Software Evolution

Date: Thursday 23rd May 2013
Time: 09:45 - 11:15

Please answer any TWO Questions from the FOUR Questions provided

Use a SEPARATE answerbook for each QUESTION.

This is a CLOSED book examination
The use of electronic calculators is NOT permitted
1. a) For each of the four types of software change (perfective, corrective, adaptive and preventive), state whether top-down or bottom-up reading is likely to be the most appropriate reading strategy to use, or whether both are equally likely to be useful. Give a brief justification of your answer in each case. [8 marks]

b) The code fragment shown below is taken from a scientific workflow published on the myExperiment.org website. It is implemented in bean-shell, a lightweight scripting language based on Java. (The workflow from which this code was taken was implemented by Don Cruikshank, and is licenced under the Creative Commons Attribution-No Derivative Works 3.0 Unported License (http://creativecommons.org/licenses/by-nd/3.0/))

Draw a control flow graph for the body of the try-catch block (i.e., lines 3-20). [5 marks]

```java
1  readOrthoFile(File f) {
2      try {
3          BufferedReader br = new BufferedReader(new FileReader(f));
4          String line = br.readLine();
5          while (line != null) {
6              String [] fields = line.split("\t");
7              //int start = line.indexOf("");
8              //int end = line.indexOf("," , start+1);
9              //String proteinID = line.substring(start+1,end);
10             if (fields != null && fields.length > 2) {
11                 if(fields[5].contains("B.subtilis") ) {
12                     sourceHashSet.add(fields[2]);
14                     //String orthoProteinID = fields[7].replace(";","");
15                     //System.out.println("ortho >>" + orthoProteinID + "<<");
16                 }
17             }
18             line = br.readLine();
19         }
20       } catch(Exception ex) {
21           System.out.println(ex);
22       }
23   }
```

c) Which of the idioms mentioned in the course unit is present in this fragment? Give the language-independent statement of each idiom you discover, and state clearly (e.g. using the line numbers provided) which parts of the code correspond to which components of the idiom. [4 marks]

Question continues on next page
1) (Continued from previous page)

d) Examine the following method definition, taken from the source code for the H2 in-memory database system. Propose an idiom that we did not cover in lectures, or in the Moodle resources, that occurs in this code. You should give a name, plus a language-independent statement of the idiom, as well as pointing out the location of the idiom in the example code (for example, by listing line numbers).

[3 marks]

```java
/**
 * Adds a column to the result set.
 * All columns must be added before adding rows.
 * 
 * @param name null is replaced with C1, C2,...
 * @param sqlType the value returned in getColumnType(..)
 * (ignored internally)
 * @param precision the precision
 * @param scale the scale
 */

public void addColumn(String name, int sqlType,
        int precision, int scale) {
    if (rows != null && rows.size() > 0) {
        throw new IllegalStateException(
            "Cannot add a column after adding rows");
    }
    if (name == null) {
        name = "C" + (columns.size() + 1);
    }
    Column column = new Column();
    column.name = name;
    column.sqlType = sqlType;
    column.precision = precision;
    column.scale = scale;
    columns.add(column);
```

2. 

a) Give three justifications why the phrase “Good’ design does not last long” can be considered true.  

b) A company A that sells timber to the public through its website has just been taken over by company B that sells timber and other building supplies to building firms from its depots.

The architecture of company A’s computer system is shown in Appendix A, it is a reasonably modern system implemented in PHP on top of a relational database, with web-based clients. The architecture of company B’s system is shown in Appendix B; the main interface is a specialist application that runs on computers placed at the checkout of the depots. The database for this is implemented in COBOL.

To support the operation of the enlarged company B, the two computer systems will be re-engineered into a single system that supports both depot and web based sales of all products. It should also support full management assessment of the operation of the company. The company’s management also have a goal to increase the company’s revenue by offering customers a web based design service that will need to be supported by the enhanced computer system.

i) You are the manager responsible for the re-engineering project. By referring to the two architectures, characterise, with reasons, each of the architectures in terms of its decomposability.  

ii) Your first task is to undertake an evaluation of possible architectures for the re-engineered system. Outline an architecture that could be the outcome of this evaluation; you should state any assumptions that you make and justify your architecture.  

iii) Based on the requirements for the re-engineered system, evaluate each of the three migration strategies (forward, reverse and general) that could be used during the re-engineering project. From your analysis, clearly state which of the possible strategies you would adopt for this task.
The chief executives of ParcelMe and HomeRun, two parcel delivery companies operating in the North West of England, recently found themselves on opposite sides of the same first class rail table. By the end of the journey, they had sketched out a plan on the back of an envelope for a cooperative system for handling missed deliveries. If a delivery operative from one of the companies was unable to deliver a parcel, details of the delivery would be shared with the other company, in case they could offer a faster or cheaper redelivery option with one of their operatives who was going into the same area in the near future. For example, if HomeRun has a delivery operative going into an area where ParcelMe recently had a missed delivery, then ParcelMe would just need to deliver the parcel to the nearest HomeRun depot to get a quick and cheaper redelivery attempt. The costs and profits on such shared deliveries would be divided between the two companies, (hopefully) to their mutual long term benefit.

