Software Evolution

Date:      Tuesday 20th May 2014
Time:     09:45 - 11:15

Please answer any TWO Questions from the FOUR Questions provided

This is a CLOSED book examination

The use of electronic calculators is NOT permitted
1. a) You have recently been appointed as the IT manager for a firm that supplies vegetables to local schools. The firm’s IT system was created for them a few years ago by another firm that are no longer in business. Fortunately, the contact required that the design documents and source code was supplied to your new employers. One of your first jobs is to make a perfective change in the system to allow an analysis of how each school’s order changes with the season.

   i) Excluding the source code, outline three source of information that you could use to understand the system. For each source you should describe why the source could be useful to you. [3 marks]

   ii) Describe how top-down, bottom-up and hybrid code reading can be used to help you make the required perfective change. [3 marks]

b) Briefly define what code idioms and coding conventions are, and describe why they can assist in the process of software comprehension. [4 marks]

c) The code fragment shown below comes from the software that checks laboratory group allocations for the second year of programmes run by the School of Computer Science. Draw a control flow graph for the body of the method (i.e., lines 4-23). [6 marks]

```java
1 private void checkChoiceAllocation(
2     final Student_Choices choice,
3     final Person_Reduced student) {
4     for (Activity_Templates template :
5         choice.getUnit().getActivityTemplates()) {
6         if (!template.isIgnore_Group_Assign()
7             && isTemplateRelevant(template)) {
8             final Student_Activity_Allocation allocation
9               = findAllocation(template,
10               student.getAllocations());
11             if (allocation != null) {
12                 checkAllocationForClash(allocation, student);
13             } else {
14                 logger.warn("{}: … {} {} {}",
15                     new Object[] {
16                         template.getName(),
17                         student.getId(),
18                         student.getFirstName(),
19                         student.getFamilyName()
20                     });
21             }
22         }
23     }
24 }
```

d) Which of the idioms mentioned in the course unit is present in this fragment? Give the language-independent pseudocode description 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]
2. a) Give two reasons why Big Up Front Design (BUFD) usually fails. [2 marks]

b) Describe evolutionary design at both the code and system levels, and explain why these can address the failures seen in BUFD. [6 marks]

c) Briefly describe what a code smell is, and describe its relationship to evolutionary design and refactoring. [2 marks]

d) Identify three bad code smells in the following piece of code. You should clearly indicate, e.g. by using line numbers, where the code smells you have identified are located. [5 marks]

```java
public class Exam {
    Collection<String> names;

    public String x(String z) {
        for (String i : names) {
            if (z.equals(i)) {
                return i;
            }
        }
        return null;
    }

    public String y(String z) {
        for (String i : names) {
            if (z.matches(i + ".*")) {
                return i;
            }
        }
        return null;
    }

    // Display the objects content
    public String toString() {
        StringBuffer str = new StringBuffer();
        for (String i : names) {
            str.append(i);
            str.append(', ');
        }
        return str.toString();
    }
}
```

Question 2 continues on next page
Question 2 (continued)

e) One of the skills that a maintenance engineer must have is coping with unfamiliar languages. The code below is written in the Atlas Transformation Language (ATL) a model-to-model transformation language. Identify five characteristics of this language or questions you would need to solve to understand it more.

[5 marks]

```
module exam;
create jsf : JSF from website : Website, orm : ORM;

helper def: findOrmEntity(name : String) : ORM!Entity
  = ORM!Entity.allInstancesFrom('orm')->any(e | e.name = name);

abstract rule NamedElement {
  from website : Website!NamedElement
to jsf : JSF!NamedElement {
  name <- website.name
}

-- @extends NamedElement
rule Service {
  from website : Website!Service
to jsf : JSF!Service {
  modelName <-
    if not website.modelName.oclIsUndefined() then
      website.modelName
    else
      website.encapsulates->first().name
    endif,
  entities <-
    website.encapsulates->collect(e | thisModule.findOrmEntity(e.name)),
  displayLabels <- website.displayLabels,
  selections <- website.selections,
  includedFeatures <- website.includedFeatures
}
```
3. Two regional supermarkets A and B have recently agreed to merge to form a joint company and expect to make savings by eventually combining their back office and home delivery logistics operations. As delivering customer orders to their homes is an expensive operation, the management of the new company have agreed that one of their first priorities is to combine this aspect of the old supermarkets.

The architecture of supermarket A’s computer system is shown in Appendix A. As it was recently implemented, it is based on a web application framework backed by a relational database giving it an Model-View-Control (MVC) structure. The architecture of supermarket B’s system is shown in Appendix B. It is older and has much less of the structure associated with modern systems.

Originally you worked for supermarket A as its IT manager. Someone else has now been appointed to oversee the on-going operation of the Supermarket A’s IT system and you have been tasked with merging the IT systems of the two supermarkets into one. You have been given a report from consultants on how to support a merged delivery operation that suggests three options: 1) mutual limited query access between the two original IT systems, 2) a shared database populated with relevant data from the two existing systems, and 3) delaying the merging of the delivery operations until a new combined IT system is in place.

a) Your first task is to evaluate the options listed in the consultant’s report on supporting a merged home delivery operation and recommend to the board the option to be followed with justifications (e.g. cost, complexity, delay until operational). [6 marks]

b) If option 2, shared database, was selected for supporting the combined home delivery operation, describe the options available for keeping the contents of this database sufficiently up-to-date for successful operation. Note, a customer will expect an order to be delivered within a few hours of the order being placed. [4 marks]

c) Your second task is to define the architecture of the combined IT system for the new supermarket. Outline an architecture that could result from the activity; assumptions that you make should be stated and the board will want justification for your recommendation. [5 marks]

d) It has been decided that a forward migration strategy will be used to migrate the two current systems to the modernised architecture. Outline how you plan to do this. [5 marks]
4. a) In terms of software evolution, briefly describe three consequences of using open-source elements in the development of a system. [3 marks]

b) You are head of the IS section of a company that does fracking for natural gas. Before starting fracking operations at any site, a prolonged investigation of the site occurs. This investigatory phase involves drilling many holes to allow a seismic analysis of the underground geology of the area. This analysis involves to collection of significant amounts of data from many sensors and complicated numeric processing of the data. Someone has suggested that if the results of the analysis were post-processed before presenting them to your engineers, the engineers would be able to reach reliable conclusions about the underground geology quicker.

Another company have an existing implementation of the analysis algorithm that you could license; experience within the fracking industry suggests that this implementation is reliable. However, the results that it outputs are unstructured, which makes the addition of a post-processing operation non-trivial. It has occurred to you 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 whether buying or creating the analysis algorithm is better in terms of the relative effort from your team, the quality of the solution that they would provide and their long-term maintenance costs. With reasons, identify which of these options you would recommend. [10 marks]

c) You have heard that an open source version of the core analysis algorithm mentioned in part b) is being developed. Apparently, rather than being a solid block, this will have an application programming interface (API) that allows integrators control over how they combine the algorithm into a complete system. Major releases of the software are expected every two years and minor update releases every few months. As the software is new, the API may evolve with each major release. However, the API will remain stable between major releases.

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

END OF EXAMINATION