Object-Oriented Programming

August 2017

Notes or documents of any kind forbidden. Duration: 3 1/2h. Please answer the questions on separate sheets labeled with your name, section, and student id.

Question 1

A *matrix* is a rectangular array of numbers arranged in m rows and n columns, with $m, n \geq 1$. The individual elements of a matrix A are denoted $a_{i,j}$, with $i = 1, \ldots, m$, and $j = 1, \ldots, n$:

$$A = \begin{pmatrix} a_{1,1} & a_{1,2} & a_{1,3} & \cdots \\ a_{2,1} & a_{2,2} & a_{2,3} & \cdots \\ a_{3,1} & a_{3,2} & a_{3,3} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}.$$

The problem consists in developing a Java library for representing and manipulating matrices with integer elements. This library must provide a class `Matrix` satisfying the following requirements:

- A new matrix can be created by providing a bi-dimensional array containing the value of its elements.
- Given a matrix A, one can extract its dimensions m and n, as well as consult or modify any of its elements $a_{i,j}$.
- The following operations must be implemented:
  - Computing the sum $S = A + B$ of two matrices A and B. The elements $s_{i,j}$ of S, for $i = 1, \ldots, m$, and $j = 1, \ldots, n$, are defined as
  $$s_{i,j} = a_{i,j} + b_{i,j}.$$
  - Computing the scalar product $P = z\,A$ of a matrix A by an integer z. The elements $p_{i,j}$ of P, for $i = 1, \ldots, m$, and $j = 1, \ldots, n$, are defined as
  $$p_{i,j} = z\,a_{i,j}.$$
  - Computing the transpose $T = A^\top$ of a matrix A. If A has m rows and n columns, then T has n rows and m columns. The elements $t_{i,j}$ of T for $i = 1, \ldots, n$, and $j = 1, \ldots, m$, are defined as
  $$t_{i,j} = a_{j,i}.$$

- It should be possible to check whether two given matrices are identical (in other words, whether they share the same dimensions, and their corresponding elements have the same value).
- Matrices should be clonable.
- In the case of any error, a dedicated exception should be thrown.

Note: Using the Java package mechanism is not required.

Question 2

(All answers should be thoroughly justified.)

1. What is an object?
2. What are polymorphic methods? What benefit do they provide?
3. What is the limited form of multiple inheritance allowed by Java?
4. In Java, how are source files associated with packages?
5. Explain the purpose of the serialization operation.