

OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS, 2004

OBJECT ORIENTED PROGRAMMING AND INTERNET PROGRAMMING [CS424]

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Time allowed: Two hours.

Answer *three* of the following problems.

1.

- (a) Define a Java class **Numbers** that represents finite sets of nonnegative integers, as follows.
- What data fields can be used to store the elements of a set?
 - Provide a method **size()** which determines the size of a set,
 - a method **contains()** which given a number as argument, decides whether or not the number is an element of the set,
 - and a method **intersection()** which forms the intersection with another **Numbers** set.
 - Also provide a constructor that builds a **Numbers** object from an array of integers.
- (b) Describe the difference between static and instance members. Should your **Numbers** class have static members? Describe the difference between public and private members of a class. Which members of your **Numbers** class should be declared private?

2.

- (a) Define a class **Relation** to represent binary relations on the set $\{0, 1, \dots, n-1\}$ of size n as follows.
- Provide a private array of **Numbers** to store the data of a relation R in the form of sets $\{y \mid xRy\}$ for all $x \in \{0, 1, \dots, n-1\}$.
 - Provide a constructor which builds a relation from an array of arrays of integers, using a suitable constructor from the **Numbers** class.
 - Provide a method **relates()** which for two given elements x and y decides whether x is related to y .
 - Provide a method **isTransitive()** which determines whether or not this relation is transitive.
 - Provide a method that constructs the reflexive closure of this relation.
- (b) What is the contract of a class and where is it usually found? Sketch a contract for the **Relation** class.

p.t.o.

3.

- (a) What is a method? Describe the (at least four) parts of a method header. What does the signature of a method consist of? Illustrate your answers by an example.
- (b) What is a class? Describe the relationship between classes, data types and objects. What is a constructor? Describe its form and its function.
- (c) Suppose that you are designing a class **NumbersPanel** for the graphical display of a **Numbers** object by means of a row of checkboxes, and that a **NumbersPanel** holds a **Numbers** object in a private field **numbers**. Define a private class **NumberBox** which implements the **ItemListener** interface as a subclass of **JCheckBox** consisting of:
 - i. a private data field of type **int** containing the number;
 - ii. a constructor which takes a number and a **boolean** argument indicating whether or not this box is selected, calls the superclass constructor with a string version of the number and the boolean value as arguments, stores the number in the designated data field, and installs itself as **ItemListener**;
 - iii. an implementation of **itemStateChanged()** which adds or removes (here you may assume the existence of suitable methods **add()** and **remove()**) the number represented by this box to or from the set displayed by this **NumbersPanel**, depending on whether or not the box has been selected, and then calls a method **set()** to update all other parts of the display.

4.

- (a) Describe briefly the similarities and the differences between the four different types of variables that can occur in a Java program.
- (b) Describe inheritance and the concept of packages as relationships between Java classes. Explain the relationship between the constructor of an extended class and the constructor of its superclass.
- (c) What does 'polymorphism' mean for a Java program? Explain what is meant by 'overloading' and 'overriding'. What is it that is overloaded or overridden?
- (d) Define a class **PartialOrder** as subclass of **Relation** and override the two methods **isTransitive()** and **ReflexiveClosure()** with suitable implementations.