

Entrance Examination - Computer Science

Name and Surname - fill in the field	Application No.	Test Sheet No.
		1

Algorithms and data structures

1 Which statement is correct for the data structure known as an array with n items (items are stored in memory continuously one after each other)?

- A** Named key is used to access the particular item.
 - *B** If the position (index) of the requested item is not known, then the time complexity of retrieving this item is $O(n)$.
 - C** This data structure is optimal for use in situations where insertion of a new item between existing two items is often required.
 - D** Memory overhead of an array is typically higher than for a doubly linked list.
 - E** Time complexity of retrieval of an item at the known position (index) is $O(n)$.
-

2 Assume two arrays with n items (with floating point values) on input. You should provide a single array containing $2*n$ values sorted in an ascending order. The input arrays are already sorted (in ascending order) and there can be some values occurring in both the input arrays. Assume an algorithm, implementing such operation. Which statement is correct?

- A** The lowest time complexity can be obtained if we copy both input arrays into the output array and apply the Quick sort algorithm. Resulting time complexity is $O(\log(n)*n)$.
 - B** The lowest time complexity can be obtained if we copy both input arrays into the output array and apply the Bubble sort algorithm. Resulting time complexity is $O(n*n)$.
 - *C** The lowest time complexity can be obtained if we copy items gradually from both input arrays into the output array, keeping it sorted. Resulting time complexity is $O(n)$.
 - D** The lowest time complexity can be obtained if we copy items from input arrays into the output array, without any need of additional sorting. Resulting time complexity is $O(1)$.
 - E** The lowest time complexity can be obtained if we transform input arrays into a binary search tree and save the tree's leaves into the output array. Resulting time complexity is $O(\log(n)*n)$.
-

3 Assume existence of doubly linked list of items (data structure) with stored pointer to last item. The length (number of items) of the list is n . Which statement is correct?

- A** Time complexity of insertion of a new item behind last item is $O(n)$.
 - B** Time complexity of retrieval of the first item is $O(1)$.
 - *C** Time complexity of search for the specific item is $O(n)$.
 - D** Time complexity of insertion of a new item behind found item is $O(n)$.
 - E** Memory overhead of list is the same as for plain array of values stored continuously in memory.
-

4 Which statement is correct for the data structure known as balanced binary search tree?

- A** It is not necessary to balance the balanced binary search tree after any insertion of a new node.
 - B** Depth of balanced binary search tree is linear to number of nodes in the worst case.
 - C** If there are n nodes, there are exactly n edges.
 - D** Search operation in balanced binary search tree with n nodes has time complexity $O(\log(\log(n)))$.
 - *E** Time complexity of node removal from balanced binary search tree with n nodes is $O(\log(n))$.
-

- 5** Let's assume having N network nodes with some of them connected by a physical connection. Your goal is to verify if a data connection can be established between any two network nodes X and Y . Which option is the optimum one with respect to the time complexity?
- A** Search for the longest tunnel in the graph of network nodes. If the tunnel consists of at least 2 nodes, then there is at least one network node Y inaccessible from other node X .
 - B** Depth-first search on graph of network nodes. If there is a cycle in the graph, then there is at least one network node Y inaccessible from other node X .
 - *C** Search for the minimal spanning tree on graph of network nodes. If there is no such spanning tree, there is at least one network node Y inaccessible from another node X .
 - D** Brute-force examination of all possible paths in graph of network nodes. If there is no path between node X and Y , then Y is not reachable from X .
 - E** Search for the shortest cycle in the graph. If such a cycle is detected, then Y is not reachable from X .
-

Programming

6

```
a = 3;
b = 0;
c = 0;
while (b < 3) {
    while (a > b) {
        c = c + 1;
        b = b + 1;
    }
    a = a - 1;
    b = b + 1;
}
```

Which values will the variables a , b , c have after the execution of the given code?

