Ollscoil na hÉireann
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Fourth Science: Computer Science

CS4000 Software Engineering

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Answer four questions (all questions carry equal marks)

Three hours

1.

(a) "All current software development projects should follow an agile process, such as extreme programming, rather than a more traditional waterfall process." Discuss the validity of this statement, giving a balanced view, with detailed reasons for your answer. Support your discussion with software application examples. (8 marks)

(b) Describe two benefits and two limitations of model-driven engineering. (6 marks)

A new software system will control the allocation and co-ordination of emergency response units (e.g. Fire brigade, ambulance) in a city. You are the software manager for this project. (Please ensure your answers are relevant to this particular project.)

(c) Describe what general software process (organizing the set of activities) you would use, and give three reasons for its use on this particular project. (8 marks)

(d) Assuming you have an excellent technical team, generous finances and a supportive management team, describe what would be the two biggest risks that might lead to the project failing. (4 marks)

(e) Describe what you would do to reduce these two risks. (6 marks)

(f) State, and give reasons, your choice for the single most important method of validation that should be used on this project. (4 marks)

(g) State, and give reasons, your choice for the single most important method of verification that should be used on this project. (4 marks)

2.

A software system is being developed for an online fast-food delivery service. The system will support functions such as browsing the menu, making food orders, canceling orders, paying, tracking orders. A software process using the UML (for example Larman's lightweight UML process) will be used in the development of this system.

(a) Give an overview of the main activities in the UML-based software development process, going from requirements through to implementation. Describe briefly each activity and describe any relationship between activities and their associated artifacts (i.e. text, code, UML diagrams etc.) (15 marks)

(b) Give one example of a diagram (or piece of text) that is produced in the UML-based software development of the online restaurant delivery service, for each of four of the stages of the software development for this application. (12 marks)

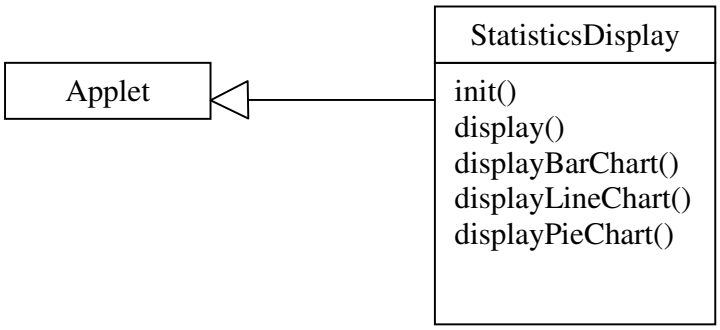
(c) Discuss what data in this system should be persistent, and describe two methods of making the data persistent. (7 marks)

(d) Describe how Larman's Controller software design pattern might be used in this system, and describe the benefits of this pattern for this project. (6 marks)

3.

(a) Software systems may be developed using component-based software engineering (CBSE). What, in your opinion, are the three most difficult issues in using components in software development? (6 marks)

The following diagram illustrates a simple design for an application that displays statistical data in various forms. The init() method sets various parameters, including the display choice to be displayed; the display() method calls the appropriate method displayBarChart(), displayLineChart(), displayPieChart() according to the display choice parameter.



(b) Show how the above design can be improved by the Strategy software design pattern. Describe two benefits of using Strategy and illustrate your answer with a class diagram. (8 marks)

(c) Describe the Factory software design pattern and discuss how it might improve the above design. (6 marks)

(d) Discuss the use of the term Six Sigma in software engineering, giving its two main interpretations, i.e. non-mathematical and mathematical. (4 marks)

(e) How relevant is the mathematical interpretation of Six Sigma to software quality? Give detailed reasons for your answer. (6 marks)

A program takes an item and a list of items, and returns the first position of the item within the list, and zero if not found. The following questions relate to this program.

(f) What are the black-box tests that should be used to test this program? (6 marks)

(g) Given the source code for this program, what other tests would you add? (4 marks)

4.

(a) Certain properties of a distributed system are captured by Brewer's CAP conjecture (later proved as a theorem). State Brewer's CAP theorem, and explain how the CAP theorem influences companies such as Amazon in the design of their information systems. (6 marks)

(b) What relationship (if any) is there between different software architectures and non-functional properties? (4 marks)

(c) Describe any differences between a service-oriented architecture and a component-based architecture. (4 marks)

An on-line electrical goods store is being developed. The system will allow customers to browse, search and order electrical items. As well as access to the company's own stock, customers will also be able to access the stock of various designated suppliers. The system will keep customer profiles, provide recommendations, and return sets of choices when customers search for items. Different kinds of user interface will be supported, for example, to enable high-bandwidth desktop or lower-bandwidth mobile phone access. (Please ensure that your answers for following questions are relevant to this particular project.)

(d) What is the most suitable distributed architecture model for this system? Give detailed reasons for your answer, stating three benefits and any limitations of the architecture. (8 marks)

(e) State the three most important non-functional requirements for this system. Describe in detail how you would implement the system to satisfy these, and describe any trade-offs that arise when trying to satisfy these non-functional requirements. (12 marks)

(f) Describe an alternative distributed architecture model that might be suitable, and describe two advantages and two disadvantages with respect to the previous architecture. (6 marks)

5.

(a) Describe what is meant by a hard real-time system and a soft real-time system. (4 marks)

(b) A software controller for a phone supports a User making calls to a remote party, Other. This is a simple phone that just makes calls (does not receive them) and has a set of hot-keys for dialing numbers. The software must respond to events from the user such as UserPickUp, UserHangUp etc., and events from the other party such as OtherPickUp OtherHangUp etc. Conditions it must react to include NetworkBusy NoAnswer etc. The controller must perform necessary actions and activities, such as play the dial tone. Construct a statechart to model precisely a software controller for this phone. Include in the statechart at least four features, such as hierarchical states, not found in conventional state machines, and indicate clearly these particular features. (16 marks)

(c) Additional inputs to the phone controller are Interrupt and Resume. If a call is in progress, on receipt of an Interrupt event the controller goes to a Mute state; on receipt of a Resume event the controller continues in its previous state. Amend your answer to the previous question to model this additional behaviour. Indicate clearly on the diagram this amendment. (4 marks)

(d) Give the meaning of the Hoare triple {P}C{Q} as used in program verification. (5 marks)

(e) Discuss any similarities and any differences between the use of the Hoare triple and Meyer's Design by Contract paradigm for the development of object-oriented software. (5 marks)

(f) A class represents a simple controller for a DVD player. This DVDPlayer class has attributes representing the state of the DVD player: stopped; playing; open; noDVD. Write down a suitable class invariant in the propositional calculus for this class. Specify, using a contract expressed in the propositional calculus, two operations (methods) for the class: playDVD() to start playing, and open() to open the DVD player. (6 marks)