (theoretical exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statuom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

Branko Šter: Selective recurrent neural network. *Neural processing letters*, 38(1): 1-15, 2013.

Dominik Olszewski, Branko Šter: Asymmetric clustering using the alpha-beta divergence. *Pattern Recognition*, 47(5): 2031-2041, 2013.

Rok Gaber, Tina Lebar, Andreja Majerle, Branko Šter, Andrej Dobnikar, Mojca Benčina, Roman Jerala: Designable DNA-binding domains enable construction of logic circuits in mammalian cells. *Nature Chemical Biology*, 10(3): 203-208, 2014.

Andrej Dobnikar, Branko Šter: Structural properties of recurrent neural networks. *Neural processing letters*, 29(2): 75-88, 2009.

Jernej Zupanc, Damjana Drobne, Branko Šter: Markov random field model for segmenting large populations of lipid vesicles from micrographs. *Journal of liposome research*, 21(4): 315-323, 2011.

BREZZIČNA IN MOBILNA OMREŽJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------|
| Predmet: | Brezžična in mobilna omrežja |
| Course title: | Mobile and Wireless Networks |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039623 |
| Koda učne enote na članici/UL Member course code: | 63259 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|-----------------------|
| | Prerequisites: |
|--|-----------------------|

| Vsebina: | Content (Syllabus outline): |
|--|---|
| predavanja: <ol style="list-style-type: none">Uvod v brezžična omrežjaFizični nivoLokalna in osebna omrežjaMestna in prostrana omrežjaPriključevanje v omrežjeMobilna omrežja (GSM, UMTS, LTE, 5G)Virtualizacija brezžičnih omrežijKomunikacija naprava – naprava (M2M)Satelitski prenos podatkov | lectures: <ol style="list-style-type: none">Introduction to wireless networksPhysical layerLocal and personal wireless networksMetropolitan and wide area wireless networksConnecting to the networkMobile networks (GSM, UMTS, LTE, 5G)Mobile network virtualizationMachine-to-machine communication (M2M)Data transfer via satellite |

Temeljna literatura in viri/Readings:

1. Matthew S. Gast, 802.11 Wireless Networks: The Definitive Guide: Enabling Mobility with Wi-Fi Networks 3rd Edition, O'Reilly Media, ISBN-10: 1491963549
2. Sauter, Martin, "From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband 4rd Edition", Wiley; 4 edition, 2021, ISBN: 9781119714675
3. C. Siva Ram Murthy and B. S. Manoj, "Ad-Hoc Wireless Networks: Architectures and Protocols," Prentice-Hall, 2004, ISBN: 0-13-147023-X.
4. David Coleman: "Wi-Fi 6 For Dummies, Extreme Networks Special Edition", John Wiley & Sons, Inc. 2020, ISBN 978-1-119-64285-5 Amitava Ghosh, Rapeepat Ratasuk, Simone Redana, Peter Rost 5G-Enabled Industrial IoT Networks, "Artech House 2020", ISBN-13: 978-1-63081-855-5

| | |
|--|---|
| Cilji in kompetence: | Objectives and competences: |
| Cilj predmeta je študentom računalništva in informatike predstaviti brezžična in mobilna omrežja. Poudarek je na posebnostih, ki jih prinaša brezžičen prenos podatkov in mobilnost terminalov v računalniška omrežja. | The purpose of the course is to give the students a sound understanding of the architecture and operating principles of mobile and wireless networks. This course provides a general introduction to mobile networking, with an emphasis on the wireless data transmission and mobility of terminals. |

| | |
|---|---|
| Predvideni študijski rezultati: | Intended learning outcomes: |
| <p>Znanje in razumevanje: Po uspešno opravljenem modulu na bi bili študenti zmožni: izkazati znanje in razumevanje osnovnih principov brezžičnih omrežij, razlikovati med osebnimi, lokalnimi in prostranimi brezžičnimi omrežji, zasnovati brezžično lokalno omrežje z vstopno točko, zasnovati brezžično Ad Hoc omrežje, razumeti metode prijavljanja v brezžično omrežje, uporabiti različna mobilna omrežja, predlagati hibridna brezžična omrežja.</p> <p>Uporaba: Uporaba brezžičnih in mobilnih omrežij pri raznih pogojih uporabe (industrija, hišna omrežja, osebna omrežja, ...).</p> <p>Refleksija: Spoznavanje in razumevanje uglasenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja brezžičnega prenosa podatkov. Prenosljive spretnosti - niso vezane le na en predmet: Reševanje drugih konceptualno sorodnih problemov (npr. telefonska omrežja 3G in 4G).</p> | <p>Knowledge and understanding: After successful completion of the course, students should be able to: to understand the principles of wireless networks, distinguish between personal, local, and wide area wireless networks, design a wireless local area network with an access point, design a wireless ad hoc network, understand authentication and authorization methods in the wireless network, use different mobile networks, propose hybrid wireless networks.</p> <p>Application: Wireless and mobile networks applications in various working conditions (industrial, house, personal networks ...)</p> <p>Reflection: Comprehension and understanding wireless data transmission theory and its application in real world application from the field.</p> <p>Transferable skills: Solving of the similar problems from field of the computer communications.</p> |

| | |
|-------------------------------------|---------------------------------------|
| Metode poučevanja in učenja: | Learning and teaching methods: |
| Predavanja, laboratorijske vaje. | Lectures, lab practice. |

| | | |
|--|---------------------|--|
| Načini ocenjevanja: | Delež/Weight | Assessment: |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, midterm exams, project work) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |

| | | |
|--|--|---|
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |
|--|--|---|

Reference nosilca/Lecturer's references:

VASYLCHENKOVA, Anastasiia, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. Classical mechanics approach applied to analysis of genetic oscillators. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], May/Jun. 2017, vol. 14, no. 3, str. 721-727,

BORDON, Jure, MOŠKON, Miha, ZIMIC, Nikolaj, MRAZ, Miha. Fuzzy logic as a computational tool for quantitative modelling of biological systems with uncertain kinetic data. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2015, vol. 12, no. 5, str. 1199-120

PETRONI, Mattia, ZIMIC, Nikolaj, MRAZ, Miha, MOŠKON, Miha. Stochastic simulation algorithm for gene regulatory networks with multiple binding sites. *Journal of computational biology*, ISSN 1066-5277. [Print ed.], Mar. 2015, vol. 22, no. 3, str. 218-226,

ŠOBERL, Domen, ZIMIC, Nikolaj, LEONARDIS, Aleš, KRIVIC, Jaka, MOŠKON, Miha. Hardware implementation of FAST algorithm for mobile applications. *Journal of signal processing systems for signal, image, and video technology*, ISSN 1939-8018. [Print ed.], 2015, vol. 79, no. 3, str. 247-256,

PEČAR, Primož, MRAZ, Miha, ZIMIC, Nikolaj, JANEŽ, Miha, LEBAR BAJEC, Iztok. Solving the ternary quantum-dot cellular automata logic gate problem by means of adiabatic switching. *Japanese journal of applied physics*, ISSN 0021-4922, 2008, vol. 47, no. 6, str. 5000-5006

DIPLOMSKI SEMINAR

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------------------|----------------------|
| Predmet: | Diplomski seminar |
| Course title: | Undergraduate Thesis |
| Članica nosilka/UL Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039530 |
| Koda učne enote na članici/UL Member course code: | 63282 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| | | | | 20 | 100 | 4 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

| | |
|----------------------|--|
| Predavanja/Lectures: | |
| Vaje/Tutorial: | |

| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
|--|--------------------------------------|
| Pogoj za vključitev v delo je vpis v 3. letnik študija. | Enrollment into 3rd year of studies. |

| Vsebina: | Content (Syllabus outline): |
|-------------------------------------|--|
| Vsebina je odvisna od izbrane teme. | Content depends on the selected topic. |

Temeljna literatura in viri/Readings:

| |
|---|
| Literatura je odvisna od izbrane teme. Literature depends on the selected topic. |
|---|

| Cilji in kompetence: | Objectives and competences: |
|--|---|
| Diplomski seminar je pisni izdelek, v katerem študent strokovno poglobljeno obdela problem, ki ga je določil izbrani mentor. Temeljni cilj predmeta je, da študent pridobi sposobnost samostojnega strokovnega dela in pisne ter ustne predstavitve rezultatov. | The diploma seminar is a written section in which the student addresses in the appropriate professional depth a problem determined by the mentor. The fundamental aim of the subject is for the student to acquire the ability for independent professional work and for written and oral presentation of results. |

| Predvideni študijski rezultati: | Intended learning outcomes: |
|--|------------------------------------|
| Znanje in razumevanje | Knowledge and understanding |

| | |
|---|--|
| <p>Študent pridobi znanje in sposobnost samostojnega definiranja problema, določanja ciljev in metod dela ter priprave zaključnega strokovnega dela v pisni obliki.</p> <p>Uporaba Študent se usposobi, da znanje, pridobljeno v teku študija uporabi pri reševanju strokovnega problema.</p> <p>Refleksija Kritično vrednotenje pridobljenega znanja in spretnosti na izbranem strokovnem področju.</p> <p>Prenosljive spretnosti – niso vezane le na en predmet Študent se usposobi za samostojno uporabo literature, kritični pristop pri zbiranju in interpretaciji podatkov ter za pisno in ustno sporočanje.</p> | <p>Students acquire knowledge and the ability to independently define a problem, determine goals and methods of work and prepare a concluding professional piece of work in writing.</p> <p>Application Students gain the ability to apply the knowledge acquired during studies in solving professional problems.</p> <p>Reflection Critical evaluation of knowledge acquired and skills in the selected professional field.</p> <p>Transferable skills – not tied to just one subject Students are trained in the independent use of literature, taking a critical approach to the collection and interpretation of data and in written and oral reporting.</p> |
|---|--|

| | |
|--|--|
| <p>Metode poučevanja in učenja: konzultacije, samostojno strokovno in raziskovalno delo</p> | <p>Learning and teaching methods: consultations, independent professional and research work</p> |
|--|--|

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|---|---------------------|---|
| <p>Pisna naloga in javni zagovor seminarja. Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL)</p> | <p>100,00 %</p> | <p>Written assignment and public defence of seminar. Grading: 6-10 pass, 5 fail (according to University Statute)</p> |

| |
|--|
| <p>Reference nosilca/Lecturer's references:</p> |
|--|

DISKRETNE STRUKTURE 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-----------------------|
| Predmet: | Diskretne strukture 1 |
| Course title: | Discrete Structures 1 |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 1. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039514 |
| Koda učne enote na članici/UL Member course code: | 27202 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 45 | | | 90 | 6 |

Nosilec predmeta/Lecturer: Primož Potočnik, Riste Škrekovski

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

| Vsebina: | Content (Syllabus outline): |
|--|--|
| Izjavni račun, predikatni račun. Množice in relacije. Urejenosti in mreže. Funkcije in permutacije. Moč množic. Teorija števil. | Predicate logic, predicate calculus. Sets and relations. Orders and lattices. Functions and permutations. Cardinality of sets. Number theory. |

Temeljna literatura in viri/Readings:

Riste Škrekovski: *Diskretne strukture I [Elektronski vir] : zapiski predavanj*, <http://www.fmf.uni-lj.si/skrekko/Gradiva/DS1-skripta.pdf>, ISBN 978-961-92887-2-6, 88 str.

G. Fijavž, *Diskretne strukture*, Ljubljana, 2014, matematika.fri.uni-lj.si/ds/ds.pdf.

Vladimir Batagelj, Izidor Hafner: *Matematika – logika*, Državna založba Slovenije, Ljubljana 1991, 62 str.

Vladimir Batagelj: *Diskretne strukture – logika*, samozaložba, Ljubljana 1998, 100.

Vladimir Batagelj: *Diskretne strukture – množice*, samozaložba, Ljubljana 1998, 40.

Vladimir Batagelj in Sandi Klavžar: *DS1 – Logika in množice: naloge*, Društvo matematikov, fizikov in astronomov Slovenije, Ljubljana 2000, ISBN: 961-212-039-0, 126 str.

Cilji in kompetence:

Diskretne strukture predstavljajo osnovo računalniške znanosti, saj je delovno poznavanje osnovnih konceptov diskretnih struktur potrebno na skoraj vseh področjih računalništva. Pri Diskretnih strukturah I študent spozna osnovne pojme logike, teorije množic, teorije števil.

Objectives and competences:

Discrete structures are the basis of computer science, because it is a working knowledge of the basic concepts of discrete structures needed in almost all areas of computing. In Discrete Structures I, the student learns the basic concepts of logic, set theory, number theory.

Predvideni študijski rezultati:

Znanje in razumevanje: Študentje spoznajo: osnove logike, osnove teorije množic, osnove relacijskega računa, osnovne pojme teorije števil.
Uporaba: Študentje znajo: logično sklepati s pomočjo naravne dedukcije, ugotavljati lastnosti relacij in struktur urejenosti, reševati linearne diofantske enačbe z dvema neznankama, računati s kongruencami.
Refleksija: Študentje spoznajo razliko med zvezno in diskretno matematiko.
Prenosljive spretnosti - niso vezane le na en predmet: uporaba matematične logike za analizo sklepanja, modeliranje odnosov v realnem svetu z relacijami in mrežami.

Intended learning outcomes:

Knowledge and understanding: Students learn about: fundamentals of logic, set theory basics, basics of calculus queries, the basic concepts of the theory of numbers.
Application: Students know: a logical conclusion with the help of deduction, to determine the properties of relations and the structures of orders, solve linear Diophantine equations with two unknowns, to reckon with congruity.
Reflection: Students learn the difference between continuous and discrete mathematics.
Transferable skills: the use of mathematical logic for the analysis of reasoning, modeling relationships in the real world of relationships and networks.

Metode poučevanja in učenja:

Predavanja in vaje, domače naloge.

Learning and teaching methods:

Lectures and tutorial sessions, homework.

Načini ocenjevanja:

2 kolokvija namesto izpita iz vaj, izpit iz vaj,
ustni izpit / izpit iz teorije.
6-10 (pozitivno), in 5 (negativno) (po Statutu UL).

Delež/Weight

50,00 %
50,00 %

Assessment:

2 midterm exams instead of written exam, written exam,
oral exam / theoretical test.
6-10 (pass), 1-5 (fail) (according to the Statute of UL)

Reference nosilca/Lecturer's references:

Primož Potočnik:

- POTOČNIK, Primož. Edge-colourings of cubic graphs admitting a solvable vertex-transitive group of automorphisms. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2004, vol. 91, no. 2, str. 289-300 [COBISS.SI-ID 13087321]
- POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. Cubic vertex-transitive graphs on up to 1280 vertices. Journal of symbolic computation, ISSN 0747-7171, 2013, vol. 50, str. 465-477 [COBISS.SI-ID 16520537]
- POTOČNIK, Primož. Tetravalent arc-transitive locally-Klein graphs with long consistent cycles. European journal of combinatorics, ISSN 0195-6698, 2014, vol. 36, str. 270-281 [COBISS.SI-ID 16862041]

Riste Škrekovski:

- JUNGIC, Veselin, KRÁL, Daniel, ŠKREKOVSKI, Riste. Colorings of plane graphs with no rainbow faces. Combinatorica, ISSN 0209-9683, 2006, vol. 26, no. 2, str. 169-182 [COBISS.SI-ID 13954393]
- DVOŘÁK, Zdeněk, ŠKREKOVSKI, Riste. A theorem about a contractible and light edge. SIAM journal on discrete mathematics, ISSN 0895-4801, 2006, vol. 20, no. 1, str. 55-61 [COBISS.SI-ID 14249305]
- KAISER, Tomáš, ŠKREKOVSKI, Riste. T-joins intersecting small edge-cuts in graphs. Journal of graph theory, ISSN 0364-9024, 2007, vol. 56, no. 1, str. 64-71 [COBISS.SI-ID 14373977]

DISKRETNE STRUKTURE 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-----------------------|
| Predmet: | Diskretne strukture 2 |
| Course title: | Discrete Structures 2 |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 1. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039515 |
| Koda učne enote na članici/UL Member course code: | 27205 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 45 | | | 90 | 6 |

Nosilec predmeta/Lecturer: Primož Potočnik, Riste Škrekovski, Sandi Klavžar

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

Osnovno o grafih. Drevesa. Eulerjevi in Hamiltonovi grafi. Usmerjeni grafi in turnirji. Povezanost in ravninskost grafov. Barvanje vozlišč in povezav grafa. Osnove algebre: grupe, kolobarji, polinomi, komutativni obsegi.

Content (Syllabus outline):

Basics of graph theory. Eulerian and Hamiltonian graphs. Digraphs and tournaments. Connectivity and planarity. Vertex and edge colorings. Basics of abstract algebra: groups, rings, polynomials, fields.

Temeljna literatura in viri/Readings:

Gasper Fijavž: *Diskretne strukture, Fakulteta za računalništvo in informatiko (2015) [elektronski vir]*, <http://matematika.fri.uni-lj.si/ds/ds.pdf>

Riste Škrekovski: *Diskretne strukture II [Elektronski vir] : zapiski predavanj*, <http://www.fmf.uni-lj.si/skreko/Gradiva/DS2-skripta.pdf>, ISBN 978-961-92887-3-3, 62 str.

I. N. Herstein, *Abstract Algebra*, Wiley and sons (1999).

Martin Juvan in Primož Potočnik: *Teorija grafov in kombinatorika: primeri in rešene naloge*, Društvo matematikov, fizikov in astronomov Slovenije, Ljubljana 2000, ISBN: 961-212-105-2, 173 str.

Cilji in kompetence:

Objectives and competences:

| | |
|--|---|
| Pri Diskretnih strukturah 2 študent osvoji zahtevnejše vsebine iz teorije grafov in se spozna z osnovami abstraktne algebre. | In Discrete Structures 2 student gains the demanding contents from graph theory and learn the basics of abstract algebra. |
|--|---|

Predvideni študijski rezultati:

Znanje in razumevanje: Predmet temelji na znanju, pridobljenem pri Diskretnih strukturah 1. Vsebine predmeta Diskretne strukture 2 so del potrebnega predznanja za predmete Teorija kodiranja in kriptografija, Kombinatorika ter Optimizacijske metode.

Uporaba: Teorija grafov je uporabna v teoriji algoritmov kot orodje za modeliranje raznih problemov. Algebrske strukture se uporabljajo v kriptografiji in kodiranju.

Refleksija: Študentje spoznajo razliko med zvezno in diskretno matematiko.

Prenosljive spretnosti - niso vezane le na en predmet: Modeliranje problemov in omrežnih struktur z grafi in drevesi. Obvladanje osnovnih algebrskih struktur.

Intended learning outcomes:

Knowledge and understanding: The course is based on the knowledge gained in Discrete Structures 1. The contents of the course Discrete Structures 2 are part of the necessary background knowledge for the courses Coding theory and cryptography, Combinatorics and Optimization methods.

Application: Graph theory is useful in the theory of algorithms as a tool for modeling various problems. Algebraic structures used in cryptography and coding.

Reflection: Students learn the difference between continuous and discrete mathematics.

Transferable skills: Modeling problems and network structures with graphs and trees. Mastering basic algebraic structures.

Metode poučevanja in učenja:

Predavanja in vaje, domače naloge.

Learning and teaching methods:

Lectures and tutorial sessions, homework.

Načini ocenjevanja:

Delež/Weight

Assessment:

| | | |
|---|---------|--|
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj, | 50,00 % | 2 midterm exams instead of written exam, written exam, |
| ustni izpit / izpit iz teorije. | 50,00 % | oral exam / theoretical test. |
| 6-10 (pozitivno), in 5 (negativno) (po Statutu UL). | | 6-10 (pass), 5 (fail) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

Primož Potočnik:

– POTOČNIK, Primož. Edge-colourings of cubic graphs admitting a solvable vertex-transitive group of automorphisms. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2004, vol. 91, no. 2, str. 289-300 [COBISS.SI-ID 13087321]

– POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. Cubic vertex-transitive graphs on up to 1280 vertices. Journal of symbolic computation, ISSN 0747-7171, 2013, vol. 50, str. 465-477 [COBISS.SI-ID 16520537]

– POTOČNIK, Primož. Tetravalent arc-transitive locally-Klein graphs with long consistent cycles. European journal of combinatorics, ISSN 0195-6698, 2014, vol. 36, str. 270-281 [COBISS.SI-ID 16862041]

Riste Škrekovski:

– JUNGIC, Veselin, KRÁL, Daniel, ŠKREKOVSKI, Riste. Colorings of plane graphs with no rainbow faces. Combinatorica, ISSN 0209-9683, 2006, vol. 26, no. 2, str. 169-182 [COBISS.SI-ID 13954393]

– DVOŘÁK, Zdeněk, ŠKREKOVSKI, Riste. A theorem about a contractible and light edge. SIAM journal on discrete mathematics, ISSN 0895-4801, 2006, vol. 20, no. 1, str. 55-61 [COBISS.SI-ID 14249305]

– KAISER, Tomáš, ŠKREKOVSKI, Riste. T-joins intersecting small edge-cuts in graphs. Journal of graph theory, ISSN 0364-9024, 2007, vol. 56, no. 1, str. 64-71 [COBISS.SI-ID 14373977]

Sandi Klavžar:

BREŠAR, Boštjan, HENNING, Michael A., KLAVŽAR, Sandi, RALL, Douglas F. Domination games played on graphs. Cham: Springer Nature, cop. 2021. X, 122 str. [COBISS.SI-ID 60317443]

KLAVŽAR, Sandi, MOLLARD, Michel. Daisy cubes and distance cube polynomial. European journal of combinatorics. Aug. 2019, vol. 80, str. 214-223. [COBISS.SI-ID 18659161]

HENNING, Michael A., KLAVŽAR, Sandi, RALL, Douglas F. The 4/5 upper bound on the game total domination number. Combinatorica. 2017, vol. 37, iss. 2, str. 223-251. [COBISS.SI-ID 18018137]

BUJTÁS, Csilla, KLAVŽAR, Sandi. Improved upper bounds on the domination number of graphs with minimum degree at least five. *Graphs and combinatorics*. 2016, vol. 32, iss. 2, str. 511-519. [COBISS.SI-ID 17630041]

KLAVŽAR, Sandi. Structure of Fibonacci cubes: a survey. *Journal of combinatorial optimization*. 2013, vol. 25, iss. 4, str. 505-522. [COBISS.SI-ID 16603737]

BREŠAR, Boštjan, KLAVŽAR, Sandi, RALL, Douglas F. Domination game and an imagination strategy. *SIAM journal on discrete mathematics*. 2010, vol. 24, no. 3, str. 979-991. [COBISS.SI-ID 15648089]

ELEKTRONSKO POSLOVANJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------|
| Predmet: | Elektronsko poslovanje |
| Course title: | Electronic Business |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Multimedija, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Multimedija (študijski program) | | 1. semester | izbirni |
| Računalništvo in informatika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039614 |
| Koda učne enote na članici/UL Member course code: | 63249 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Denis Trček

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

- Uvod in temeljne definicije.
- E-poslovanje kot prva faza digitalne transformacije, industrija 4.0 kot druga faza digitalne transformacije.
- Sistemske pogled (poslovna dinamika) na e-poslovanje skozi analizo generičnih struktur (zunanje in notranje logistične verige in verige dodane vrednosti ter vpliv odločanja na njihovo obnašanje).
- Tehnološki vidiki: RIP, XML, spletne storitve, komponentne arhitekture, digitalni plačilni sistemi in bločne verige (BitCoin), semantični splet, integracija podatkov, integracija poslovnih procesov (BPEL,

Content (Syllabus outline):

- The course contains the following themes:
- Introduction and basic definitions.
 - E-business as the first phase of digital transformation, industry 4.0 as the second phase.
 - Systemic view (business dynamics) on e-business through its generic structures (internal and external logistic and value added chains, the influence of decision making on their behavior).
 - Technological views: EDI, XML, web services, component architectures, digital payment systems (BitCoin) and blockchains, semantic web technologies, data integration, business processes

| | |
|--|---|
| <p>BPNM), internet stvari, mobilne aplikacije, varnost pri e-poslovanju.</p> <p>5. Organizacijski vidiki: evolucija poslovnih funkcij, procesov in informacijskih sistemov, novi poslovni modeli, revizijski postopki (COBIT).</p> <p>6. Zadnji trendi – prodor na umetni inteligenci (UI) temelječih rešitev, poslovne simulacije s pomočjo umentnih agentov, osnove strojnega učenja s pomočjo agentnih simulacij.</p> <p>7. Zakonodajni vidiki s poudarkom na ZEPEP, ZEPEP-A, ZEKOM in KZ.</p> <p>8. Specifični vidiki načrtovanja in vpeljave sistemov e-poslovanja: spremembe strateškega načrtovanja IS, uporaba formalnih metod (jezik Z), skladnost s pomebnejšimi standardi kot je Common Criteria.</p> <p>9. Varovanje intelektualne lastnine, kokretnih pristopi in najnovejša zakonodaja.</p> <p>10. Zaključki.</p> <p>11. Addendum: Mini vložki s praktičnim delom, ki pokrivajo najnovejše trende.</p> | <p>integration (BPEL, BPMN), internet of things and mobile applications, security in e-Business.</p> <p>5. Organizational views: evolution of business functions, processes and information systems, new business models, auditing procedures (COBIT).</p> <p>6. Latest trends – penetration of artificial intelligence (AI) based solutions, artificial agents based business simulations and machine learning basics through agents simulations.</p> <p>7. Legislation views with emphasis on ZEPEP, ZEPEP-A, ZEKOM and KZ.</p> <p>8. Specific views related to development and introduction of e-business systems: strategic planning changes, use of formal methods (language Z), and compliance with standards like Common Criteria.</p> <p>9. Intellectual property issues, concrete examples and procedures with the latest legislation in this area.</p> <p>10. Conclusions.</p> <p>11. Addendum: Mini practical tasks covering the latest selected technological trends.</p> |
|--|---|

Temeljna literatura in viri/Readings:

1. D. Trček: Elektronsko poslovanje, kopije prosojnic, FRI UL, Ljubljana, 2023.
 2. D. Trček, Trust and reputation management systems : an e-business perspective. [S. l.]: Springer, cop. 2018. ilustr. Springer Briefs in inf. Systems, ISBN 978-3-319-62374-0.
- Dodatna literatura / Additional literature:
3. G.Westerman et al, Leading Digital: Turning Technology into Business Transformation, Harward Business Review Press, Boston, 2014.
 4. Dave Chaffey: E-Business and E-Commerce Management, FT Prentice Hall, 2011.
 5. Sterman J.: Business Dynamics, Prentice Hall, 2002.

Cilji in kompetence:

Cilj predmeta je seznaniti študenta s tehnološkimi, organizacijskimi in zakonskimi (pravnimi) znanji, ki jih prinaša elektronsko poslovanje (ter najnovejšimi trendi na tem področju). Poudarek je na praktični usposobljenosti študenta, saj se študent nauči modelirati poslovni (pod)proces, razvije ustrezno aplikacijo za e-poslovanje v okviru tega (pod)procesa in jo integrira v zaledni informacijski sistem.

Kategorizirane kompetence:

- Sposobnost definiranja, razumevanja in reševanja kreativnih profesionalnih izzivov na področju računalništva in informatike.
- Sposobnost profesionalnega komuniciranja v materinem in tujem jeziku.
- Sposobnost biti skladen z varnostnimi, funkcionalnimi in okoljskimi zahtevami.
- Sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih relevantnih področjih (organizacija, itd.).
- Sposobnost samostojnega reševanja in izvedbe manj zahtevnih oz. manj kompleksnih inženirskih in organizacijskih opravil v računalništvu in informatiki.

Objectives and competences:

The objective of the course is to familiarize students with technological, organizational and legal knowledge that is required in e-business along with the latest trends in this area. The emphasis is on practical skills, i.e., students model a business (sub)process, develop a necessary e-business application and integrate it with the background information system.

Categorized competences:

- The ability to define, understand and solve creative professional challenges in computer and information science.
- The ability of professional communication in the native language as well as in a foreign language.
- Compliance with security, functional, economic and environmental principles.
- The ability to understand and apply computer and information science knowledge to other technical and relevant fields (organisational science, etc).
- The ability to independently perform less demanding and less complex engineering and organisational tasks requiring the application of in computer and information systems domain.

| Predvideni študijski rezultati: | Intended learning outcomes: |
|---|---|
| <p>Po opravljenem predmetu bo študent:</p> <ul style="list-style-type: none"> -razumel koncepte elektronskega poslovanja; -poznal ključne poslovne rešitve s področja e-poslovanja; -sposoben razvoja osnovnih rešitev s področja e-poslovanja in njihovega upravljanja; -sposoben integracije pridobljenih znanj z drugimi pridruženimi inženirskimi področji, predvsem razvoja informacijskih sistemov ter spletnih in mobilnih aplikacij; -obvladal temeljne koncepte podjetniškega razmišljanja; -sposoben samostojne pisne in ustne predstavitve problematike s področja e-poslovanja. | <p>After completing this course a student will:</p> <ul style="list-style-type: none"> -understand the key concepts of e-business; -know the key business solutions in the area of e-business; -be able to develop basic solutions for e-business and their administration; -will know how to integrate acquired knowledge with associated engineering areas, in particular information systems development, web and mobile applications; -will be familiar with the basic principles of business thinking; -will be able to prepare short articles and their oral presentations with themes in the area of e-business. |

| Metode poučevanja in učenja: | Learning and teaching methods: |
|--|--|
| <p>Predavanja, vaje s projektnim delom (praktične prototipne implementacije), lastne predstavitve. Udeležba na vajah je obvezna (zahtevan procent udeležbe se določi ob začetku študijskega leta). Nosilec predmeta lahko določi obvezno udeležbo tudi na predavanjih.</p> | <p>Lectures, laboratory work (with practical prototype implementations), students' presentations. Attendance of laboratory work is mandatory (the exact percentage is announced at the beginning of a study year). The lecturer may impose mandatory attendance of lectures.</p> |

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|--|
| 50 % ocene predstavlja sprotno delo študenta v obliki preverjanj na vajah (domače naloge, kvizi, praktičen projekt), | 50,00 % | 50% of the final grade is obtained on the basis of on-going laboratory work (home-works, quizzes, practical project implementations and presentations). |
| 50 % ocene pa predstavlja izpit, ki je načeloma v pisni obliki, lahko pa tudi v pisni in ustni obliki (pri čemer lahko nosilec namesto ustnega izpita uvede seminar). | 50,00 % | The other 50% is obtained on the basis of a written exam, or written and oral exam (the lecturer may decide that a seminal work replaces the oral exam). |
| Za uspešno opravljene obveznosti pri predmetu morata biti pozitivni obe delni oceni. Pristop k pisnemu izpitu je možen le po uspešno opravljenih obveznostih pri vajah (in v primeru dodatnih zahtev, ki se nanašajo na predavanja, po izpolnitvi le-teh). | | To be eligible for the written exam, a candidate must have successfully completed laboratory work, and fulfilled other obligations related to lecturing that the lecturer may have imposed. For successful completion of the course both grades have to be positive. |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

| |
|---|
| <ol style="list-style-type: none"> 1. TRČEK, Denis. Trust and reputation management systems : an e-business perspective, Springer, cop. 2018. ilustr. Springer Briefs in inf. Systems, ISBN 978-3-319-62374-0. 2. TRČEK, Denis. E-government 4.0 : managing APIs as facilitators for digital transformation. Academic journal of interdisciplinary studies. Jan. 2022, vol. 11, no. 1, str. 1-14, ilustr. ISSN 2281-3993, DOI: 10.36941/ajis-2022-0001. 3. LIKAR, Borut, TRČEK, Denis. Orde ab Chao method for disruptive innovations creation (with COVID-19 pandemic case application). Frontiers in psychology. Feb. 2021, vol. 11, str. 1-12, ilustr. ISSN 1664-1078. 4. TRČEK, Denis. Trust management in the pervasive computing era. IEEE security & privacy, ISSN 1540-7993. [Print ed.], 2011, vol. 9, no. 4, str. 52-55, ilustr. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5968087&tag=1. |
|---|

5. TRČEK, Denis. Trust management methodology and agents simulations framework for conflict research. *Advanced theory and simulations*. 2023, vol. , no. , str. 1-7, ilustr. ISSN 2513-0390.
<https://onlinelibrary.wiley.com/doi/10.1002/adts.202200705>, DOI: 10.1002/adts.202200705

Celotna bibliografija je dostopna na SICRISu:

The whole bibliography can be obtained at the below URL:

<https://bib.cobiss.net/biblioweb/eval/si/slv/evalrsr/11077>.

FINANČNA MATEMATIKA 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-------------------------|
| Predmet: | Finančna matematika 1 |
| Course title: | Financial Mathematics 1 |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039566 |
| Koda učne enote na članici/UL Member course code: | 27222 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

Obrestni račun, vrednotenje denarnih tokov, časovna struktura obrestnih mer.
Obveznice. Izvedeni finančni instrumenti.
Modeli trgov: opis tipov vrednostnih papirjev, diskretni modeli gibanja cen, osnovna izreka vrednotenja.
Vrednotenje opcij: definicije opcij, evropske opcije, ameriške opcije, eksotične opcije.
Vrednotenje evropskih opcij: Binomski model. Black-Scholesova formula.
Optimalne naložbe: pojem strategije, statistični primer, dinamični primer.
Ameriške opcije: pogojne terjatve ameriškega tipa, časi ustavljanja, Snellova ovojnica, kupčeva cena, prodajalčeva cena.
Stohastične obrestne mere: diskretni modeli, opcije na obrestne mere.

Content (Syllabus outline):

Interest rates, time value of money, term structure.
Bonds, financial derivatives.
Market model: finite sets of assets, discrete time, The Fundamental Asset Pricing Theorems.
Option pricing: definitions, European options, American options, exotic options.
Pricing of European options: Binomial model, Black-Scholes Formula.
Optimal investment: strategies, static model, dynamic model.
American options: American contingent claims, stopping times, Snell envelope, buyer's price, seller's price.
Stochastic models of interest rates: discrete models, term rate options.

Temeljna literatura in viri/Readings:

. Koch Medina, S. Merino. *Mathematical finance and probability: a discrete introduction*. Birkhäuser, 2003.
 J. Hull. *Options, futures and other derivatives*. Prentice Hall. 8. izdaja, 2011.
 S. E. Shreve. *Stochastic calculus for finance 1: The binomial asset pricing model*. Springer, 2005.
 S. M. Ross, *An elementary introduction to mathematical finance : options and other topics*. 2. izdaja, Cambridge University Press, 2003.
 D.G. Luenberger. *Investment science*. Oxford University Press, 2. izdaja, 2013.
 Z. Bodie, A. Kane, A. Marcus. *Investments*. 9. izdaja, McGraw-Hill Irwin, Boston, ZDA, 2011.
 B. Steiner. *Mastering financial calculations: A step-by-step guide to the mathematics of financial market instruments*. 2. izdaja, Financial Times Prentice Hall, 2007.
 M. Capiński, T. Zastawniak: *Mathematics for Finance : An Introduction to Financial Engineering*, Springer, London, 2005.
 J. Y. Campbell, L. M. Viceira: *Strategic Asset Allocation : Portfolio Choice for Long-Term Investors*, Oxford Univ. Press, Oxford, 2002.