- *A** $a = 2, b = 4, c = 3$
 - B** $a = 3, b = 0, c = 0$
 - C** $a = 3, b = 4, c = 3$
 - D** $a = 2, b = 5, c = 3$
 - E** the program will end up in an infinite loop
-

```

7 int offset = 0;
  int dataset[10];
  void put(int value) {
    if (offset < 10) {
      dataset[offset] = value;
      offset = offset + 1;
    }
  }
  int get() {
    if (offset > 0) {
      if (offset < 11) {
        offset = offset - 1;
        return dataset[offset];
      } else return -1;
    } else return -1;
  }

```

The given program provides two basic functions for manipulation of a frequently used data structure. The variables *offset* and *dataset* are global variables. The data type *int* represents signed integer numbers and *dataset[offset]* returns a value at the position *offset+1* in the *dataset* array (indexed from zero). Decide which statement is correct for the given program:

- A** functions implement a data structure known as FIFO for an unlimited number of items
 - B** functions implement a data structure known as LIFO for an unlimited number of items
 - C** functions implement a data structure known as linked list for an unlimited number of items
 - D** functions implement a data structure known as FIFO for a limited number of items
 - *E** functions implement a data structure known as LIFO for a limited number of items
-

8 Decide which statement is valid in common OOP languages (C++, Java, C#):

- A** Object is an instance of a class and a class is an instance of object.
 - B** There can be more instances of a given object and every instance is known as a class.
 - C** There can be exactly one object created from a given class.
 - D** Class declares a method (method's fingerprint) and objects provide its implementation.
 - *E** Class contains declarations of methods and may contain also their implementation.
-

9 Assume a class *X*. Decide which statement is valid in common OOP languages (C++, Java, C#):

- *A** If a method is virtual in the class *X*, its implementation can be changed in classes inheriting from *X*.
 - B** If a method is virtual in the class *X*, its implementation cannot be changed in classes inheriting from *X*.
 - C** Overhead associated with a call to virtual methods is typically lower than to methods called with the early binding (non-virtual).
 - D** A method can be marked as virtual only in the interface (Java - interface, C++ - abstract class).
 - E** If a method is not virtual in the class *X*, it cannot be re-declared into a virtual method in classes inheriting from *X*.
-

- 10** Assume that a class *A* has methods *publicFoo()*, *protectedFoo()* and *privateFoo()* with access rights (accessibility) for *publicFoo()* defined as public, for *protectedFoo()* as protected and for *privateFoo()* as private. Decide which statement is valid in common OOP languages (C++, Java, C#):
- A** Object *X* can call all methods if and only if *X* is an instance of a class inherited from *A*.
 - B** Object *X* can call only the methods *publicFoo()* and *protectedFoo()*. *X* cannot call *privateFoo()*, no matter if *X* is an instance of a class inherited from *A*.
 - C** Object *X* can call only the method *publicFoo()*. *X* cannot call *protectedFoo()* and *privateFoo()*, no matter if *X* is an instance of a class inherited from *A*.
 - D** Object *X* can call the method *publicFoo()* if and only if *X* is not an instance of a class inherited from *A*. *X* cannot call *protectedFoo()* and *privateFoo()* no matter if *X* is an instance of a class inherited from *A*.
 - *E** Object *X* can always call only the method *publicFoo()*. *X* can call the method *protectedFoo()* if *X* is an instance of a class *A* or a class inherited directly from *A*. *X* can call the method *privateFoo()* if and only if *X* is an instance of *A*.

Databases

- 11** B-Tree is:
- A** an abbreviation for the Binary Search Tree
 - B** an extension of the A-tree
 - C** a tree, where each node is having exactly two successors
 - *D** a balanced *n*-ary tree
 - E** a tree, where each node is also a root
- 12** Let's assume relational database with the table *readers* having the key (*id_reader*), table *books* having the key (*id_book*) and the table *loans* having the key (*what, who*). Which is the correct result of the following SQL query?
- ```
SELECT readers.id_reader, count(*)
FROM readers, books, loans
WHERE loans.what=books.id_book and loans.who=readers.id_reader
 and books.title LIKE '%SQL%'
GROUP BY readers.id_reader;
```
- A** Identifiers of all the books in the library and the number how many times they have been loaned.
  - B** Reader identifiers of readers who have never borrowed any book.
  - \*C** Reader identifiers and the number of books (having the string SQL in their title) they have borrowed.
  - D** Number of readers registered with the library.
  - E** Identifiers of readers and names of books (having the string SQL in their title) they have borrowed.

