Pattern-based Software Development

Date: Wednesday 23rd May 2012
Time: 14:00 - 16:00

Answer ALL Questions in Section A
and
ONE question from EACH of Sections B and C

This is a CLOSED book examination
The use of electronic calculators is NOT permitted
Section A

Answer ALL parts of this section

A1. Explain why design patterns are important in object-oriented software development. (4 marks)

A2. Explain how the State pattern works. (4 marks)

A3. Under what circumstances is it appropriate to use the State pattern and what is the most common alternative? (2 marks)

A4. What are the major concerns that need to be addressed in a software architecture and how? (2 marks)

A5. What are the two main roles played by a physical architecture? (2 marks)

A6. Using your own words, critically and concisely describe the two major problems with pure classes. (2 marks)

A7. In the context of object-oriented design, what are design abstraction and refinement? (2 marks)

A8. Concisely describe the purposes of partitions and layers in software organization. (2 marks)
Section B

Answer ONE question from this section
Both questions in this section are based on the following scenario:

You are designing a software system which will help in the management of large hierarchical organisations such as armies, governments or universities. The aim is to provide a general-purpose system which can be customised for different organisations. The system will keep track of the personnel in an organisation, and also the material resources it requires.

All such organisations consist of sections, which have subsections, and so on. The software cannot make any assumptions about how many sections an organisation has or how many levels there are in the organisation. Also, different organisations have different names for their sections (e.g. “regiment”, “brigade” in an army or “faculty”, “school” in a university).

We can, however, assume that 1. Each section has a person who leads it, with a job title and a name, and 2. Every organisation has a unit section, which is not divided further, but which normally has more than one member of staff (such as a platoon in the army).

B1. a) Draw a UML class diagram which shows how the Composite design pattern could be applied to system organisations as described above. (5 marks)

b) Explain how the total wage bill of an organisation could be calculated based on this design. (3 marks)

c) Large organisations generally have large numbers of items of equipment, for example an army will have a very large number of bullets. Briefly explain what a factory is and state two advantages of using one in this situation. (3 marks)

d) Suppose we have a particularly conscientious army which wishes to keep track of every single bullet it possesses. A bullet can be in number of states, e.g. in storage (at some place), allocated (to some unit), or used.

i) Briefly explain why it would probably not be appropriate to use the State pattern in this case, and what you would do instead. (2 marks)

ii) Briefly explain the principle behind the Flyweight pattern. (2 marks)

iii) Explain how Flyweight could be applied to this particular situation, in a way that minimises the amount of storage required to represent bullets. (3 marks)

iv) How is the Flyweight pattern related to GRASP principles? (2 marks)
B2.  

a)  
   i) Explain the idea and purpose of data driven programming and how it is related to the Interpreter pattern. (3 marks)

   ii) Different organisations calculate overtime payments in broadly the same way, but details such as the total amount of overtime allowed vary both between organisations and between sections within them. How could the Interpreter pattern be used to enable us to calculate overtime payments without writing many different versions of the overtime calculation algorithm? (3 marks)

   iii) How is the Interpreter pattern related to GRASP principles? (2 marks)

b)  
   i) Airlines have aircraft which may be in one of several states, e.g. they may be in the air, on the ground being serviced, in a hangar being maintained etc. State changes may happen at any time (e.g. an aircraft may become unserviceable at short notice) and may need to be known about in multiple places. Explain how the Observer pattern can be used to deal in this situation. (4 marks)

   ii) Other organisations have similar situations but with different equipment and state changes. For example an ambulance service needs to keep track of its ambulances. Draw a UML class diagram to show how the Observer pattern can be used to track both airplanes and ambulances, in a way that can be extended (by adding extra classes) to other cases. (5 marks)

   iii) How could data driven programming be used along with the Observer pattern to avoid the need to add new classes for each new situation? (3 marks)
Section C

Read the following description carefully and then answer ONE question in this section.

C1. This question consists of the following two parts:

   a) Clearly and concisely describe the MVC software architecture. Show the mapping from this architecture to the client-server computing architecture. Use diagrams to illustrate your answer where appropriate. The answer to this question should not exceed one page of the examination book. (10 marks)

   b) A doctor appointment system contains the following classes: Patient, Appointment, PatientTable, AppointmentTable, PatientUI, AppointmentUI, PatientDataAccess, and AppointmentDataAccess. Arrange these classes into a layered architecture. Describe which class is placed on which layer; show and explain the dependency relationships between these classes. Use diagrams to aid your answer where appropriate. The total answer to this question should not exceed one page of the examination book. (10 marks)

C2. Clearly and concisely describe the business model that underlies IBM’s Patterns for e-business. Critically explain how different types of business patterns have resulted from this business model. Use diagrams and examples to illustrate your answer where appropriate. The answer to this question should not exceed 2 pages of the examination book. (20 marks)