Cilji in kompetence:

Celotni finančni matematiki je skupnih nekaj osnovnih principov. Namen predmeta je predstaviti te principe na diskretnih modelih, kjer je najlažje predstaviti intuitivne ideje. V prvem delu obravnavamo vprašanje naložb. To nas navede na vprašanje modelov trga, optimalne izbire naložb, osnovnega izreka vrednotenja opcij in mer tveganja. Osrednji del je namenjen binomskemu modelu in Black-Scholesovi formuli ter časom ustavljanja in vrednotenju pogojnih terjatev ameriškega tipa. Pomemben element finančne matematike so tudi stohastični modeli obrestnih mer.

Objectives and competences:

Celotni finančni matematiki je skupnih nekaj osnovnih principov. Namen predmeta je predstaviti te principe na diskretnih modelih, kjer je najlažje predstaviti intuitivne ideje. V prvem delu obravnavamo vprašanje naložb. To nas navede na vprašanje modelov trga, optimalne izbire naložb, osnovnega izreka vrednotenja opcij in mer tveganja. Osrednji del je namenjen binomskemu modelu in Black-Scholesovi formuli ter časom ustavljanja in vrednotenju pogojnih terjatev ameriškega tipa. Pomemben element finančne matematike so tudi stohastični modeli obrestnih mer.

Predvideni študijski rezultati:

Znanje in razumevanje: Razumevanje matematičnih modelov, ki se uporabljajo za vrednotenje finančnih produktov. Razumevanje zveze med izbiro modela in posledicami izbire modela.
 Uporaba: Uporabnost konceptov je dana sama po sebi, saj so vse metode neposredno uporabne v finančnem svetu. Poleg tega je ta tečaj osnova za matematično bolj zahtevne modele.
 Refleksija: Razumevanje teoretičnih konceptov na številnih primerih iz prakse.
 Prenosljive spretnosti – niso vezane le na en predmet: Pridobljene spretnosti so neposredno prenosljive v delovno prakso v finančnih ustanovah, kot so banke ali zavarovalnice. Poleg praktične vrednosti pa gre za brušenje sposobnosti matematičnega modeliranja.

Intended learning outcomes:

Knowledge and understanding: Understanding of mathematical models that are used in the pricing and hedging on the financial markets. Understanding the relation of model selection and its consequences.
 Application: All the methods are directly applicable in the financial markets. They also give a base to study more advanced models.
 Reflection: Understanding theoretical concepts in practice.
 Transferable skills: The knowledge is directly transferable to the practice in financial institutions, such as banks and insurance companies. Beside the practical aspects also skills of financial modelling are advanced through the course.

Metode poučevanja in učenja:

Predavanja, vaje, konzultacije

Learning and teaching methods:

Lectures, exercises, consultations

Načini ocenjevanja:**Delež/Weight****Assessment:**

| | | |
|---|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj | 50,00 % | 2 midterm exams instead of written exam, written exam |
| izpit iz teorije | 50,00 % | theoretical exam |

| | |
|--|---|
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |
|--|---|

Reference nosilca/Lecturer's references:

Janez Bernik:

– BERNIK, Janez, MASTNAK, Mitja, RADJAVI, Heydar. Positivity and matrix semigroups. *Linear Algebra and its Applications*, ISSN 0024-3795. [Print ed.], 2011, vol. 434, iss. 3, str. 801-812 [COBISS.SI-ID 15745625]

– BERNIK, Janez, MARCOUX, Laurent W., RADJAVI, Heydar. Spectral conditions and band reducibility of operators. *Journal of the London Mathematical Society*, ISSN 0024-6107, 2012, vol. 86, no. 1, str. 214-234. [COBISS.SI-ID 16357721]

– BERNIK, Janez, MASTNAK, Mitja. Lie algebras acting semitransitively. *Linear Algebra and its Applications*, ISSN 0024-3795. [Print ed.], 2013, vol. 438, iss. 6, str. 2777-2792. [COBISS.SI-ID 16553561]

Tomaž Košir:

– KOŠIR, Tomaž, OBLAK, Polona. On pairs of commuting nilpotent matrices. *Transformation groups*, ISSN 1083-4362, 2009, vol. 14, no. 1, str. 175-182 [COBISS.SI-ID 15077977]

– BUCKLEY, Anita, KOŠIR, Tomaž. Plane curves as Pfaffians. *Annali della Scuola normale superiore di Pisa, Classe di scienze*, ISSN 0391-173X, 2011, vol. 10, iss. 2, str. 363-388 [COBISS.SI-ID 15928409]

– GRUNENFELDER, Luzius, KOŠIR, Tomaž, OMLADIČ, Matjaž, RADJAVI, Heydar. Finite groups with submultiplicative spectra. *Journal of Pure and Applied Algebra*, ISSN 0022-4049. [Print ed.], 2012, vol. 216, iss. 5, str. 1196-1206 [COBISS.SI-ID 16183385]

Mihael Perman:

– HUZAK, Miljenko, PERMAN, Mihael, ŠIKIĆ, Hrvoje, VONDRAČEK, Zoran. Ruin probabilities and decompositions for general perturbed risk processes. *Annals of applied probability*, ISSN 1050-5164, 2004, vol. 14, no. 3, str. 1378-1397 [COBISS.SI-ID 13168985]

– HUZAK, Miljenko, PERMAN, Mihael, ŠIKIĆ, Hrvoje, VONDRAČEK, Zoran. Ruin probabilities for competing claim processes. *Journal of Applied Probability*, ISSN 0021-9002, 2004, vol. 41, no. 3, str. 679-690 [COBISS.SI-ID 13207641]

– KOMELJ, Janez, PERMAN, Mihael. Joint characteristic functions construction via copulas. *Insurance. Mathematics & economics*, ISSN 0167-6687, 2010, vol. 47, iss. 2, str. 137-143 [COBISS.SI-ID 16242777]

INTELIGENTNI SISTEMI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|----------------------|
| Predmet: | Inteligentni sistemi |
| Course title: | Intelligent Systems |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039643 |
| Koda učne enote na članici/UL Member course code: | 63266 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 6 | 24 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Marko Robnik Šikonja

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|------------|
| Predavanja/Lectures: | Angleščina |
| Vaje/Tutorial: | Angleščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|---|--|
| Za uspešno delo je potrebno poznavanje osnov statistike in programiranja. | Prerequisites: Knowledge of basic statistics and programming. |
|---|--|

Vsebina:

| Teme predavanj: | Content (Syllabus outline): |
|--|---|
| Teme predavanj: <ol style="list-style-type: none">Uvod v inteligentne sisteme in podatkovne vedeRačunanje po vzorih iz narave (genetski algoritmi, genetsko programiranje)Uvod v strojno učenjePristranskost, varianca in pretirano prilagajanjeUčenje predstavitev in izbira atributovAnsambelske metodeJedrne metodeNevronske mreže: arhitekture, vzvratno razširjenje napak, globoke nevrnske mrežeRazlaga modelov | Lecture topics: <ol style="list-style-type: none">Introduction to intelligent systems and data scienceNature inspired computing (genetic algorithms, genetic programming)Introduction to predictive modellingBias, variance and overfittingRepresentation learning and feature selectionEnsemble methodsKernel methodsNeural networks: architectures, backpropagation, deep neural networksModel inference and explanation |

| | |
|---|--|
| 10. Obdelava naravnega jezika: predstavitev besedil, pridobivanje informacij, klasifikacija besedil, semantična podobnost | 10. Natural language processing: text representation, information extraction, text classification, semantic similarity |
| 11. Spodbujevano učenje: osnovni pristopi in algoritmi, učenje Q, učenje TD, globoko spodbujevano učenje | 11. Reinforcement learning: basic approaches and algorithms, Q learning, TD learning, deep RL |

Temeljna literatura in viri/Readings:

G. James, D. Witten, T. Hastie, and R. Tibshirani, 2021. *An introduction to statistical learning with applications in R, 2nd edition*. New York: Springer.

D. Jurafsky, J. H. Martin. *Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition. 3rd edition draft*, 2022

Richard S. Sutton and Andrew G. Barto: Reinforcement Learning, An Introduction, 2nd edition, MIT press, 2018

Cilji in kompetence:

Cilj predmeta je študente seznaniti s področjem inteligentnih sistemov, ki vsebuje nabor orodij in pristopov za reševanje problemov, ki jih je težko ali nepraktično reševati z drugimi metodami. Študenti morajo biti sposobni teoretično znanje praktično uporabiti na realnih problemih iz znanstvenega in poslovnega okolja. Študenti morajo biti za dani problem sposobni presoje, katero od predstavljenih tehnik uporabiti, ter sestaviti prototip rešitve.

Splošne kompetence:

sposobnost razumevanja in reševanja profesionalnih izzivov,
sposobnost profesionalne komunikacije v domačem in tujem jeziku,
sposobnost samostojne uporabe pridobljenega znanja za reševanje tehničnih in znanstvenih problemov v računalništvu in informatiki,
seznanjenost z raziskovalnimi metodami na področju računalništva in informatike.

Predmetno-specifične kompetence:

uporaba osnovnih algoritmov strojnega učenja
predpriprava podatkov za podatkovno rudarjenje
izbira pomembnih atributov
vrednotenje odločitvenih modelov
uporaba sistemov za podatkovno analizo
uporaba sistemov za optimizacijo z evolucijskim računanjem
analiza besedil s tehnikami podatkovnega rudarjenja
uporaba orodij za spodbujevano učenje.

Objectives and competences:

The goal of the course is the students to become acquainted with the field of intelligent systems, which includes a collection of tools and approaches for solving problems which are difficult or unpractical to tackle with other methods. Students will be able to apply the gained theoretical knowledge on real-world problems from scientific and business environment. The students shall be able to decide which of the presented techniques should be used for a given problem, and to develop a prototype solution.

General competences:

the ability to understand and solve professional challenges in computer and information science, the ability of professional communication in the native language as well as a foreign language, the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science, familiarity with research methods in the field of computer science.

Subject-specific competences:

using basic machine learning algorithms
preprocessing data for data mining
feature subset selection
evaluation of decision models
using data mining systems
using optimizations packages with evolutionary techniques
text analysis and text mining
using reinforcement learning tools

Predvideni študijski rezultati:

Ob koncu predmeta bodo študenti; poznali in uporabljali različne tehnike in metode, ki se uporabljajo pri modeliranju inteligentnih sistemov poznali in uporabljali orodja za strojno učenje poznali in uporabljali pristope za analizo besedil

Intended learning outcomes:

Upon course completion the student will:

- know and use various techniques and methods for modelling of intelligent systems
- know and use machine learning tools
- know and use text analysis approaches

| | |
|--|---|
| reševali in analizirali konkretne primere inteligentnih sistemov z uporabo znanstvenih metod uporabljali in vrednotili orodja za statistično modeliranje in podatkovno rudarjenje sposobni analize problemov s področja inteligentnih sistemov in izbora primernih tehnik za njihovo reševanje uporabljali in medsebojno primerjali metode evolucijskega računanja | <ul style="list-style-type: none"> • solve and analyse examples of intelligent systems using scientific methods • use and evaluate tools for statistical modelling and data mining • be capable to analyse problems from the area of intelligent systems and choose adequate approaches for their solutions • use and compare different approaches for evolutionary computing |
|--|---|

Metode poučevanja in učenja:

| |
|---|
| Predavanja, vaje z ustnimi nastopi in predstavitevami, seminarski način dela pri domačih nalogah. Študenti bodo v manjših skupinah samostojno reševali realen problem. Skupine bodo svoje naloge in rešitve opisale v pisnem poročilu in predstavile ostalim v obliki kratke predstavitve, ki je ocenjena skupaj s poročilom. |
|---|

Learning and teaching methods:

| |
|--|
| Lectures, assignments with written and oral demonstrations and presentations, seminar works and homework. Students from small project teams and autonomously solve assignments based on real-life problems. The teams describe their solutions in written reports and prepare short oral presentations. Written reports and oral presentations are graded. |
|--|

Načini ocenjevanja:

Delež/Weight

Assessment:

| | | |
|--|---------|---|
| Način: pisni in ustni izpit, naloge, projekt. | | Type: written and oral exam, coursework, project. |
| Sprotno preverjanje: domače naloge, kolokviji in projektno delo. | 50,00 % | Continuing: homework, project work. |
| Končno preverjanje: pisni in ustni izpit. | 50,00 % | Final: written and oral exam. |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statuom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

| |
|--|
| <ol style="list-style-type: none"> 1. VREŠ, Domen, ROBNIK ŠIKONJA, Marko. Preventing deception with explanation methods using focused sampling. <i>Data mining and knowledge discovery</i>. 2023, vol. , no. , str. 1-46 2. MIOK, Kristian, ŠKRLJ, Blaž, ZAHARIE, Daniela, ROBNIK ŠIKONJA, Marko. To BAN or not to BAN: Bayesian attention networks for reliable hate speech detection. <i>Cognitive computation</i>. Jan. 2022, vol. 14, iss. 1, str. 353-371 3. ŠKVORC, Tadej, GANTAR, Polona, ROBNIK ŠIKONJA, Marko. MICE: mining idioms with contextual embeddings. <i>Knowledge-based systems</i>. Jan. 2022, vol. 235, str. 1-11 4. MARTINC, Matej, POLLAK, Senja, ROBNIK ŠIKONJA, Marko. Supervised and unsupervised neural approaches to text readability. <i>Computational linguistics</i>. 2021, vol. 47, no. 1, str. 141-179 5. LAVRAČ, Nada, ŠKRLJ, Blaž, ROBNIK ŠIKONJA, Marko. Propositionalization and embeddings: two sides of the same coin. <i>Machine learning</i>. 2020, vol. 109, no. 7, str. 1465-1507. <p>Celotna bibliografija je dostopna na SICRISu https://cris.cobiss.net/ecris/si/sl/researcher/8741 Complete bibliography is available in SICRIS: https://cris.cobiss.net/ecris/si/en/researcher/8741</p> |
|--|

IZBRANA POGLAVJA IZ MATEMATIKE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|--------------------------------|
| Predmet: | Izbrana poglavja iz matematike |
| Course title: | Topics in Mathematics |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039523 |
| Koda učne enote na članici/UL Member course code: | 27209 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: Primož Potočnik, prof. dr. Petar Pavešič

Vrsta predmeta/Course type: obvezni predmet/compulsory course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

Kolobarji, primeri in osnovne lastnosti, obrnljivi elementi in delitelji nič, Wedderburnov izrek, karakteristika, homomorfizmi, ideali (glavni ideali, praideali in maksimalni ideali), kvocientni kolobar, izrek o izomorfizmu.

Obsegi, konstruktibilna števila, razširitve obsegov, razpadni obsegi, končni obsegi.

Fourierova vrsta, razvoj periodične funkcije v vrsto sinusov in kosinusov, kompleksni zapis vrste, konvergenca, fazni portret, primeri uporabe (toplotna/valovna enačba, analiza signala,...).

Fourierova transformacija, obstoj, osnovne lastnosti (linearnost, razteg in premik, transformacija odvoda in odvod transformiranke,...), inverzna transformacija, konvolucija. Diskretna Fourierova transformacija, hitra Fourierova transformacija, primeri uporabe.

Content (Syllabus outline):

Rings, examples and basic properties, invertible elements and zero divisors, Wedderburn theorem, characteristics, homomorphisms, ideals (principal, prime and maximal ideals), quotient ring, isomorphism theorems.

Fields, constructible numbers, field extensions, splitting fields, finite fields.

Fourier series, expansion as sum of sines and cosines, complex expansion, convergence, phase portrait, applications (heat/wave equation, signal analysis,...).

Fourier series, existence, basic properties (linearity, translation, shift, differentiation,...), inverse transform, convolution. Discrete Fourier transform, fast Fourier transform, applications.

Other mathematical topics of lecturer's choosing.

| | |
|--|--|
| Poleg navedenih predavatelj izbere tudi druge matematične teme, povezane z računalništvom. | |
|--|--|

Temeljna literatura in viri/Readings:

| |
|---|
| Zapiski predavanj/course notes T. W. Judson: Abstract Algebra Theory and Applications (2013), http://abstract.ups.edu/ E. Kreyszig: <i>Advanced Engineering Mathematics, 9th ed., Wiley (2006)</i> S. Coutinho: The Mathematics of Ciphers: Number Theory and RSA Cryptography, A.K. Peters ltd.,1999 |
|---|

Cilji in kompetence:

| | |
|--|--|
| Študent pri predmetu spozna nekaj novih pojmov iz algebre (kolobarji in obsegi) ter matematične analize (Fourierova vrsta in transformacija). Te vsebine imajo zelo širok spekter uporab v računalništvu (kodiranje, kriptografija, analiza signalov, kompresija podatkov, obdelava slik,...). Študent se spozna z izbranimi matematičnimi problemi in se jih nauči samostojno reševati. | Objectives and competences: Students learn about concepts and techniques in Algebra (rings and fields) and Mathematical Analysis (Fourier series and transform) that have a wide specter of applications in Computer Science (coding, cryptohgraphy, signal analysis, data compression, image processing,...). Students familiarise with selected mathematical problems and gain basic problem-solving skills. |
|--|--|

Predvideni študijski rezultati:

| | |
|---|---|
| Znanje in razumevanje: Poznavanje in razumevanje osnovnih definicij in izrekov ter primerov uporabe. Uporaba: obdelane teme so nujne za razumevanje uporabe matematičnih metod v računalništvu. Refleksija: Razumevanje teorije na podlagi uporabe. Prenosljive spretnosti - niso vezane le na en predmet: Spretnosti uporabe domače in tuje literature in drugih virov, identifikacija in reševanje problemov, kritična analiza. | Intended learning outcomes: Knowledge and understanding of basic definitions, theorems and of selected applications. Application: course content is essential for the understanding of the applications of mathematical methods in Computer Science. Reflection: Understanding the theory and its relation to the applications. Transferable skills: familiarity with the the literature and other sources, ability to identify and solve the problems, critical analysis. |
|---|---|

Metode poučevanja in učenja:

| | |
|---------------------|---|
| Predavanja in vaje. | Learning and teaching methods: Lecture and exercises. |
|---------------------|---|

Načini ocenjevanja:

| | | |
|---------------------------------|------------------------------|--|
| Pisni izpit z ustnim zagovorom. | Delež/Weight 100,00 % | Assessment: Written exam with oral defense. |
|---------------------------------|------------------------------|--|

Reference nosilca/Lecturer's references:

| |
|---|
| <p>Petar Pavešić – PAVEŠIĆ, Petar CONNER, Gregory R., HERFORT, Wolfgang, KENT, Curtis, PAVEŠIĆ, Petar. Recognizing the second derived subgroup of free groups. <i>Journal of algebra</i>, ISSN 0021-8693, Dec. 2018, vol. 516, str. 396-400.</p> <p>– PAVEŠIĆ, Petar A topologist's view of kinematic maps and manipulation complexity. V: GRANT, Mark (ur.). <i>Topological complexity and related topics : Mini-Workshop Topological Complexity and Related Topics, February 28 - March 5, 2016, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany</i>, (Contemporary mathematics, ISSN 0271-4132, 702). Providence: American Mathematical Society.</p> <p>– PAVEŠIĆ, Petar. Complexity of the forward kinematic map. <i>Mechanism and Machine Theory</i>, ISSN 0094-114X. [Print ed.], 2017, vol. 117, str. 230-243.</p> <p>– PAVEŠIĆ, Petar. Splošna topologija, (Izbrana poglavja iz matematike in računalništva, 43). Ljubljana: DMFA - založništvo, 2008. VI, 89 str., ilustr. ISBN 978-961-212-205-8 [COBISS.SI-ID 240425984]</p> |
|---|

Primož Potočnik:

– POTOČNIK, Primož. Edge-colourings of cubic graphs admitting a solvable vertex-transitive group of automorphisms. *Journal of combinatorial theory. Series B*, ISSN 0095-8956, 2004, vol. 91, no. 2, str. 289-300 [COBISS.SI-ID 13087321]

– POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. Cubic vertex-transitive graphs on up to 1280 vertices. *Journal of symbolic computation*, ISSN 0747-7171, 2013, vol. 50, str. 465-477 [COBISS.SI-ID 16520537]

– POTOČNIK, Primož. Tetravalent arc-transitive locally-Klein graphs with long consistent cycles. *European journal of combinatorics*, ISSN 0195-6698, 2014, vol. 36, str. 270-281 [COBISS.SI-ID 16862041]

IZRAČUNLJIVOST IN RAČUNSKA ZAHTEVNOST

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|--|
| Predmet: | Izračunljivost in računska zahtevnost |
| Course title: | Computability and Computational Complexity |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 1. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039588 |
| Koda učne enote na članici/UL Member course code: | 63283 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Borut Robič

Vrsta predmeta/Course type: obvezni predmet / compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|-----------------------|
| | Prerequisites: |
|--|-----------------------|

Vsebina:

- Predavanja:**
- Uvod:* Algoritem intuitivno.
 - Zgodovina:* Kriza v osnovah matematike 20. stoletja. Reševanje iz krize. Formalni sistemi. Hilbertov program. Godlova izreka.
 - Uvod v izračunljivost:* Kaj je algoritem in računanje? Računski modeli. Church-Turingova teza. Turingov stroj in različice. Nedeterminizem.
 - Univerzalni TS. Model RAM in splošno namenski računalniki. Izrek o rekurziji, rekurzivno definiranje in računanje.
 - Neizračunljivost.* Jezik in množica. Odločitveni problemi. Neizračunljivi problemi obstajajo. Metode za dokazovanje neizračunljivosti (diagonalizacija, prevedbe, Riceov izrek) Primeri neizr. problemov in praktične posledice na raznih

Content (Syllabus outline):

- Lectures:**
- Introduction:* Algorithm intuitively.
 - History:* Foundational crisis in 20th century mathematics. Solving the crisis. Formal systems. Hilbert's program. Godel's theorems.
 - Introduction to computability:* What is algorithm and computation? Models of comp. Church-Turing thesis. Turing machine and versions. Nondeterminism.
 - Universal TM. RAM model and general purpose computers. Recursion theorem, recursive definitions and execution.
 - Incomputability.* Sets vs. languages. Decision problems. Incomputable problems exist. Methods of proving incomputability (diagonalization, reductions, Rice's theorem).

| | |
|--|--|
| <p>področjih.(Osnovno o relat. izračunljivosti in hierarhijah.)</p> <p>6. <i>Avtomati, gramatike, jeziki</i>: Končni avtomat, regularna gramatika, izraz in jezik. Skladovni avtomat, kontekstno neodvisna gramatika in jezik. Linearno omejeni avtomat, kontekstno odvisna gramatika in jezik. Primeri in uporaba.</p> <p>7. <i>Uvod v računske zahtevnosti</i>: Časovna, prostorska, in druge zahtevnosti. Lahki in težki problemi. Razreda P, NP, EXP in drugi. NP-polnost/težkost in njeno dokazovanje. Primeri in uporaba.</p> <p>8. <i>Ovladovanje težkih problemov</i>: Osnovno o verjetnostnem, aproksimativnem in paralelnem računanju. Osnovno o interaktivnem dokazovanju. Primeri v praksi.</p> <p>9. <i>Novejši pristopi</i>: Osnovno o kvantnem računanju.</p> | <p>Examples of incomputable problems and consequences in various fields. (Basics of relative computability and hierarchies.)</p> <p>6. <i>Automata, grammars, languages</i>: Finite automata, regular grammars, expressions and languages. Pushdown automata, context-free grammars and languages. Linear bounded automata, context-sensitive grammars and languages. Examples and application.</p> <p>7. <i>Introduction to computational complexity</i>: Time, space, and other complexities. Easy and hard problems. Classes P, NP, EXP and other complexity classes. NP-completeness/hardness and methods of proving it. Examples and applications.</p> <p>8. <i>Coping with hard problems</i>: Basics of randomized, approximation, and parallel computing. Basics of interactive proving. Examples and application.</p> <p>9. <i>Recent approaches</i>: Basics of quantum computing.</p> |
|--|--|

Temeljna literatura in viri/Readings:

B. Robič: *The Foundations of Computability Theory*, Springer, 2014 (to appear)
S.Arora, B.Barak *Computational Complexity: A modern approach*, Cambridge Univ Press (2009)

Dodatna literatura:

M. Sipser: *Introduction to the Theory of Computation*, Course Technology (2006)
B. Robič: *Aproksimacijski algoritmi*, Založba FE in FRI, 2. izd. (2009)

Cilji in kompetence:

Cilj predmeta je dvojen: 1) študenta opremiti s sodobnim znanjem s področja teoretičnega računalništva in 2) študenta usposobiti, da bo lahko to znanje uspešno uporabljal pri reševanju problemov v praksi.

Objectives and competences:

Major part of the course is devoted to computability and computational complexity theory emphasizing on application on various disciplines of computer science. In part the course covers the historical development of the field as well as its recent achievements, again focusing on practical problem solving.

Predvideni študijski rezultati:

Študent bo po opravljenem predmetu:

- razumel delovanje in uporabo končnih avtomatov, regularnih jezikov, izrazov in gramatik;
- razumel delovanje in uporabo skladovnih avtomatov, kontekstno neodvisnih jezikov in gramatik;
- razumel delovanje in uporabo Turingovih strojev in izračunljivih ter izračunljivo preštevni jezikov;
- razumel (Church/Turingovo) Tezo o izračunljivosti in zvezo med izračunljivimi (izračunljivo preštevni, neizračunljivimi) jeziki ter odločljivimi (polodločljivimi, neodločljivimi) problemi;
- spoznal nekaj nerešljivih računskih problemov;
- razumel vlogo nedeterminizma v računanju;
- razumel časovno ali prostorsko zahtevnost računskim problemov in osnovne razrede zahtevnosti (D'TIME, N'TIME, DSPACE, NSPACE, and P, NP, ...);
- razumel pojme NP-polnosti in NP-težkosti računskega problema;

Intended learning outcomes:

After completing the course the student will:

- understand the working, properties, and use of finite automata, regular languages, expressions, and grammars;
- understand the working, properties, and use of pushdown automata, context-free languages and grammars;
- understand the working, properties, and use of Turing machines computable and computably enumerable (c.e.) languages;
- understand the (Church/Turing) Computability Thesis, and the link between computable (c.e., incomputable) languages and decidable (semi-decidable, undecidable) problems;
- be acquainted with selected incomputable computational problems;
- understand the role of non-determinism in computation;
- understand the time- and space-complexity of computational problems and fundamental complexity

| | |
|--|--|
| - spoznal problem SAT, nekatere druge NP-polne probleme ter metodo dokazovanja NP-polnosti s prevedbo. | classes (DTIME, NTIME, DSPACE, NSPACE, and P, NP, ...) — understand the concept of NP-completeness and NP-hardness; — know the SAT, some other NP-complete problems, and the method of proving NP-completeness by reduction. |
|--|--|

Metode poučevanja in učenja:

Predavanja, domače naloge, seminarski način dela pri vajah. Poudarek je na sprotne študiju in samostojnem delu pri vajah, seminarskih in domačih nalogah.

Learning and teaching methods:

Lectures and exercise groups, homework assignments. Frequent homework assignments shall not be time consuming. Some of the homework assignments will be more demanding – projects – which may be distributed to students divided in groups.

Načini ocenjevanja:

Delež/Weight

Assessment:

| | | |
|---|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): Oceno sestavljata dva dela: | | Type: exam, oral, coursework, project Continuing: homework, project work |
| prvi (50%) je za sprotno delo, | 50,00 % | Continuing: homework, project work |
| drugi (50%) pa za ustni in pisni izpit. | 50,00 % | Final: written and oral exam |
| Obveznosti predmeta so uspešno opravljene, če sta oba dela pozitivna. V sprotno delo sodijo vaje in seminarske naloge. Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

ROBIČ, B. *The Foundations of Computability Theory*, Springer, 2014 (to appear)
 BEZENŠEK, M., ROBIČ, B. A survey of parallel and distributed algorithms for the Steiner tree problem. *Int. J. Par. Program.* 42:287-319, 2013
 MIHELIC, J., MAHJOUB, A., RAPINE, C., ROBIČ, B. Two-stage flexible-choice problems under uncertainty. *Eur. J. Oper. Res.* 201(2):399-403, 2010
 MIHELIC, J., ROBIČ, B. Flexible-attribute problems. *Comput. Optimiz. Appl.* 47(3):553-566, 2010
 TROBEC, R., ŠTERK, M., ROBIČ, B. Computational complexity and parallelization of the meshless local Petrov-Galerkin methods. *Comput. Struct.* 87(1/2):81-90, 2009.
 Celotna bibliografija je dostopna na SICRISu:
<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=5202>.

KOMBINATORIKA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|-----------------------------------|---------------|
| Predmet: | Kombinatorika |
| Course title: | Combinatorics |
| Članica nosilka/UL Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039525 |
| Koda učne enote na članici/UL Member course code: | 27208 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 45 | | | 120 | 7 |

Nosilec predmeta/Lecturer: Matjaž Konvalinka, Primož Potočnik, Sandi Klavžar

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

Osnovna načela preštevanja. Binomski koeficienti, razdelitve, Stirlingova števila 1. in 2. vrste, Bellova števila, Lahova števila, razčlenitve naravnega števila. Dvanajstera pot. Načelo vključitev in izključitev in trdnjavski polinomi. Polyaeva teorija: delovanje grupe na množici, Burnsidova lema, število orbit. Rodovne funkcije in uporaba pri rekurzivnih enačbah. Catalanova števila. Delno urejene množice in mreže: verige in antiverige, Dilworthov izrek, Spernerjev izrek. Teorija načrtov: načrti, t-načrti, ciklične konstrukcije načrtov.

Content (Syllabus outline):

Basic principles of counting. Binomial coefficients, set partitions, Stirling numbers of the first and second kind, Bell numbers, Lah numbers, partitions of integers. Twelve-fold way. Inclusion exclusion principle, rook polynomials. Polya theory: action of groups on sets, Burnside lemma, number of orbits. Generating function and applications to recurrence relations. Catalan numbers. Partially ordered sets and lattices: chains and antichains, Dilworth's theorem, Sperner's theorem. Design theory: designs, t-designs, cyclic constructions of designs.

Temeljna literatura in viri/Readings:

Miklos Bona, A Walk Through Combinatorics, 2nd ed. World Scientific, New York, 2006.
N. Biggs, Discrete Mathematics, 2nd ed., Oxford University Press (2002)
M. Juvan, P. Potočnik: Teorija grafov in kombinatorika, DMFA-založništvo, Ljubljana, 2000.
Primož Potočnik, Zapiski predavanj iz Diskretne matematike I, <http://www.fmf.uni-lj.si/~potocnik/Ucbeniki/DM-Zapiski2010.pdf>

Cilji in kompetence:

Študent se spozna z nekaterimi klasičnimi problemi kombinatorike in se jih nauči samostojno reševati.

Objectives and competences:

Students familiarize themselves with some classical problems of combinatorics and learn how to independently solve them.

Predvideni študijski rezultati:

Znanje in razumevanje: Poznavanje osnovnih pojmov iz klasične kombinatorike ter razumevanje osnovnih povezav med njimi. Osnovno znanje natančnega štetja objektov z določenimi lastnostmi iz dane množice.

Uporaba: Uporaba diskretnih matematičnih struktur za predstavitev različnih objektov in procesov.

Tovrstne predstavitve so nepogrešljive na primer pri obdelavi podatkov z računalniki.

Refleksija: Povezovanje teoretičnih spoznanj s praktičnimi uporabami na primer v optimizaciji in pri programiranju. Sposobnost prepoznavanja problemov, ki jih lahko uspešno opišemo z diskretnimi matematičnimi modeli.

Prenosljive spretnosti – niso vezane le na en predmet: Poznavanje osnovnih prijemov za delo z diskretnimi matematičnimi strukturami. Natančnost pri razmišljanju in reševanju problemov. Sposobnost prebiranja strokovne literature iz diskretne matematike in sorodnih področij.

Intended learning outcomes:

Knowledge and understanding: Knowledge about basic concepts from classical combinatorics, and understanding of basic connections among them. Basic knowledge of exact counting of objects from a given set and with specific properties.

Application: Use of discrete mathematical structures for representation of various objects and processes. Such representations play a key role in data processing with computers.

Reflection: Connection of theoretical knowledge with applications, for instance in optimizations and computer programming. Capability of recognizing problems that could be successfully described by discrete mathematical models.

Transferable skills: Knowledge about basic approaches regarding use of discrete mathematical structures. Exactness at thinking and problem solving. Capability of reading and understanding of expert literature on discrete mathematics and other closely related fields.

Metode poučevanja in učenja:

Predavanja in vaje.

Learning and teaching methods:

Lecture and exercises.

Načini ocenjevanja:

Pisni in ustni izpit.

Delež/Weight Assessment:

100,00 %

Written and oral exam.

Reference nosilca/Lecturer's references:

Sandi Klavžar:

– IMRICH, Wilfried, KLAVŽAR, Sandi, RALL, Douglas F. Topics in graph theory : graphs and their Cartesian product. Wellesley (Mass.): A. K. Peters, 2008. XIV, 205 str., ilustr. ISBN 978-1-56881-429-2 [COBISS.SI-ID 14965081]

– BREŠAR, Boštjan, KLAVŽAR, Sandi, RALL, Douglas. Domination game and an imagination strategy. SIAM journal on discrete mathematics, ISSN 0895-4801, 2010, vol. 24, no. 3, str. 979-991 [COBISS.SI-ID 15648089]

– HAMMACK, Richard H., IMRICH, Wilfried, KLAVŽAR, Sandi. Handbook of product graphs, (Discrete mathematics and its applications). Boca Raton, London, New York: CRC Press, cop. 2011. XVIII, 518 str., ilustr. ISBN 978-1-4398-1304-1 [COBISS.SI-ID 15916121]

Matjaž Konvalinka:

– KONVALINKA, Matjaž, PAK, Igor. Geometry and complexity of O'Hara's algorithm. Advances in applied mathematics, ISSN 0196-8858, 2009, vol. 42, iss. 2, str. 157-175 [COBISS.SI-ID 15545945]

– KONVALINKA, Matjaž. Skew quantum Murnaghan-Nakayama rule. Journal of algebraic combinatorics, ISSN 0925-9899, 2012, vol. 35, no. 4, str. 519-545 [COBISS.SI-ID 16250713]

– KONVALINKA, Matjaž. On quantum immanants and the cycle basis of the quantum permutation space. Annals of combinatorics, ISSN 0218-0006, 2012, vol. 16, no. 2, str. 289-304 [COBISS.SI-ID 16310873]

Primož Potočnik:

- POTOČNIK, Primož. Edge-colourings of cubic graphs admitting a solvable vertex-transitive group of automorphisms. *Journal of combinatorial theory. Series B*, ISSN 0095-8956, 2004, vol. 91, no. 2, str. 289-300 [COBISS.SI-ID 13087321]
- POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. Cubic vertex-transitive graphs on up to 1280 vertices. *Journal of symbolic computation*, ISSN 0747-7171, 2013, vol. 50, str. 465-477 [COBISS.SI-ID 16520537]
- POTOČNIK, Primož. Tetravalent arc-transitive locally-Klein graphs with long consistent cycles. *European journal of combinatorics*, ISSN 0195-6698, 2014, vol. 36, str. 270-281 [COBISS.SI-ID 16862041]

LINEARNA ALGEBRA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------|
| Predmet: | Linearna algebra |
| Course title: | Linear algebra |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-----------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 1. letnik | Celoletni | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039516 |
| Koda učne enote na članici/UL Member course code: | 27203 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 60 | | 60 | | | 180 | 10 |

| | |
|-----------------------------------|---|
| Nosilec predmeta/Lecturer: | David Dolžan, Jakob Cimprič, Klemen Šivic |
|-----------------------------------|---|

| | |
|------------------------------------|-----------------------------------|
| Vrsta predmeta/Course type: | obvezni predmet/compulsory course |
|------------------------------------|-----------------------------------|

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|-----------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| | |

Vsebina:

Prvi semester (obveznosti za 5 ECTS):
Vektorji v R^n . Osnove analitične geometrije.
Matrike in determinante. Sistemi linearnih enačb.
Osnovne algebraične strukture.
Vektorski prostori, linearna neodvisnost, baze.
Linearne preslikave in njihove matrike.
Drugi semester (obveznosti za 5 ECTS):
Lastne vrednosti in lastni vektorji matrik.
Diagonalizacija in Jordanova kanonična forma.
Vektorski prostori s skalarnim produktom, ortonormirane baze. Adjungirana preslikava.
Simetrične, normalne in ortogonalne matrike.
Kvadratne forme. Krivulje in ploskve 2. reda.

