Software Evolution

Date:      Tuesday 31st May 2016
Time:      14:00 - 15:30

Please answer any TWO Questions from the FOUR Questions provided

This is a CLOSED book examination

The use of electronic calculators is NOT permitted

[PTO]
**Question 1.**

a) Outline three reasons why software has to change. [3 marks]

b) Briefly describe why changing software is difficult [4 marks]

c) You have recently become the IT manager for a firm that supplies accessories to wedding planners. The firm’s IT system was developed by one of the founders of the company; she never documented the software. She has now left the company and wants nothing more to do with it. Your first development task is to make a change to the system. Excluding the source code, identify what you believe will be the three most useful sources of information that you could use to understand the system. For each of your sources, describe why it will be useful to you. [3 marks]

d) Conventions are a significant part of current program development. Describe four different conventions that you know from at least two different languages and, for each one, outline how they can help programmers understand code with which they are not familiar. [4 marks]

e) Understanding a program with which you are not familiar always involves some human effort. However, ideally this is assisted by automated analysis of structural aspects of a program. Control Flow Graphs (CFGs) and post-dominates relationships are part of this automated process. For the following CFG, identify all of the post-dominates relationships that are present. [6 marks]
Question 2.

a) Lehman’s Sixth Law of Software Evolution can be paraphrased as “the longer software exists, the large it becomes”. Outline why this is true. [3 marks]

b) Describe what a bad code smell is and explain why they are important in software development. [2 marks]

c) Identify three bad code smells and the appropriate action to take when they are encountered. [3 marks]

d) Code refactoring is one-way to improve the quality of software. However, historical studies have shown that it was seldom performed. Explain why this lack of refactoring occurred and why it is now more common. [3 marks]
Question 2 (continued)

e) One of the skills that a maintenance engineer must have is coping with unfamiliar languages. The code below comes from the Wikipedia page on ALGOL 68, a scientific programming language.

i) Identify three characteristics of this language or questions you would need to answer to understand it. For each of these, set them in terms of general programming knowledge that you have. [6 marks]

ii) Identify three characteristics of the algorithm implemented, or questions that the code raises about the algorithm. For each of these, justify why you think this is a valid characteristic or question. [3 marks]

1 begin # ...

2 proc error = (string s) void:
  {print( ( newline, " error: ", s, newline)); goto stop};

3 proc one to = (int n) list:
  {proc f = (int m,n) list:
    (m>n | nil | cons(m, f(m+1,n))): f(1,n)};

4 mode list = ref node;

5 mode node = struct (int h, list t);

6 proc cons = (int n, list l) list: heap node := (n,l);

7 proc hd = (list l) int:
  (l is nil | error("hd nil"); skip | h of l);

8 proc tl = (list l) list:
  (l is nil | error("tl nil"); skip | t of l);

9 proc show = (list l) void:
  (l isnt nil | print(" ",whole(hd(l),0)); show(tl(l)));

10 proc filter = (proc (int) bool p, list l) list:
  if l is nil then nil
11  elif p(hd(l)) then cons(hd(l), filter(p,tl(l))
12  else filter(p, tl(l))
13  fi;

14 proc sieve = (list l) list:
  if l is nil then nil
15  else
16    proc not multiple = (int n) bool: n mod hd(l) ≠ 0;
17    cons(hd(l), sieve( filter( not multiple, tl(l) )))
18  fi;

19 proc primes = (int n) list: sieve( tl( one to(n) ));

20 show( primes(100) )

21 end
Question 3.

A large regional supermarket is taking over a chain of local convenience stores. One reason for the takeover is that the convenience stores have the facility for customers to order on-line and have their order delivered to their door whereas the regional supermarket does not. One key goal of the takeover is combining the IT services of these companies. The architecture of the supermarket’s, reasonably modern, IT system is shown in Appendix A. The architecture convenience stores’s IT is more ad hoc and is shown in Appendix B; notably it does not support any useful management reports on the operation of the business.

You are the IT manager for the supermarket. Your deputy is being asked to oversee the current systems, and you have been assigned the role of merging your IT services with those of the convenience stores. You have been given a report from IT consultants on merging the systems that suggests three options: 1) mutual limited query access between the two original IT systems, 2) migrating convenience store data into your current system and then continuing to use this system, and 3) developing a new combined IT system.

a) Your first task is to assess each of the consultant’s options, (for example in terms of cost, complexity, and speed of deployment), and to recommend to the board, with justifications, which of them should be followed. [6 marks]

b) If option 2, migration to supermarket system, was selected for supporting the combined business, describe the process via which you would achieve this with no data being lost and all existing data being available to staff. [5 marks]

c) If option 3, new system, was chosen, your second task would be to define the architecture of the combined IT system. Outline an architecture that could result from this task; assumptions that you make should be stated and the board will want justification for your recommended architecture. [4 marks]

d) Assuming that your architecture from part c) is accepted and that a forward migration strategy will be used to migrate the current systems to this new architecture. Outline how you plan to do this; your plan should clearly identify the order in which elements of the system are migrated. [5 marks]
Question 4.

a) You are head of the IS section of a road building firm. Currently you are using some in-house software to manage your projects (delivery of materials, hire of construction equipment, timing of sub-contractors …). As this was written many years ago when your firm was much smaller and there were less legal processes to be fulfilled, it is best described as “no longer fit for purpose”.

You have heard that another company has an implementation of a project management program that you could license; experience within the construction industry suggests that this implementation is reliable. However, it outputs unstructured results, which means that post-processing software would need to be created to make the results useful to you. It has also occurred to you that if you had a new implementation of your own the need for post-processing software could be avoided.

Evaluate which of licencing or creating the project management program 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. Identify which of these options you would recommend and explain why. [10 marks]

b) You have heard that an open source version of a project management program is being developed. Also, rather than being a solid block of code, it will have an application programming interface (API) that allows integrators control over how they use it in a complete system.

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 a). Recommend whether or not your recommendation of part a) should be changed to the adoption of this open-source software solution and explain why. [6 marks]

c) Software evolution is not just about evolving programs, it is also about evolving the techniques and languages that are used to develop programs. For Aspect Oriented Programming (AOP) outline what software evolution is and describe what advantages the adoption of AOP techniques can bring to the development of software. [4 marks]
Appendix A – Supermarket’s IT System Architecture

Diagram:
- Checkout Staff
- Warehouse Staff
- Management
- Store Tills
- Goods in
- Management
- Stock Control
- Reports
- Access Layer
- Disk
Appendix B – Convenience Store’s IT System Architecture

END OF EXAMINATION