University *of Ljubljana*
Faculty *of Computer and Information Science*

Ljubljana,
5 April 2017

Catalogue of Knowledge

for enrolment into the second cycle Master's study programme

Computer Science Education

2017/2018

University of Ljubljana
Faculty of Computer and Information Science

The Catalogue of Knowledge for the Selection Exam for Enrolment into the Second Cycle Master's Study Programme Computer Science Education

Programming

- basics of object-oriented and procedural programming
- program constructs for flow control (branching, loops, program structures)
- Iteration and recursion
- basic data types (integers, real numbers, streams, logic types) and operators
- exception handling

Magnus L. Hetland: Beginning Python, 2nd ed., Apress, 2008.

Algorithms

- basics of algorithmic complexity (notation by large O)
- data structures (list, queue, stack, set, priority queue, hash table, trees, graphs)
- basic programing techniques (greedy search, divide and concur, dynamic programming)
- standard algorithms (sort, minimum spanning tree search, shortest path search, etc.)

Kononenko in sod. Programiranje in algoritmi, Založba FE & FRI, 2008 (chapters 4.5.1, 5, 6.2.1, 7).

Cormen et al.: Introduction to algorithms, 3rd ed., The MIT press, 2009, chapters 2, 3.1, 4.1, 7.1, 7.2, 10.1, 10.2, 11.2, 12.1, 12.2, 12.3, 15.1, 16.1, 22.1, 22.2, 22.3, 22.4., 23.1, 23. 2.

Computer systems

- basics of digital circuits (Bool algebra, combinatorial and sequence logic, finite automata)
- number representation in computers
- basics of computer architecture

Kodek, Dušan: Arhitektura in organizacija računalniških sistemov, BI-TIM, Ljubljana, 2008 (ISBN 978-961-6046-08-4)

Didactics and developmental psychology

- factors and principles of mental development
- psychological characteristics of children, adolescent and adults
- individual differences and their impacts on personal development

Planning, teaching and evaluating educational process

- taxonomy of learning goals
- didactical components of teaching: from introduction to assessment Individual differences and their impacts on personal development
- teaching and learning methods. Forms of classroom interaction (individual work, group-cooperative work, tandem, frontal work)
- differentiation and individualization in teaching and learning
- teaching and learning strategies: inquiry education, problem-solving, project work

Sample Tasks for Elective Exams

TASK 1

The following segment of program code is given:

```
count = 0
i = 0
while count < 1000:
    if random.random() < 0.3:
        i = i + 1
    else:
        if random.random() < 0.3:
            i = i + 2
    count = count + 1
print(i)
```

Explanation: The function `random.random()` returns a random real number from the interval `[0.0, 1.0)`.

What is the expected value of the variable `i` after execution of the above program?

a) 600
b) 720
c) 840
d) 880
e) 900

TASK 2

The following recursive function is given, which contains a part of the stopping criterion that is marked with yellow:

```
def fun_rek(n):
    if n == _____:
        return 2
    else:
        return n * fun_rek(n+1)
```

Which of the following values of the stopping criterion causes the call `fun_rek(2)` to return result `240`?

a) 6
b) 10
c) 32
d) 80
e) 120

TASK 3

The following segment of a program code is given:

```
data = [[0,0,0,0],[0,0,0,0]]
for i in range(0, len(data)):
    for j in range(0, len(data[0])):
        if (i+j)%3 == 0:
            continue
        if (i+j) >= 3:
            break
        data[i][j] = i+j
```

Explanations:

- function `range(0,b)` returns a list of numbers `[0, 1, 2, ..., b-1]`,
- function `len(list)` returns a number of elements in list `list`,
- indexing of list elements in the above programming language starts with index 0.

What is the value of list `data` after the execution of the above code?

a) `[[0, 1, 2, 3], [1, 2, 3, 4]]`
b) `[[0, 1, 2, 0], [1, 2, 0, 4]]`
c) `[[0, 1, 0, 0], [1, 0, 0, 0]]`
d) `[[0, 1, 2, 0], [1, 2, 0, 0]]`
e) `[[0, -1, 0, 0], [-1, 0, 0, 0]]`

TASK 4

The functions `c` and `d` below call subroutines `a1`, `a2` and `a3` with the following computational complexities:

`a1 = O(n), a2 = O(n^3)` in `a3 = O(n log n)`.

```
void c(int n) {
  int z = 0 ;
  if (a1(n)+a2(n)*a3(n) > 1)
    z = 1 + a1(n) ;
  return z ;
}
```

```
void d(int n) {
  int i, j, s = 0 ;
  for (i=0 ; i < n ; i++)
    for (j=0 ; j < n ; j++)
      s = s + a3(n) ;
  return s ;
```