Content (Syllabus outline):

First semester (5 ECTS)
Vectors in R^n . Fundamentals of analytic geometry.
Matrices and determinants. Systems of linear equations.
Basic algebraic structures.
Vector spaces, linear independence, bases.
Linear transformations and their matrices.
Second semester (5 ECTS)
Eigenvalues and eigenvectors of matrices.
Diagonalization and Jordan canonical form.
Inner product spaces, orthonormal bases, adjoint of a linear transformation.
Symmetric, normal and orthogonal matrices.
Quadratic forms. Curves and surfaces of degree two.

Temeljna literatura in viri/Readings:

Učbeniki in zbirke vaj (Textbooks and problem sets)

J. Grasselli, A. Vadnal: Linearna algebra, linearno programiranje, DMFA založništvo, Ljubljana, 1986.
 S. I. Grossman, Elementary linear algebra with applications, McGraw-Hill 1994.
 E. Kramar, Rešene naloge iz linearne algebre, DMFA, Ljubljana 1994.
 M. Dobovišek, D. Kobal, B. Magajna, Naloge iz algebre I, DMFA, Ljubljana, 2000.
 S. Lipschutz: Linear Algebra (Schaum's O.S.), McGraw-Hill, New York 1968.
 Elektronski viri (Electronic sources)
 Tomaž Košir, Algebra 1, <http://www.fmf.uni-lj.si/~kosir/poucevanje/0910/alg1-fm.html>
 Bojan Orel, Linearna algebra, <http://matematika.fri.uni-lj.si/LA/la1.pdf>

Cilji in kompetence:

Študentje spoznajo osnovne pojme iz linearne algebre, potrebne pri nadaljnjem študiju: osnove dvo- in tro-razsežne evklidske geometrije, matrično algebro, reševanje sistemov linearnih enačb, računanje s polinomi in osnovne elemente abstraktne algebre. Naučijo se matematičnega načina razmišljanja in pridobijo praktično in delovno znanje s področja linearne algebre.

Objectives and competences:

Students get familiar with the basic concepts of linear algebra, necessary for further study: basics of two and three-dimensional euclidean geometry, matrix algebra, solving systems of linear equations, calculating with polynomials and basic elements of abstract algebra. They learn a mathematical way of thinking and achieve practical and working knowledge from the field of linear algebra.

Predvideni študijski rezultati:

Poznavanje in razumevanje osnovnih pojmov in postopkov linearne algebre. Sposobnost uporabe pridobljenega znanja v matematiki in drugod.

Intended learning outcomes:

Familiarity with basic notions and algorithms of Linear algebra. Ability to apply the knowledge in mathematics and elsewhere.

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge, konzultacije.

Learning and teaching methods:

Lectures, tutorials, homework assignments, consultations.

Načini ocenjevanja:

Delež/Weight

Assessment:

| | | |
|----------------------------|---------|--------------------------------|
| Način: pisni izpit, naloge | 50,00 % | Type: Written exam, coursework |
| ustno izpraševanje | 50,00 % | Oral exam |

Reference nosilca/Lecturer's references:

Jakob Cimprič:
 – CIMPRič, Jaka. Strict positivstellensätze for matrix polynomials with scalar constraints. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2011, vol. 434, iss. 8, str. 1879-1883 [COBISS.SI-ID 15863385]
 – CIMPRič, Jaka. Archimedean operator-theoretic Positivstellensätze. Journal of functional analysis, ISSN 0022-1236, 2011, vol. 260, iss. 10, str. 3132-3145 [COBISS.SI-ID 15997529]
 – CIMPRič, Jaka. Real algebraic geometry for matrices over commutative rings. Journal of algebra, ISSN 0021-8693, 2012, vol. 359, str. 89-103 [COBISS.SI-ID 16315993]
 Klemen Šivic:
 - JELISIEJEW, Joachim, ŠIVIC, Klemen. Components and singularities of Quot schemes and varieties of commuting matrices. Journal für die Reine und Angewandte Mathematik. 2022, vol. 2022, iss. 788, str. 129-187. ISSN 0075-4102. [COBISS.SI-ID 117558275]
 - BUCKLEY, Anita, ŠIVIC, Klemen. New examples of extremal positive linear maps. Linear algebra and its applications. Aug. 2020, vol. 598, str. 110-144. ISSN 0024-3795. [COBISS.SI-ID 16956675]
 -KANDIĆ, Marko, ŠIVIC, Klemen. On the dimension of the algebra generated by two positive semicommuting matrices. Linear algebra and its applications. 2017, vol. 512, str. 136-161. ISSN 0024-3795. [COBISS.SI-ID 17776985]
 David Dolžan:
 - DOLŽAN, David. The probability of zero multiplication in finite rings. Bulletin of the Australian Mathematical Society, ISSN 0004-9727, 2022, vol. 106, no. 1, str. 83-88. [COBISS-SI-ID 94750723]
 - DOLŽAN, David. Bounds for the number of idempotents in finite rings. Communications in algebra, ISSN 0092-7872, 2021, vol. 49, no. 11, str. 4800-4807, 2021. [COBISS-SI-ID 65073923]

- DOLŽAN, David. Zero-divisor graph of direct products of matrices over semirings. Journal of algebra and its applications, ISSN 0219-4988, 2021, vol. 20, no. 5, 10 str. [COBISS-SI-ID 22818819]

MATEMATIČNO MODELIRANJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-------------------------|
| Predmet: | Matematično modeliranje |
| Course title: | Mathematical Modelling |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039567 |
| Koda učne enote na članici/UL Member course code: | 27224 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: Emil Žagar, George Mejak

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

Reševanje problemov s programskim paketom Matlab: osnove programskega paketa Matlab, delo z matrikami in polji, grafika, pisanje programskih in funkcijskih datotek, pregled osnovnih Matlabovih knjižnic (reševanje linearnih in nelinearnih sistemov enačb, optimizacija, numerično integriranje in reševanje diferencialnih enačb, delo z razpršenimi matrikami), uporaba programskega paketa Matlab pri reševanju preprostih problemov.

Optimizacija: reševanje problemov, vezanih na iskanje ekstremov funkcij (diskretna verižnica, simetrična diskretna verižnica, simetrična verižnica s sodo in liho mnogo členki).

Variacijski račun: problem brahistohrone, zvezna verižnica, posplošeni problem brhistohrone.

Content (Syllabus outline):

Problem solving using Matlab package: introduction into Matlab package, manipulation of matrices and arrays, graphics, writing scripts and functions, overview of basic Matlab toolboxes (numerical solution of systems of linear and nonlinear equations, optimization, numerical integration and numerical solution of ordinary differential equations, sparse matrices), Matlab as a tool for solving some simple problems.

Optimization: solving problems based on constrained optimization (discrete catenary, symmetric discrete catenary, symmetric discrete catenary having an odd or even number of segments).

Calculus of variations: brachistochrone problem, catenary, minimal rotational surface.

Simulations: basics of pseudorandom number generation and simple simulations.

| | |
|--|--|
| <p>Simulacije: osnove generiranja psevdonaključnih števil in preproste simulacije. Osnove računalniško podprtega geometrijskega oblikovanja: polinomske parametrične krivulje, Bernstein-Bezierjeva reprezentacija, de Casteljauov algoritem, zlepki Bezierjevih krivulj.</p> | <p>Basics of computer aided geometric design: parametric polynomial curves, Bernstein-Bezier representation, de Casteljau algorithm, Bezier spline curves.</p> |
|--|--|

Temeljna literatura in viri/Readings:

| |
|---|
| <p>E. Zakerajšek: <i>Matematično modeliranje, DMFA-založništvo, Ljubljana, 2004.</i> D. J. Higham, N. J. Higham: <i>Matlab Guide, 2nd edition, SIAM, Philadelphia, 2005.</i> B. Jurčič Zlobec, A. Berkopec: <i>Matlab z uvodom v numerične metode, Založba FE in FRI, Ljubljana, 2005.</i> V. M. Tikhomirov: <i>Stories About Maxima and Minima, AMS, Providence, 1991.</i> D. E. Knuth: <i>The Art of Computer Programming II : Seminumerical Algorithms, Addison-Wesley, Reading, 1981.</i></p> |
|---|

Cilji in kompetence:

| | |
|---|---|
| <p>Slušatelj spozna osnovne pristope za reševanje problemov matematičnega modeliranja, nauči se uporabljati Matlab kot orodje in kritično presojati dobljene rezultate. Podrobneje spozna nekaj problemov, ki temeljijo na iskanju ekstremov gladkih funkcij, problemov iz variacijskega računa, statistike in simulacij.</p> | <p>Objectives and competences: Slušatelj spozna osnovne pristope za reševanje problemov matematičnega modeliranja, nauči se uporabljati Matlab kot orodje in kritično presojati dobljene rezultate. Podrobneje spozna nekaj problemov, ki temeljijo na iskanju ekstremov gladkih funkcij, problemov iz variacijskega računa, statistike in simulacij.</p> |
|---|---|

Predvideni študijski rezultati:

| | |
|---|--|
| <p>Znanje in razumevanje: Poznavanje osnov programiranja v programskem paketu Matlab. Sposobnost reševanja nekaterih preprostih problemov matematičnega modeliranja s pomočjo Matlaba. Poznavanje teoretičnih osnov za praktično iskanje ekstremov gladkih funkcij, reševanje nalog variacijskega računa ter izvajanje statističnih testov in simulacij. Uporaba: Uporaba programskega paketa Matlab kot orodja za reševanje preprostejših problemov, ki slonijo na matematičnih modelih. Refleksija: Razumevanje teorije na podlagi izkušenj praktičnega dela (programiranja). Prenosljive spretnosti – niso vezane le na en predmet: Spretnost uporabe računalnika, posebej paketa Matlab. Poznavanje osnovnih pristopov za reševanje matematičnih problemov in kritično presojanje rezultatov. Predmet nadgrajuje znanja iz mnogih predmetov študija matematike (analiza, algebra, programiranje ...)</p> | <p>Intended learning outcomes: Knowledge and understanding: Basic programming in Matlab. Capability of solving some simple problems of mathematical modelling using Matlab. Understandig of theoretical fundamentals to solve problems involving scalar field extrema, capability of solving problems in calculus of variations and skills in implementation of statistical simulations. Application: Using Matlab package as a tool for solving some simple problems arising from mathematical models. Reflection: Understanding theory through practical experiments (computer programme coding). Transferable skills: Capability of using computer software, particularly Matlab package. Understanding of basic approaches for solving mathematical problems and evaluation of results. The subject upgrades the knowledge obtained from several other subjects of mathematical studies (analysis, algebra, programming,...)</p> |
|---|--|

Metode poučevanja in učenja:

| | |
|---|--|
| <p>predavanja, vaje, domače naloge, laboratorijsko delo, konzultacije, samostojna izdelava projekta</p> | <p>Learning and teaching methods: Lectures, exercises, homework, laboratory work, consultations, individual projects</p> |
|---|--|

Načini ocenjevanja:

| | | |
|--|----------------------------|--|
| <p>Način (pisni izpit, ustno izpraševanje, naloge, projekt):</p> | <p>Delež/Weight</p> | <p>Assessment: Type (examination, oral, coursework, project): 2 homeworks and a project instead of written exam,</p> |
|--|----------------------------|--|

| | | |
|---|---------|--|
| 2 domači nalogi in projekt namesto izpita iz vaj, izpit iz vaj, | 50,00 % | written exam |
| izpit iz teorije | 50,00 % | oral exam |
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | Type (examination, oral, coursework, project): 2 homeworks and a project instead of written exam, written exam oral exam grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

George Mejak:

– MEJAK, George. Finite element solution of a model free surface problem by the optimal shape design approach. International journal for numerical methods in engineering, ISSN 0029-5981. [Print ed.], 1997, vol. 40, str. 1525-1550 [COBISS.SI-ID 9983833]

– MEJAK, George. Two scale finite element method. V: 21st International congress of theoretical and applied mechanics, August 15-21, 2004, Warsaw, Poland. ICTAM04 : abstracts and CD-ROM proceedings. Warszawa: IPPT PAN, 2004, str. 209 [COBISS.SI-ID 13216857]

– MEJAK, George. Eshebly tensors for a finite spherical domain with an axisymmetric inclusion. European journal of mechanics. A, Solids, ISSN 0997-7538. [Print ed.], 2011, vol. 30, iss. 4, str. 477-490 [COBISS.SI-ID 16025177]

Emil Žagar:

– JAKLIČ, Gašper, ŽAGAR, Emil. Curvature variation minimizing cubic Hermite interpolants. Applied mathematics and computation, ISSN 0096-3003. [Print ed.], 2011, vol. 218, iss. 7, str. 3918-3924 [COBISS.SI-ID 16049241]

– JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. An approach to geometric interpolation by Pythagorean-hodograph curves. Advances in computational mathematics, ISSN 1019-7168, 2012, vol. 37, no. 1, str. 123-150 [COBISS.SI-ID 16051289]

– JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. Hermite geometric interpolation by rational Bézier spatial curves. SIAM journal on numerical analysis, ISSN 0036-1429, 2012, vol. 50, no. 5, str. 2695-2715 [COBISS.SI-ID 16449369]

MODELIRANJE RAČUNALNIŠKIH OMREŽIJ

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-----------------------------------|
| Predmet: | Modeliranje računalniških omrežij |
| Course title: | Computer Networks Modeling |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039625 |
| Koda učne enote na članici/UL Member course code: | 63257 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Miha Mraz

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

Predavanja:

- Uvod (zahteve, strežniki, čakalne vrste, komunikacijska pot, ciklični proces simulacijske analize)
- Teorija strelbe (Kendallova notacija, Littleovo pravilo, uporabnostni faktor, prostor stanj, časovni prostor, intenzivnost prihajanja in strelbe, rojstno smrtni proces, vzorčne strelne enote, strelba s prioriteto, strelne mreže)
- Petrijeve in barvne Petrijeve mreže (definicija, drevo označitev, dosegljivost stanj, primeri modelov s področja računalništva in računalniških omrežij, varnost, omejenost, konservativnost)

Content (Syllabus outline):

Lectures:

- Introduction (requests, servers, queues, communication path, cyclic process of simulation analysis)
- Theory of service (Kendall's notation, Little's rule, utility factor, state space, time space, intensity of arrival and service, birth-death process, sample service units, priority service, service networks)
- Petri and colored Petri nets (definition, marking tree, reachability of states, examples of models from the field of computer science and computer safeness, limitation, conservatism)

| | |
|--|---|
| <ol style="list-style-type: none"> 4. Metrike in orodja za ocenjevanje zmogljivosti omrežij (latenca, število skokov paketov, energetska učinkovitost) 5. Pridobivanje vrednosti kvantitativnih spremenljivk omrežja 6. Kvalitativne metrike za ocenjevanje delovanja omrežij 7. Modeli generiranja prometa v računalniških omrežjih <p>Vaje: Namen vaj pri navedenem predmetu je predvsem v predstavitvi uporabe zgoraj navedenih teoretičnih osnov na reševanju praktičnih problemov s področja računalniških omrežij. V ta namen se bodo uporabljala na vajah ustrezna programska orodja (npr. OpNet, NS2, OMNeT++, TETCOS, GTNetS, itd.).</p> | <ol style="list-style-type: none"> 4. Metrics and tools for evaluating network performance (latency, number of packet hops, energy efficiency) 5. Obtaining the values of quantitative variables of the network 6. Qualitative metrics for evaluating network performance 7. Traffic generation models in computer networks <p>Laboratory courses: Methods and approaches presented during the lectures will be demonstrated on practical computer network examples during the laboratory courses. Different software tools will be used such as OpNet, NS2, OMNeT++, TETCOS, GTNetS, etc.</p> |
|--|---|

Temeljna literatura in viri/Readings:

1. M. Mraz: Modeliranje računalniških omrežij (e-učbenik), 169 strani, <https://ucilnica.fri.uni-lj.si/course/view.php?id=84>, 2023
2. J.F.Shortle, J.M.Thomson, D.Gross, C.M.Harris: Fundamentals of queueing theory, John Wiley and Sons Inc., 2018
3. G.Giambene: Queueing theory and Telecommunications, Springer, 2021

Cilji in kompetence:

Cilj predmeta je študentom računalništva in informatike predstaviti osnovne metode izgradnje modelov in izvajanja simulacij z zornega kota računalniških omrežij. S teoretičnega vidika temelji predmet na splošni teoriji strežbe, ki študente seznanja s problematiko zahtev, strežnikov (resursov), čakalnih vrst, ozkih grl, itd. S praktičnega vidika bo študentom predstavljen prenos teoretičnega znanja na reševanje praktičnih problemov, do katerih prihaja na področju računalniških omrežij.

Ostale kompetence:
Razvoj spretnosti v analitičnem in sinteznem razmišljanju
Praktično obvladovanje sestavnih delov računalniških sistemov za uspešno profesionalno delo
Zmožnost razumevanja in reševanja profesionalnih problemov
Zmožnost uporabe in nadgradnje znanja pri samostojnem delu

Objectives and competences:

Objective of the course is to present the basics in modelling and simulation of computer networks to the students of computer and information science. The course is based on the theory of service which acknowledges the students with the terms such as demands, serving units (resources), queues, bottlenecks etc. Students will learn the practical values of theoretical knowledge on the problems that arise in the field of computer networks.

Other competences:
Developing skills in critical, analytical and synthetic thinking.
Practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science.
The ability to understand and solve professional challenges in computer and information science.
The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.

Predvideni študijski rezultati:

Po uspešnem zaključku tega predmeta bo študent: razumel osnovne koncepte modeliranja in simulacij, poznal osnove teorije strežbe, poznal osnove modeliranja delovanja komunikacijskih protokolov, sposoben oceniti ali pridobiti kvantitativne vrednosti modeliranega omrežja,

Intended learning outcomes:

After the completion of the course a student will be able to:

- understand the basics of modelling and simulation,
- know the basics of service theory,
- know the basics of the modelling of communication protocols,

| | |
|--|---|
| sposoben identificirati sestavne dele omrežja in njegove zmogljivostne karakteristike sposoben postavitve modela računalniškega omrežja kot celote in ocene njegove zmogljivosti ter ozkih grl. | - will be capable to assess or acquire the quantitative properties of modelled network, - will be able to identify the composition of the network and its capabilities, - will be able to construct the model of a computer network and asses its capabilities and bottlenecks. |
|--|---|

Metode poučevanja in učenja:

Predavanja bodo potekala ustno, vaje v obliki projektne dela na konkretnih aplikativnih zgledih.

Learning and teaching methods:

Lectures and oral presentations of the subject.
Seminal work on real-life examples and problems.

Načini ocenjevanja:
Delež/Weight
Assessment:

| | | |
|--|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, midterm exams, project work) |
| Končno preverjanje (ustni izpit) | 50,00 % | Final (oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

1. MOŠKON, Miha, PUŠNIK, Žiga, STANOVNIK, Lidija, ZIMIC, Nikolaj, MRAZ, Miha. A computational design of a programmable biological processor. *Biosystems*. Nov. 2022, vol. 221, str. 1-12.
2. REŽEN, Tadeja, MARTINS, Alexandre, MRAZ, Miha, ZIMIC, Nikolaj, ROZMAN, Damjana, MOŠKON, Miha. Integration of omics data to generate and analyse COVID-19 specific genome-scale metabolic models. *Computers in Biology and Medicine*. [Print ed.]. Jun. 2022, vol. 145, str. 1-10.
3. MOŠKON, Miha, MRAZ, Miha. Programmable evolution of computing circuits in cellular populations. *Neural computing & applications*. Nov. 2022, vol. 34, iss. 21, str. 19239-19251.
4. WALAKIRA, Andrew, ROZMAN, Damjana, REŽEN, Tadeja, MRAZ, Miha, MOŠKON, Miha. Guided extraction of genome-scale metabolic models for the integration and analysis of omics data. *Computational and Structural Biotechnology Journal*. 2021, vol. 19, str. 3521-3530.
5. BORDON, Jure, MOŠKON, Miha, ZIMIC, Nikolaj, MRAZ, Miha. Semi-quantitative modelling of gene regulatory processes with unknown parameter values using fuzzy logic and Petri nets. *Fundamenta informaticae*. 2018, vol. 160, no. 1/2, str. 81-100.

Celotna bibliografija je dostopna na SICRISu.

MODULSKI IZBIRNI PREDMET 1/3

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------|
| Predmet: | Modulski izbirni predmet 1/3 |
| Course title: | |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0101002 |
| Koda učne enote na članici/UL Member course code: | 0012 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

| | |
|----------------------|--|
| Predavanja/Lectures: | |
| Vaje/Tutorial: | |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

| | |
|--|--|
| | |
|--|--|

Content (Syllabus outline):

Temeljna literatura in viri/Readings:

| |
|--|
| |
|--|

Cilji in kompetence:

| | |
|--|--|
| | |
|--|--|

Objectives and competences:

Predvideni študijski rezultati:

| | |
|--|--|
| | |
|--|--|

Intended learning outcomes:

Metode poučevanja in učenja:

| | |
|--|--|
| | |
|--|--|

Learning and teaching methods:

Načini ocenjevanja:

Delež/Weight Assessment:

| | | |
|--|--|--|
| | | |
|--|--|--|

Reference nosilca/Lecturer's references:

| |
|--|
| |
|--|

MODULSKI IZBIRNI PREDMET 2/3

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------|
| Predmet: | Modulski izbirni predmet 2/3 |
| Course title: | |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0101003 |
| Koda učne enote na članici/UL Member course code: | 0013 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

| | |
|----------------------|--|
| Predavanja/Lectures: | |
| Vaje/Tutorial: | |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

| | |
|--|--|
| | |
|--|--|

Content (Syllabus outline):

Temeljna literatura in viri/Readings:

| |
|--|
| |
|--|

Cilji in kompetence:

| | |
|--|--|
| | |
|--|--|

Objectives and competences:

Predvideni študijski rezultati:

| | |
|--|--|
| | |
|--|--|

Intended learning outcomes:

Metode poučevanja in učenja:

| | |
|--|--|
| | |
|--|--|

Learning and teaching methods:

Načini ocenjevanja:

Delež/Weight Assessment:

| | | |
|--|--|--|
| | | |
|--|--|--|

Reference nosilca/Lecturer's references:

| |
|--|
| |
|--|

MODULSKI IZBIRNI PREDMET 3/3

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------|
| Predmet: | Modulski izbirni predmet 3/3 |
| Course title: | |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0101005 |
| Koda učne enote na članici/UL Member course code: | 0014 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

| | |
|----------------------|--|
| Predavanja/Lectures: | |
| Vaje/Tutorial: | |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

| | |
|--|--|
| | |
|--|--|

Content (Syllabus outline):

Temeljna literatura in viri/Readings:

| |
|--|
| |
|--|

Cilji in kompetence:

| | |
|--|--|
| | |
|--|--|

Objectives and competences:

Predvideni študijski rezultati:

| | |
|--|--|
| | |
|--|--|

Intended learning outcomes:

Metode poučevanja in učenja:

| | |
|--|--|
| | |
|--|--|

Learning and teaching methods:

Načini ocenjevanja:

Delež/Weight Assessment:

| | | |
|--|--|--|
| | | |
|--|--|--|

Reference nosilca/Lecturer's references:

| |
|--|
| |
|--|

MULTIMEDIJSKI SISTEMI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-----------------------|
| Predmet: | Multimedijski sistemi |
| Course title: | Multimedia Systems |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0070361 |
| Koda učne enote na članici/UL Member course code: | 63270 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Luka Čehovin Zajc

Vrsta predmeta/Course type: izbirni predmet/elective course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|-----------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| | |

Vsebina:

- Predavanja:**
1. Pregled področja Multimedijskih sistemov in izzivi
 2. Manipulacija slikovnih gradiv
 3. Manipulacija video podatkov in standardi zapisa video podatkov
 4. Pridobivanje informacij s tekstom
 5. Arhitektura sistema za pridobivanje multimedijskih informacij
 6. Evalvacija multimedijskih sistemov za pridobivanje informacij
 7. Metode za avtomatsko opisovanje vsebine slik
 8. Razgradnja slikovne informacije
 9. Razgradnja video informacije
 10. Interaktivni mediji in obogatena resničnost v multimedijskem sistemu
 11. Standardi za brezizgubno stiskanje multimedijskih vsebin

Content (Syllabus outline):

- Lectures:**
1. Introduction to multimedia, overview of the field and challenges
 2. Manipulation of image data
 3. Video standards and manipulation of video data
 4. Text-based information retrieval
 5. Architecture of multimedia information retrieval
 6. Evaluation of multimedia systems for information retrieval
 7. Automatic image content description
 8. Segmentation of image content
 9. Segmentation of video content
 10. Interactive media and augmented reality in multimedia systems
 11. Lossless compression standards in multimedia
 12. Lossy compression standards in multimedia
- Exercises and seminar:**

| | |
|--|--|
| <p>12. Standardi za izgubno stiskanje multimedijskih vsebin</p> <p>Vaje in seminar:</p> <p>Vaje bodo potekale v obliki projektno-orientiranih nalog in seminarjev v primerno opremljenih študentskih laboratorijih. Študentje v okviru projektov samostojno implementirajo algoritme, ki jih obravnavamo na predavanjih in jih preizkušajo na različnih naborih podatkov zajetih z različnimi senzorskimi sistemi. Sprotno in obvezno delo na projektih omogoča poglobljeno in kritično razumevanje obravnavane tematike, spodbuja pa tudi samostojno mišljenje in kreativnost.</p> | <p>Exercises will take a form of project-oriented exercises and seminars in properly equipped student laboratories. Students will implement various algorithms, that will be covered in lectures, and test them on different datasets using a variety of sensor systems. Exercises will support an in-depth understanding of the theory. They will also encourage independent thinking and creativity.</p> |
|--|--|

Temeljna literatura in viri/Readings:

| |
|--|
| <p>Obvezna:</p> <ul style="list-style-type: none"> • Mark S. Li Ze-Nian and Drew, Fundamentals of Multimedia, Prentice-Hall of India (2005) • C. D. Manning, P. Raghavan, H. Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008 <p>Dopolnilna:</p> <ul style="list-style-type: none"> • A. Del Bimbo: Visual Information Retrieval, Morgan Kaufmann 1999, ISBN 1-55860-624-6. <p>Članki iz revij, kot npr. IEEE Multimedia. (dostopno na spletu)</p> |
|--|

Cilji in kompetence:

| | |
|---|---|
| <p>Multimedijski sistemi so nepogrešljiv del sodobnih informacijskih tehnologij. Študenti naj bi v okviru tega predmeta pridobili znanja in veščine potrebne za uporabo, načrtovanje in razvoj multimedijskih sistemov. Obravnavani bodo problemi učinkovitih predstavitev in obdelave več predstavitev in podatkov, kot so besedilo, grafika, animacije, slike in video.</p> <p>Polega tega bodo študenti osvojili naslednje kompetence:</p> <p>Sposobnost razumevanja in reševanja strokovnih izzivov s področja računalništva in informatike</p> <p>Sposobnost strokovne komunikacije v materinem in tujem jeziku.</p> <p>Sposobnost neodvisnega reševanja tako manj zahtevnih kakor kompleksnih inženirskih in organizacijskih problemov iz ozkih področij, kakor tudi specifičnih dobro definiranih problemov s področja računalništva in informatike.</p> | <p>Objectives and competences:</p> <p>Multimedia systems are an indispensable part of modern information technology. In the framework of this course, the students will acquire knowledge and skills needed for use, design and development of multimedia systems. The course will also deal with the problems related to efficient representations and processing multimedia data, such as text, graphics, animations, images, and video.</p> <p>In addition, the students will obtain the following competences:</p> <ul style="list-style-type: none"> • The ability to understand and solve professional challenges in computer and information science. • The ability of professional communication in the native language as well as a foreign language. • The ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science. |
|---|---|

Predvideni študijski rezultati:

| | |
|--|--|
| <p>Po uspešnem zaključku predmeta naj bi študenti:</p> <ul style="list-style-type: none"> - razumeli osnove razgradnje in preoblikovanja slik za uporabo v informacijskih in multimedijskih sistemih, - razumeli osnove sistemov za pridobivanje informacij na podlagi teksta, - bili sposobni implementirati sisteme za avtomatsko razgradnjo videa in sisteme za poizvedovanje po video vsebini, - razumeli osnovne postopke stiskanja slik in videa, ki se uporabljajo v standardnih kodekih. | <p>Intended learning outcomes:</p> <p>After completing this course a students will be able to:</p> <ul style="list-style-type: none"> - understand the basics of image decomposition and transformation for use in information and multimedia systems, - understand the basics of text-based information retrieval systems, - implement systems for automatic video decomposition and video querying, - understand the basics of image and video compression used in standard codecs, |
|--|--|

| | |
|--|---|
| - razumeli osnove obogatene resničnosti in bili sposobni načrtovati sisteme obogatene resničnosti z markerjem. - poznal algoritmično ozadje računalniških tehnologij in računalniških metodologij značilne za mnoge aplikacije multimedijskih sistemov. | - understand the basics of augmented reality and be able to design marker-based augmented reality systems, - know the algorithmic background of computer technologies and methodologies specific for modern multimedia applications. |
|--|---|

Metode poučevanja in učenja:

Predavanja, laboratorijske vaje v računalniški učilnici z aktivnim sodelovanjem. Individualno delo na vajah. Teorija s predavanj se praktično analizira na vajah. Poseben poudarek je na sprotnem študiju in sprotnem delu pri vajah.

Learning and teaching methods:

Lectures, laboratory exercises in computer classroom with active participation. Individual work on exercises. Theory from the lectures made concrete with hands-on laboratory exercises. Special emphasis will be put on continuous assessment at exercises.

Načini ocenjevanja:

Delež/Weight

Assessment:

| Način (pisni izpit, ustno izpraševanje, vaje): | Delež/Weight | Assessment: |
|--|--------------|---|
| Sprotno preverjanje (domače naloge in laboratorijske vaje) | 50,00 % | Type (examination, oral, laboratory exercises): Continuing (homework and laboratory exercises) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

LUKEŽIČ, Alan, ČEHOVIN ZAJC, Luka, VOJÍŘ, Tomáš, MATAS, Jiří, KRISTAN, Matej. Performance evaluation methodology for long-term single-object tracking. *IEEE transactions on cybernetics*. [Print ed.]. 2020, vol. , no. , str. 1-14, ilustr. ISSN 2168-2267. [COBISS.SI-ID 1538564803]

ČEHOVIN ZAJC, Luka. TraX : the visual Tracking eXchange protocol and library. *Neurocomputing*. [Print ed.]. Oct. 2017, vol. 260, str. 5-8, ilustr. ISSN 0925-2312. [COBISS.SI-ID 1537470147],

LUKEŽIČ, Alan, ČEHOVIN ZAJC, Luka, KRISTAN, Matej. Deformable parts correlation filters for robust visual tracking. *IEEE transactions on cybernetics*, ISSN 2168-2267, 2017, vol. , no. , str. 1-13, [COBISS.SI-ID [1537625283](#)],

KRISTAN, Matej, MATAS, Jiří, LEONARDIS, Aleš, VOJÍŘ, Tomáš, PFLUGFELDER, Roman, FERNÁNDEZ, Gustavo, NEBEHAY, Georg, PORIKLI, Fatih, ČEHOVIN ZAJC, Luka. A novel performance evaluation methodology for single-target trackers. *IEEE transactions on pattern analysis and machine intelligence*, ISSN 0162-8828. [Print ed.], Nov. 2016, vol. 38, no. 11, str. 2137-2155, [COBISS.SI-ID [1536872643](#)]

KRISTAN, Matej, LEONARDIS, Aleš. Online discriminative kernel density estimator with Gaussian kernels. *IEEE transactions on cybernetics*, vol. 44, (3), 2014, str. [355-365], [COBISS.SI-ID [9907284](#)]

ČEHOVIN, Luka, KRISTAN, Matej, LEONARDIS, Aleš. Robust visual tracking using an adaptive coupled-layer visual model. *IEEE trans. pattern anal. mach. intell.*. [Print ed.], 2012, str. [1-14], [COBISS.SI-ID [9431124](#)]

Celotna bibliografija je dostopna na SICRISu:

<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=32801>.

NUMERICNE METODE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-------------------|
| Predmet: | Numerične metode |
| Course title: | Numerical methods |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039531 |
| Koda učne enote na članici/UL Member course code: | 27215 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 45 | | | 120 | 7 |

Nosilec predmeta/Lecturer: Bor Plestenjak, Emil Žagar, Marjetka Knez

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

Uvod v numerično računanje. Izvori napak pri numeričnem računanju. Občutljivost problemov, konvergenca metod in stabilnost računskih procesov. Ocena za celotno napako.
Reševanje nelinearnih enačb. Bisekcija. Splošna iteracija. Tangentna in sekantna metoda. Reševanje algebraičnih enačb. Reševanje sistemov nelinearnih enačb. Splošna iteracija. Newtonova metoda.
Reševanje sistemov linearnih enačb. Vektorske in matrične norme. Občutljivost. Ocena za napako. Gaussova eliminacijska metoda. Pivotiranje. Posebni linearni sistemi.
Linearni problem najmanjših kvadratov. Predoločeni sistemi. Normalni sistem. Ortogonalni razcep. Givensove rotacije in Householderjeve transformacije. Singularni razcep. Pseudoinverz. Uporaba singularnega razcepa. Regularizacija. Nelinearni problem najmanjših kvadratov.

