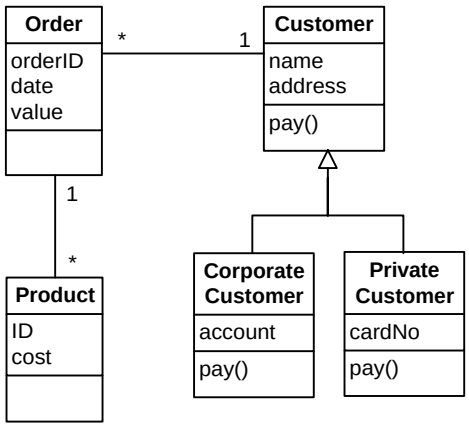
1B11 Programming I & II
1999 Exam
3 Hours

Lecturer: Dr. Graham Roberts, Dept. of Computer Science

Answer ALL questions from Part I and THREE questions from Part II

Part I

1. The *incomplete* UML class diagram below represents the basic structure of a program for collecting product orders for a company.



a) Write a Java version of the Product class. Include methods to allow product information to be accessed.

[5 marks]

b) Write a straightforward version of the Order class in Java.

[5 marks]

c) Assume class Customer is abstract. *Outline* Java versions of class Customer and the two concrete Customer subclasses, clearly showing how inheritance is expressed. Include a description of the pay() methods required in all three classes (the pay() method is used to arrange payment of an order).

[10 marks]

d) Briefly describe a test program that could be used to test your classes by simulating the orders being made and paid for.

[5 marks]

e) Briefly describe how a test plan and individual tests should be structured.

[5 marks]

[Total 30 marks]

2. Explain each of the following:

dynamic binding, substitutability, static variable, protected, deep copy

[2 marks each]

[Total 10 marks]

3. a) The following are three examples of actual-parameter-lists:

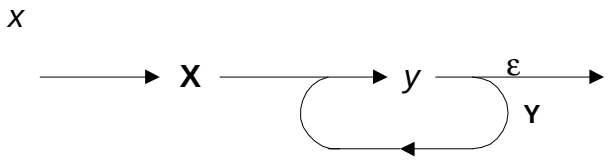
( ) (17) (17, x+17, (x+17))

Draw syntax diagram(s) to define actual-parameter-list. You may assume that expression has already been defined.

Add lookaheads to your syntax diagram(s) to aid parsing.

[3 marks]

b) Show how the following syntax diagram for the construct x could be translated into a Java method for implementation in a recursive descent parser:



Note: y is a reference to another syntax diagram, X and Y are tokens.

[2 marks]

[Total 5 marks]

Part II
Answer THREE questions from this part

4. a) Explain what an object reference is.

[3 marks]

b) Describe how object references allow tree and list data structures to be constructed. Include an outline example of how each data structure is implemented.

[10 marks]

c) References allow object sharing. What are the advantages and disadvantages of shared objects?

[5 marks]

[Total 18 marks]

5. A SortedStringQueue stores a queue of Strings in sorted order. Write a SortedStringQueue class.

Include the following methods:

- add a String to the queue,
- remove a String from the front of the queue,
- clone the queue object.

. Where necessary, methods should throw exceptions if an error occurs.

[Total 18 marks]

6. Write the following methods:

a) A method that takes two character array arguments and returns true if the sequence of characters stored in the second array is a sub-sequence of those characters stored in the first array.

[9 marks]

b) A method that takes two character array arguments and returns true if both arrays contain the same characters but not necessarily in the same order.

[9 marks]

[Total 18 marks]

7. Consider a cut-down version of Java which has only four kinds of statement:
   - compound statements
   - if statements, with an optional else part
   - while statements
   - assignments

   Supposing that you are given syntax diagrams for assignment and condition:

   a) Draw syntax diagrams for statement, compound_statement, if_else_statement, and while_statement.

   [7 marks]

   b) Add lookaheads to your syntax diagrams.

   [2 marks]

   c) Show how your syntax diagrams could be implemented as Java methods in a recursive-descent parser.

   [6 marks]

   d) Briefly describe the nature and purpose of any other methods or objects to which your implementation refers.

   [3 marks]

   Note: your implementation need not be syntactically perfect but it should be clear and unambiguous.

   [Total 18 marks]

8. a) What does the following recursive method do if called with both arguments >= 0?

```
public static long f(int x, int y)
{
   if (y == 0)
   {
      return 1 ;
   }
   else
   if ((y % 2) == 0)
   {
      return f(x,y/2) * f(x,y/2) ;
   }
   else
   {
      return x * f(x,y-1) ;
   }
}
```

[5 marks]

b) Rewrite the method using iteration instead of recursion.

[6 marks]

c) What are the strengths and weaknesses of recursion when compared with iteration?

[7 marks]

[Total 18 marks]

END OF PAPER