Select tight bounds for the asymptotic computational complexity of functions `c` and `d`.

a) $c = O(n^6 \log n)$ in $d = O(n^2)$
b) $c = O(n^4 \log n)$ in $d = O(n^3 \log n)$
c) $c = O(n^3)$ in $d = O(n^3 \log n)$
d) $c = O(n^4)$ in $d = O(n^3 \log n)$
e) $c = O(n^3)$ in $d = O(n^2 \log n)$
f) $c = O(n^4 \log n)$ in $d = O(n^2)$

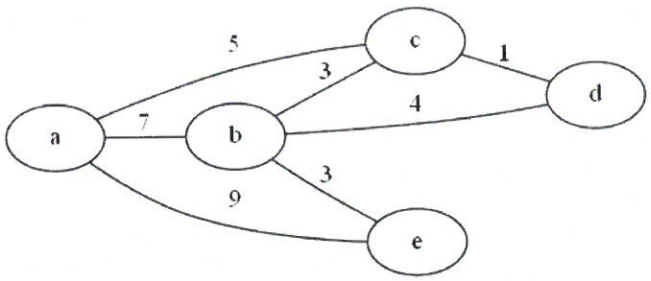
TASK 5

In a program we use data structures stack, queue and priority queue (with smaller values having larger priority). Into the structures we insert the sequence of values: 5, 7, 12, 3 and 9. Which elements we get if we use operation pop on stack, dequeue on queue and deleteMin on priority queue?

a) stack: 5, queue: 9, priority queue: 12
b) stack: 9, queue: 3, priority queue: 12
c) stack: 12, queue: 5, priority queue: 3
d) stack: 36, queue: 5, priority queue: 5
e) stack: 36, queue: 5, priority queue: 7
f) stack: 9, queue: 5, priority queue: 3

TASK 6

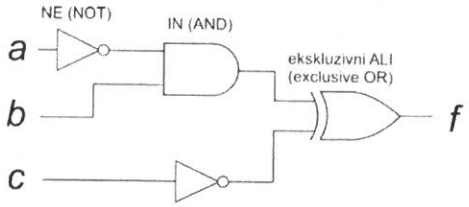
Find the cost of the minimum spanning tree for the graph below.



a) 5
b) 1
c) 13
d) 12
e) 32
f) 14
g) 25

TASK 7

Determine $f(a,b,c)$ for two cases of logic values on the inputs: $f(0,0,1)$ and $f(0,1,1)$.



a) 0, 0
b) 0, 1
c) 1, 0
d) 1, 1

TASK 8

Minimize logic function $f(x,y,z) = xz' \vee xyz \vee x'z'$. (' stands for negation)

a) $xz' \vee x'z'$
b) $x'y \vee z$
c) $xyz \vee x'$
d) $xy \vee z'$

TASK 9

Which decimal integer is represented by 0xE4 in the 8-bit two's complement notation?

a) −28
b) 28
c) −228
d) 228

TASK 10

For which choice of a real number a are the line $x = y - 1 = \frac{z+1}{2}$ and the plane $ax + y + 2z = 3$ in $\mathbb{R}^3$ parallel?

a) $a = -5$
b) $a = 0$
c) $a = 1$
d) Nothing of the above.

TASK 11

For which choice of a real number a does the following system of equations have a solution?

$$\begin{aligned} x + ay - z &= 0 \\ x + y + 3z &= 12 \\ y - 2z &= 3 \end{aligned}$$

a) $a \neq 1$
b) $a \neq 3$
c) System has a solution for every $a \in \mathbb{R}$
d) Nothing of the above

TASK 12

Let a continuous and differentiable funcion f on the interval $[-5,5]$ have its local maximum in $(-2,3)$ and its local minimum in $(1,-3)$. Which od the following statements can be false?

a) $f'(-2) = 0$
b) The graph of f has a tangent line at $x = 1$parallel to x-axis
c) Maximum value of $f$on the interval $(-5,5)$ is equal to 3
d) The graph of f intersects x-axis and y-axis

TASK 13

For given complex numbers $z = 2\,e^{i\frac{\pi}{2}}$ and $w = \frac{1}{2}\,e^{i\frac{\pi}{4}}$, what is the absolute value of the complex number $\frac{z}{w}$?

a) 1
b) 4
c) $\frac{\pi}{4}$
d) $\frac{3\pi}{4}$