Content (Syllabus outline):

Introduction to numerical computations. Sources of errors in numerical computing. Stability of problems, convergence of methods and stability of computational processes. Error bounds.
Solving of nonlinear systems. Bisection. Iteration. Tangent and secant method. Solving of algebraic equations. Solving systems of nonlinear equations. Iteration. Newton method.
Solving of systems of linear equations. Vector and matrix norms. Stability. Error bounds. Gauss elimination. Pivoting. Special linear systems. Linear least squares problem. Predetermined systems. Normal equations. QR decomposition. Givens rotations and Householder reflections. Singular value decomposition. Pseudoinverse. SVD applications. Regularization. Nonlinear least square problem.

| | |
|--|--|
| Računanje z večdimenzionalnimi matrikami (tenzorji). Predstavitev različnih formatov in metod za aproksimacijo s tenzorji nizkega ranga. | Computation with multidimensional matrices (tensors). Introduction to different forms and methods for approximation with low rank tensors. |
|--|--|

Temeljna literatura in viri/Readings:

| |
|--|
| <p>B. Plestenjak: <i>Razširjen vvod v numerične metode, DMFA – založništvo, Ljubljana, 2015</i></p> <p>M. T. Heath, <i>Scientific Computing: An Introductory Survey</i>, McGraw-Hill, Boston, 2002.</p> <p>J. W. Demmel: <i>Uporabna numerična linearna algebra, DMFA-založništvo, Ljubljana, 2000.</i></p> <p>G.H. Golub, C. F. Van Loan: <i>Matrix Computations</i>, 4th edition, Johns Hopkins Univ. Press, Baltimore, 2013</p> <p>B. N. Datta: <i>Numerical Linear Algebra and Applications</i>, Brooks/Cole, Pacific Grove, 1995.</p> |
|--|

Cilji in kompetence:

Študent spozna osnove numeričnega računanja in dopolni poznavanje analitičnih metod za reševanje nelinearnih enačb in sistemov linearnih enačb z nekaterimi najbolj znanimi numeričnimi metodami. Pri vajah in z domačimi nalogami se pridobljeno znanje praktično utrdi kot tudi spozna programsko opremo, namenjeno predvsem numeričnem računanju.

Objectives and competences:

Student learns basic facts on numerical computation and analytical methods for solving nonlinear equations and systems of linear equations with some of well known numerical methods. In tutorial and homework the gained knowledge is increased and computer software, used by numerical computations, is applied.

Predvideni študijski rezultati:

Znanje in razumevanje:
Razumevanje računanja s plavajočo vejico in izvorov napak pri numeričnem računanju. Obvladaje osnovnih algoritmov za reševanje linearnih in nelinearnih sistemov. Znanje programiranja in uporabe Matlaba oz. drugih sorodnih orodij za reševanje tovrstnih problemov.

Intended learning outcomes:

Knowledge and understanding:
Understanding of computation in floating point arithmetics and causes of errors in numerical computations. Knowledge of basic algorithms for solving systems of linear equations and systems of nonlinear equations. Programming and use of Matlab and other similar tools for solving these kinds of problems.

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge, konzultacije.

Learning and teaching methods:

Lectures, tutorial, homework, consultations.

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|--------------|--|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt) | | Type (examination, oral, coursework, project): |
| pisni izpit | 30,00 % | written exam |
| ustni izpit | 50,00 % | oral exam |
| 2 domači nalogi | 20,00 % | 2 homeworks |
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | grades: 5 (negative), 6-10 (positive) (by The statues of UL) |

Reference nosilca/Lecturer's references:

| |
|---|
| <p>Marjetka Knez:</p> <p>– KOZAK, Jernej, KRAJNC, Marjetka. Geometric interpolation by planar cubic polynomial curves. <i>Computer Aided Geometric Design</i>, ISSN 0167-8396, 2007, vol. 24, no. 2, str. 67-78 [COBISS.SI-ID 14227545]</p> <p>– KRAJNC, Marjetka. Interpolation scheme for planar cubic G [sup] 2 spline curves. <i>Acta applicandae mathematicae</i>, ISSN 0167-8019, 2011, vol. 113, no. 2, str. 129-143 [COBISS.SI-ID 16215385]</p> <p>– KRAJNC, Marjetka, VITRIH, Vito. Motion design with Euler-Rodrigues frames of quintic Pythagorean-hodograph curves. <i>Mathematics and computers in simulation</i>, ISSN 0378-4754. [Print ed.], 2012, vol. 82, iss. 9, str. 1696-1711 [COBISS.SI-ID 1024447572]</p> <p>Bor Plestenjak:</p> |
|---|

– MUHIČ, Andrej, PLESTENJAK, Bor. On the quadratic two-parameter eigenvalue problem and its linearization. *Linear Algebra and its Applications*, ISSN 0024-3795. [Print ed.], 2010, vol. 432, iss. 10, str. 2529-2542 [COBISS.SI-ID 15469913]

– PLESTENJAK, Bor, GHEORGHIU, C. I., HOCHSTENBACH, Michiel E. Spectral collocation for multiparameter eigenvalue problems arising from separable boundary value problems. *Journal of computational physics*, ISSN 0021-9991, 2015, vol. 298, str. 585-601 [COBISS.SI-ID 17347417]

– MEERBERGEN, Karl, PLESTENJAK, Bor. An Sylvester-Arnoldi type method for the generalized eigenvalue problem with two-by-two operator determinants. *Numerical linear algebra with applications*, ISSN 1070-5325, 2015, vol. 22, iss. 6, str. 1131-1146 [COBISS.SI-ID 17494105]

Emil Žagar:

– JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. An approach to geometric interpolation by Pythagorean-hodograph curves. *Advances in computational mathematics*, ISSN 1019-7168, 2012, vol. 37, no. 1, str. 123-150 [COBISS.SI-ID 16051289]

– JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. Hermite geometric interpolation by rational Bézier spatial curves. *SIAM journal on numerical analysis*, ISSN 0036-1429, 2012, vol. 50, no. 5, str. 2695-2715 [COBISS.SI-ID 16449369]

– KOVAČ, Boštjan, ŽAGAR, Emil. Some new G^1 quartic parametric approximants of circular arcs. *Applied mathematics and computation*, ISSN 0096-3003. [Print ed.], 2014, vol. 239, str. 254-264 [COBISS.SI-ID 17031769]

NUMERIČNE METODE 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|-----------------------------------|---------------------|
| Predmet: | Numerične metode 2 |
| Course title: | Numerical Methods 2 |
| Članica nosilka/UL Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039568 |
| Koda učne enote na članici/UL Member course code: | 27225 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: Bor Plestenjak, Marjetka Knez

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|---|
| Opravljen predmeta Analiza 1 in Algebra 1. | Completed courses Analysis 1 and Algebra 1. |
|--|---|

| Vsebina: | Content (Syllabus outline): |
|---|---|
| Nesimetrični problem lastnih vrednosti. Schurova forma. Potenčna metoda. Inverzna potenčna metoda. QR-iteracija. Simetrični problem lastnih vrednosti. Občutljivost. Tridiagonalna QR-iteracija. Rayleighov kvocient. Jacobijeva metoda. Posplošeni problemi lastnih vrednosti. Računanje singularnega razcepa. QR-iteracija za bidiagonalno matriko. Jacobijeva metoda. Aproksimacija podatkov. Metoda najmanjših kvadratov. Aproksimacija periodičnih podatkov. Konstrukcija empiričnih formul. Interpolacija s polinomi. Lagrangeeva oblika interpolacijskega polinoma. Linearna interpolacija. Zaporedne linearne interpolacije. Deljene diference. Newtonova oblika interpolacijskega polinoma. Numerično odvajanje. | Nonsymmetric eigenvalue problem. Schur form. Power iteration. Inverse iteration. QR iteration. Symmetric eigenvalue problem. Condition numbers. Tridiagonal QR iteration. Rayleigh quotient. Jacobi method. Generalized eigenvalue problem. Singular value decomposition computation. QR iteration for bidiagonal matrices. Jacobi method. Data approximation. Least squares problems. Approximation of periodic data. Construction of empirical formulas. Polynomial interpolation. Lagrange interpolation. Linear interpolation. Successive linear interpolation. Divided differences. Newton interpolation. Numerical differentiation. Numerical integration. Newton-Cotes rules. Composite rules. Romberg extrapolation. Gaussian quadrature. |

| | |
|---|---|
| <p>Numerično integriranje. Newton-Cotesova pravila. Sestavljena pravila. Rombergova ekstrapolacija. Gaussova kvadratura pravila. Numerično reševanje navadnih diferencialnih enačb. Metode za reševanje enačb prvega reda. Enokoračne metode. Metode tipa Runge-Kutta. Večkoračne metode. Robni problemi.</p> | <p>Numerical methods for ordinary differential equations. Methods for initial value problems. One-step methods. Runge-Kutta methods. Multi-step methods. Boundary problems.</p> |
|---|---|

Temeljna literatura in viri/Readings:

. W. Demmel: *Uporabna numerična linearna algebra, DMFA-založništvo, Ljubljana, 2000.*
 B. N. Datta: *Numerical Linear Algebra and Applications, Brooks/Cole, Pacific Grove, 1995.*
 Z. Bohte: *Numerične metode, DMFA-založništvo, Ljubljana, 1991.*
 L. N. Trefethen, D. Bau: *Numerical Linear Algebra, SIAM, Philadelphia, 1997.*
 D. R. Kincaid, E. W. Cheney: *Numerical Analysis : Mathematics of Scientific Computing, 3rd edition, Brooks/Cole, Pacific Grove, 2002.*
 R. L. Burden, J. D. Faires: *Numerical Analysis, 8th edition, Brooks/Cole, Pacific Grove, 2005.*
 E. Zakrajšek: *Uvod v numerične metode, DMFA-založništvo, Ljubljana, 2000.*

Cilji in kompetence:

Študent spozna osnovne metode za reševanje problemov lastnih vrednosti in osnovne metode v numerični aproksimaciji in interpolaciji, numeričnem integriranju ter numeričnem reševanju navadnih diferencialnih enačb. Pri vajah in z domačimi nalogami pridobljeno znanje praktično utrdi.

Objectives and competences:

Students learn basic numerical methods for eigenvalue computation, polynomial approximation and interpolation, numerical quadrature, and methods for the ordinary differential equations. The acquired knowledge is consolidated by exercises and homework assignments.

Predvideni študijski rezultati:

Znanje in razumevanje: Obvladanje osnovnih numeričnih algoritmov za računanje lastnih vrednosti, interpolacijo, integriranje, in reševanje diferencialnih enačb. Znanje programiranja in uporabe programskega paketa Matlab oziroma drugih sorodnih orodij za reševanje tovrstnih problemov. Uporaba: Ekonomično in natančno numerično reševanje različnih matematičnih problemov. Poleg matematike se uporablja še v številnih preostalih področjih, vsakič ko je mogoče problem opisati z matematičnim modelom in se išče rezultat v numerični obliki. Številnih problemov se ne da rešiti analitično, temveč le numerično, v nekaterih primerih pa je numerično reševanje mnogo bolj ekonomično od analitičnega. Refleksija: Razumevanje teorije na podlagi primerov in uporabe. Prenosljive spretnosti – niso vezane le na en predmet: Izbira primerne metode, reševanje problema, analiza doseženega rezultata na primerih. Spretnost uporabe računalnika pri reševanju matematičnih problemov. Razumevanje razlik med eksaktnim in numeričnim računanjem. Predmet konstruktivno nadgrajuje znanja algebre in analize.

Intended learning outcomes:

Knowledge and understanding: Understanding of basic numerical methods for eigenvalue computation, interpolation, quadrature, and methods for the ordinary differential equations. Knowledge of computer programming and Matlab or other similar software for solving such problems. Application: Economical and accurate numerical solution of various mathematical problems. In addition to mathematics, numerical methods are used in many other fields when the problem can be described by a mathematical model and a result in a numerical form is required. Many problems can not be solved analytically but only numerically. Also, in some cases, the numerical solution is much more economical than the analytical one. Reflection: Understanding of the theory from the applications. Transferable skills: The ability to select an appropriate method, solve a problem, and analyze the obtained results. The ability to solve mathematical problems using a computer. Understanding the differences between the exact and the numerical computation. The subject enriches constructively the knowledge of algebra and analysis.

Metode poučevanja in učenja:

Predavanja, laboratorijske vaje, domače naloge, konzultacije

Learning and teaching methods:

Lectures, lab exercises, homework, consultations

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, midterm exams, project |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | work)Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL) | | Grading: 6-10 pass, 5 fail (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

Marjetka Knez:

- KOZAK, Jernej, KRAJNC, Marjetka. Geometric interpolation by planar cubic polynomial curves. Computer Aided Geometric Design, ISSN 0167-8396, 2007, vol. 24, no. 2, str. 67-78 [COBISS.SI-ID 14227545]
- KRAJNC, Marjetka. Interpolation scheme for planar cubic G [sup] 2 spline curves. Acta applicandae mathematicae, ISSN 0167-8019, 2011, vol. 113, no. 2, str. 129-143 [COBISS.SI-ID 16215385]
- KRAJNC, Marjetka, VITRIH, Vito. Motion design with Euler-Rodrigues frames of quintic Pythagorean-hodograph curves. Mathematics and computers in simulation, ISSN 0378-4754. [Print ed.], 2012, vol. 82, iss. 9, str. 1696-1711 [COBISS.SI-ID 1024447572]

Bor Plestenjak:

- PLESTENJAK, Bor. Numerical methods for the tridiagonal hyperbolic quadratic eigenvalue problem. V: Fifth international workshop on accurate solution in eigenvalue problems : hagen, Germany from June 29 to July 1, 2004. Philadelphia: SIAM, 2006, vol. 28, no. 4, str. 1157-1172 [COBISS.SI-ID 14367833]
- MUHIČ, Andrej, PLESTENJAK, Bor. On the quadratic two-parameter eigenvalue problem and its linearization. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2010, vol. 432, iss. 10, str. 2529-2542 [COBISS.SI-ID 15469913]
- GHEORGHIU, C. I., HOCHSTENBACH, Michiel E., PLESTENJAK, Bor, ROMMES, Joost. Spectral collocation solutions to multiparameter Mathieu's system. Applied mathematics and computation, ISSN 0096-3003. [Print ed.], 2012, vol. 218, iss. 24, str. 11990-12000 [COBISS.SI-ID 16484185]

OPTIMIZACIJSKE METODE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-----------------------|
| Predmet: | Optimizacijske metode |
| Course title: | Optimization Methods |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039526 |
| Koda učne enote na članici/UL Member course code: | 27210 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 45 | | | 120 | 7 |

Nosilec predmeta/Lecturer: Arjana Žitnik

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

Optimizacijske naloge in problemi, primeri, podobne in enakovredne naloge,

- rešljivost, globalni in lokalni ekstremi,
- lokalna optimizacija, konveksnost, reševanje v R^n , sedla, prirejene in dualne naloge,
- Lagrangeova prirejenost, Karush- Kuhn- Tuckerjev izrek, numerični postopki, kazenske metode,
- linearno programiranje, metoda simpleksov, dualne naloge,
- diskretne optimizacijske naloge, zahtevnost problemov, pristopi k reševanju diskretnih nalog,
- primeri (predavatelj izbere nekatere izmed naslednjih tem: najcenejši razvoz, pretoki po omrežju, prirejanja in pokritja, barvanje grafov, razvrščanje v skupine, ...).

Content (Syllabus outline):

Optimization problems, examples, similar and equivalent problems

- solvability, global and local extrema,
- local optimization, convex problems, solving in R^n , saddle points, associated and dual problems,
- Lagrange duality, Karush- Kuhn- Tucker theorem, numerical algorithms, penalty methods,
- linear programming, simplex method, dual problem,
- discrete optimization problems, complexity, approaches to solving discrete optimization problems, examples (the lecturer chooses some of the following topics: transshipment problem, network flow, matchings and coverings, graph colorings, clustering...).

Temeljna literatura in viri/Readings:

Vašek Chvátal: *Linear Programming*, W. H. Freeman and Co., New York, 1983

B. H. Korte, J. Vygen: Combinatorial Optimization : Theory and Algorithms, 3. izdaja, Springer, Berlin, 2006.
 Stephen Boyd, Lieven Vandenberghe: Convex Optimization, Cambridge University Press, Cambridge, 2004
 V. Batagelj: Optimizacijske metode, Zpiski predavanj, Ljubljana.http://vlado.fmf.uni-lj.si/vlado/optim/opt1.pdfhttp://vlado.fmf.uni-lj.si/vlado/optim/lp.pdf
 V. Batagelj, M. Kaufman: Naloge iz optimizacijskih metod, Ljubljana.http://vlado.fmf.uni-lj.si/vlado/optim/optnal.pdf
 Jiří Matoušek, Bernd Gärtner: Understanding and Using Linear Programming, Springer 2007
 M.Minoux: Mathematical programming. Theory and algorithms. Wiley, Chichester, 1986
 M.S.Bazaraa, H.D.Sherali, C.M.Shetty: Nonlinear Programming, Theory and Algorithms. Wiley, New York 1993.
 C.H.Papadimitriou, K.Steiglitz: Combinatorial optimization: Algorithms and complexity. Prentice- Hall, Englewood Cliffs, New Jersey 1990

| | |
|---|---|
| Cilji in kompetence: | Objectives and competences: |
| Podati v poenoteni obliki osnovna znanja o zvezni in kombinatorični optimizaciji. | To provide a basic knowledge on "continuous" and combinatorial optimization in a unified way. |

| | |
|---|---|
| Predvideni študijski rezultati: | Intended learning outcomes: |
| Znanje in razumevanje: Študent pridobi osnovno znanje o zvezni in kombinatorični optimizaciji. Obvlada temeljne optimizacijske postopke in jih zna uporabiti ob pomoči računalnika. Uporaba: Reševanje optimizacijskih problemov v vsakdanjem življenju. Refleksija: Pomen ustreznega modeliranja problemov iz uporabe za njihovo učinkovito reševanje. Prenosljive spretnosti – niso vezane le na en predmet: Sposobnost predstavitve različnih praktičnih problemov v obliki matematičnih optimizacijskih nalog. Veščina uporabe izbranega programskega orodja za reševanje osnovnih optimizacijskih problemov. | Knowledge and understanding: The student obtains basic knowledge about continuous and combinatorial optimization. He or she is familiar with basic optimization methods and knows how to solve them with a computer. Application: Solving optimization problems from real life. Reflection: The importance of modelling of problems for their effective resolution. Transferable skills: The ability to present various everyday problems in the form of mathematical optimization tasks. Ability to use computer programs to solve basic optimization problems |

| | |
|---|---|
| Metode poučevanja in učenja: | Learning and teaching methods: |
| predavanja, vaje, domače naloge, konzultacije | lectures, exercises, homeworks, consultations |

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt) | | Type (examination, oral, coursework, project): |
| domače naloge ali projekt | 10,00 % | homeworks or project |
| pisni izpit | 45,00 % | written exam |
| ustni izpit | 45,00 % | oral exam |
| Ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | Grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:
 Arjana Žitnik:
 MILANIČ, Martin, PISANSKI, Tomaž, ŽITNIK, Arjana. Dilation coefficient, plane-width, and resolution coefficient of graphs. Monatshefte für Mathematik, ISSN 0026-9255, 2013, vol. 170, no. 2, str. 179-193. [COBISS.SI-ID 1024499540]
 PISANSKI, Tomaž, ŽITNIK, Arjana. Representing graphs and maps. V: BEINEKE, Lowell W. (ur.), WILSON, Robin J. (ur.). Topics in topological graph theory, (Encyclopedia of mathematics and its applications, ISSN 0953-4806, 128). Cambridge [etc.]: Cambridge University Press, cop. 2009, str. 151-180. [COBISS.SI-ID 15227481]

ŽITNIK, Arjana. Series parallel extensions of plane graphs to dual-eulerian graphs. *Discrete Mathematics*, ISSN 0012-365X. [Print ed.], 2007, vol. 307, iss. 3-5, str. 633-640. [COBISS.SI-ID 14183769]

OSNOVE DIGITALNIH VEZIJ

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|----------------------------------|
| Predmet: | Osnove digitalnih vezij |
| Course title: | Introduction to Digital Circuits |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 1. letnik | 1. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 1. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039580 |
| Koda učne enote na članici/UL Member course code: | 63204 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

| | |
|----------------------|--|
| Predavanja/Lectures: | |
| Vaje/Tutorial: | |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

| |
|--|
| |
|--|

| Vsebina: | Content (Syllabus outline): |
|---|---|
| <p>predavanja:</p> <ol style="list-style-type: none"> 1. Realizacija avtomatov 2. Osnove VHDL 3. Programabilna logična vezja 4. Boolova algebra 5. Preklopne funkcije in preklopna vezja 6. Funkcijsko polni sistemi 7. Minimizacija preklopnih funkcij 8. Strukturalna preklopna vezja (kodirnik, dekodirnik, multiplekser, ROM, ...) 9. Aritmetično logična vezja 10. Sekvenčna vezja 11. Načrtovanje avtomatov | <p>lectures:</p> <ol style="list-style-type: none"> 1. Boolean algebra 2. Switching functions and circuits 3. Functionally complete logic systems 4. Circuit minimization 5. Structural switching circuits (coder, decoder, multiplexer, ROM, ...) 6. Arithmetical and logical circuits 7. Sequential circuits 8. Automata design 9. Automata realization 10. VHDL basics 11. Programmable logic circuits |

| | |
|--|--|
| | |
|--|--|

Temeljna literatura in viri/Readings:

| |
|--|
| <p>Osnovna: J. Virant, Logične osnove odločanja in pomnjenja v računalniških sistemih, Ljubljana: Fakulteta za računalništvo in informatiko, 1996, ISBN 961-6209-01-9. I. Lebar Bajec, Preklopne strukture in sistemi: zbirka rešenih primerov in nalog z rešitvami, Ljubljana: Fakulteta za računalništvo in informatiko, 2002, ISBN 961-6209-31-0. M. Moškon, Priprave na vaje za predmet Osnove digitalnih vezij, 2016, elektronska različica M. Morris R. Mano, Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog (6th Edition), 2017, 0134549899</p> |
|--|

Cilji in kompetence:

| |
|---|
| <p>Študenti v okviru tega predmeta pridobijo osnovna znanja s področja digitalne logike. Spoznajo se z osnovnimi gradniki v računalništvu ter ustrezno logično obravnavo le-teh. Seznanijo se s časom v preklopnih strukturah in sistemih, pomnilnimi celicami in osnovami avtomatov.</p> |
|---|

Objectives and competences:

| |
|--|
| <p>The object of this course is mastering and understanding efficient practical solutions and gaining a thorough understanding of digital logic, time in digital domain, memory cell and basic of the automaton.</p> |
|--|

Predvideni študijski rezultati:

| |
|---|
| <p>Znanje in razumevanje: Po uspešnem zaključku tega predmeta bo študent zmožen: izkazati znanje in razumevanje osnovnih principov digitalne logike, uporabljati postopke minimizacije preklopnih funkcij, razumeti in uporabiti strukturalen zapis logičnih funkcij, uporabiti aritmetično-logična vezja kot gradnike, razumeti delovanje sekvenčnih vezij, analizirati delovanje avtomata, realizirati avtomat z logičnimi vezji. Uporaba: Uporaba osnovnih orodij za načrtovanje vezij in izdelava enostavnih logičnih sklopov. Refleksija: Spoznavanje in razumevanje uglasenosti med teorijo in njeno aplikacijo na konkretnih primerih s enostavnih logičnih in sekvenčnih vezij. Prenosljive spretnosti - niso vezane le na en predmet: Uporaba binarne logike. Načrtovanje in izgradnja enostavnih digitalnih vezij.</p> |
|---|

Intended learning outcomes:

| |
|--|
| <p>Knowledge and understanding: After successful completion of the course, students should be able to: understand the basic principles of digital logic, use techniques for minimizing switching functions, understand and apply a structural logic functions, use arithmetic logic circuits like building blocks, understand the operation of sequential logical circuits, analyze the operation of the state automaton, realize an automaton with logical circuits. Application: Using basic tools for circuit development and realization. Reflection: Comprehension and understanding of the basics of digital circuits design. Transferable skills: Boolean logic concepts. Basic digital circuits design.</p> |
|--|

Metode poučevanja in učenja: Learning and teaching methods:

| | |
|--|--------------------------------|
| <p>Predavanja , laboratorijske vaje.</p> | <p>Lectures, lab practice.</p> |
|--|--------------------------------|

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|--------------|-------------|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | |

Reference nosilca/Lecturer's references:

VASYLCHENKOVA, Anastasiia, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. Classical mechanics approach applied to analysis of genetic oscillators. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], May/Jun. 2017, vol. 14, no. 3, str. 721-727,

BORDON, Jure, MOŠKON, Miha, ZIMIC, Nikolaj, MRAZ, Miha. Fuzzy logic as a computational tool for quantitative modelling of biological systems with uncertain kinetic data. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2015, vol. 12, no. 5, str. 1199-120

PETRONI, Mattia, ZIMIC, Nikolaj, MRAZ, Miha, MOŠKON, Miha. Stochastic simulation algorithm for gene regulatory networks with multiple binding sites. *Journal of computational biology*, ISSN 1066-5277. [Print ed.], Mar. 2015, vol. 22, no. 3, str. 218-226,

ŠOBERL, Domen, ZIMIC, Nikolaj, LEONARDIS, Aleš, KRIVIC, Jaka, MOŠKON, Miha. Hardware implementation of FAST algorithm for mobile applications. *Journal of signal processing systems for signal, image, and video technology*, ISSN 1939-8018. [Print ed.], 2015, vol. 79, no. 3, str. 247-256,

PEČAR, Primož, MRAZ, Miha, ZIMIC, Nikolaj, JANEŽ, Miha, LEBAR BAJEC, Iztok. Solving the ternary quantum-dot cellular automata logic gate problem by means of adiabatic switching. *Japanese journal of applied physics*, ISSN 0021-4922, 2008, vol. 47, no. 6, str. 5000-5006

OSNOVE PODATKOVNIH BAZ

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------|
| Predmet: | Osnove podatkovnih baz |
| Course title: | Basics of Databases |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 1. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039591 |
| Koda učne enote na članici/UL Member course code: | 63208 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Marko Bajec

Vrsta predmeta/Course type: obvezni predmet/compulsory course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: **Prerequisites:**

| | |
|--|--|
| | |
|--|--|

| Vsebina: | Content (Syllabus outline): |
|---|--|
| predavanja: I. Uvod v PB 1. Zgodovina področja; 2. Sistemi za upravljanje s PB (SUPB); 3. Vrste SUPB; 4. Vloge pri upravljanju PB; II. Opisovanje, shranjevanje ter poizvedovanje v PB 5. tri-nivojska predstavitev podatkov; 6. Shramba in indeksiranje podatkov; 7. Formalni poizvedovalni jeziki; 8. Osnove SQL; 9. Predstavitev QBE; 10. XML PB in XQuery; III. Osnove načrtovanja PB | lectures: I. Introduction to DB 1. History of data bases; 2. DB management systems (DBMS); 3. Types of DBMS; 4. Roles in DB Management; II. Describing, Storing and Querying data in DB 5. 3-tire data representation; 6. Data storing and indexing; 7. Formal query languages; 8. SQL basics; 9. QBE; 10. XML SUPB, XQuery; III. DB design - basics |

| | |
|---|--|
| 11. tri-nivojski pristop k načrtovanju PB; 12. Konceptualno načrtovanje; 13. Logično načrtovanja; 14. Osnove normalizacije; 15. Fizično načrtovanje. 16. Podatkovna skladišča in njihovo načrtovanje Opcijsko: noSQL in newSQL osnove | 11. 3-level data modelling approach; 12. Conceptual data modelling; 13. Logical data modelling; 14. Normalisation - basics; 15. Physical data modelling. 16. Data warehouses and their design; Optional: noSQL and newSQL basics |
|---|--|

Temeljna literatura in viri/Readings:

Thomas M. Connolly, Carolyn E. Begg (2009). *Database Systems, A Practical Approach to Design, Implementation and Management*, Fifth Edition, Addison-Wesley.
Raghu Ramakrishnan, Johannes Gehrke (2003). *Database Management Systems*, Third Edition, McGraw-Hill.

Cilji in kompetence:

Cilj predmeta je študentom računalništva in informatike predstaviti osnove o podatkovnih bazah, kaj so prednosti uporabe podatkovnih baz v primerjavi z drugimi načini shranjevanja podatkov; kako podatkovne baze delujejo in kako upravljamo z njimi; kako poizvedujemo po podatkih v podatkovnih bazah, kako jih načrtujemo ter kako z njimi upravljamo.

Splošne kompetence:

- Sposobnost razumevanja in reševanja strokovnih problemov s področja računalništva in informatike.
- Sposobnost iskanja virov informacij in kritične evaluacije razpoložljivih virov.
- Sposobnost uporabe pridobljenega znanja za samostojno reševanje problemov; sposobnost izpopolnjevanja pridobljenega znanja;

Specifične kompetence:

- Osnovne spretnosti s področja računalništva in informatike;
- Sposobnost prenosa znanja na sodelavce tako v tehničnih kot raziskovalnih skupinah.

Osnovno znanje in spretnosti, ki so potrebni za nadaljevanje študija na drugi bolonjski stopnji.

Objectives and competences:

The aim of this course is to explain students the basics of databases, i.e. advantages of using database systems over using file systems, how databases and database management systems work, how we manage them; how we design databases, how we query databases etc.

General competencies:

- The ability to understand and solve professional challenges in computer and information science.
- The ability to search knowledge sources and to search for resources and critically evaluate information.
- The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.

Specific competencies:

- Basic skills in computer and information science, which includes basic theoretical skills, practical knowledge and skills essential for the field of computer and information science;
- The ability to transmit knowledge to co-workers in technology and research groups.
- Basic skills in computer and information science, allowing the continuation of studies in the second study cycle.

Predvideni študijski rezultati:

Po uspešno zaključenem modulu bodo študenti zmožni:

- načrtovati enostavne in kompleksnejše podatkovne baze,
- razviti aplikacije z dostopom do različnih sistemov za upravljanje s podatkovnimi bazami,
- poizvedovati po različnih vrstah podatkovnih baz,
- analizirati poizvedbe,
- optimizirati podatkovne baze ter poizvedbe,
- uporabiti algoritme s področja podatkovnih baz na sorodnih problemih.

Intended learning outcomes:

After successful completion of the module, students will be able to:

design simple and complex databases, develop applications with access to various database management systems, retrieve data from different types of databases, analyze queries from performance perspective, optimize databases and queries, reuse database algorithms for similar problems.

Metode poučevanja in učenja:

Predavanja, računske vaje z ustreznimi nastopi, projektni način dela pri domačih nalogah in seminarjih.

Learning and teaching methods:

Lectures, Practical exercises, homeworks and seminars in team.

Načini ocenjevanja:**Delež/Weight****Assessment:**

| | | |
|--|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, midterm exams, project work) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

ŽITNIK, Slavko, ŠUBELJ, Lovro, BAJEC, Marko. SkipCor : skip-mention coreference resolution using linear-chain conditional random fields. *PLoS one*, ISSN 1932-6203, Jun. 2014, vol. 9, no. 6, str. 1-14

ŠUBELJ, Lovro, FIALA, Dalibor, BAJEC, Marko. Network-based statistical comparison of citation topology of bibliographic databases. *Scientific reports*, ISSN 2045-2322, 2014, 4, str. 1-10

FIALA, Dalibor, ŠUBELJ, Lovro, ŽITNIK, Slavko, BAJEC, Marko. Do PageRank-based author rankings outperform simple citation counts?. *Journal of informetrics*, ISSN 1751-1577, Apr. 2015, vol. 9, no. 2, str. 334-348

KRALLINGER, Martin, ŽITNIK, Slavko, BAJEC, Marko, et al. The CHEMDNER corpus of chemicals and drugs and its annotation principles. *Journal of cheminformatics*, ISSN 1758-2946. [Online ed.], 2015, vol. 7, suppl. 1, str. 1-17

ŠUBELJ, Lovro, FIALA, Dalibor, BAJEC, Marko. Network-based statistical comparison of citation topology of bibliographic databases. *Scientific reports*, ISSN 2045-2322, 2014, 4, str. 1-10

OSNOVE UMETNE INTELIGENCE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|-----------------------------------|---|
| Predmet: | Osnove umetne inteligence |
| Course title: | Introduction to Artificial Intelligence |
| Članica nosilka/UL Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Multimedija, prva stopnja, univerzitetni | Multimedija (študijski program) | 3. letnik | 1. semester | obvezni |
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039610 |
| Koda učne enote na članici/UL Member course code: | 63214 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Zoran Bosnić

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

Uvod v umetno inteligenco in primeri uporabe
Prostor stanj in osnovni algoritmi preiskovanja: globinsko, širinsko, iterativno poglobljanje, zahtevnost teh algoritmov
Hevristično preiskovanje, algoritma A* in IDA*, izrek o popolnosti A*, lastnosti ocenitvenih funkcij ter analiza časovne in prostorske zahtevnosti
Dekompozicija problemov z AND/OR grafi, algoritmi iskanja v AND/OR grafih, hevristično preiskovanje in algoritem AO*
Strojno učenje: problem učenja iz podatkov, iskanje zakonitosti v podatkih in podatkovno rudarjenje, opisni jeziki in prostori hipotez, učenje odločitvenih dreves, regresijskih dreves, modelnih dreves, ter

Content (Syllabus outline):

- Introduction to Artificial Intelligence, examples of applications
- State space and basic search algorithms: depth-first, breadth-first and iterative deepening, complexity of these algorithms
- Heuristic search, algorithms A* and IDA*, admissibility theorem for A*, properties of heuristic function and analysis of time and space complexity
- Problem decomposition with AND/OR graphs, search in AND/OR graphs, heuristic search algorithm AO*
- Machine learning: problem of learning from data, data mining, description languages and

| | |
|---|--|
| <p>pravil. Programska orodja strojnega učenja in primeri uporabe.</p> <p>Predstavitev znanja in ekspertni sistemi: predstavitev znanja s pravili, ogrodji, semantičnimi mrežami, ontologije; algoritmi sklepanja in generiranje razlage; obravnavanje negotovega znanja, bayesovske mreže</p> <p>Planiranje po principu sredstev in ciljev, planiranje s popolno in delno urejenostjo, regresiranje ciljev, primeri uporabe v robotiki in logistiki</p> | <p>hypothesis spaces, induction of decision trees, regression trees, model trees, and rules. Software tools for machine learning and applications.</p> <ul style="list-style-type: none"> • Knowledge representation and expert systems: knowledge representation with rules, frames, semantic networks, ontologies; inference algorithms and generation explanation; handling uncertain knowledge, Bayesian networks • Means-ends planning, total-order and partial-order planning, goal regression, applications in robotics and logistics |
|---|--|

Temeljna literatura in viri/Readings:

| |
|--|
| <p>. Bratko, Prolog Programming for Artificial Intelligence, 4th edition, Pearson Education, Addison-Wesley 2011, ISBN: 0201403757.</p> <p>S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Third edition, Pearson Education, Prentice-Hall 2010, ISBN: 0136042597.</p> <p>I. Bratko, Prolog in umetna inteligenca, Založba FE in FRI, ponatis 2011.</p> <p>I. Kononenko, Strojno učenje, Založba FE in FRI, 2005.</p> <p>Materiali na spletu (Spletna učilnica FRI; Ivan Bratko home page): Prosojnice predavanj, naloge.</p> |
|--|

Cilji in kompetence:

| | |
|--|--|
| <p>Seznaniati slušatelje z osnovnimi koncepti, idejami, metodami in tehnikami umetne inteligence</p> <p>Sposobnost reševanja problemov z metodami umetne inteligence</p> <p>Zmožnost razumevanja literature s področja umetne inteligence</p> <p>Prispevati k razumevanju relevantnosti tehničnih dosežkov umetne inteligence glede na njihove implikacije v filozofiji in psihologiji</p> | <h3>Objectives and competences:</h3> <p>Teach basic concepts, ideas, methods and techniques of artificial intelligence (AI)</p> <p>Ability to solve problems with methods of artificial intelligence</p> <p>Ability to understand the literature in the area of AI</p> <p>Contribute to the understanding of the relevance of technical achievements of AI with respect to their implications in philosophy and psychology</p> |
|--|--|

Predvideni študijski rezultati:

| | |
|--|--|
| <p>Po uspešnem zaključku predmeta bo študent:</p> <ul style="list-style-type: none"> - poznal osnovne in najpogostejše uporabljane metode umetne inteligence, - sposoben pojasniti implikacije dosežkov umetne inteligence in relacije s kognitivno znanostjo, psihologijo, medicino, logiko, matematiko in drugimi sorodnimi področji. - sposoben opredeliti, kje so tehnične meje področja, - sposoben uporabe preiskovalnih algoritmov in metod strojnega učenja na realnih problemih, - sposoben primerjanja časovne in prostorske učinkovitosti uporabljenih metod, - sposoben formulirati probleme iz realnega življenja kot probleme, ki so rešljivi z metodami umetne inteligence. | <h3>Intended learning outcomes:</h3> <p>After the completion of the course the student will be able to:</p> <ul style="list-style-type: none"> - know the basic and most commonly used methods in the field of artificial intelligence (AI), - explain implications of the AI achievements, and its relation with cognitive science, psychology, medicine, logic, mathematics and other related fields, - define the technical boundaries of the field, - use the search and machine learning algorithms on real problems, - compare time and spatial complexity of the taught algorithms, - formulate selected problems from the real world as problems that are solvable with the AI algorithms. |
|--|--|

Metode poučevanja in učenja:

| | |
|--|---|
| <p>Predavanja, laboratorijske vaje, domače naloge, individualni ali skupinski projekti</p> | <h3>Learning and teaching methods:</h3> <p>Lectures, laboratory exercises, homework, individual and team projects</p> |
|--|---|

Načini ocenjevanja:

Delež/Weight Assessment:

| | | |
|--|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (written and oral exam, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, project work) |
| Končno preverjanje (pisni in/ali ustni izpit) | 50,00 % | Final (written and/or oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

1. ZUPANC, Kaja, BOSNIĆ, Zoran. Automated essay evaluation with semantic analysis. Knowledge-based systems, ISSN 0950-7051. [Print ed.], Mar. 2017, vol. 120, str. 118-132.
2. OCEPEK, Uroš, RUGELJ, Jože, BOSNIĆ, Zoran. Improving matrix factorization recommendations for examples in cold start. Expert systems with applications, ISSN 0957-4174. [Print ed.], Nov. 2015, vol. 42, no. 19, str. 6784-6794.
3. BOSNIĆ, Zoran, DEMŠAR, Jaka, KEŠPRET, Grega, Rodrigues, Pedro Pereira, Gama, João, Kononenko, Igor. Enhancing data stream predictions with reliability estimators and explanation. Engineering applications of artificial intelligence, ISSN 0952-1976. [Print ed.], 2014, vol. 34, str. 178-192.
4. BOSNIĆ, Zoran, KONONENKO, Igor. Estimation of individual prediction reliability using the local sensitivity analysis. Applied intelligence, ISSN 0924-669X. [Print ed.], Dec. 2008, vol. 29, no. 3, str. 187-203, ilustr.
5. BOSNIĆ, Zoran, KONONENKO, Igor. Comparison of approaches for estimating reliability of individual regression predictions. Data & Knowledge Engineering, ISSN 0169-023X. [Print ed.], Dec. 2008, vol. 67, no. 3, str. 504-516.

