

Software Patterns (INSP-06)
Examination (Wed. June 27, 2007)

You are allowed to use books and course notes during the examination

Question 1 (5 points)

You are the architect responsible for designing an e-learning system for higher education, similar to "Nestor" used in RUG. The following (incomplete) requirements have been assembled by the requirement engineer:

1. The system will support the creation, administration and usage of online courses.
 - a. There are several possible use cases for the support of online courses, so have flexibility in how courses are created and managed.
2. There will be user accounts.
 - a. They allow users to set preferences.
 - b. They allow lecturers to build the courses either from scratch or by reusing existing courses and learning resources.
 - c. They allow students to interact with the learning resources.
 - d. They allow teaching assistants and administrators to perform additional tasks.
3. The system has extensive communication facilities between the different users, e.g. email, chat, discussion forum, announcements etc.
4. The system will support searching through the learning resources.
5. Usability is of paramount importance for the system. All the users must be able to learn how to use the system quickly and easily, and they should be highly satisfied with it.
6. The system has strong security needs. Personal information must remain safe, and especially grading must not be compromised.
7. The system should be highly flexible for its types of users. Different teachers set up courses in a completely different style and students need to have a unique way of organizing their learning space.
8. The system must be up 99.99% of the time.

Assume that you can propose changes to these requirements if you come up with convincing reasons or if your architectural decisions result in relevant tradeoffs. Of course as an architect you can prioritize the requirements according to your judgment. Your tasks are the following:

- a. Make a preliminary architectural design of the system by applying at least four patterns. The patterns can be architectural, enterprise, design, or other kinds. If you use patterns that were not covered in the lectures (i.e. from sources other than POSA, GOF and Fowler) briefly explain them. You do **not** have to tackle **all** of the above requirements. For each applied pattern elaborate on:
 - o the requirement(s) it tackles,
 - o the specific variant of the pattern that you use and why,
 - o which other alternative patterns could be applied for the same purpose and why you selected the particular one.

- b. Explain how the patterns are combined in the system design (for example a pattern delegates part of its solution to another pattern) and if certain components undertake responsibilities from more than one pattern.
- c. Evaluate the impact of the combined patterns to the system's quality attributes. Consider at least 3 Quality Attributes, explain what tradeoffs have been made and justify them.

Question 2 (2 Points)

By giving an example (you may refer to the e-Learning system of Question 1 if you want), answer the following:

- a. The benefits and liabilities of patterns are explicit but usually only expressed as positive, negative or neutral. How useful is this information when an architect applies patterns into the system's design? (1)
- b. What is the result of applying a **combination** of patterns to the overall system and especially the quality attributes? (0.5)
- c. If many patterns are combined in a system design then an element may undertake responsibilities from different patterns. How does this affect the **understandability** of the design? (0.5)

Question 3 (3 Points)

- a. What do we mean by the phrase "patterns contain an inherent variability" and why is this a necessary ingredient of patterns? Give an example of a pattern where a variant differs significantly from its pure form and explain their difference in benefits and/or liabilities. (1)
- b. What are the advantages of forming pattern languages and what are the disadvantages? Give an example for both advantages and disadvantages. (1)
- c. Do you consider "Linked Lists" as a pattern? Justify your answer. (0.5)
- d. Provide a case and an example where the application of a pattern can degrade the quality of a software system. (0.5)