Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Applying UML and Patterns

Friday 18th January 2008

Time: 14:00 – 16:00

Please answer Question 1 and two other questions

The questions are based on the online assessment software case study used throughout the course. You should use your knowledge of the domain to make reasonable assumptions as necessary. If in doubt, state those assumptions. For full marks your answers should be concise as well as accurate.

This paper will be taken on-line and this is the paper format which will be available as a back-up.
Question 1

1. **Compulsory**

When an exam is taking place, student activity is monitored by a tool, which shows a dynamically updated table of the students taking the exam, with information such as when the most recent backup occurred for each student, and whether any students have attempted to cheat by accessing applications or web pages other than the exam. The tool works by sending HTTP messages to the server, receiving data in response, so to a firewall it looks just like a web browser. In other words, the tool is polling the server at intervals for batches of information, rather than the server providing each piece of information as soon as it’s available.

a) Explain the notion of a **design pattern**, and why design patterns are important in object-oriented software development. (4 marks)

b) In the first version of the tool, there was a 1-1 mapping between exams and monitoring tool instances. It was not possible for one exam to be monitored by many tools, or many exams to be monitored by one tool. Also, we expect in the future to have different types of tools for different users, e.g. invigilators in a room vs. managers overseeing the whole exam process. We might even have different types of servers, e.g. local vs. remote. Explain how the **Observer** design pattern can be used to remove these restrictions and provide the basis of future developments. (4 marks)

c) Draw a UML diagram to illustrate the Observer pattern as applied to this situation. (6 marks)

d) In what way does the method of communication between the tool and the server described above require changes to the standard Observer pattern? (2 marks)

e) Explain another way in which the Observer pattern could be used in the monitoring tool. (2 marks)

f) Briefly suggest how two other design patterns might be used in the monitoring process. (2 marks)
Answer only two of the following questions (Questions 2-5)

2. You are producing exam software with a fairly long timescale (3 years) but a small team (3 people), using the Unified Process. You expect there to be a large number of requirements, and many changes to the requirements during the project (which is one of the reasons you’re using the UP). In what follows you may regard a fully dressed use case to be a separate artefact from a brief or casual format one.

a) Name three UP artefacts (other than the code) that you would definitely expect to produce as part of the project, briefly explaining why in each case. (6 marks)

b) Name three UP artefacts which you would not expect to produce as part of the project, briefly explaining why in each case. (6 marks)

c) Students are obviously stakeholders in the examination process. Name four other categories of people who are. (2 marks)

d) For three types of stakeholders (other than students), briefly explain how you would interact with them in the Elaboration phase of the project, including any UP artefacts you might use. (6 marks)

3. a) Explain whether each of the following is a reasonable candidate use case, based on the standard tests given by Larman:

i) Authenticate User (2 marks)

ii) Monitor Exam (2 marks)

iii) Backup Student Answer (2 marks)

b) Write the main success scenario of the Mark Exam use case in casual format: no more than 150 words, in paragraphs, not bullet points. You should assume that the examiner gets the data from the exam server at the beginning and returns the marks there at the end, but that the process of marking itself is done offline, using a marking tool like the one you’ve seen in the course. Also assume that an exam may contain a combination of multiple choice, text and diagram questions. (8 marks)

c) Is it worth writing a fully dressed use case for Mark Exam? Explain your reasoning. (2 marks)

d) Suggest important non-functional requirements related to this use case, in the following “URPS” categories:

i) Usability (1 mark)

ii) Reliability (1 mark)

iii) Performance (1 mark)

iv) Supportability (1 mark)
4.  
   a) What is the purpose of domain modelling? Your answer should include the relationship between domain classes and design classes, and the factors which influence the amount of effort worth spending on domain modelling.  

   (5 marks)

   b) Consider the following description of the process of marking traditional paper exam scripts:

   “The examiner is given a set of exam scripts and a mark sheet on which to record the marks. Each script contains the answers to the exam from one student, identified by a library card number on the front cover. The front cover also holds the real name of the student (hidden under a sticky flap), the title and course code of the exam, and a table for the examiner to enter the marks. The mark sheet has a row for each student, identified by library card number, with columns for the marks for each question and the total. The examiner marks all the answers for a complete question from all the students. Marks for each sub-question and the question total are written in the margins of the pages of the script. The question totals are transcribed onto the table on the front page of the script and onto the mark sheet. This process is repeated for each question, checking carefully that every page of the script has been inspected. The examiner adds up the marks on the mark sheet to give the totals. All the additions and transcriptions of marks are checked by clerical staff. Once checking is complete, they are entered into a central database.”

   Draw a class diagram to represent the significant domain classes suggested by this description and their important relationships and attributes.

   (7 marks)

   c) To what extent would these domain classes correspond to design classes?  

   (4 marks)

   d) Suggest ways in which the marking process could be improved in the software implementation.  

   (4 marks)
5. a) Explain the role of the GRASP patterns in object-oriented software development. (4 marks)

b) In an early iteration you have decided to implement a cut-down version of Take Exam where the exam consists of multiple choice questions (MCQs) only, and the set of MCQs in an exam is fixed when it is set. Classes which have been identified include Exam, MCQ (a multiple choice question), MCQChoice (one of the choices in an MCQ), Script(an answer from one student to one Exam), ScriptSet (the set of all answers from all students to one Exam) and MCQAnswer (an answer to one MCQ).

Based on the appropriate GRASP patterns, suggest which of these classes should implement the following operations:

i) getTotalMarks() and...
   getTotalmarks(StudentID student) - one student's mark for the exam. (2 marks)

ii) getCorrectChoice() – return the correct choice for an MCQ. (1 mark)

iii) getFeedback() – return a String containing feedback for a student after they have taken a self-assessment test, prepared in advance. (Suggest two options for this). (2 marks)

iv) createMCQOption() – create an instance of the MCQOption class (suggest two possibilities). (2 marks)

c) In the next iteration, the application will be extended to provide more flexible tests. What additional classes are suggested by the other GRASP patterns? (4 marks)

d) Explain the notion of a Controller, and the different types of controller, using the monitoring tool described in question 1 as an example. Suggest what sort of controller, if any, would be most appropriate for that tool. (5 marks)

END OF EXAMINATION