Celotna bibliografija je dostopna na SICRISu / For complete bibliography see SICRIS:

<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=31318>.

PORAZDELJENI SISTEMI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------|
| Predmet: | Porazdeljeni sistemi |
| Course title: | Distributed Systems Computer |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039627 |
| Koda učne enote na članici/UL Member course code: | 63261 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|----------------------|------------------|-----------------|-----------------------------------|--|--|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Uroš Lotrič

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

1. Arhitektura vzporednih sistemov.
2. Sočasnost, procesi in niti: prepletanje, vzporedenje, vrstni red izvajanja, preklapljanje med nitmi.
3. Delo z nitmi: ustvarjanje, pridruževanje, težave.
4. Sočasen dostop do skupnih podatkov: tvegano stanje in medsebojno izključevanje, atomične operacije.
5. Sinhronizacija dogodkov: smrtni objem, pogojne spremenljivke, pregrada.
6. Vzorci: semaforji, izdelovalec-porabnik, bralci in pisatelji, bazen nalog.
7. Večnitnost v praksi: varno delo z nitmi, prednosti večnitnih programov, modeli večnitnih programov
8. Arhitektura grafičnih pospeševalnikov.

Content (Syllabus outline):

1. Parallel systems architecture.
2. Concurrency, processes and threads: interleaving, parallelism, execution order, pre-emption.
3. Working with threads: creation, joining, and problems.
4. Concurrent access to shared data: race condition and mutual exclusion, atomic operations.
5. Event synchronisation: deadlock, conditional variables, barrier.
6. Patterns: semaphores, producer-consumer, readers and writers, task pool.
7. Multithreading in practice: thread-safe programming, advantages of multithreaded programs, multithreaded program models

| | |
|--|---|
| <p>9. Programiranje grafičnih pospeševalnikov.</p> <p>10. Porazdeljeni sistemi: prednosti in izzivi, mrežni protokoli, sistemi odjemalec-strežnik, klicanje oddaljenih funkcij (RPC).</p> <p>11. Modeli sistemov in napake: sinhroni, delno sinhroni in ne sinhroni, odpoved sistema, napake in odpornost na napake, bizantinske napake in problem dveh generalov.</p> <p>12. Čas in razvrščanje dogodkov: fizične ure, univerzalni čas, sinhronizacija in polzenje časa, protokol NTP, vzročnost.</p> <p>13. Logični čas: Lamportova ura, vektorske ure, protokol širjenja informacij.</p> <p>14. Podvajanje in sklepčnost: konsistentnost replik, branje po pisanju, podvajanje z avtomati stanj, podvajanje z voditeljem.</p> <p>15. Soglasje: izbiranje voditelja, algoritem Raft.</p> <p>16. Porazdeljeni sistemi na primerih iz prakse: soglasje, vzročno širjenje, dvostopenjsko potrjevanje.</p> | <p>8. Graphical accelerator architecture.</p> <p>9. Graphical accelerator programming, offload model.</p> <p>10. Distributed systems: benefits and challenges, network protocols, client-server systems, remote function calling (RPC).</p> <p>11. Systems models and faults: synchronous, partially synchronous and non-synchronous, system failure, faults and fault tolerance, Byzantine faults and the two-generals problem.</p> <p>12. Clock time and event classification: physical clocks, universal time, time synchronisation and drift, protocol NTP, causality.</p> <p>13. Logical time: Lamport clock, vector clocks, broadcast.</p> <p>14. Replication and quorums: replica consistency, read-after-write consistency, state machine replication, leader-based replication.</p> <p>15. Consensus: leader selection, the Raft algorithm.</p> <p>16. Distributed systems use cases: consensus, causal propagation, two-stage commit.</p> |
|--|---|

Temeljna literatura in viri/Readings:

| |
|---|
| <ol style="list-style-type: none"> 1. P.S. Pacheco. An Introduction to Parallel Programming, Morgan Kaufman, 201 2. V. Alessandrini, Shared Memory Application Programming, Concepts and strategies in multicore application programming, Morgan Kaufmann, 2016. 3. B.R. Gaster et al. Heterogeneous computing with OpenCL. Morgan Kaufmann, 201 4. A.S. Tanenbaum and M. van Steen. Distributed systems, 3rd edition, CreateSpace Independent Publishing Platform, 2017. 5. G. Couloris et al. Distributed Systems: Concepts and Design. Pearson, 2012. |
|---|

Cilji in kompetence:

| | |
|--|---|
| <p>Razumeti temeljne koncepte in načela vzporednih in porazdeljenih sistemov s stališča računalniške arhitekture, algoritmov in programskih modelov, razviti spretnosti in tehnike za načrtovanje, vzpostavitev in testiranje vzporednih in porazdeljenih aplikacij z uporabo izbranih programskih jezikov in orodij, znati oceniti smiselnost uporabe različnih modelov in pristopov za doseganje zelenega cilja, uporabiti pridobljeno znanje o vzporednih in porazdeljenih sistemih za reševanje pogostih problemov in izzivov.</p> | <p>Objectives and competences:</p> <p>Understand the fundamental concepts and principles of parallel and distributed systems from the point of view of computer architecture, algorithms and programming models; develop the skills and techniques to design, build and test parallel and distributed applications using selected programming languages and tools, be able to evaluate the applicability of different models and approaches to achieve a desired goal, apply the acquired knowledge of parallel and distributed systems to solve common problems and challenges.</p> |
|--|---|

Predvideni študijski rezultati:

| | |
|--|---|
| <p>Po uspešnem zaključku predmeta bo študent poznal tipične vzporedne in porazdeljene računalniške sisteme. Pri vzporednih sistemih bo imel poglobljeno znanje o delu z nitmi, znal bo identificirati probleme v večnitnih aplikacijah in jih razreševati z uporabo znanih konceptov. Poznal bo orodja, ki jih izbrani programski jeziki ponujajo za nadzor nad delovanjem niti in bo sposoben oceniti vpliv različnih pristopov na robustnost, zmogljivost in pravilnost delovanja aplikacije. Spoznal se bo z arhitekturo grafičnih pospeševalnikov in konceptom razbremenitve glavnega procesorja pri njihovem programiranju.</p> | <p>Intended learning outcomes:</p> <p>After completing the course successfully, the student will be familiar with standard parallel and distributed computing systems. In parallel systems, the student will have an in-depth knowledge of working with threads and be able to identify problems in multithreaded applications and solve them using familiar concepts. He will be familiar with the selected programming languages and tools offered to control the operation of threads. He will be able to assess the impact of different approaches on the application's robustness, performance and correctness. The student will be familiar with the</p> |
|--|---|

| | |
|--|--|
| Poznal bo arhitekture porazdeljenih sistemov in vpliv mrežne povezave na njihovo delovanje ter različne programske modele in abstrakcije, kot je protokol RPC, in njihovo uporabo v izbranih programskih jezikih. Razumel bo koncepte kot so logični čas in vzročnost in odpornost na napake. Spoznal bo pristope k replikaciji podatkov ter algoritme za določanje soglasja in izbiranje voditelja. | architecture of graphics accelerators and the concept of offloading the workload to the accelerator. He will be familiar with distributed system architectures, and the impact of network interconnects on their performance, as well as with different programming models and abstractions, such as the RPC protocol, and their use in selected programming languages. Besides, he will understand concepts such as logical time and causality and learn about fault tolerance, data replication approaches, and consensus and leader selection algorithms. |
|--|--|

| | |
|--|---------------------------------------|
| Metode poučevanja in učenja: | Learning and teaching methods: |
| Predavanja, seminarji, laboratorijske vaje, projektno delo na laboratorijskih vajah, individualne domače naloge. | Lectures, laboratories, homework |

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|---|
| Način (ustno izpraševanje, domače naloge, projektno delo): | | Type (examination, oral, homework): |
| Domače naloge | 50,00 % | Home assignments |
| Ustni izpit | 50,00 % | Oral exam |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

| |
|---|
| Reference nosilca/Lecturer's references: |
| <ol style="list-style-type: none"> SILVA, Catarina, LOTRIČ, Uroš, RIBEIRO, Bernardete, DOBNIKAR, Andrej. Distributed text classification with an ensemble kernel-based learning approach. IEEE trans. syst. man cybern., Part C Appl. rev., May 2010, vol. 40, 287-297 CANKAR, Matija, ARTAČ, Matej, ŠTERK, Marjan, LOTRIČ, Uroš, SLIVNIK, Boštjan. Co-allocation with collective requests in grid systems. Journal for universal computer science, 2013, vol. 96, 282-300 LOTRIČ, Uroš, PILIPOVIĆ, Ratko, BULIĆ, Patricio. A hybrid radix-4 and approximate logarithmic multiplier for energy efficient image processing. Electronics. May 2021, vol. 10, 1-20 PILIPOVIĆ, Ratko, BULIĆ, Patricio, LOTRIČ, Uroš. A two-stage operand trimming approximate logarithmic multiplier. IEEE transactions on circuits and systems. I, Regular papers. Jun. 2021, vol. 68, 2535-2545 PILIPOVIĆ, Ratko, RISOJEVIĆ, Vladimir, BOŽIČ, Janko, BULIĆ, Patricio, LOTRIČ, Uroš. An approximate GEMM unit for energy-efficient object detection. Sensors. Jun. 2021, vol. 21, 1-19 Celotna bibliografija je dostopna na SICRIS: https://bib.cobiss.net/biblioweb/biblio/si/slv/cris/16109 |

POSTOPKI RAZVOJA PROGRAMSKE OPREME

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------------|
| Predmet: | Postopki razvoja programske opreme |
| Course title: | Software Development Processes |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039629 |
| Koda učne enote na članici/UL Member course code: | 63254 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Branko Matjaž Jurič

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

| |
|--|
| |
|--|

Vsebina:

1. Razvoj večslojnih aplikacijskih rešitev, spoznavanje postopkov razvoja.
2. Razvoj vmesnega sloja in poslovne ter funkcionalne logike.
3. Arhitekture večslojnih informacijskih sistemov
4. Porazdeljeni objektni modeli
5. Oddaljeno proženje metod
6. Strežniške komponentne tehnologije in vsebniki
7. Strežniška javanska zrna
8. Vzorci za vmesni sloj
9. Sporočilni sistemi, vrste in teme ter spoznavanje JMS
10. Zagotavljanje trajnega stanja podatkov
11. Objektno-relacijska preslikava in uporaba JPA
12. Razvoj predstavitvenega nivoja z uporabo JSP in Servletov

Content (Syllabus outline):

1. Development of multi-tier application solutions, learn about development processes.
2. Development of the middle tier and the business and functional logic.
3. Multi-tier architecture of information systems
4. Distributed object models
5. Remote method invocation
6. Server component technologies and component containers
7. Enterprise Java Beans
8. Patterns for the middle-tier
9. Messaging systems, queues and topics, learn about JMS
10. Ensuring data persistence
11. Object-relational mapping and the use of JPA

| | |
|--|---|
| 13. Pristopi k razvoju programske opreme: <ol style="list-style-type: none"> Objektno orientiran pristop Storitveno orientiran pristop (SOA) 14. Spoznavanje platforme Java EE 15. Praktični primer razvoja strežniške aplikacije z uporabo Java EE 16. Upravljanje z izvorno kodo, preoblikovanje kode 17. Verzioniranje in upravljanje sprememb 18. Testiranje programske opreme, avtomatsko testiranje, testno voden razvoj programske opreme 19. Upravljanje izvorne kode in delo v skupinah | 12. Development of presentation layer using JSP and Servlets 13. Approaches to software development: <ol style="list-style-type: none"> Object-oriented approach Service-oriented approach (SOA) 14. Understanding the Java EE Platform 15. A practical example of development of server applications using Java EE 16. Source code management, code refactoring 17. Versioning and change management 18. Software testing, automated testing, test-driven software development 19. Source code management and collaborative work |
|--|---|

Temeljna literatura in viri/Readings:

| |
|--|
| <ol style="list-style-type: none"> I. Sommerville: Software Engineering: (8th Edition), Addison Wesley, 2006. S. McConnell Code Complete: A Practical Handbook of Software Construction, Microsoft Press; 2nd edition, 2004. JURIČ, Matjaž B., LOGANATHAN, Ramesh, SARANG, Poornachandra G., JENNINGS, Frank. <i>SOA approach to integration: XML, web services, ESB, and BPEL in real-world SOA projects</i>. Birmingham; Mumbai: Packt Publishing, cop. 2007. VIII, 366 str., ilustr. ISBN 978-1-904811-17-6 JURIČ, Matjaž B., KRIŽEVNIK, Marcel. <i>WS-BPEL 2.0 for SOA composite applications: define, model, implement, and monitor real-world BPEL business processes with SOA-powered BPM</i>. Birmingham: Packt Publishing, cop. 2010. 616 str., ilustr. ISBN 978-1-847197-94-8 D. Phillips: <i>The Software Project Manager's Handbook: Principles That Work at Work (Practitioners)</i>, Wiley-IEEE Computer Society Press, 2004. |
|--|

Cilji in kompetence:

| | |
|--|--|
| Cilj predmeta je študente seznaniti z osnovami sodobnih metod razvoja programske opreme in inženirskim pristopom k razvoju ter na praktičnem primeru preizkusiti postopke razvoja, kot se uporabljajo v realnem svetu v podjetjih. Tako se študentje spoznajo z najsodobnejšimi postopki razvoja programske opreme in se bodo po zaključku študija lažje vključili v ekipe razvijalcev in vodij projektov. | Objectives and competences: The objective is to get familiar with the contemporary software development methods and engineering approach to development, and to verify the development approaches on a practical example, as software development is done in real-world projects in companies. Students will get familiar with the state-of-the-art software development approaches and will be able to seamlessly integrate with real world projects and teams. |
|--|--|

Predvideni študijski rezultati:

| | |
|--|---|
| Po uspešnem zaključku predmeta bo študent: <ul style="list-style-type: none"> - sposoben razvijati sodobne programske rešitve in uporabljati sodobne postopke razvoja programske opreme, - razumel in uporabljal najprimernejše postopke razvoja programske opreme glede na tip in zahteve, - načrtoval arhitekturo kompleksnih aplikacij in programskih sistemov, - razvijal vmesni sloj programske opreme, - razumel, načrtoval in razvijal spletne storitve, - uporabljal sodobna razvojna orodja, - razumel in apliciral načrtovalske vzorce, - uporabljal agilne pristope in DevOps orodja, - poznal programske platforme. | Intended learning outcomes: After successful completion of the course a student will be able to: <ul style="list-style-type: none"> - develop modern software solutions and use modern software development processes, - understand and use the most suitable software development procedures according to the software type and requirements, - plan the architecture of complex applications and software systems, - develop middleware layer, - understand, plan and develop web services, - use modern development tools, - understand and apply design patterns, - use agile approaches and DevOps tools, - be familiar with programming platforms. |
|--|---|

Metode poučevanja in učenja:

Learning and teaching methods:

| | |
|--|--|
| Predavanja, praktično delo na primerih, seminarska naloga s praktičnim preizkusom razvoja programske opreme z uporabo naj sodobnejših metod. | Lectures, practical work on examples, seminar work with practical verification of software development using contemporary methods. |
|--|--|

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|--------------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, midterm exams, project work) |
| Končno preverjanje (pisni izpit) | 50,00 % | Final (written exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

| |
|---|
| <p>Najpomembnejše objave:</p> <p>WSDL and BPEL extensions for event driven architecture. <i>Inf. softw. technol.</i> [Print ed.], 2010, vol. 52, iss. 10, str. 1023-1043, doi: 10.1016/j.infsof.2010.04.005.</p> <p>WSDL and UDDI extensions for version support in web services. <i>J. syst. softw.</i> [Print ed.], 2009, vol. 82, iss. 8, str. 1326-1343.</p> <p>WS-BPEL extension for versioning. <i>Inf. softw. technol.</i> [Print ed.], 2009, vol. 51, iss. 8, str. 1261-1274.</p> <p>Business process execution language for web services: an architect and developer's guide to orchestrating web services using BPEL4WS. Birmingham: Packt Publishing, 2006. X, 353 str., ilustr. ISBN 1-904811-81-7.</p> <p>SOA approach to integration: XML, web services, ESB, and BPEL in real-world SOA projects. Birmingham; Mumbai: Packt Publishing, cop. 2007. VIII, 366 str., ilustr. ISBN 978-1-904811-17-6.</p> <p>Business process driven SOA using BPMN and BPEL: from business process modeling to orchestration and service oriented architecture. Birmingham; Mumbai: Packt Publishing, cop. 2008. V, 311 str., ilustr. ISBN 978-1-84719-146-5.</p> <p>Oracle fusion middleware patterns: real-world composite applications using SOA, BPM, Enterprise 2.0, business intelligence, identity management, and application infrastructure: 10 unique architecture patterns powered by Oracle Fusion Middleware. Birmingham: Packt Publishing, cop. 2010. 224 str., ilustr. ISBN 978-1-847198-32-7.</p> <p>WS-BPEL 2.0 for SOA Composite Applications with IBM WebSphere 7: define, model, implement, and monitor real-world BPEL 2.0 business processes with SOA-powered BPM. Birmingham: Packt Publishing, cop. 2010. 644 str., ilustr. ISBN 978-1-849680-46-2.</p> <p>Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=10545.</p> |
|---|

PRINCIPI PROGRAMSKIH JEZIKOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-------------------------------------|
| Predmet: | Principi programskih jezikov |
| Course title: | Principles of Programming Languages |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0070335 |
| Koda učne enote na članici/UL Member course code: | 63220 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Andrej Bauer

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

Modeli računanja in paradigme programiranja: imperativno, postopkovno programiranje; deklarativno, nepostopkovno, programiranje; objektno programiranje; funkcijsko programiranje; logično in relacijsko programiranje; programiranje z omejitvami; paralelno programiranje; genetsko programiranje; programiranje s primeri; itd. Pregled programskih jezikov za razne paradigme programiranja
Elementi jezikov postopkovnega programiranja
Nepostopkovno programiranje, logično programiranje in programski jezik prolog: logika kot programski jezik, postopkovni pomen programa kot avtomatsko dokazovanje izrekov, primeri simboličnega programiranja in deklarativnega snovanja programov
Programiranje z omejitvami: ideje, principi in primeri, logično programiranje z omejitvami (CLP)

Content (Syllabus outline):

- Computational models and programming paradigms: imperative, procedural programming; declarative, non-procedural programming; functional programming; logic and relational programming; programming with constraints; parallel programming; genetic programming; programming by examples; etc.
- Overview of programming languages for various programming paradigms
- Elements of languages for imperative programming
- Declarative programming, logic programming and the Prolog language: logic as a programming language, procedural meaning of programs as automatic theorem proving, examples of symbolic programming and declarative program design

| | |
|--|---|
| <p>Obravnavanje sintakse in semantike programskih jezikov: gramatike, operativna, prevajalska, denotacijska in aksiomatska semantika Denotacijska semantika, povezava s gramatiko jezika, primeri denotacijskih definicij Aksiomatska semantika in dokazovanje pravilnosti programov: parcialna in totalna pravilnost, invariantni pogoji, tehnike dokazovanja pravilnosti programov, uporaba najšibkejših predpogojev, avtomatsko dokazovanje pravilnosti</p> | <ul style="list-style-type: none"> • Programming with constraints: ideas, principles and examples, constraint logic programming (CLP) • Handling of syntax and semantics of programming languages: grammars, operational, translational, denotational and axiomatic semantics • Denotational semantics, relation to the the grammar of a language, examples of denotational definitions • Axiomatic semantics and proving correctness of programs: partial and total correctness, invariant conditions, techniques of proving program correctness, using weakest preconditions, automatic correctness proving |
|--|---|

Temeljna literatura in viri/Readings:

| |
|---|
| <p>Robert W. Sebesta, Concepts of Programming Languages, 8th edition, Addison-Wesley 2007. Peter van Roy, Seif Haridi, Concepts, Techniques, and Models of Computer Programming, MIT Press 2004. Ivan Bratko, Prolog Programming for Artificial Intelligence, 4th edition, Pearson Education, Addison-Wesley, 2001. Ivan Bratko, Prolog in umetna inteligenca, Založba FE in FRI, ponatis 2011.</p> |
|---|

Cilji in kompetence:

| | |
|---|---|
| <p>Cilj je predstaviti principe in pregled vrst programskih jezikov, vključno z različnimi modeli računanja, formalnim obravnavanjem sintakse in semantike jezikov ter pravilnosti programov; Razumevanje različnih vzorcev oz. paradigem programiranja ter njihove uporabe v ustreznih programskih jezikih; Praktična uporaba simboličnega programiranja, nepostopkovnega programiranja in programiranja z omejitvami.</p> | <p>Objectives and competences: To introduce the principles and types of programming languages, including models of computation, formal treatment of the syntacs and semantics of languages and program correctness; Understanding of various programming paradigms and their use in corresponding programming languages; Practical applications of symbolic, declarative and constraint programming.</p> |
|---|---|

Predvideni študijski rezultati:

| | |
|--|--|
| <p>Znanje in razumevanje: Razumevanje različnih pristopov k programiranju in primernost raznih pristopov za reševanje raznih problemov; Pregled principov in mehanizmov raznih vrst programskih jezikov; Razumevanje načinov za opisovanje sintakse in pomena programskih jezikov ter formalno dokazovanje pravilnosti programov. Uporaba: Razvoj spretnosti simboličnega programiranja, programiranja v logiki in programiranja z omejitvami. Refleksija: Sposobnost razmišljanja o alternativnih formulacijah problemov ter pristopov k njihovem reševanju; Kako različni modeli računanja, paradigme programiranja in vrste jezikov spodbujajo alternativne pristope k računalniškemu reševanju problemov. Prenosljive spretnosti - niso vezane le na en predmet: Razširjene spretnosti snovanja programov.</p> | <p>Intended learning outcomes: Knowledge and understanding: Understanding of various approaches to programming and suitability of these approaches to solving various problems; Overview of the principles and mechanisms of types of programming languages; Understanding ways of defining the syntax and semantics of languages, and formal proofs of program correctness. Application: Skill of symbolic programming, logic and constrain programming Reflection: Ability of thinking about alternative formulations of problems and approaches to their solution; How different computational models, programming paradigms and languages, support alternative approaches to computer problem solving Transferable skills: Enhanced skills of program design.</p> |
|--|--|

| | |
|--|--|
| Metode poučevanja in učenja: | Learning and teaching methods: |
| Predavanja, avditorne vaje and exercises, domače naloge. | Lectures, practical work and exercises, home work. |

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge) | 50,00 % | Continuing (homework) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

BAUER, Andrej, PRETNAR, Matija. Programming with algebraic effects and handlers. V: Journal of logical and algebraic methods in programming : Special Issue on Domains X, International workshop on Domain Theory and applications, Swansea, 5-7 September, 2011, (Journal of logical and algebraic methods in programming, ISSN 2352-2208, Vol. 84, iss. 1, 2015). <http://dx.doi.org/10.1016/j.jlamp.2014.02.001>

BAUER, Andrej, PRETNAR, Matija. An effect system for algebraic effects and handlers. Logical methods in computer science, ISSN 1860-5974, 2014, vol. 10, iss. 4, paper 9 (str. 1-29). <http://arxiv.org/pdf/1306.6316>.

BAUER, Andrej, PLOTKIN, Gordon, SCOTT, Dana S. Cartesian closed categories of separable Scott domains. Theoretical computer science, ISSN 0304-3975, 2014, vol. 546, str. 17-29.

BAUER, Andrej, HOFMANN, Martin, KARBYSHEV, Aleksandr. On monadic parametricity of second-order functionals. V: PFENNING, Frank (ur.). Foundations of software science and computation structures : 16th International Conference, FOSSACS 2013, held as part of the European Joint Conferences on Theory and Practice of Software, ETAPS 2013, Rome, Italy, March 16-24, 2013 : proceedings, 16th International Conference on Foundations of Software Science and Computational Structures, FOSSACS 2013, Rome, Italy, March 16-24, 2013, (Lecture notes in computer science, ISSN 0302-9743, 7794). Berlin; Heidelberg: Springer, cop. 2013, str. 225-240. http://dx.doi.org/10.1007/978-3-642-37075-5_15.

BAUER, Andrej, STONE, Christopher A. RZ: a tool for bringing constructive and computable mathematics closer to programming practice. Journal of logic and computation, ISSN 0955-792X, 2009, vol. 19, no. 1, str. 17-43. <http://dx.doi.org/10.1093/logcom/exn026>

BAUER, Andrej, HÖTZEL ESCARDÓ, Martín, SIMPSON, Alex. Comparing functional paradigms for exact real-number computation. V: WIDMAYER, Peter (ur.). Automata, languages and programming : 29th international colloquium, ICALP 2002, Málaga, Spain, July 8-13, 2002 : proceedings, (Lecture notes in computer science, ISSN 0302-9743, 2380). Berlin; London: Springer, cop. 2002, str. 488-500.

PROGRAMIRANJE 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-----------------|
| Predmet: | Programiranje 1 |
| Course title: | Programming 1 |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 1. letnik | 1. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039583 |
| Koda učne enote na članici/UL Member course code: | 63277 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Luka Fürst

Vrsta predmeta/Course type: obvezni predmet / compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

predavanja:

Pregled programskih jezikov s poudarkom na sodobnih programskih jezikih 3. generacije
Primer preprostega programa, postopek priprave programa, prevajanje in izvajanje
Osnovni podatkovni tipi
Predstavitev celih in realnih števil, znakov ter logičnih vrednosti
Deklaracije konstant in spremenljivk
Stavki
Prireditveni stavek, pisanje izrazov, operatorji in njihova prioriteta
Izbirni stavki
Ponavljalni stavki
Metode
Vloga in vrste metod
Formalni in dejanski parametri
Rekurzija

Content (Syllabus outline):

lectures:

Overview of programming languages with emphasis on 3rd generation
Writing, compiling and executing a simple computer program
Basic data types
Integer and real numbers, characters and logical values
Constants and variables declaration
Programming statements
The assignment statement, expressions, operators, operator precedence
Conditional statements
Loops
Methods
The role and classification of methods
Formal and actual parameters
Recursion

| | |
|---|---|
| <p>Razredi in objekti Spremenljivke in metode objekta Konstruktorji, večkratno definiranje konstruktorjev Dostopna določila Vnaprej deklarirani razredi Tabele Enodimenzionalne in večdimenzionalne tabele Tabele objektov Nizi Dedovanje Redefinicija metod Konstruktorji v podrazredih Dinamično povezovanje podprogramov Abstraktni razredi in abstraktne metode Razred Object Vmesnik (interface) Grafične knjižnice, komponente grafičnega uporabniškega vmesnika Dogodkovno vodeno programiranje</p> <p>vaje: Na vajah študenti rešujejo praktične probleme, s katerimi utrjujejo snov, ki so jo obravnavali na predavanjih. Poudarek je na samostojnem delu ob pomoči asistentov.</p> <p>domače naloge: Študenti dobijo seznam nalog (programov), ki jih morajo izdelati doma in zagovarjati na vajah v vnaprej predpisanih rokih. S tem jih vzpodbujamo k sprotnemu študiju in samostojnemu delu. Študent, ki nima pozitivno ocenjenih domačih nalog, ne more pristopiti k izpitu.</p> | <p>Classes and objects Instance variables and methods Constructors, overloading constructors Access modifiers Using predefined classes Arrays One-dimensional and multidimensional arrays Arrays of objects Strings Inheritance Overriding superclass methods Using superclass constructors in subclasses Dynamic method binding Abstract classes and abstract methods The Object class Creating and using interfaces Graphics and GUI widget toolkits, components of GUI Event driven programming</p> <p>lab practice: Students solve practical problems to reinforce the understanding of topics covered during lectures. Individual work under the guidance of teaching assistants is emphasized.</p> <p>homework: Students are given a list of programs that must be developed outside contact hours and submitted for evaluation within prescribed deadlines, thus preventing them from procrastinating and encouraging self-reliance. Completion of these assignments is a prerequisite for entering the exam.</p> |
|---|---|

Temeljna literatura in viri/Readings:

V. Mahnič, L. Fürst, I. Rožanc: Java skozi primere, Bi-TIM, 2008.
J. Farrell: Java Programming, Seventh Edition, Course Technology, Cengage Learning, 2014.
Dodatna literatura:
I. Horton: Beginning Java, Java 7 Edition, John Wiley & Sons, Inc., 2011
Uroš Mesojedec, Borut Fabjan: Java 2: Temelji programiranja, Pasadena, 2004.

Cilji in kompetence:

Cilj predmeta je študentom predstaviti osnovne koncepte objektno usmerjenega programiranja v enem izmed splošno namenskih programskih jezikov 3. generacije in jih usposobiti za samostojen razvoj enostavnih računalniških programov.
Predvidene kompetence:
razvoj sposobnosti za kritično, analitično in sintetično razmišljanje,
sposobnost razumevanja in reševanja strokovnih izzivov na področju računalništva in informatike,
sposobnost uporabe pridobljenega znanja pri samostojnem delu za reševanje tehničnih in znanstvenih problemov na področju računalništva in informatike; sposobnost nadgradnje pridobljenega znanja,
temeljna znanja na področju računalništva in informatike, ki vključujejo temeljna teoretična znanja,

Objectives and competences:

The main objective is to teach students basic concepts of object-oriented programming in a general-purpose 3rd generation programming language, thus making them able to develop computer programs of low complexity.
The competences students gain are:
developing skills in critical, analytical and synthetic thinking,
the ability to understand and solve professional challenges in computer and information science.
the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.
basic skills in computer and information science, which includes basic theoretical skills, practical

| | |
|---|---|
| praktična znanja in znanja, ki so bistvena za področje računalništva in informatike, temeljna znanja na področju računalništva in informatike, ki so pomembna za nadaljevanje študija na drugi stopnji. | knowledge and skills essential for the field of computer and information science. basic skills in computer and information science, allowing the continuation of studies in the second study cycle. |
|---|---|

| | |
|---|--|
| Predvideni študijski rezultati: | Intended learning outcomes: |
| Po uspešnem zaključku tega predmeta bo študent zmožen: razumeti postopek priprave, prevajanja in izvajanja računalniškega programa razumeti in uporabljati osnovne programske konstrukte in podatkovne strukture razumeti koncepte objektno usmerjenega programiranja (vključno z dedovanjem) razumeti in uporabljati osnovne algoritme za reševanje tipičnih programerskih problemov izkazati poznavanje osnov računalniške grafike in osnovnih komponent grafičnega uporabniškega vmesnika izkazati poznavanje osnov dogodkovno vodenega programiranja pisati enostavne računalniške programe v splošno namenskem jeziku tretje generacije | After the completion of the course, a student will be able to: understand the process of writing, compiling, and running a computer program understand and use basic programming constructs and data structures understand the concepts of object-oriented programming (including inheritance) understand and use basic algorithms for solving typical programming problems know the basics of computer graphics and basic components of GUI know the principles of event-driven programming write simple computer programs in a general purpose programming language |

| | |
|---|--|
| Metode poučevanja in učenja: | Learning and teaching methods: |
| <i>Predavanja</i> z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov); <i>Laboratorijske vaje</i> (refleksija izkušenj, praktično reševanje več tipičnih problemov na računalniku, predstavitev in zagovor programskih rešitev, diskusija, sporočanje povratne informacije); <i>Domače naloge</i> (samostojna izdelava računalniških programov) Individualne <i>konsultacije</i> (diskusija, dodatna razlaga, obravnava specifičnih vprašanj) | <i>Lectures</i> with active participation of students (explanation, discussion, questions, examples, problem solving); <i>Lab practice</i> (reflection of experience, practical problem solving, presentation of solutions, discussion, communication of feedback information) <i>Homework</i> (individual development of simple computer programs) Individual consultation hours (discussion, additional explanation, specific problems solving) |

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|---|---------------------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (3 seminarske naloge, kratki testi v obliki kvizov) | 50,00 % | Continuing (three homework programming projects, short tests) |
| Končno preverjanje (izpit) | 50,00 % | Final (exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

| |
|---|
| Reference nosilca/Lecturer's references: |
| Pet najpomembnejših del: |
| Pet najpomembnejših del: |
| FÜRST, Luka, MERNIK, Marjan, MAHNIČ, Viljan. Improving the graph grammar parser of Rekers and Schürr. IET Software, 2011, vol. 5, no. 2, str.246-261. |
| FÜRST, Luka, MERNIK, Marjan, MAHNIČ, Viljan. Converting metamodels to graph grammars: doing without advanced graph grammar features. Software and systems modeling, 2015, vol. 14, no. 3, str. 1297-1317. |
| FÜRST, Luka, ČIBEJ, Uroš, MIHELIC, Jurij. Maximum exploratory equivalence in trees. FedCSIS 2015, Łódź, Poljska, september 2015, str. 507-518. |

FÜRST, Luka, MAHNIČ, Viljan. Introductory programming course: motivating students with prior knowledge. *World transactions on engineering and technology education*, ISSN 1446-2257, 2013, vol. 11, no. 4, str. 400-405. [http://wiete.com.au/journals/WTE&TE/Pages/Vol.11,%20No.4%20\(2013\)/08-Fuerst-L.pdf](http://wiete.com.au/journals/WTE&TE/Pages/Vol.11,%20No.4%20(2013)/08-Fuerst-L.pdf).