You are an employee of ParcelMe. You have been put in charge of implementing the software systems and databases needed to put this idea into action. ParcelMe stores information about its delivery jobs in a single database called PMDB, which supports all operational and tactical functions related to delivery handling. It contains details of the sender and recipient of each job, delivery charges plus payment status, personnel assigned to the tasks relating to each delivery, and current status of the delivery (pre-delivery, waiting-for-delivery, on-delivery, waiting-for-redelivery, etc.).

Your first task is to determine the architecture of the system needed to support the cooperation the chief executives have in mind. Your team comes up with three basic architectural options:

i) Each company allows the other’s computer systems some limited query access to their main delivery databases, to extract the redelivery data.

ii) A shared database is created, which will be managed jointly by the companies, and into which each will export selected redelivery data.

iii) Each company exports selected redelivery data to the other, allowing them to manage the information as they see fit. ParcelMe, for example, could create a separate database to house and manage the shared redelivery data from both companies.

List the pros and cons of each of these architectural options for ParcelMe. Based on your analysis, which of the three would you recommend for implementation? 

[7 marks]

b) What degree of freshness is required for the shared redelivery data if this cooperative venture is to succeed? Must each company always have fully accurate data on the other’s redelivery tasks, or can some less costly form of sharing be equally successful? State your answer as precisely as you can (e.g. “data should be refreshed for the start of each working week”, rather than “data should be refreshed weekly”), but you’ll need to back up your answer with a clear argument in terms of ParcelMe’s working practices to earn marks.

[3 marks]

Question continues on next page
3) (Continued from previous page)

c) PMDB has a trigger capability, but the loading on the database is such that you are unlikely to be allowed more than 1 or 2 additional triggers to be set up. You also have access to PMDBs logs, which are transferred from PMDB at midnight every day, to a separate, less heavily loaded server. They are kept on this server for a week, before being archived into long term storage. Bearing these points in mind, state how you would achieve the desired data freshness using the architecture you selected in your answer to part a), without placing an unacceptable additional processing load on ParcelMe’s mission critical systems. (You may find it easier to give a clear and concise answer, if you draw an architecture diagram for your solution.) [4 marks]

d) For each of the following kinds of data quality problem, give an example of how that problem might appear in ParcelMe’s chosen solution for cooperation with HomeRun. (The problem might be with HomeRun’s exported data, with ParcelMe’s own data, or with a combination of the two.) Explain how your example data quality problem will make it difficult for ParcelMe to get value out of the cooperation with HomeRun.

i) Representational inconsistency

ii) Incompleteness

iii) Lack of portability [6 marks]
4. 

a) In terms of software evolution, briefly describe three consequences of using black-box elements in the development of a system. [3 marks]

b) You are head of the IS section of an architectural company. The company believes that it can make money by adopting a new construction technique that reduces the cost of creating a building. This technique relies on a particular structural analysis algorithm. Your company also thinks that it can maximise its market share by processing the results of this algorithm before providing information to its engineers.

There is an existing implementation of the structural analysis algorithm that you could buy; experience within the construction industry suggests that this implementation is reliable. This implementation simply outputs its results to standard output. From an initial investigation that you have worked out that if you had your own implementation of the algorithm, the analysis results could be passed to the subsequent processing code via internal data structures.

Evaluate the options buying of creating the analysis algorithm in terms of 1) the relative effort from your team, 2) the quality of the solution built on them, 3) their long-term maintenance costs and 4) any legal consequences. With reasons, identify which of these options you would recommend. [10 marks]

c) An open source version of the structural analysis algorithm mentioned in part b) is being developed. Rather than being a closed program, this will have an application programming interface (API) that allows integrators control over how they combine the algorithm into a complete system. The open source developers are predicting annual major releases and minor update releases every few months. They are promising that the API will remain stable during the period of each major release, but that as the software is new, the API may evolve with each major release.

Evaluate the use of this open-source solution using the same criteria (effort from your team, the quality of the solution, long-term maintenance costs and legal consequences) as you used in part b). Recommend, with reasons, whether or not your recommendation of part b) should be altered to the adoption of this open-source software solution. [7 marks]
Appendix A – Company A’s System Architecture

- Ordering System
- Telephone Support
- Dispatch System
- Finance System

Product/Order Information

Customers

Warehouse Staff

Finance Staff
Appendix B – Company B’s System Architecture

![System Architecture Diagram]

END OF EXAMINATION