- 13** Closure of a set of functional dependencies can be computed using:
- A** the Boyce-Codd axioms
  - \*B** the Armstrong's axioms
  - C** the first normal form
  - D** the Chomsky normal form
  - E** the Horn axioms

- 14** Select a **false** statement about the normalisation of a relation scheme:
- A** normalisation is done to satisfy the normal forms
  - \*B** normalisation can cause loss of data
  - C** during normalisation it may be necessary to split a table into two tables
  - D** data redundancy is a frequently addressed problem during normalisation
  - E** a normalisation algorithm may also take into account functional dependencies

**15** Select a **false** statement about candidate key:

- A One entity set can have more candidate keys.
- B Candidate key is a key.
- C Candidate key is a super key.
- D Primary key is a selected candidate key.
- \*E Candidate key is any subset of attributes.

---

## Computer networks

---

**16** One-bit information transfer between a stationary satellite and a terrestrial gate takes

- A 270 seconds
- B 270 picoseconds
- C 270 nanoseconds
- \*D 270 milliseconds
- E 270 mikroseconds

**17** ISO OSI reference model prescribes to organize the functionality of distributed systems into hierarchically arranged layers:

- A physical, link, network, transport, application
- B physical, link, network, transport, session, application
- C physical, link, network, transport, session, security, presentation, application
- \*D physical, link, network, transport, session, presentation, application
- E physical, link, network, transport, session, transaction, security, presentation, application

**18** The http protocol uses by default the port number:

- A 22
- B 25
- \*C 80
- D 88
- E 110

**19** A connection-oriented communication protocol guarantees delivery of all transmitted data in the original order in which data has been transmitted. Select a true statement:

- A Connection-oriented protocol can only be used between nodes directly connected by a transmission medium.
- B Connection-oriented protocol can only be used between nodes in one network domain.
- C Connection-oriented protocol can only be used between nodes meeting the constraints of the ISO OSI Model.
- \*D Using the connection-oriented protocols is not a necessary requirement for achieving reliable communication in environments with errors.
- E Using the connection-oriented protocols is a necessary requirement for achieving reliable communication in environments with errors.

**20** The place providing transport services based on TCP/IP on the Internet is:

- A selected system processes (demons)
- \*B numerically identifiable data box (port)
- C communication link driver interface in the kernel of operating system
- D communication link controller interface
- E MAC address

---

## Computer systems

---

- 
- 21** Which binary number is an equivalent of the hexadecimal number 29AF?
- A 0001 1001 1010 1111
  - \*B 0010 1001 1010 1111
  - C 1111 1010 1001 0010
  - D 1001 0010 1010 1111
  - E 10671
- 
- 22** Select a **false** statement about the computer representation of real numbers:
- A real numbers are often stored according to IEEE 754
  - B real numbers are usually represented using the sign, exponent and mantissa
  - C in real number representations different representations can be used for floating point numbers and fixed point numbers
  - D some real number representations support the value of infinity
  - \*E a significant problem of all computer representations of real numbers is the so-called Boolean algebra problem
- 
- 23** Select a true statement about interrupts in computer systems:
- A interrupts can be triggered symmetrically or asymmetrically
  - B no interrupt can be masked
  - C interrupts are always non-deterministic
  - D in modern operating systems each process creates its own interrupt table
  - \*E interrupt can usually be triggered also by a special instruction
- 
- 24** Inter-process synchronization and communication in modern operating systems is **not** based on:
- A pipe
  - B semaphore
  - \*C bridge
  - D mutex
  - E shared memory
- 
- 25** Page fault interrupt is triggered by:
- A a hardware fault of the memory chip
  - \*B a reference to the address that is not present in the physical address space
  - C each access to the virtual memory
  - D verification of the file permissions
  - E an I/O device communication fault
-