MAHNIČ, Viljan, FÜRST, Luka, ROŽANC, Igor. *Java skozi primere*. Šenčur: Bi-tim, 2008. XIV, 478 str., ponovni ponatis 2012.

Celotna bibliografija je dostopna na Cobissu oziroma Sicrisu:

<http://bib.cobiss.si/cobiss/BibPersonal.jsp?init=t&code=25527>

PROGRAMIRANJE 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-----------------|
| Predmet: | Programiranje 2 |
| Course title: | Programming 2 |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 1. letnik | 2. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni (od študijskega leta 2023/2024 dalje) | Ni členitve (študijski program) | 1. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039584 |
| Koda učne enote na članici/UL Member course code: | 63278 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Boštjan Slivnik

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

| Vsebina: | Content (Syllabus outline): |
|---|--|
| Uvod v programski jezik C. Osnovni podatkovni tipi in osnovne kontrolne strukture. Razvoj programov in razhroščevanje. Kazalci in tabele (1. del). Kazalci in tabele (2. del). Funkcije in prenos argumentov. Dinamično dodeljevanje pomnilnika. Nizi. Vhodno-izhodne operacije. Strukture. Enostavni algoritmi urejanja. Rekurzija in algoritmi sestopanja (1. del). Rekurzija in algoritmi sestopanja (2. del). | Introduction to C programming language. Basic data types and basic control structures. Program design and debugging. Pointers and arrays (part 1). Pointers and arrays (part 2). Functions and parameter passing. Dynamic memory allocation. Strings. Input-output operations. Structures. Simple sorting algorithms. Recursion and backtracking (part 1). Recursion and backtracking (part 2). Preprocessor. |

| | |
|---------------|--|
| Predprocesor. | |
|---------------|--|

Temeljna literatura in viri/Readings:

B. W. Kernighan, D. Ritchie: Programski jezik C, Fakulteta za računalništvo in informatiko, 1994.
 T. Dobravec: abC, Fakulteta za računalništvo in informatiko, 2010.
 A. Kavčič, M. Privošnik, C. Bohak, M. Marolt, S. Divjak: Programiranje in algoritmi skozi primere, Založba FE in FRI, 2010

Cilji in kompetence:

Cilj predmeta je razširiti znanje programiranja skozi študij bazičnih in naprednejših tehnik programiranja.

Splošne kompetence:

Sposobnost kritičnega, analitičnega in sintetičnega razmišljanja
 Sposobnost razumevanja in reševanja strokovnih izzivov v računalništvu in informatiki
 Sposobnost uporabe pridobljenega znanja pri samostojnem reševanju tehničnih in znanstvenih problemov v računalništvu in informatiki; sposobnost razširjanja pridobljenega znanja

Predmetno-specifične kompetence:

Osnovne veščine v računalništvu in informatiki – osnovne teoretične veščine, praktično znanje, bistvene veščine za področje računalništva in informatiki
 Osnovne veščine v računalništvu in informatiki, ki omogočajo nadaljevanje študija na drugi stopnji

Objectives and competences:

The goal of the course is to widen the programming skills by learning the most basic and advanced programming techniques.

General competences:

Developing skills in critical, analytical and synthetic thinking
 The ability to understand and solve professional challenges in computer and information science
 The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge

Subject-specific competences:

Basic skills in computer and information science, which includes basic theoretical skills, practical knowledge and skills essential for the field of computer and information science
 Basic skills in computer and information science, allowing the continuation of studies in the second study cycle

Predvideni študijski rezultati:

Po uspešnem zaključku tega predmeta bo študent: znal reševati zmerno težke programske naloge; sposoben pisati programe v programskem jeziku C; razumel nizko nivojsko programiranje; sposoben uporabljati rekurzijo za reševanje problemov; sposoben uporabljati kazalce za pisanje učinkovitih programov; sposoben uporabljati dinamično dodeljevanje in sproščanje pomnilnika; sposoben uporabljati rekurzivne podatkovne strukture; sposoben uporabljati sistemske klice v programskem jeziku C; sposoben pisati programe sestavljene iz več neodvisnih enot.

Intended learning outcomes:

After the completion of the course a student will be able to:
 solve medium-level programming exercises;
 write programs in C programming language;
 understand low-level programming techniques;
 use recursion to solve programming problems;
 use pointers to write efficient programs;
 manage dynamic memory allocation and deallocation;
 use recursive data structures;
 use system calls in the C programming language;
 write C programs consisting of multiple compilation units.

Metode poučevanja in učenja:

Predavanja, domače naloge, seminarski način dela pri vajah. Poseben poudarek je na sprotnem študiju in domačih nalogah.

Learning and teaching methods:

Lectures, home works, seminar works during tutorials. The emphasis is on continuous study and homeworks.

Načini ocenjevanja:

Način (pisni izpit, ustno izpraševanje):

Delež/Weight

Assessment:

Type (examination, written and oral):

| | | |
|--|----------|---|
| Končno preverjanje (pisni izpit ali oba pozitivna kolokvija) | 100,00 % | Final (written exam or 2 positive midterm exams) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

SLIVNIK, Boštjan. On different LL and LR parsers used in LLLR parsing. *Computer Languages, Systems & Structures*, ISSN: 1477-8424, Dec. 2017, vol. 50, str. 108-126.

SLIVNIK, Boštjan, VILFAN, Boštjan. Producing the left parse during bottom-up parsing. *Information processing letters*, ISSN 0020-0190, Dec. 2005, vol. 96, no. 6, str. 220-224.

SLIVNIK, Boštjan. Measuring the complexity of domain-specific languages developed using MDD. *Software quality journal*, ISSN 0963-9314, Sep. 2016, vol. 24, no. 3, str. 737-753.

ROŽANC, Igor, SLIVNIK, Boštjan. Using reverse engineering to construct the platform independent model of a web application for student information systems. *Computer Science and Information Systems*, ISSN 1820-0214, 2013, vol. 10, no. 4, str. 1557-1583.

POTOČNIK, Matic, ČIBEJ, Uroš, SLIVNIK, Boštjan. Linter - a tool for finding bugs and potential problems in Scala code. *Proceedings of the 29th Annual ACM Symposium on Applied Computing*, Gyeongju, Korea, March 24-28, 2014, str. 1615-1616.

Celotna bibliografija je dostopna na SICRISu:
<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=7849>.

PROGRAMIRANJE SPECIFIČNIH PLATFORM

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------------|
| Predmet: | Programiranje specifičnih platform |
| Course title: | Platform Based Development |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0069537 |
| Koda učne enote na članici/UL Member course code: | 63287 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Veljko Pejović

Vrsta predmeta/Course type: izbirni predmet/elective course

| | | |
|--------------------------|----------------------|-------------------------|
| Jeziki/Languages: | Predavanja/Lectures: | Angleščina, Slovenščina |
| | Vaje/Tutorial: | Angleščina, Slovenščina |

| | |
|--|-----------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| | |

Vsebina:

Predmet vsebuje teme s področja programiranja specifičnih platform, ki so priporočene v ACMjevem kurikulumu za računalništvo. Konkretna vsebina se bo letno prilagajala trendom, zato kurikulum ni omejen na konkretne platforme.

- pregled platform (mobilne, vgradne, porazdeljene, spletne, industrijske, robotske, paralelne/skalabilne,...),
- podprti programski jeziki
- programiranje z uporabo specifičnih knjižnic,
- programiranje glede na omejitve posamezne platforme,
- programski jeziki za mobilne platforme,
- ravnotežje poraba/zmogljivost in analiza izvrševanja programa,

Content (Syllabus outline):

The course will include topics in platform based development recommended in the ACM curriculum for CS. The topics will continually adapt to contemporary trends, thus the course is not constrained to a specific platform.

- overview of platforms (mobile, embedded, distributed, web, industrial, robotic, parallel/scalable,...),
- supported/domain-specific programming languages
- programming via platform-specific APIs
- programming under platform constraints,
- mobile platform languages,
- performance/power tradeoffs and profiling,
- mobile platform constraints and challenges with wireless communication

| | |
|---|---|
| <p>7. omejitve in izzivi mobilnih platform ter brezžična komunikacija,</p> <p>8. odčitavanje mobilnih senzorjev in konektno zavedanje (npr. lokacijske aplikacije),</p> <p>9. programiranje in pristopi za časovno kritične interaktivne platforme,</p> <p>10. omejitve platform za časovno kritične interaktivne aplikacije,</p> <p>11. izbrane vsebine iz mobilnega zdravstva, pametnih mest/hiš/tovarn, in ostalih domen,</p> <p>Vaje potekajo konzultacijsko in seminarsko. Gradi se projekt skozi sprinte po Scrum metodi razvoja programske opreme.</p> | <p>8. mobile sensing and context awareness (e.g. location-aware applications)</p> <p>9. programming languages and approaches for time-critical interactive platforms,</p> <p>10. platform constraints for time-critical interactive applications,</p> <p>11. selected topics from mobile healthcare, smart city/home/factory, and other domains</p> <p>Practical part of the course consists of seminar work and consultations (tutorial). Students build the project using sprints as specified by Scrum software engineering methodology.</p> |
|---|---|

Temeljna literatura in viri/Readings:

1. Yener, M., & Dundar, O. (2016). *Expert Android Studio*. John Wiley & Sons.
2. Simon DE. (1999). *An embedded software primer*. Addison-Wesley Professional
3. R. Meier: *Professional Android 4 Application Development*, 3rd Edition; Wrox, 2012.
4. R. Ierusalimsky: *Programming in LUA*, Lua.org, 2013.

Cilji in kompetence:

Cilj predmeta je spoznati različne moderne računalniške platforme in se spoznati s specifikami razvoja programske opreme na teh platformah.

Splošne kompetence:

- Zmožnost kritičnega razmišljanja.
- Zmožnost definirati, razumeti in rešiti kreativne strokovne izzive na področju računalništva in informatike.
- Zmožnost apliciranja in nadgrajevanja pridobljenega znanja.

Predmetno specifične kompetence:

- Zmožnost prenosa znanja sodelavcem v tehnoloških ekipah.
- Veščine in praktično znanje o posebnih strojni opremi platform, specialnih programskih jezikih in omejitvah posameznih platform.

Objectives and competences:

The aim of the course is to gain expertise on several modern platforms and learn the specifics of software development for these.

General competences:

- Ability of critical thinking.
- The ability to define, understand and solve creative professional challenges in computer and information science.
- The ability to apply and upgrade acquired knowledge.

Subject specific competences:

- The ability to transmit knowledge to co-workers in technology groups.
- Practical knowledge and skills of particular computer hardware of specific platforms, special programming languages, and constraints associated with these.

Predvideni študijski rezultati:

Po uspešno opravljenem predmetu bodo študenti zmožni:

- razlikovati med specifikami različnih platform,
- prenesti osvojena znanja med platformami,
- uporabiti platformo za realizacijo produkta,
- razviti programski izdelek na platformi,
- analizirati zmogljivost strojne opreme in potrebe po virih programskega izdelka,
- argumentirati izbor specifične strojne in programske opreme za razvoj izdelka.

Intended learning outcomes:

After successful completion of the course, students will be able to:

- differentiate between specifics of different platforms,
- transfer obtained knowledge between platforms,
- use the platform for product development,
- develop software product on the platform,
- analyze hardware efficiency and software product needs for resources,
- argument selection of specific hardware and software for the development of the product.

Metode poučevanja in učenja:

Learning and teaching methods:

| | |
|---|---|
| Predavanja in domača naloga. Poseben poudarek je na individualnem delu študentov. | Lectures and homework with special emphasis on individual work. |
|---|---|

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|--------------|---|
| Način (pisni izpit, ustno izpraševanje, naloga, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge) | 50,00 % | Continuing (homework) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

Pet najpomembnejših del:

1. PEJOVIĆ, Veljko, MUSOLESI, Mirco. Anticipatory mobile computing : a survey of the state of the art and research challenges. *ACM computing surveys*, ISSN 0360-0300. [Print ed.], Apr. 2015, vol. 47, no. 3, str. 1-29
2. PEJOVIĆ, Veljko, BELDING, Elizabeth M. WhiteRate : a context-aware approach to wireless rate adaptation. *IEEE transactions on mobile computing*, ISSN 1536-1233. [Print ed.], Apr. 2014, vol. 13, no. 4, str. 921-934
3. LATHIA, Neal, PEJOVIĆ, Veljko, RACHURI, Kiran K., MASCOLO, Cecilia, MUSOLESI, Mirco, RENTFROW, Peter J. Smartphones for large-scale behavior change interventions. *IEEE pervasive computing : mobile and ubiquitous systems*, ISSN 1536-1268. [Print ed.], 2013, vol. 12, no. 3, str. 66-73
4. PEJOVIĆ, Veljko, LATHIA, Neal, MASCOLO, Cecilia, MUSOLESI, Mirco. Mobile-based experience sampling for behaviour research. V: TKALČIČ, Marko (ur.), et al. *Emotions and personality in personalized services : models, evaluation and applications*, (Human-computer interaction series, ISSN 1571-5035). [S. l.]: Springer. cop. 2016, str. 141-161
5. PEJOVIĆ, Veljko, MUSOLESI, Mirco. InterruptMe. V: *UbiComp'14 : proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing, September 13-17, 2014, Seattle, WA, USA*. New York (NY): ACM. cop. 2014, str. 897-908

Celotna bibliografija je dostopna na SICRISu:

<http://www.sicris.si/search/rsr.aspx?opt=1&lang=slv&id=43813>.

RAČUNALNIŠKA GRAFIKA IN TEHNOLOGIJA IGER

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|--|
| Predmet: | Računalniška grafika in tehnologija iger |
| Course title: | Computer Graphics and Game Technology |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039619 |
| Koda učne enote na članici/UL Member course code: | 63269 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Matija Marolt

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

| Vsebina: | Content (Syllabus outline): |
|--|--|
| Predavanja: <ol style="list-style-type: none">Uvod.Matematične osnove.Afine transformacije, koordinatni sistemi. Homogene koordinate. Projekcije.Predstavitve predmetov: poligoni, deljene ploskve, parametrične krivulje. Hierarhije.Lokalno osvetljevanje in senčenje.Teksture.Grafični cevovod: izločanje in rezanje, rasterizacija, z-buffer.SenčilnikiDetekcija trkov.Metode razdelitve prostora.Barve.Globalno upodabljanje: sledenje žarka. | Lectures: <ol style="list-style-type: none">Introduction.Basic math.Affine transformations, coordinate systems, homogeneous coordinates. Projections.Representations: polygons, subdivision surfaces, parametric curves.Local illumination and shading.Texture mapping.Graphics pipeline: culling and clipping, rasterisation, z-buffer.ShadersCollision detection.Space partitioning methods.Colors. |

| | |
|--|--|
| <p>Vaje: Laboratorijski projekt izdelave interaktivne igre. Na vajah podan uvod v OpenGL in Unity in samostojno delo na projektih z zaključno predstavitvijo študentov.</p> | <p>12. Global illumination: raytracing. Laboratory: Students will implement an interactive game. Exercises will include an introductory course on OpenGL and Unity and individual project work with final public presentation of results.</p> |
|--|--|

Temeljna literatura in viri/Readings:

| |
|---|
| <ol style="list-style-type: none"> 1. Nikola Guid: Računalniška grafika. Univerza v Mariboru, FERl. 2. D. Hearn, M.P. Baker: Computer Graphics with OpenGL, Pearson Prentice Hall, NJ USA. 3. D.H. Eberly: 3D Game Engine Design, Morgan Kaufman Publishers, CA USA. |
|---|

Cilji in kompetence:

| |
|--|
| <p>Cilj predmeta je študentom predstaviti programsko in algoritmično ozadje računalniške grafike in iger. Študenti bodo pridobili naslednje kompetence:</p> <ul style="list-style-type: none"> - razumevanje in reševanje izzivov na področju računalništva in informatike; - uporabo znanja za samostojno delo pri reševanju tehničnih in znanstvenih problemov na področju računalništva in informatike; sposobnost nadgradnje znanj; - sposobnost samostojnega izvajanja manj in bolj zahtevnih inženirskih in organizacijskih nalog na ožjih področjih in samostojno reševanje dobro definiranih nalog na področju računalništva in informatike; - sposobnost samostojnega razvoja 3D interaktivnih grafičnih aplikacij in iger. |
|--|

Objectives and competences:

| |
|---|
| <p>The objective is to present students the programming and algorithmic background of computer graphics and games. When completing the course, students will be able to gain the following competences:</p> <ul style="list-style-type: none"> - the ability to understand and solve professional challenges in computer and information science. - the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge. - the ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science - the ability to independently develop interactive 3D applications and games. |
|---|

Predvideni študijski rezultati:

| |
|---|
| <p>Po uspešnem zaključku tega predmeta bo študent:</p> <ul style="list-style-type: none"> - razumel matematično ozadje osnovnih algoritmov v računalniški grafiki - poznal različne načine predstavitve 3D predmetov - razumel delovanje posameznih faz grafičnega cevovoda - razumel osnove optimizacijskih tehnik potrebnih za doseganje interaktivnosti v grafičnih aplikacijah - razumel principe nizkonivojskega in visokonivojskega programiranje 3D grafičnih aplikacij - sposoben implementirati interaktivno 3D grafično aplikacijo in igro z uporabo nizkonivojskih ali visokonivojskih programskih knjižnic. |
|---|

Intended learning outcomes:

| |
|---|
| <p>After the completion of the course the student will be able to:</p> <ul style="list-style-type: none"> - understand the mathematical background of basic computer graphics algorithms - know the different representations of 3D objects - understand the inner workings of the graphics pipeline - understand the basics of optimization techniques needed to develop interactive graphical applications - understand the principles of low-level and high-level 3D graphics programming - develop an interactive 3D graphical application or game using low-level or high-level programming libraries. |
|---|

Metode poučevanja in učenja:

| |
|---|
| <p>Predavanja s praktičnimi demonstracijami, izvajanje laboratorijskega projekta pod mentorstvom asistenta.</p> |
|---|

Learning and teaching methods:

| |
|---|
| <p>Lectures with practical demonstrations, laboratory work under the supervision of assistants.</p> |
|---|

Načini ocenjevanja:

| |
|--|
| <p>Način (pisni izpit, ustno izpraševanje, naloge, projekt):</p> |
|--|

Delež/Weight

| |
|---------|
| <p></p> |
|---------|

Assessment:

| |
|---|
| <p>Type (examination, oral, coursework, project):</p> |
|---|

| | | |
|--|---------|---|
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, midterm exams, project work) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

1. LESAR, Žiga, BOHAK, Ciril, MAROLT, Matija. Evaluation of angiogram visualization methods for fast and reliable aneurysm diagnosis. Medical imaging 2015 : image perception, observer performance, and technology assessment : 25-26 February 2015, Orlando, Florida, United States.
2. BOHAK, Ciril, SODJA, Anže, MAROLT, Matija, MITROVIĆ, Uroš, PERNUŠ, Franjo. Fast segmentation, conversion and rendering of volumetric data using GPU. IWSSIP 2014 : proceedings, (International Conference on Systems, Signals, and Image Processing (Print), ISSN 2157-8672), 2014, str. 239-242.
3. MAROLT, Matija. A connectionist approach to automatic transcription of polyphonic piano music. IEEE trans. multimedia. [Print ed.], str. 439-449, ilustr. [COBISS.SI-ID 4203860]
4. MAROLT, Matija. A mid-level representation for melody-based retrieval in audio collections. IEEE trans. multimedia. [Print ed.], Dec. 2008, vol. 10, no. 8, str. 1617-1625, ilustr. [COBISS.SI-ID 6908756]
5. PESEK, Matevž, LEONARDIS, Aleš, MAROLT, Matija. Robust real-time music transcription with a compositional hierarchical model. PloS one, ISSN 1932-6203, Jan. 2017, vol. 12, no. 1, str. 1-21 [COBISS.SI-ID 1537322179]

Celotna bibliografija je dostopna na SICRISu:

<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8948>.

RAČUNALNIŠKE KOMUNIKACIJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|---------------------------|
| Predmet: | Računalniške komunikacije |
| Course title: | Computer Communications |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 1. letnik | 2. semester | obvezni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 2. letnik | 2. semester | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039585 |
| Koda učne enote na članici/UL Member course code: | 63209 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Zoran Bosnić

Vrsta predmeta/Course type: obvezni predmet/compulsory course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

Uvod: računalniška omrežja in internet
Osnovni pojmi: plasti, protokoli, storitve, protokolarni sklad. Hrbtenica in krajevna omrežja; kje nastajajo zakasnitve.
Aplikacijska plast: storitve, pregled standardnih protokolov. Zasnova omrežnih aplikacij, standardni protokoli HTTP, FTP, SMTP, DNS. Delovanje e-pošte, peer-to-peer aplikacij, vtičev (socket) in uporaba storitev transportne plasti.
Predstavitvena in sejna plast: vsebina in storitve, primeri.
Transportna plast: storitve, multipleksiranje, povezavni in nepovezavni prenos (TCP in UDP), zanesljiv prenos podatkov, nadzor zasičenja (congestion control), izvedba le tega v TCP.

Content (Syllabus outline):

Introduction: Computer networks and internet
Basic notions: layer, protocol, service, protocol stack.
Backbone and local area networks; transmission latency sources.
Application layers: services, network application basics, overview of well-known protocols. Protocols HTTP, FTP, SMTP, DNS. E-mail functionalities, peer-to-peer applications, sockets, use of transport layer services.
Presentation and session layer: their purpose and services.
Transport layer: services, multiplexing, connection-oriented and connectionless transfer (TCP and UDP), reliable data transfer, congestion control and its implementation inside TCP.

| | |
|--|---|
| <p>Omrežna plast: storitve, virtualne zveze in datagranske povezave, delovanje usmerjevalnikov, naslavljanje v internetu (IP in IPv6), temeljni usmerjanja.</p> <p>Prenosni sistem – povezavna in fizična plast, krajevna omrežja (LAN): storitve, zaznavanje in odpravljanje napak, protokoli za skupinski prenosni medij, Fizični naslovi (MAC) in preslikava v IP naslove (ARP), delovanje stikal. Ethernet, PPP, brezžična omrežja, aktualni standardi (npr. IEEE 802.11x, Bluetooth). Celularna omrežja, mobilnost. Prenos signalov, prenosni mediji, vrste modulacije.</p> <p>Omrežna varnost, zanesljivost in zaščita, celovitost sporočil, avtentikacija, pregled varovanja e-pošte, TCP povezav (SSL), omrežne povezave (IPSec), brezžične povezave. Požarne pregrade, IDS, IPS sistemi. Aktualni omrežni napadi in obramba pred njimi.</p> <p>Pomen upravljanja omrežja.</p> | <p>Network layer: services, virtual and datagram connections, routing, addressing in internet (IPv4 and IPv6), routers.</p> <p>Transmission system – data link and physical layer, local area networks (LANs): services, error detection and correction techniques, media access protocols, addressing (MAC addresses) and mapping of MAC address to IP addresses (protocol ARP), switches and their functionalities. Ethernet, PPP, wireless networks, current standards (IEEE 802.11x, Bluetooth), cellular networks, mobile networks, transmission of signals, media types, modulations.</p> <p>Network security, reliability and protections. Message integrity, authentication, protection of e-mail, TCP connections (SSL), network connection (IPSec), wireless connections). Firewalls, IDS/IPS systems.</p> <p>Network attacks and defense from them.</p> <p>Network management.</p> |
|--|---|

Temeljna literatura in viri/Readings:

J. F. Kurose, K. W. Ross, M. Ciglarič, Z. Bosnić: Računalniške komunikacije. Pearson, England, 2014, ISBN 978-1-78399-776-3.

Dodatna literatura:

J. F. Kurose, K. W. Ross: Computer Networking, A top-down Approach Featuring Internet. 4. izdaja, Addison Wesley 2007. Poglavja 2-6 in 8.A.S. Tanenbaum, Computer Networks, 4. izdaja, Prentice Hall PTR, 2002.

Cilji in kompetence:

Cilj predmeta je študentom računalništva in informatike predstaviti osnove delovanja računalniških omrežij in pomembnejših protokolov. Kompetence, ki jih bo študent pridobil, so zlasti:

- sposobnost uporabe informacijsko-komunikacijske tehnologije in sistemov
- razumevanje delovanja večplastnih sistemov sodobnih komunikacij
- sposobnost uporabe in načrtovanja omrežnih storitev
- usposobljenost za načrtovanje omrežij in smiselno dodeljevanje omrežnih naslovov
- usposobljenost za postavitev preprostega omrežja (domače omrežje), za osnovno nastavljanje kompleksnih usmerjevalnikov in za postavitev krajevnega omrežja s stikali in brezžičnimi dostopnimi točkami.

Objectives and competences:

The main goal is to present the students of computer science and informatics the basics of computer networking and the most important communication protocols in this area. The competences that the students will acquire, are:

- capability to use information and communication systems and technology
- understanding of how multi-layer communication systems work
- use and design of network services
- being capable of designing network architectures and implementing network addressing
- capability for installing and administering a simple (home) network, performing basic routing settings and configuring switches and wireless access points.

Predvideni študijski rezultati:

Po uspešnem zaključku predmeta bo študent:

- poznal komunikacijska modela TCP/IP in ISO/OSI,
- sposoben definirati namen poglavitnih protokolov na vsaki plasti modela TCP/IP,
- znal pojasniti lastnosti in glavne komunikacijske protokole v omrežju Internet,

Intended learning outcomes:

After the completion of the course the student will be able to:

- know communication models TCP/IP and ISO/OSI,
- define the purpose of major protocols on each of the TCP/IP layers,
- explain characteristics and functions of main Internet protocols,

| | |
|---|--|
| <ul style="list-style-type: none"> - sposoben uporabiti virtualno okolje za načrtovanje omrežij, - sposoben uporabljati analizatorje omrežnega prometa za vpogled v komunikacijo in odpravljanje težav, - sposoben načrtovanja postavitve in administriranja manjših lokalnih omrežij. | <ul style="list-style-type: none"> - use virtual environment for planning and designing networks, - use network traffic analyzers for protocol analysis and network troubleshooting, - plan and administer smaller local area networks. |
|---|--|

Metode poučevanja in učenja:

Predavanja, laboratorijske vaje, seminarski način dela pri domačih nalogah, konzultacije pri izvajanju seminarских nalog (konkretni projekti). Poseben poudarek je na tekočem sledenju teorije in na timskem delu in medsebojnem usklajevanju pri vajah in seminarjih.

Learning and teaching methods:

Lectures, tutorials, homeworks in the form of seminars, consultations for preparing of seminars (particular selected projects). Special emphasis is given on the following and understanding of given theoretical knowledge and on team work and cooperation within tutorials and seminars.

Načini ocenjevanja:

Delež/Weight

Assessment:

| | | |
|--|----------|---|
| Način (pisni izpit ali ustno izpraševanje, naloge, projekt): Sprotno preverjanje (domače naloge, kolokviji in laboratorijske vaje) | | Type (examination, oral, coursework, project): Continuing (homework, midterm exams, laboratory exercises) |
| Končno preverjanje (pisni ali ustni izpit) | 100,00 % | Final (written or oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

1. KUROSE, James F., ROSS, Keith W., BOSNIĆ, Zoran (avtor, urednik), CIGLARIČ, Mojca (avtor, urednik). Računalniška omrežja : compiled from Computer networking, sixth edition. [2. izd.]. Harlow (England) [etc.]: Pearson, 2015. 462 str., ilustr. ISBN 978-1-78447-872-8.
2. OCEPEK, Uroš, BOSNIĆ, Zoran, NANČOVSKA ŠERBEC, Irena, RUGELJ, Jože. Exploring the relation between learning style models and preferred multimedia types. Computers & Education, ISSN 0360-1315. [Print ed.], Nov. 2013, vol. 69, str. 343-355.
3. BOSNIĆ, Zoran, KONONENKO, Igor. Estimation of individual prediction reliability using the local sensitivity analysis. Appl. intell. (Boston). [Print ed.], Dec. 2008, vol. 29, no. 3, p. 187-203, ilustr.
4. BOSNIĆ, Zoran, KONONENKO, Igor. Comparison of approaches for estimating reliability of individual regression predictions. Data knowl. eng.. [Print ed.], Dec. 2008, vol. 67, no. 3, p. 504-516
5. ŠTRUMBELJ, Erik, BOSNIĆ, Zoran, KONONENKO, Igor, ZAKOTNIK, Branko, GRAŠIČ-KUHAR, Cvetka. Explanation and reliability of prediction models: the case of breast cancer recurrence. Knowledge and information systems, 2010, vol. 24, no. 2, p. 305-324

Celotna bibliografija je dostopna na SICRISu:

<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=31318>

RAZVOJ INFORMACIJSKIH SISTEMOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|---------------------------------|
| Predmet: | Razvoj informacijskih sistemov |
| Course title: | Information Systems Development |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0100860 |
| Koda učne enote na članici/UL Member course code: | 63252 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 20 | 10 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Marko Bajec

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

| Vsebina: | Content (Syllabus outline): |
|---|--|
| predavanja: I. Splošno o razvoju IS 1. opis življenjskih modelov razvoja IS 2. pristopi in metodologije razvoja IS 3. problem obvladovanja kakovosti razvoja IS; II. Strukturni razvoj 4. osnove strukturnega razvoja; 5. predstavitev osnovnih aktivnosti strukturnega razvoja; III. Objektni razvoj 6. osnove objektnega razvoja; 7. predstavitev osnovnih aktivnosti objektnega razvoja; 8. primerjava objektni-strukturni razvoj; | Lectures: I. General information about IS development 1. software development life cycles; 2. IS development approaches and methods; 3. Managing quality of IS development; II. Structured IS development 4. Basics of structured IS development; 5. Main activities of structured IS development; III. Object-oriented development 6. Basics of object-oriented IS development; 7. Main activities of object-oriented IS development; 8. Comparison of structured and object-oriented IS development; |

| | |
|--|---|
| <p>IV. Sodobne lahke in agilne metodologije</p> <p>9. predstavitev osnovnih konceptov;</p> <p>10. predstavitev dobrih praks;</p> <p>11. konkretni primeri lahkih in agilnih pristopov.</p> | <p>IV. Light and agile methods for IS development</p> <p>9. Basic concepts;</p> <p>10. Good practices;</p> <p>11. Examples of light and agile approaches.</p> |
|--|---|

Temeljna literatura in viri/Readings:

| |
|--|
| <p>Jeffrey A. Hoffer, Joey George, Joe Valacich (2013), Modern Systems Analysis and Design (7th Edition), Addison-Wesley.</p> <p>Martin Fowler (2003). UML Distilled: A Brief Guide to the Standard Object Modeling Language, Third Edition. Addison-Wesley.</p> <p>Thomas A. Pender (2002). UML Weekend Crash Course. Wiley Publishing.</p> <p>Per Kroll, Philippe Kruchten, Grady Booch (2003), The Rational Unified Process Made Easy: A Practitioner's Guide to the RUP), Addison-Wesley.</p> <p>Martin, C. Robert (2003). Agile Software Development: Principles, Patterns and Practices. Prentice Hall.</p> <p>Cockburn, A (2006). Agile Software Development (2nd Edition). Pearson Education.</p> |
|--|

Cilji in kompetence:

| | |
|--|--|
| <p>Cilj predmeta je študente naučiti sistematičnih in discipliniranih pristopov k razvoju informacijskih sistemov. V okviru predmeta bodo predstavljeni tako tradicionalni kot tudi modernejši pristopi k razvoju informacijskih sistemov.</p> <p>Splošne kompetence:</p> <ul style="list-style-type: none"> • Sposobnost kritičnega razmišljanja; • Razvoj spretnosti s kritičnim, analitičnim in sintetičnim razmišljanjem; • Sposobnost definiranja, razumevanja in reševanja strokovnih izzivov s področja računalništva in informatike; • Sposobnost uporabe pridobljenega znanja za samostojno reševanje problemov; sposobnost izpopolnjevanja pridobljenega znanja; • Sposobnost timskega dela v profesionalnem okolju; • Vodenje manjšega strokovnega tima. <p>Specifične kompetence</p> <ul style="list-style-type: none"> • Sposobnost samostojnega izvajanja lažjih in zahtevnejših inženirskih ter organizacijskih nalog na določenih ožjih področjih računalništva in informatike. • Osnovno znanje in spretnosti, ki so potrebni za nadaljevanje študija na drugi bolonjski stopnji. | <p>Objectives and competences:</p> <p>The goal of this course is to teach students how to manage non-trivial IS development using systematical and disciplined approaches. Within the course the students will learn both, traditional and modern approaches and principles of IS development.</p> <p>General competencies:</p> <ul style="list-style-type: none"> • Ability of critical thinking; • Developing skills in critical, analytical and synthetic thinking; • The ability to define, understand and solve creative professional challenges in computer and information science; • The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge; • The ability of teamwork within the professional environment; management of a small professional team. <p>Specific competencies:</p> <ul style="list-style-type: none"> • The ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science. <p>Basic skills in computer and information science, allowing the continuation of studies in the second study cycle.</p> |
|--|--|

Predvideni študijski rezultati:

| | |
|---|--|
| <p>Po uspešno zaključenem modulu bodo študenti zmožni:</p> <ul style="list-style-type: none"> • načrtovati enostavne in kompleksnejše IS, • analizirati zahteve za razvoj ali nakup IS, • klasificirati vrste IS glede na njihove lastnosti, ki so pomembne za razvoj, | <p>Intended learning outcomes:</p> <p>After successfully completing the course, the students will be able to:</p> <p>design simple and complex IS,</p> <p>analyze requirements for development or procurement of IS,</p> <p>classify IS types based on their characteristics important for development,</p> |
|---|--|

| | |
|---|--|
| <ul style="list-style-type: none"> • izbrati najprimernejše postopke in tehnike za posamezen primer razvoja ali nakupa IS, • oceniti primernost posameznih metodoloških pristopov za konkreten primer razvoja ali nakupa IS, • razlikovati med življenjskimi cikli razvoja IS. | select most appropriate approaches and techniques for individual cases of IS development/procurement, evaluate methodological guidelines for their suitability in individual cases of IS development/procurement, differentiate among various IS development cycles. |
|---|--|

Metode poučevanja in učenja:

Predavanja, računske vaje z ustnimi nastopi, projektni način dela.

Learning and teaching methods:

Lectures, exercises, project work.

Načini ocenjevanja:

Delež/Weight

Assessment:

| | | |
|--|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, midterm exams, project work) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

- BAJEC, Marko, KRISPER, Marjan. Agilne metodologije razvoja informacijskih sistemov. *Uporab. inform. (Ljubl.)*, apr., maj, jun. 2003, letn. 11, št. 2, str. 68-76, ilustr. [COBISS.SI-ID [3679060](#)] kategorija: 1C (Z2); upoštevana uvrstitev: MBP; tipologijo je verificiral OSICT točke: 15, št. avtorjev: 2
- BAJEC, Marko, VAVPOTIČ, Damjan, KRISPER, Marjan. Practice-driven approach for creating project-specific software development methods. *Inf. softw. technol.* [Print ed.], 2007, vol. 49, no. 4, str. [345]-365, ilustr. [COBISS.SI-ID [5815124](#)], [JCR, WoS, št. citatov do 24. 5. 2011: 10, brez avtocitatov: 7, normirano št. citatov: 6] kategorija: 1A3 (Z1); upoštevana uvrstitev: SCI; tipologijo je verificiral OSICT točke: 21.95, št. avtorjev: 3
- BAJEC, Marko, VAVPOTIČ, Damjan. A framework and tool-support for reengineering software development methods. *Informatica (Vilnius)*, 2008, vol. 19, no. 3, str. 321-344, ilustr. [COBISS.SI-ID [6701396](#)], [JCR, WoS, št. citatov do 6. 5. 2011: 2, brez avtocitatov: 2, normirano št. citatov: 2] kategorija: 1A3 (Z1); upoštevana uvrstitev: SCI; tipologijo je verificiral OSICT točke: 37.85, št. avtorjev: 2
- VAVPOTIČ, Damjan, BAJEC, Marko. An approach for concurrent evaluation of technical and social aspects of software development methodologies. *Inf. softw. technol.* [Print ed.], 2009, vol. 51, no. 2, str. 528-545, ilustr. [COBISS.SI-ID [6803284](#)], [JCR, WoS, št. citatov do 6. 8. 2011: 3, brez avtocitatov: 2, normirano št. citatov: 2] kategorija: 1A1 (Z1); upoštevana uvrstitev: SCI; tipologijo je verificiral OSICT točke: 52.59, št. avtorjev: 2
- ŽVANUT, Boštjan, BAJEC, Marko. A tool for IT process construction. *Inf. softw. technol.* [Print ed.], Apr. 2010, vol. 52, no. 4, str. 397-410, ilustr. [COBISS.SI-ID [7558484](#)], [JCR, WoS, št. citatov do 7. 5. 2010: 0, brez avtocitatov: 0, normirano št. citatov: 0] kategorija: 1A1 (Z1); upoštevana uvrstitev: SCI; tipologijo je verificiral OSICT točke: 52.59, št. avtorjev: 2

Celotna bibliografija je dostopna na SICRISu:
<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=9270>.

SISTEMSKA PROGRAMSKA OPREMA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-----------------------------|
| Predmet: | Sistemska programska oprema |
| Course title: | System Software |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039613 |
| Koda učne enote na članici/UL Member course code: | 63264 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Tomaž Dobravec

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------------------|
| Predavanja/Lectures: | Angleščina, Slovenščina |
| Vaje/Tutorial: | Angleščina, Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

- osnova zbirnih in strojnih jezikov;
- vsebina in organizacija objektnih datotek;
- zbirnik, nalagalnik in povezovalnik;
- statično in dinamično povezovanje
- makro procesorji;
- sistemske klici in prekinitve;
- implementacija vhoda in izhoda ter orodja datotečnega sistema;
- upravljanje s pomnilnikom
- razhroščevalniki;
- jedro operacijskega sistema Linux;
- navidezni stroji.
- nalaganje, povezovanje in izvajanje v javanskem navideznem stroju

Content (Syllabus outline):

basics about machine and assembly languages
content and organization of object files
assembler, linker, loader
static and dynamic linking
macro processors
system calls and interrupts
input/output implementation and file system tools
memory management
debugging
linux kernel
virtual machines
loading, linking and running in java virtual machine

Temeljna literatura in viri/Readings:

Leland L. Beck: System software: An Introduction to Systems Programming (3. izdaja). Addison-Wesley, 1997.

- K. Robbins and S. Robbins: UNIX Systems Programming: Communication, Concurrency and Threads (2.izdaja). Prentice Hall, 2003.
- Damjan Zazula, Mitja Lenič: Principi sistemske programske opreme. Založba FERI 2008

Cilji in kompetence:

Cilj:

Cilj predmeta je študentom računalništva in informatike predstaviti sistemske programe, orodja in standarde sistemske programske opreme, ter prikazati podobnosti in razlike med pristopi, ki se uporabljajo v aktualnih operacijskih sistemih.

Kompetence:

Razvijanje sposobnosti kritičnega, analitičnega in sintetičnega razmišljanja.

Sposobnost razumevanja in reševanja strokovnih izzivov na področju računalništva in informatike.

Sposobnost opredelitve, razumevanja in reševanja poklicnih izzivov.

Sposobnost za uporabo pridobljenega znanja pri samostojnem reševanju tehničnih in znanstvenih problemov v računalništvu in informatiki; sposobnost nadgradnje pridobljenega znanja.

Osnovna znanja iz računalništva in informatike, ki vključujejo osnovne teoretične spretnosti, praktična znanja in spretnosti, ki so pomembne za področje računalništva in informatike.

Praktično znanje in poznavanje računalniške strojne opreme, programske opreme in informacijske tehnologije, ki je potrebno za uspešno strokovno delo na področju računalništva in informatike.

Objectives and competences:

Objectives:

The main goal of this course is to introduce the concepts, tools and standards of system programming and to show the current implementations in the actual operating systems.

Competences:

Developing skills in critical, analytical and synthetic thinking.

The ability to understand and solve professional challenges in computer and information science.

The ability to define, understand and solve creative professional challenges in computer and information science;

The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.

Basic skills in computer and information science, which includes basic theoretical skills, practical knowledge and skills essential for the field of computer and information science;

Practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science.

Predvideni študijski rezultati:

Po uspešnem zaključku tega predmeta bo študent:

- znal opredeliti razliko med uporabniško in sistemske programske opreme ter pomen te razlike pri izdelavi programskih komponent,
- sposoben izkazati znanje in razumevanje osnovnih pojmov sistemske programske opreme in delovanja računalnika na najnižjem programskem nivoju,
- razumel pojme zbiranja, povezovanja in nalaganja ter razumel razliko med statičnim in dinamičnim povezovanjem programskih komponent,
- sposoben samostojno razviti komponente sistemske programske opreme,
- znal raziskati komponente sistemske programske opreme,
- sposoben zagovarjati pomen poznavanja programske opreme na najnižjem nivoju.

Intended learning outcomes:

After the completion of the course a student will be able to:

- understand the difference between the user- and the system-software and the meaning of this difference in the phase of software development,
- show the knowledge of the notions of the system software and the low-level operations of the computer,
- understand the basic operation of the assembler, linker and loader and the difference between the static and dynamic linking of the software components,
- use the fundamental results to develop the components of system software,
- explore the components of system software,
- present the knowledge of the low-level components of computer system

Metode poučevanja in učenja:

Predavanja, laboratorijske vaje, domače naloge.

Learning and teaching methods:

Lectures, exercises and home work

Načini ocenjevanja:

Delež/Weight Assessment:

| | | |
|--|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 50,00 % | Continuing (homework, midterm exams, project work) |
| Končno preverjanje (pisni in ustni izpit) | 50,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

KLOBOVES, Klemen, MIHELIČ, Jurij, BULIĆ, Patricio DOBRAVEC, Tomaž. FPGA-Based SIC/XE Processor and Supporting Toolchain. *International Journal of Engineering Education*, 2017, vol. 33, no. 6(A), pp. 1927–1939

MIHELIČ, Jurij, DOBRAVEC, Tomaž. SicSim: a simulator of the educational SIC/XE computer for a system-software course. *Computer applications in engineering education*, ISSN 1061-3773, 2015, vol. 23, no. 1, pp. 137-146

ČEŠNOVAR, Rok, RISOJEVIĆ, Vladimir, BABIĆ, Zdenka, DOBRAVEC, Tomaž, BULIĆ, Patricio. A GPU implementation of a structural-similarity-based aerial-image classification. *The journal of supercomputing*, ISSN 0920-8542, 2013, vol. 65, no. 2, pp. 978-996

BULIĆ, Patricio, DOBRAVEC, Tomaž. An approximate method for filtering out data dependencies with a sufficiently large distance between memory references. *The journal of supercomputing*, ISSN 0920-8542, 2011, vol. 56, no. 2, pp. 226-244

DOBRAVEC, Tomaž, ROBIČ, Borut. Restricted shortest paths in 2-circulant graphs. *Comput. commun.* [Print ed.], March 2009, vol. 32, no. 4, str. 685-690

Celotna bibliografija je dostopna na SICRISu:
<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=10416>.

SPLOŠNA TOPOLOGIJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|--------------------|
| Predmet: | Splošna topologija |
| Course title: | General Topology |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039569 |
| Koda učne enote na članici/UL Member course code: | 27217 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: Dušan Repovš, Janez Mrčun, prof. dr. Petar Pavešić

Vrsta predmeta/Course type: izbirni predmet/elective course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|------------------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Opravljen predmet Analiza 1. | Completed course Analysis 1. |

| | |
|---|--|
| Vsebina: Topološki prostori, zvezne preslikave, homeomorfizmi. Baze in podbaze. Produktna topologija, preslikave v produkte. Podprostori, vložitev, odsekoma definirane preslikave. Dedne in multiplikativne lastnosti. Separacijske lastnosti. Povezanost in povezanost s potmi, komponente, lokalna povezanost. Kompaktnost, lokalna kompaktnost, kompaktifikacija. Bairov izrek, Cantorjeva množica. Prostori preslikav, kompaktno-odprta topologija. Preslikave na normalnih prostorih, Urysonova lema, Tietzejev izrek. Stone-Weierstrassov izrek. Urysonov metrizacijski izrek, retrakti in ekstenzorji, razčlenitve enote. | Content (Syllabus outline): Topological spaces, continuous mappings, homeomorphisms. Bases and subbases. Product topology, mappings into products. Subspaces, embeddings, piecewise definition of mappings. Hereditary and multiplicative properties. Separation axioms, connectedness and path-connectedness, components, local-connectedness. Compactness, local compactness, compactification. Baire theorem, Cantor set. Mapping spaces, compact-open topology. Mappings on normal spaces, Urysohn lemma, Tietze theorem, Stone-Weierstrass theorem. Urysohn metrization theorem, retracts and extensors, partitions of unity. |
|---|--|

| |
|---|
| Temeljna literatura in viri/Readings: <i>Dugundji: Topology.</i> J. R. Munkres: Topology : A First Course. |
|---|

J. Mrčun: Topologija, zapiski predavanj.
 P. Pavešić: Splošna topologija.
 N. Prijatelj: Matematične strukture III : Okolice.

Cilji in kompetence:

Študent spozna osnove splošne topologije, kot so povezanost, kompaktnost, separacijske lastnosti, topologija na produktih in funkcijskih prostorih.

Objectives and competences:

Student gets familiar with basic concepts point-set topology, such as connectedness, compactness, separation properties, topology on products and function spaces.

Predvideni študijski rezultati:

Znanje in razumevanje: Razumevanje pojmov topologije, zvezne preslikave, povezanosti in kompaktnosti. Poznavanje osnovnih prijemov za delo s temi pojmi in povezav z drugimi področji matematike.
 Uporaba: Splošna topologija sodi med temeljne matematične predmete. Študent spozna osnovne pojme in tehnike dela, na katerih sloni vrsta drugih matematičnih predmetov.
 Refleksija: Razumevanje teorije na podlagi primerov in uporabe.
 Prenosljive spretnosti – niso vezane le na en predmet: Formulacija problemov v primernem jeziku, reševanje in analiza doseženega na primerih.

Intended learning outcomes:

Knowledge and understanding: Understanding of notions such as topology, continuous map, connectedness and compactness. Knowledge of basic concepts of the above notions and connection with other areas of mathematics.
 Application: Point-set topology is one of the basic mathematical courses. Student gets familiar with basic definitions and techniques that are foundations for several other mathematical courses.
 Reflection: Understanding of the theory from the applications.
 Transferable skills: The ability to formulate a problem in suitable language, find a solution of the problems and analyse the method on real examples.

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge, konzultacije

Learning and teaching methods:

Lectures, exercises, homework, consultations

Načini ocenjevanja:

Delež/Weight

Assessment:

| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | Delež/Weight | Assessment: |
|---|--------------|---|
| izpit iz vaj | 50,00 % | written exam |
| izpit iz teorije | 50,00 % | oral exam |
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

Janez Mrčun:
 – MOERDIJK, Ieke, MRČUN, Janez. Introduction to foliations and Lie groupoids, (Cambridge studies in advanced mathematics, 91). Cambridge, UK: Cambridge University Press, 2003. IX, 173 str., ilustr. ISBN 0-521-83197-0 [COBISS.SI-ID 12683097]
 – KALIŠNIK, Jure, MRČUN, Janez. Equivalence between the Morita categories of étale Lie groupoids and locally grouplike Hopf algebroids. Indagationes mathematicae, ISSN 0019-3577, 2008, vol. 19, no. 1, str. 73-96 [COBISS.SI-ID 14978393]
 – KALIŠNIK, Jure, MRČUN, Janez. A Cartier-Gabriel-Kostant structure theorem for Hopf algebroids. Advances in mathematics, ISSN 0001-8708, 2013, vol. 232, iss. 1, str. 295-310 [COBISS.SI-ID 16432473]
 – MRČUN, Janez. Topologija, (Izbrana poglavja iz matematike in računalništva, 44). Ljubljana: DMFA - založništvo, 2008. VI, 147 str., ilustr. ISBN 978-961-212-207-2 [COBISS.SI-ID 243021824]
 Petar Pavešić:
 – PAVEŠIĆ, Petar. Decompositions of groups of invertible elements in a ring. Proceedings. Section A, Mathematics, ISSN 0308-2105, 2009, vol. 139, iss 6, str. 1275-1287 [COBISS.SI-ID 15505497]
 – PAVEŠIĆ, Petar. A note on trivial fibrations. Glasnik matematički. Serija 3, ISSN 0017-095X, 2011, vol. 46, no. 2, str. 513-519 [COBISS.SI-ID 16078681]

- PAVEŠIĆ, Petar. Rešene naloge iz topologije, (Izbrana poglavja iz matematike in računalništva, 32). Ljubljana: Društvo matematikov, fizikov in astronomov Slovenije, 1995. 132 str. ISBN 961-212-042-0 [COBISS.SI-ID 47811328]
- PAVEŠIĆ, Petar. Splošna topologija, (Izbrana poglavja iz matematike in računalništva, 43). Ljubljana: DMFA - založništvo, 2008. VI, 89 str., ilustr. ISBN 978-961-212-205-8 [COBISS.SI-ID 240425984]
- Dušan Repovš:
 - BANAKH, Taras, REPOVŠ, Dušan. Direct limit topologies in the categories of topological groups and of uniform spaces. Tohoku mathematical journal, ISSN 0040-8735, 2012, vol. 64, no. 1, str. 1-24 [COBISS.SI-ID 16215897]
 - CÁRDENAS, Manuel, LASHERAS, Francisco F., QUINTERO, Antonio, REPOVŠ, Dušan. On manifolds with nonhomogeneous factors. Central European Journal of Mathematics, ISSN 1895-1074, 2012, vol. 10, no. 3, str. 857-862 [COBISS.SI-ID 16241753]
 - KARIMOV, Umed H., REPOVŠ, Dušan. On generalized 3-manifolds which are not homologically locally connected. Topology and its Applications, ISSN 0166-8641. [Print ed.], 2013, vol. 160, iss. 3, str. 445-449 [COBISS.SI-ID 16558681]
 - CENCELJ, Matija, REPOVŠ, Dušan. Topologija, (Zbirka Pitagora). 1. ponatis. Ljubljana: Pedagoška fakulteta, 2011. XVI, 169 str., ilustr. ISBN 978-86-7735-051-2 [COBISS.SI-ID 254230528]

SPLOŠNO IZBIRNI PREDMET

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|----------------------------|
| Predmet: | Splošno izbirni predmet |
| Course title: | Specialist elective course |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0070326 |
| Koda učne enote na članici/UL Member course code: | 0002 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 60 | | 60 | | | 180 | 10 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

| | |
|----------------------|--|
| Predavanja/Lectures: | |
| Vaje/Tutorial: | |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

| | |
|--|--|
| | |
|--|--|

Content (Syllabus outline):

Temeljna literatura in viri/Readings:

| |
|--|
| |
|--|

Cilji in kompetence:

| | |
|--|--|
| | |
|--|--|

Objectives and competences:

Predvideni študijski rezultati:

| | |
|--|--|
| | |
|--|--|

Intended learning outcomes:

Metode poučevanja in učenja:

| | |
|--|--|
| | |
|--|--|

Learning and teaching methods:

Načini ocenjevanja:

Delež/Weight Assessment:

| | | |
|--|--|--|
| | | |
|--|--|--|

Reference nosilca/Lecturer's references:

| |
|--|
| |
|--|

STROKOVNO IZBIRNI PREDMET FMF

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-------------------------------|
| Predmet: | Strokovno izbirni predmet FMF |
| Course title: | General elective course FMF |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0070324 |
| Koda učne enote na članici/UL Member course code: | 0001 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 30 | | | 75 | 5 |

Nosilec predmeta/Lecturer:

Vrsta predmeta/Course type:

Jeziki/Languages:

| | |
|----------------------|--|
| Predavanja/Lectures: | |
| Vaje/Tutorial: | |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| |
|--|
| |
|--|

Prerequisites:

Vsebina:

| |
|--|
| |
|--|

Content (Syllabus outline):

Temeljna literatura in viri/Readings:

| |
|--|
| |
|--|

Cilji in kompetence:

| |
|--|
| |
|--|

Objectives and competences:

Predvideni študijski rezultati:

| |
|--|
| |
|--|

Intended learning outcomes:

Metode poučevanja in učenja:

| |
|--|
| |
|--|

Learning and teaching methods:

Načini ocenjevanja:

Delež/Weight Assessment:

| | | |
|--|--|--|
| | | |
|--|--|--|

Reference nosilca/Lecturer's references:

| |
|--|
| |
|--|

TEHNOLOGIJA UPRAVLJANJA PODATKOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|----------------------------------|
| Predmet: | Tehnologija upravljanja podatkov |
| Course title: | Data Management Technologies |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039622 |
| Koda učne enote na članici/UL Member course code: | 63226 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Matjaž Kukar

Vrsta predmeta/Course type: izbirni predmet/elective course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|-----------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| | |

| Vsebina: | Content (Syllabus outline): |
|--|--|
| Predavanja obsegajo dva tematska sklopa: Eksterni vidiki obvladovanja podatkov: Podatkovne baze in podatkovna skladišča Načrtovanje podatkovnih baz Konceptualno, logično in fizično načrtovanje Normalizacija relacij Optimizacija performans Porazdeljene podatkovne baze Načrtovanje podatkovnih skladišč Namen in načrtovanje podatkovnih skladišč Zagotavljanje kvalitete shranjenih podatkov Pristopi k analizi shranjenih podatkov Načrtovanje nerelacijskih podatkovnih baz Nerelacijsko modeliranje podatkov Interni vidiki obvladovanja podatkov: | Course topics: External data management: 1. Databases and data warehouses 2. Database design: <ul style="list-style-type: none">conceptual, logical and physical designadvanced normalization,performance optimizationdistributed databases 3. Data warehouse design: <ul style="list-style-type: none">design methodologies,data quality assurance,data analysis 4. Non-relational database design (NoSQL) <ul style="list-style-type: none">Non-relational data modelling |

| | |
|--|--|
| <p>Zagotavljanje dostopnosti in konsistentnosti podatkov Upravljanje sočasnosti dostopa do podatkovne baze Varovanje in obnavljanje podatkovne baze Porazdeljeni in vzporedni podatkovni sistemi Optimizacija in evalvacija poizvedb Načrtovanje izvajanja poizvedb Vrednotenje zahtevnosti osnovnih operacij Alternativne strategije izvajanja poizvedb Upravljanje delno strukturiranih in nestrukturiranih podatkov Sodobni nerelacijski podatkovni sistemi Delo s prostorskimi in časovnimi podatki Delo z drugimi delno strukturiranimi ali nestrukturiranimi podatki (tekst, zvok, slika, sekvence, JSON, XML)</p> <p>Vaje: Seznani se s tipičnimi problemi pri obvladovanju podatkov in s pristopi za reševanje le-teh. Spoznati in obvladati orodja za načrtovanje in uporabo podatkovnih baz. Obvladati uporabo produktov teh orodij v praktičnih primerih (v obliki seminarske naloge). Pri vajah se študenti seznanijo z orodji za obvladovanje podatkov (predvsem načrtovanje) in jih v okviru svojih domačih nalog samostojno uporabijo v praktičnih primerih. Rezultate domačih nalog predstavijo v obliki seminarjev.</p> | <p>Internal data management:</p> <ol style="list-style-type: none"> Assuring availability and consistency of stored data: <ul style="list-style-type: none"> concurrent data access, data archival and recovery distributed and parallel databases Query evaluation and optimization: <ul style="list-style-type: none"> query execution planning, estimating the costs of basic operations, alternative plan considerations Management of semi-structured and unstructured data types: <ul style="list-style-type: none"> Modern non-relational database systems spatial and temporal data, other semi-structured data (audio, video, images, sequences, JSON, XML) <p>Tutorial topics: Recognize typical data management problems and approaches for solving them Get to know various tools for database design and utilization, and use them in practical problems.</p> <ol style="list-style-type: none"> the products of aforementioned tools for a practical database implementation (in terms of a substantial project) <p>Through the tutorial students get familiar with various data management tools and use them - in course of their projects – as a part of a practical problem solution. The final part of the project is a public presentation of the assigned problem, its solution and results.</p> |
|--|--|

Temeljna literatura in viri/Readings:

- 1.T. M. Connolly, C. E. Begg: Database Systems: A Practical Approach to Design, Implementation and Management, 6th edition, Pearson, 2015.
2. S. Sumathi, S. Esakkirajan: Fundamentals of Relational Database Management Systems, Springer, 2007.
3. R. Ramakrishnan, J. Gehrke: Database Management Systems, 3rd edition, McGraw-Hill, 2002.
4. I. Robinson, J. Webber, E. Eifrem: Graph Databases, O'Reilly, 2016.
5. Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement, 2nd edition, Pragmatic Bookshelf, 2018

Cilji in kompetence:

Cilj predmeta je študentom računalništva in informatike predstaviti principe in pristope za upravljanje podatkov z dveh vidikov: **zunanjega**, s poudarkom na primernem načrtovanju in pripravi, ter **notranjega**, s poudarkom na tehnologijah znotraj podatkovnih baz.

Splošne kompetence:

- sposobnost kritičnega mišljenja

Objectives and competences:

The main course objective is to present principles and approaches to data management from two points of view: **external**, focusing on proper database/data warehouse design and data preparation, and **internal**, focusing on intrinsic key database technologies.

General competences:

- ability of critical thinking

| | |
|--|--|
| <ul style="list-style-type: none"> • razvoj sposobnosti kritičnega, analitičnega in sintetičnega mišljenja • sposobnost definiranja, razumevanja in reševanja strokovnih izzivov na področju računalništva in informatike <p>Skladnost z varnostnimi, funkcionalnimi, ekonomskimi in okoljskimi vodili.</p> <ul style="list-style-type: none"> • sposobnost samostojne uporabe pridobljenega znanja pri reševanju tehničnih in znanstvenih izzivov na področju računalništva in informatike; sposobnost nadgradnje pridobljenega znanja <p>Predmetno specifične kompetence:</p> <ul style="list-style-type: none"> • sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih tehničnih in relevantnih področjih (ekonomija, organizacijske vede ipd.); • praktična znanja in veščine na področju strojne opreme, programske opreme in informacijskih tehnologij, ki so nujna za uspešno delo na področju računalništva in informatike • sposobnost samostojne izvedbe manj zahtevnih in zahtevnih inženirskih in organizacijskih opravil na določenih ozkih področjih in neodvisnega reševanja določenih dobro opredeljenih opravil na področju računalništva in informatike | <ul style="list-style-type: none"> • developing skills in critical, analytical and synthetic thinking • the ability to define, understand and solve creative professional challenges in computer and information science; • compliance with security, functional, economic and environmental principles • the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge <p>Subject specific competences:</p> <ul style="list-style-type: none"> • The ability to understand and apply computer and information science knowledge to other technical and relevant fields (economics, organisational science, etc) • practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science • the ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science |
|--|--|

Predvideni študijski rezultati:

| |
|---|
| <p>Po uspešno zaključenem predmetu bodo študenti sposobni:</p> <ul style="list-style-type: none"> - uporabiti tehnologije upravljanja s podatki na raznolikih problemskih domenah - razlikovati med principi in pristopi za reševanje podatkovnih problemov - razlikovati in primerno uporabiti transakcijske sisteme in podatkovna skladišča - razlikovati koncepte in uporabljati tehnologije s področij sodobnih nerelacijskih (NoSQL) podatkovnih sistemov - uporabljati pridobljenih znanj in orodij za obvladovanje podatkov v inženirskem in raziskovalnem delu - samostojno uporabljati metode načrtovanja, obvladovanja, hranjenja in osnovne analize različnih vrst podatkov - neposrednega ali posrednega povezovanja tehnologij upravljanja podatkov z drugimi sistemi s področij poslovne inteligence, spletnih storitev in inteligentnih sistemov. |
|---|

Intended learning outcomes:

| |
|---|
| <p>After successful course completion students will be able to:</p> <ul style="list-style-type: none"> - utilize data management technologies in diverse problem domains - differentiate between principles and approaches for solving data management problems - understand the differences between transactional databases and data warehouses and appropriately utilize them - understand the concepts behind modern nonrelational (NoSQL) databases, and utilize them when appropriate - utilize data management technologies in general engineering and research work - competently use methods and techniques for database planning, data management, storage, and basic data analytics - directly or indirectly connect data management technologies with other relevant systems, such as business intelligence, web technologies, and intelligent systems. |
|---|

Metode poučevanja in učenja:

| |
|--|
| <p>Predavanja in seminarski način dela pri domačih nalogah. Poseben poudarek je na sprotnem študiju in na skupinskem delu pri domačih nalogah in seminarjih.</p> |
|--|

Learning and teaching methods:

| |
|---|
| <p>Lectures, homework and project work with explicit focus on simultaneous studies (for homeworks) and teamwork (for projects).</p> |
|---|

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| Sprotno preverjanje (domače naloge, kolokviji in projektno delo) | 60,00 % | Continuing (homework, midterm exams, project work) |
| Končno preverjanje (pisni in ustni izpit) | 40,00 % | Final (written and oral exam) |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

Reference nosilca/Lecturer's references:

KONONENKO, Igor, KUKAR, Matjaž. Machine learning and data mining: introduction to principles and algorithms. Chichester: Horwood Publishing, 2007.

PETELIN, Boris, KONONENKO, Igor, MALAČIČ, Vlado, KUKAR, Matjaž. Multi-level association rules and directed graphs for spatial data analysis. *Expert syst. appl.* [Print ed.], 2013, vol. 40, issue 12, 4957-4970.

KUKAR, Matjaž, KONONENKO, Igor, GROŠELJ, Ciril. Modern parameterization and explanation techniques in diagnostic decision support system: a case study in diagnostics of coronary artery disease. *Artif. intell. med.*, Jun. 2011, vol. 52, no. 2, 77-90.

ŠAJN, Luka, KUKAR, Matjaž. Image processing and machine learning for fully automated probabilistic evaluation of medical images. *Computer methods and programs in biomedicine*, ISSN 0169-2607. [Print ed.], Dec. 2011, vol. 104, no. 3, 75-86,

KUKAR, Matjaž. Quality assessment of individual classifications in machine learning and data mining. *Knowledge and information systems*, 2006, vol. 9, no. 3.

Celotna bibliografija je dostopna na SICRISu:
<http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8453>.

TEORIJA IGER

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|--------------|
| Predmet: | Teorija iger |
| Course title: | Game Theory |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039570 |
| Koda učne enote na članici/UL Member course code: | 27223 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | | 45 | | | 90 | 6 |

Nosilec predmeta/Lecturer: Matjaž Konvalinka, Sergio Cabello Justo

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------|
| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

Vsebina:

Strateške igre z funkcijami preferenc za več igralcev. Nashevo ravnovesje. Najboljši odgovor. Dominiranost. Modeli duopola.

- Strateške igre s funkcijami koristnosti za več igralcev. Mešane strategije in loterije. Mešano Nashevo ravnovesje. Princip indiferentnosti. Dominiranost. Obstoje mešanega Nashevega ravnovesja.
- Bimatrične igre. Princip indiferentnosti. Iskanje Nashevega ravnovesja. Posebne bimatrične igre. Varnostni nivo.
- Matrične igre. Izrek o minimaksu. Reševanje preko linearnega programiranja in dualnosti. Posebne matrične igre.
- Bayesove igre. Bayes-Nashevo ravnovesje.
- Ekstenzivne igre. Vgnezdeno popolno Nashevo ravnovesje. Stackelbergov model duopola.

Content (Syllabus outline):

Strategic games with preference functions for several players. Nash equilibrium. Best response. Domination. Models of duopoly.

- Strategic games with utility functions for several players. Mixed strategies and lotteries. Mixed Nash equilibrium. Principle of indifference. Domination. Existence of mixed Nash equilibrium.
- Bimatrix games. Principle of indifference. Search of Nash equilibrium. Special bimatrix games. Safety level.
- Matrix games. Minimax Theorem. Solution through linear programming and duality. Special matrix games.
- Bayesian games. Bayesian Nash equilibrium.
- Extensive games. Subgame perfect Nash equilibrium. Stackelberg model of duopoly.
- Extensive games with imperfect information. Behavioral strategy. Kuhn's theorem.

| | |
|---|--|
| <ul style="list-style-type: none"> • Ekstenzivne igre z nepopolno informacijo. Strategije obnašanja. Kuhnov izrek. • Kooperativne igre. Nasheva sodniška procedura. Kooperativne igre v koalicijski obliki. Imputacije. Jedro. Shapleyjeve vrednosti. • Kombinatorne igre. Igra nim. | <ul style="list-style-type: none"> • Cooperative games. Nash bargaining solution. Cooperative games in coalitional form. Imputations. Core. Shapley values • Combinatorial games. Nim. |
|---|--|

Temeljna literatura in viri/Readings:

T.S. Ferguson: *Game Theory*. Elektronska knjiga dostopna na http://www.math.ucla.edu/~tom/Game_Theory/Contents.html
M. J. Osborne: *An Introduction to Game Theory*, Oxford University Press, 2003.
M. J. Osborne, A. Rubinstein: *A Course in Game Theory*, 10. natis, MIT Press, 2004.
B. von Stengel: *Game Theory Basics*. Lecture Notes, 2011.

Cilji in kompetence:

Študent spozna osnove teorije iger ter njeno uporabo pri modeliranju različnih situacij s poudarkom na primerih s področja ekonomije in financ. Teoretična razlaga je ilustriрана z mnogimi primeri.

Objectives and competences:

The student gets acquainted with basic game theory and its use for modeling different situations, especially in the fields of economics and finance. The theoretic concepts are explained through several examples.

Predvideni študijski rezultati:

Znanje in razumevanje: Slušatelj pozna osnovne probleme, s katerimi se ukvarja teorija iger, in razume pomen posameznih predpostavk pri posameznih vrstah iger.
Uporaba: Modeliranje vsaj potencialno konfliktnih situacij, do katerih prihaja pri interakciji osebkov.
Refleksija: Uporabe in pomanjkljivosti opisovanja in raziskovanja pojavov iz vsakdanjega življenja s pomočjo formalnih modelov.
Prenosljive spretnosti – niso vezane le na en predmet: Sposobnost natančnega matematičnega opisa, zavedanje njegovih pomanjkljivosti.

Intended learning outcomes:

Knowledge and understanding: The student knows basic problems in Game Theory and understands the meaning of the assumptions in each type of game.
Application: Modeling of conflicting situations arising from the interaction of subjects.
Reflection: Use and weaknesses of the description and exploration of phenomena in everyday life with the help of formal models.
Transferable skills: Ability of precise mathematical description and awareness of its weaknesses.

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge, konzultacije

Learning and teaching methods:

Lectures, exercises, homework, consultations

Načini ocenjevanja:

Delež/Weight

Assessment:

| | | |
|---|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj | 50,00 % | 2 midterm exams instead of written exam, written exam |
| izpit iz teorije | 50,00 % | exam of theory |
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

Sergio Cabello Justo:
– CABELLO, Sergio, MOHAR, Bojan. Crossing and weighted crossing number of near-planar graphs. V: TOLLIS, Ioannis G. (ur.), PATRIGNANI, Maurizio (ur.). Graph drawing : 16th international symposium, GD 2008, Heraklion, Crete, Greece, September 21-24, 2008 : revised papers, (Lecture notes in computer science, ISSN 0302-9743, 5417). Berlin, Heidelberg: Springer, cop. 2009, str. 38-49 [COBISS.SI-ID 15099225]

- CABELLO, Sergio, DÍAZ-BÁÑEZ, José Miguel, LANGERMAN, Stefan, SEARA, Carlos, VENTURA, Inma. Facility location problems in the plane based on reverse nearest neighbor queries. *European journal of operational research*, ISSN 0377-2217. [Print ed.], 2010, vol. 202, iss. 1, str. 99-106 [COBISS.SI-ID 15160921]
 - CABELLO, Sergio, JAKOVAC, Marko. On the b-chromatic number of regular graphs. *Discrete applied mathematics*, ISSN 0166-218X. [Print ed.], 2011, vol. 159, iss. 13, str. 1303-1310 [COBISS.SI-ID 15914329]
- Matjaž Konvalinka:
- KONVALINKA, Matjaž, PAK, Igor. Geometry and complexity of O'Hara's algorithm. *Advances in applied mathematics*, ISSN 0196-8858, 2009, vol. 42, iss. 2, str. 157-175 [COBISS.SI-ID 15545945]
 - KONVALINKA, Matjaž. Skew quantum Murnaghan-Nakayama rule. *Journal of algebraic combinatorics*, ISSN 0925-9899, 2012, vol. 35, no. 4, str. 519-545 [COBISS.SI-ID 16250713]
 - KONVALINKA, Matjaž. On quantum immanants and the cycle basis of the quantum permutation space. *Annals of combinatorics*, ISSN 0218-0006, 2012, vol. 16, no. 2, str. 289-304 [COBISS.SI-ID 16310873]

TEORIJA KODIRANJA IN KRIPTOGRAFIJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------------|
| Predmet: | Teorija kodiranja in kriptografija |
| Course title: | Coding Theory and Cryptography |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039571 |
| Koda učne enote na članici/UL Member course code: | 27221 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: Arjana Žitnik, Primož Potočnik

Vrsta predmeta/Course type: izbirni predmet/elective course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|---|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Opravljen predmeta Linearna algebra in Diskretne strukture 2. | Completed courses Linear algebra and Discrete structures 2. |

| | |
|--|---|
| Vsebina: | Content (Syllabus outline): |
| Teorija kodiranja. Informacija in entropija. Shannonova teorija. Kodi za popravljanje napak. Zgornje meje za število kodnih besed. Linearni, Hammingovi, ciklični in Reed-Mullerjevi kodi. Kriptografija. Klasična kriptografija. Sistemi z zasebnim ključem. RSA in sistemi z javnim ključem. Digitalni podpisi. Zgoščevalne funkcije. Distribucija in izmenjava ključev. Identificiranje, overjanje in delitev skrivnosti. Generiranje psevdo-naključnih števil. Dokazi z ničelno informacijo. | Coding theory. Information and entropy. Shannon's theory. Error-correcting codes. Bounds on the size of codes. Linear, Hamming, cyclic and Reed-Muller codes. Cryptography. Classical cryptography. Symmetric-key cryptosystems. RSA cryptosystem and public-key cryptography. Digital signatures. Hash functions. Key distribution and key agreement schemes. Identification, authentication, secret sharing schemes. Zero-knowledge proofs. |

Temeljna literatura in viri/Readings:

| |
|--|
| D. R. Stinson: <i>Cryptography : Theory and Practice, 3rd edition, Chapman & Hall/CRC, Boca Raton, 2005.</i> |
| J. Talbot, D. Welsh: <i>Complexity and Cryptography, Cambridge Univ. Press, Cambridge, 2006.</i> |
| D. Welsh: <i>Codes and Cryptography, Oxford Univ. Press, Oxford, 1988.</i> |

Cilji in kompetence:

Študent spozna osnove teorije kodiranja in kriptografije.

Objectives and competences:

Students learn the basics of coding theory and cryptography.

Predvideni študijski rezultati:

Znanje in razumevanje: Matematični postopki, s katerimi zagotavljamo zanesljivo in varno komunikacijo.
 Uporaba: Kodiranje in kriptografija se uporabljata pri digitalnih komunikacijah in za zagotavljanje informacijske varnosti.
 Refleksija: Osnovne tehnike sodobne kriptografije temeljijo na matematičnih pojmih in postopkih, ki zagotavljajo največjo znano mero varnosti.
 Prenosljive spretnosti – niso vezane le na en predmet: Študent pridobi sposobnost kritičnega razmišljanja in analize komunikacijskih kanalov in računalniških sistemov s stališča informacijske varnosti.

Intended learning outcomes:

Knowledge and understanding: Mathematical procedures that enable reliable and secure communication.
 Application: Coding theory and cryptography are used in digital communications and for providing information security.
 Reflection: Basic techniques of modern cryptography are based on mathematical concepts and procedures that provide the maximum level of security known.
 Transferable skills: The students will acquire skills of critical thinking and analysis of the communication channels and computer systems with respect to information security.

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge, konzultacije

Learning and teaching methods:

Lectures, exercises, homework, consultations

Načini ocenjevanja:**Delež/Weight****Assessment:**

| | | |
|---|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| 2 kolokvija namesto izpita iz vaj, izpit iz vaj | 50,00 % | 2 midterm exams instead of written exam, written exam |
| izpit iz teorije | 50,00 % | oral exam |
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

Primož Potočnik:
 POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. On the nullspace of arc-transitive graphs over finite fields. Journal of algebraic combinatorics, ISSN 0925-9899, 2012, vol. 36, no. 3, str. 389-401. [COBISS.SI-ID 16162137]
 POTOČNIK, Primož. B-groups of order a product of two distinct primes. Mathematica slovacica, ISSN 0139-9918, 2001, vol. 51, no. 1, str. 63-67. [COBISS.SI-ID 10617433]
 POTOČNIK, Primož, VERRET, Gabriel. On the vertex-stabiliser in arc-transitive digraphs. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2010, vol. 100, iss. 6, str. 497-509. [COBISS.SI-ID 15680601]
 Arjana Žitnik:
 JURIŠIĆ, Aleksandar, TERWILLIGER, Paul, ŽITNIK, Arjana. The Q-polynomial idempotents of a distance-regular graph. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2010, vol. 100, iss. 6, str. 683-690. [COBISS.SI-ID 15688537]
 KAVČIČ, Urška, MUCK, Tadeja, LOZO, Branka, ŽITNIK, Arjana. Readability of multi-colored 2D codes. Technics technologies education management, ISSN 1840-1503, 2011, vol. 6, no. 3, str. 622-630, ilustr. [COBISS.SI-ID 2673008]
 CONDER, Marston D. E., PISANSKI, Tomaž, ŽITNIK, Arjana. GI-graphs: a new class of graphs with many symmetries. Journal of algebraic combinatorics, ISSN 0925-9899, 2014, vol. 40, iss. 1, str. 209-231. [COBISS.SI-ID 16969561]

UMETNO ZAZNAVANJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|--------------------|
| Predmet: | Umetno zaznavanje |
| Course title: | Machine Perception |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Multimedija, prva stopnja, univerzitetni | Multimedija (študijski program) | | 1. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 1. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0070358 |
| Koda učne enote na članici/UL Member course code: | 63267 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 10 | 20 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Matej Kristan

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|------------|
| Predavanja/Lectures: | Angleščina |
| Vaje/Tutorial: | Angleščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

| | |
|--|--|
| | |
|--|--|

Prerequisites:

| |
|--|
| |
|--|

Vsebina:

Vsebina predmeta:

- Pregled področja umetnega zaznavanja, aplikacijski doseg in znanstveni izzivi
- Procesiranje slik
 - Nastanek slike v kameri
 - Binarizacija, morfološke operacije, segmentacija
 - Barvni prostori in zaznavanje
 - Linearni in nelinearni filtri
- Odvodi slike in zaznavanje robov
 - Zaznavanje robov z odvodi
 - Robovi za zaznavanje objektov
 - Zaznavanje parametričnih oblik
- Prileganje modelov
 - Normalne enačbe
 - Homogeni sistemi

Content (Syllabus outline):

Lectures:

- Overview of the field of Machine perception and scientific challenges
- Image processing
 - Image formation
 - Binarization, morphology, segmentation
 - Colour spaces and colour perception
 - Linear and nonlinear filters
- Image derivatives and edge perception
 - Derivative-based edge perception
 - Edge-based object perception
 - Parametric shape perception
- Model fitting
 - Normal equations
 - Homogenous systems
 - Robust approaches

| | |
|---|---|
| <ol style="list-style-type: none"> 3. Robustne metode 5. Lokalne značilnice <ol style="list-style-type: none"> 1. Detektorji kotov 2. Lokalni opisniki z izbiro merila in afino adaptacijo 6. Stereoskopija in zaznavanje globine <ol style="list-style-type: none"> 1. Nekalibrirani in kalibrirani sistemi ter rekonstrukcija 7. Razpoznavanje objektov <ol style="list-style-type: none"> 1. Podprostorske metode (PCA,LDA) 2. Razpoznavanje z lokalnimi značilnicami 8. Detekcija objektov <ol style="list-style-type: none"> 1. Zapis vizualnih lastnosti in postopki za detekcijo 9. Zaznavanje gibanja <ol style="list-style-type: none"> 1. Lokalno gibanje in metode za sledenje objektov <p>Vaje: Vaje bodo potekale v obliki projektno-orientiranih nalog v primerno opremljenih študentskih laboratorijih. Študentje v okviru nalog samostojno implementirajo algoritme in jih preizkušajo na različnih naborih podatkov zajetih z različnimi senzorskimi sistemi. Sprtno in obvezno delo na projektih omogoča poglobljeno in kritično razumevanje obravnavane tematike, spodbuja pa tudi samostojno mišljenje in kreativnost.</p> | <ol style="list-style-type: none"> 5. Local features <ol style="list-style-type: none"> 1. Corner perception 2. Local descriptors in scale space and affine adaptation 6. Stereoscopy and depth perception <ol style="list-style-type: none"> 1. Calibrated and uncalibrated systems and reconstruction 7. Object recognition <ol style="list-style-type: none"> 1. Subspace methods (PCA, LDA) 2. Local-features-based recognition 8. Object detection <ol style="list-style-type: none"> 1. Visual features and detection approaches 9. Motion perception <ol style="list-style-type: none"> 1. Local motion perception and object tracking <p>Exercises: Exercises will take a form of project-oriented exercises in properly equipped student laboratories. Students will implement various algorithms and test them on different datasets using a variety of sensor systems. Exercises will support an in-depth understanding of the theory. They will also encourage independent thinking and creativity.</p> |
|---|---|

Temeljna literatura in viri/Readings:

Obvezna:

- D. Forsyth and J. Ponce, Computer Vision: A modern approach, Prentice Hall 2011.
- R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011

Dopolnilna:

- H. R. Schiffman: Sensation and Perception, An Integrated Approach, John Wiley & Sons 2001.
- Izbrani članki iz revij IEEE PAMI, CVIU, IJCV, Pattern Recognition (dostopno na spletu)

Cilji in kompetence:

Študenti bodo v okviru tega predmeta pridobili konkretna znanja in veščine s področja računalniškega vida. Razvili bodo kompetence z nizkonivojskega procesiranja slik, 3D geometrije kamer in stera, detekcije objektov, razpoznavanja objektov in osnove izračunavanja gibanja v videoposnetkih. Osvojili bodo tudi matematične osnove za reševanje zahtevnih inženirskih problemov, ki so značilni za analizo tako kompleksnih signalov kot so slike in videoposnetki.

Poleg tega bodo študenti osvojili naslednje kompetence:

Sposobnost razumevanja in reševanja strokovnih izzivov s področja računalništva in informatike
Sposobnost strokovne komunikacije v materinem in tujem jeziku.

Sposobnost neodvisnega reševanja tako manj zahtevnih kakor kompleksnih inženirskih in organizacijskih problemov iz ozkih področji, kakor

Objectives and competences:

In the framework of this course, the students will acquire concrete knowledge and skills in the area of machine perception. The students will develop competences in low-level image processing, 3D geometry of stereo systems, object detection, object recognition, and motion extraction in video sequences. The students will also practice mathematical basics crucial for solving demanding engineering problems, which are essential for analysis of complex signals such as images and video.

In addition, the students will obtain the following competences:

The ability to understand and solve professional challenges in computer and information science.

The ability of professional communication in the native language as well as a foreign language.

The ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and

| | |
|---|--|
| tudi specifičnih dobro definiranih problemov s področja računalništva in informatike. | independently solve specific well-defined tasks in computer and information science. |
|---|--|

Predvideni študijski rezultati:

Po uspešnem zaključku predmeta naj bi študenti:

- poznali računalniške tehnologije in računalniške metodologije za razvoj komponent in sistemov računalniškega zaznavanja,
- razumeli osnove nizkonivojskega procesiranja slik,
- razumeli osnove 3D geometrije kamer in stera,
- razumeli osnove detekcije in razpoznavanja objektov,
- poznali osnovne postopke izračunavanja gibanja v videoposnetkih,
- bili sposobni obravnavati moderne algoritme računalniškega vida in strojnega vida,
- bili sposobni uporabe računalniških tehnologij in računalniških metodologij pri specifičnih aplikacijah avtonomnih inteligentnih kognitivnih sistemov.

Intended learning outcomes:

After completing this course a students will be able to:

- understand computer technology and computational methodology for use and development of components for machine vision systems,
- understand the basics of low-level image processing,
- understand the basics of 3D geometry of stereo systems,
- understand the basics of object detection, object recognition,
- know basic motion extraction techniques in video sequences,
- analyze modern computer vision and machine vision algorithms,
- use computer technology and computational methodology for specific applications of autonomous intelligent cognitive systems.

Metode poučevanja in učenja:

Predavanja, laboratorijske vaje v računalniški učilnici z aktivnim sodelovanjem. Individualno delo na vajah. Teorija s predavanj se praktično analizira na vajah. Poseben poudarek je na sprotne študiju in sprotne delu pri vajah.

Learning and teaching methods:

Lectures, laboratory exercises in computer classroom with active participation. Individual work on exercises. Theory from the lectures made concrete with hands-on laboratory exercises. Special emphasis will be put on continuous assessment at exercises.

Načini ocenjevanja:

Način (pisni izpit, ustno izpraševanje, vaje):

Delež/Weight

50,00 %

50,00 %

Assessment:

Type (examination, oral, laboratory exercises):

Continuing (homework and laboratory exercises)

Final (written and oral exam)

Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL).

Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana).

Reference nosilca/Lecturer's references:

LUKEŽIČ, Alan, ČEHOVIN ZAJC, Luka, KRISTAN, Matej. Deformable parts correlation filters for robust visual tracking. *IEEE transactions on cybernetics*, ISSN 2168-2267, 2017, vol. , no. , str. 1-13, [COBISS.SI-ID [1537625283](#)],

KRISTAN, Matej, SULIĆ KENK, Vildana, KOVAČIČ, Stanislav, PERŠ, Janez. Fast image-based obstacle detection from unmanned surface vehicles. *IEEE transactions on cybernetics*, ISSN 2168-2267 , 2016, vol. 46, no. 3, str. 641-654, [COBISS.SI-ID [1536310979](#)],

KRISTAN, Matej, MATAS, Jiří, LEONARDIS, Aleš, VOJÍŘ, Tomáš, PFLUGFELDER, Roman, FERNÁNDEZ, Gustavo, NEBEHAY, Georg, PORIKLI, Fatih, ČEHOVIN ZAJC, Luka. A novel performance evaluation methodology for single-target trackers. *IEEE transactions on pattern analysis and machine intelligence*, ISSN 0162-8828. [Print ed.], Nov. 2016, vol. 38, no. 11, str. 2137-2155, [COBISS.SI-ID [1536872643](#)]

URŠIČ, Peter, LEONARDIS, Aleš, SKOČAJ, Danijel, KRISTAN, Matej. Learning part-based spatial models for laser-vision-based room categorization. *The international journal of robotics research*, ISSN 0278-3649, 2017, vol. 36, no. 4, str. 379-402, [COBISS.SI-ID [1537424323](#)]

ČEHOVIN, Luka, KRISTAN, Matej, LEONARDIS, Aleš. Robust visual tracking using an adaptive coupled-layer visual model. *IEEE trans. pattern anal. mach. intell.*. [Print ed.], 2012, str. [1-14], [COBISS.SI-ID [9431124](#)]
Celotna bibliografija je dostopna na SICRISu:

[http://sicris.izum.si/search/rsr.aspx?lang=slv&id=32801.](http://sicris.izum.si/search/rsr.aspx?lang=slv&id=32801)

UVOD V GEOMETRIJSKO TOPOLOGIJO

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|------------------------------------|
| Predmet: | Uvod v geometrijsko topologijo |
| Course title: | Introduction to Geometric Topology |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-------------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039572 |
| Koda učne enote na članici/UL Member course code: | 27219 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 30 | | 30 | | | 90 | 5 |

Nosilec predmeta/Lecturer: Dušan Repovš, Sašo Strle

Vrsta predmeta/Course type: izbirni predmet/elective course

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|--------------------------------------|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Opravljen predmet Splošna topologija. | Completed course Point-set topology. |

| | |
|---|--|
| Vsebina: | Content (Syllabus outline): |
| Kvocientna topologija, zvezne preslikave na kvocientih, zleпки. Delovanja grup in prostori orbit. Projektivni prostori. Brouwerjev izrek o negibni točki, Jordanov izrek, Brouwerjev izrek o invarianci odprtih množic. Topološke mnogoterosti, konstrukcije mnogoterosti. Poliedrske ploskve, Eulerjeva karakteristika. Klasifikacija sklenjenih ploskev. Simplicialni kompleksi in poliedri. | Quotient topology, continuous maps on quotients, adjunction spaces. Group actions and orbit spaces. Projective spaces. Brouwer's fixed point theorem, the Jordan curve theorem, Brouwer's invariance of domain theorem. Topological manifolds constructions of manifolds. Polyhedral surfaces, Euler characteristic. Classification of closed surfaces. Simplicial complexes and polyhedra. |

Temeljna literatura in viri/Readings:

| |
|---|
| . Dugundji: <i>Topology</i> , Allyn and Bacon, Boston, 1978. W. S. Massey: <i>Algebraic Topology: An Introduction</i> , Springer, New York-Heidelberg, 1989. J. R. Munkres: <i>Topology : A First Course</i> , Prentice Hall, Englewood Cliffs, 1975. |
|---|

Cilji in kompetence:

Objectives and competences:

| | |
|---|--|
| Študent spozna osnovne pojme topologije evklidskih prostorov in geometrijske topologije kot so Jordanov in Brouwerjev izrek, simplicialni kompleksi in poliedri ter mnogoterosti. | Student gets familiar with basic concepts of topology of Euclidian spaces and geometric topology, such as Jordan and Brouwer theorems, simplicial complexes and polihedra and manifolds. |
|---|--|

Predvideni študijski rezultati:

Znanje in razumevanje: Razumevanje pojmov kvocientne topologije, osnovnih vprašanj topologije evklidskih prostorov ter odnosa med lokalno in globalno podobo geometrijskih objektov. Poznavanje osnovnih prijemov za delo z geometričnimi objekti. Uporaba: V področjih matematike, ki delajo z geometričnimi objekti (kompleksna in globalna analiza, dinamični sistemi, numerična matematika, mehanika, teorija grafov), v računalništvu (grafika, prepoznavanje vzorcev), v fiziki, kemiji in drugih naravoslovnih in tehničnih vedah. Refleksija: Razumevanje teorije na podlagi primerov in uporabe. Prenosljive spretnosti – niso vezane le na en predmet: Formulacija problemov v primernem jeziku, reševanje in analiza doseženega na primerih, prehajanje iz lokalnih na globalne lastnosti.

Intended learning outcomes:

Knowledge and understanding: Understanding of notions such as quotient topology, basic questions of topology of Euclidian spaces and relations between local and global picture of geometric objects. Knowledge of basic concepts of geometric objects. Application: In the fields of mathematics, where geometric objects do appear (complex and global analysis, dynamic systems, numerical mathematics, mechanics, graph theory), in computing (graphics, pattern recognition), in physics, chemistry and other natural sciences and engineering. Reflection: Understanding of the theory from the applications. Transferable skills: Formulation of the problem in an appropriate language, the ability to solve and analyze the progress on the cases, the transition from local to global properties.

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge, seminarske naloge, konzultacije.

Learning and teaching methods:

Lectures, exercises, homework, seminar work, consultations.

Načini ocenjevanja:

Delež/Weight

Assessment:

| | | |
|---|---------|---|
| Način (pisni izpit, ustno izpraševanje, naloge, projekt): | | Type (examination, oral, coursework, project): |
| izpit iz vaj, | 50,00 % | written exam |
| izpit iz teorije | 50,00 % | oral exam |
| ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | grading: 5 (fail), 6-10 (pass) (according to the Statute of UL) |

Reference nosilca/Lecturer's references:

Dušan Repovš:
 – BANAKH, Taras, REPOVŠ, Dušan. Direct limit topologies in the categories of topological groups and of uniform spaces. *Tohoku mathematical journal*, ISSN 0040-8735, 2012, vol. 64, no. 1, str. 1-24 [COBISS.SI-ID 16215897]
 – CÁRDENAS, Manuel, LASHERAS, Francisco F., QUINTERO, Antonio, REPOVŠ, Dušan. On manifolds with nonhomogeneous factors. *Central European Journal of Mathematics*, ISSN 1895-1074, 2012, vol. 10, no. 3, str. 857-862 [COBISS.SI-ID 16241753]
 – KARIMOV, Umed H., REPOVŠ, Dušan. On generalized 3-manifolds which are not homologically locally connected. *Topology and its Applications*, ISSN 0166-8641. [Print ed.], 2013, vol. 160, iss. 3, str. 445-449 [COBISS.SI-ID 16558681]
 – CENCELJ, Matija, REPOVŠ, Dušan. *Topologija*, (Zbirka Pitagora). 1. ponatis. Ljubljana: Pedagoška fakulteta, 2011. XVI, 169 str., ilustr. ISBN 978-86-7735-051-2 [COBISS.SI-ID 254230528]
 Sašo Strle:
 – OWENS, Brendan, STRLE, Sašo. A characterisation of the n - \times - 3 form and applications to rational homology spheres. *Mathematical research letters*, ISSN 1073-2780, 2006, vol. 13, iss. 2, str. 259-271 [COBISS.SI-ID 13873241]
 – GRIGSBY, J. Elisenda, RUBERMAN, Daniel, STRLE, Sašo. Knot concordance and Heegaard Floer homology invariants in branched covers. *Geometry & topology*, ISSN 1364-0380, 2008, vol. 12, iss. 4, str. 2249-2275 [COBISS.SI-ID 14892121]

– OWENS, Brendan, STRLE, Sašo. A characterization of the $\mathbb{Z}^n \oplus \mathbb{Z}(\delta)$ lattice and definite nonunimodular intersection forms. American journal of mathematics, ISSN 0002-9327, 2012, vol. 134, no. 4, str. 891-913 [COBISS.SI-ID 16408153]

UVOD V ODKRIVANJE ZNANJ IZ PODATKOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|-------------------------------------|
| Predmet: | Uvod v odkrivanje znanj iz podatkov |
| Course title: | Introduction to Data Mining |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|---|---------------------------------|-----------|-------------|-----------|
| Računalništvo in informatika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | 2. semester | izbirni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0100896 |
| Koda učne enote na članici/UL Member course code: | 63251 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 45 | 20 | 10 | | | 105 | 6 |

Nosilec predmeta/Lecturer: Blaž Zupan

Vrsta predmeta/Course type: izbirni predmet/elective course

Jeziki/Languages:

| | |
|----------------------|-------------------------|
| Predavanja/Lectures: | Angleščina, Slovenščina |
| Vaje/Tutorial: | Angleščina, Slovenščina |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

| | |
|--|--|
| | |
|--|--|

Vsebina:

Predmet bo v teoriji in na praktičnih primerih obravnaval sledeče vsebine:

1. Kaj je poslovna inteligenca? Predstavitev področja skozi pregled značilnih aplikacij. Vloga tehnologij in pristopov poslovne inteligence v informacijskih sistemih in elektronskem poslovanju. Tehnologije znanja.
2. Računalniško podprto odločanje. Predstavitev in zajemanje znanja. Odločitveni modeli. Obravnavanje nepopolnih in negotovih odločitvenih podatkov. Razlaga in analiza odločitev.
3. Metode in tehnike za računalniško podporo odločanje v skupinah.
4. Uvod v tehnike odkrivanja znanj iz večdimenzionalnih podatkov. Vloga podatkovnih

Content (Syllabus outline):

The course will in theory and through practical exercises and hands-on lectures include the following topics:

1. Introduction to business intelligence. Typical applications. Role of information technology. Knowledge-based systems.
2. Computer-assisted decision support. Decision support models. Treatment of uncertain and incomplete data. Explanation and analysis.
3. Methods and techniques for group decision making.
4. Introduction to techniques of data mining and knowledge discovery in data bases, with emphasis on their application in business intelligence. Data preprocessing, modelling. Supervised and unsupervised learning.

| | |
|---|---|
| <p>skladišč in predobdelave podatkov. Uvod v tehnike strojne gradnje modelov odločanja in napovednih modelov.</p> <ol style="list-style-type: none"> 5. Vizualizacija podatkov in modelov. 6. Razvrščanje v skupine. 7. Tehnike poslovne inteligence na spletu. rangiranje spletnih strani. Analiza podatkov iz družabnih mrež. 8. Priporočilni sistemi. 9. Orodja in razvoj sistemov poslovne inteligence. Integracija v informacijskih sistemih. Snovanje uporabniških vmesnikov za pomoč pri odločanju. 10. Psihosociološki in etični vidiki poslovne inteligence. | <ol style="list-style-type: none"> 5. Data and model visualization. 6. Data clustering. 7. Business intelligence on the world-wide-web. Page ranking. Analysis of social networks. 8. Recommendation systems. 9. Data analysis toolboxes for business intelligence and their integration in information systems. Interface design of decision support systems. 10. Psychosociological and ethical issues. |
|---|---|

Temeljna literatura in viri/Readings:

- Zupan, B (2017) Uvod v odkrivanje znanj iz podatkov, Delovna skripta UL FRI, prosto dostopna na <https://github.com/BlazZupan/uo zp-zapiski>.
- Tan, P.-N., Steinbach, M., and Kumar, V. (2006) Introduction to Data Mining, Pearson Education.
- Dokumentacija prosto dostopnih programov za podatkovno analitiko (Orange, na strani <http://orange.biolab.si>, scikit-learn na strani <http://scikit-learn.org> in numpy na strani <http://www.numpy.org>).

Cilji in kompetence:

Cilj predmeta je spoznati metodološke osnove inteligentnih sistemov, ki so bili razviti na področju računalništva. Študente bomo naučili v praksi prepoznati njihove možne aplikacije ter tekom predmeta v okviru laboratorijskega dela naučeno znanje uporabiti na praktičnih primerih. Še posebej podrobno si bomo ogledali tehnike razvrščanja v skupine, priporočilnih sistemov, iskanja vzorcev v podatkih, gradnje napovednih modelov iz strukturiranih in tekstovnih zapisov in tehnike gradnje odločitvenih modelov.

Objectives and competences:

The aim of this course is an introduction to business intelligent methods and tools that were developed within computer science. Students will learn how to identify potential applications of business intelligence in practice. During the course, they will apply their methodological and development knowledge on real-life applications. In particular, the course will focus on data clustering, recommendations systems, association rule mining, inference of predictive models from structured and textual data, and on decision support techniques.

Predvideni študijski rezultati:

Po uspešno opravljenem predmetu bodo študenti lahko:

- Pripravili podatke v obliki tabel, primernih za uporabo strojnega učenja.
- Prepoznali, ali gre pri danih podatkih za problem odkrivanja vzorcev ali napovedovanja.
- Izbrali primerno tehniko strojnega učenja za analizo podatkov in odkrivanje vzorcev.
- Za dane podatke uporabili primerno tehniko zmanjšanja dimenzionalnosti.
- Predstavili podatke v primerni vizualizaciji.
- Za dan problem uporabili primerno tehniko za ovrednotenje rezultatov analitičnih metod.
- Uporabili knjižnice za podatkovno analitiko v programskem jeziku Python.

Intended learning outcomes:

After successful completion of the course, the students should be able to:

- Prepare the data in attribute-value format susceptible for machine learning methods.
- For a given data set, distinguish between application of supervised and unsupervised learning.
- Given the data, select the right method for its analysis.
- Use feature dimensionality reduction techniques to help in understanding of the data.
- Use the most appropriate data visualisation technique for a given problem.

| | |
|--|---|
| | <ul style="list-style-type: none"> • Apply the right model evaluation and scoring approaches to assess the quality of the modelling technique. • Use Python for data analytics. |
|--|---|

| | |
|--|--|
| Metode poučevanja in učenja: | Learning and teaching methods: |
| Predavanja s podporo avdio-vizualne opreme, laboratorijske vaje v računalniški učilnici z osnovno računalniško opremo. Delo posamezno in v skupinah. Velik poudarek na praktičnem delu in reševanju problemov. | Lectures using modern audio-visual equipment. Individual and group-based project assignments. Emphasis on practical exercises. |

| Načini ocenjevanja: | Delež/Weight | Assessment: |
|--|---------------------|---|
| Domače naloge. | 50,00 % | Homeworks. |
| Končno preverjanje (pisni izpit). | 50,00 % | Written exam. |
| Ocene: 6-10 pozitivno, 5 negativno (v skladu s Statutom UL). | | Grading: 6-10 pass, 5 fail (according to the rules of University of Ljubljana). |

| |
|---|
| Reference nosilca/Lecturer's references: |
| <p>Stajdohar M, Rosengarten RD, Kokosar J, Jeran L, Blenkus D, Shaulsky G, Zupan B (2017) dictyExpress: a web-based platform for sequence data management and analytics in Dictyostelium and beyond, <i>BMC Bioinformatics</i>. 2017 Jun 2;18(1):291.</p> <p>Zitnik M, Zupan B (2016) Jumping across biomedical contexts using compressive data fusion, <i>Bioinformatics</i> 15;32(12):i90-i100.</p> <p>Zitnik M, Nam EA, Dinh C, Kuspa A, Shaulsky G, Zupan B (2015) Gene prioritization by compressive data fusion and chaining, <i>PLoS Computational Biology</i> 11(10):e1004552.</p> <p>Staric A, Demsar J, Zupan B (2015) Concurrent software architectures for exploratory data analysis. <i>WIREs Data Mining and Knowledge Discovery</i> 5(4):165-180.</p> <p>Zitnik M, Zupan B (2015) Data fusion by matrix factorization. <i>IEEE Transactions on Pattern Analysis and Machine Intelligence</i> 37(1):41-53.</p> <p>Celotna bibliografija prof. dr. Zupana je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=7764</p> |

VERJETNOSTNI RAČUN IN STATISTIKA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

| | |
|---------------------------|----------------------------------|
| Predmet: | Verjetnostni račun in statistika |
| Course title: | Probability and Statistics |
| Članica nosilka/UL | |
| Member: | |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri | Izbirnost |
|--|---------------------------------|-----------|-----------|-----------|
| Računalništvo in matematika, prva stopnja, univerzitetni | Ni členitve (študijski program) | 3. letnik | Celoletni | obvezni |

| | |
|--|---------|
| Univerzitetna koda predmeta/University course code: | 0039533 |
| Koda učne enote na članici/UL Member course code: | 27216 |

| Predavanja /Lectures | Seminar /Seminar | Vaje /Tutorials | Klinične vaje /Clinical tutorials | Druge oblike študija /Other forms of study | Samostojno delo /Individual student work | ECTS |
|-------------------------|---------------------|--------------------|---|---|---|------|
| 60 | | 60 | | | 180 | 10 |

| | |
|-----------------------------------|-------------------------------|
| Nosilec predmeta/Lecturer: | Mihael Perman, Roman Drnovšek |
|-----------------------------------|-------------------------------|

| | |
|------------------------------------|-----------------------------------|
| Vrsta predmeta/Course type: | obvezni predmet/compulsory course |
|------------------------------------|-----------------------------------|

| | | |
|--------------------------|----------------------|-------------|
| Jeziki/Languages: | Predavanja/Lectures: | Slovenščina |
| | Vaje/Tutorial: | Slovenščina |

| | |
|--|--|
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Opravljen predmeta Analiza 1 in Analiza 2. | Completed courses Analysis 1 and Analysis 2. |

| Vsebina: | Content (Syllabus outline): |
|---|---|
| definicija verjetnosti pogojna verjetnost slučajne spremenljivke in vektorji diskretne in zvezne porazdelitve matematično upanje disperzija, kovarianca in korelacijski koeficient višji momenti in vrstilne karakteristike pogojna porazdelitev in pogojno matematično upanje rodovne funkcije, momentno rodovne funkcije zakoni velikih števil centralni limitni izrek uvod v statistiko vzorčne statistike in cenilke intervali zaupanja testiranje statističnih hipotez linearna regresija prilagoditveni testi neparametrični testi | definition of probability conditional probability random variables and vectors discrete and continuous distributions expectation variance, covariance and correlation coefficient higher moments and order statistics conditional distribution and conditional expectation generating functions, moment-generating functions laws of large numbers central limit theorem introduction to statistics sample statistics and estimators confidence intervals testing statistical hypotheses linear regression goodness of fit tests nonparametric tests |

Temeljna literatura in viri/Readings:

Hladnik M.: *Verjetnost in statistika, Založba FE in FRI, Ljubljana, 2002, ISBN: 961-6209-34-5, 140 str.*

Jamnik R.: *Matematična statistika, DZS Ljubljana, 1980, 408 str.*

Jamnik R.: *Verjetnostni račun in statistika, DMFA Slovenije, Ljubljana, 1986, 156 str.*

Grimmett G. R., Stirzaker D. R.: *Probability and random processes, Second edition, The Clarendon Press, Oxford University Press, New York, 1992, 541 str.*

Cilji in kompetence:

Predstaviti osnove teorije verjetnosti in njeno uporabo v statistiki.

Objectives and competences:

Introduction to probability theory and its applications in statistics.

Predvideni študijski rezultati:

Razumevanje teoretičnih konceptov v številnih primerih uporabe. Zmožnost razpoznavanja verjetnostnih in statističnih vsebin v drugih vedah (fizika, ekonomija, finance, aktuarstvo, medicina, biologija, industrijska statistika).

Intended learning outcomes:

Understanding of theoretical concepts in various applications. The ability to recognize probabilistic and statistical concepts in other sciences (physics, economics, finance, actuarial science, medicine, biology, industrial statistics).

Metode poučevanja in učenja:

Predavanja, vaje, domače naloge.

Learning and teaching methods:

Lectures, exercises, homeworks.

Načini ocenjevanja:

pisni izpit, teoretični test ali ustni izpit

Delež/Weight**Assessment:**

written examination, theoretical test or oral exam

Reference nosilca/Lecturer's references:

Roman Drnovšek:

– DRNOVŠEK, Roman. Triangularizing semigroups of positive operators on an atomic normed Riesz space. *Proceedings of the Edinburgh Mathematical Society*, ISSN 0013-0915, 2000, let. 43, št. 1, str. 43-55 [COBISS.SI-ID 9480281]

– DRNOVŠEK, Roman. Common invariant subspaces for collections of operators. *Integral equations and operator theory*, ISSN 0378-620X, 2001, vol. 39, no. 3, str. 253-266 [COBISS.SI-ID 10597721]

– DRNOVŠEK, Roman. An infinite-dimensional generalization of Zenger's lemma. *Journal of mathematical analysis and applications*, ISSN 0022-247X. [Print ed.], 2012, vol. 388, iss. 2, str. 1233-1238 [COBISS.SI-ID 16214617]

Mihael Perman:

– PERMAN, Mihael, SENEGAČNIK, Andrej, TUMA, Matija. Semi-Markov models with an application to power-plant reliability analysis. *IEEE transactions on reliability*, ISSN 0018-9529, 1997, vol. 46, no. 4, str. 526-532 [COBISS.SI-ID 2567707]

– PERMAN, Mihael, WELLNER, Jon A. On the distribution of Brownian areas. *Annals of applied probability*, ISSN 1050-5164, 1996, let. 6, št. 4, str. 1091-1111 [COBISS.SI-ID 7101017]

– PERMAN, Mihael, PITMAN, Jim, YOR, Marc. Size-biased sampling of Poisson processes and excursions. *Probability theory and related fields*, ISSN 0178-8051, 1992, 92, no. 1, str. 21-39 [COBISS.SI-ID 12236377]