

Exam Design Science Methodology

15th April 2014

Keep your answers short and informative

| Problem | a | b | c | d | e | |
|---------|---|---|---|---|---|----|
| 1 | 2 | 2 | 2 | 2 | 2 | 10 |
| 2 | 2 | 2 | 4 | | | 8 |
| 3 | 3 | 3 | 2 | | | 8 |
| 4 | 4 | 4 | | | | 8 |
| 5 | 3 | 3 | | | | 6 |
| 6 | 8 | | | | | 8 |
| 7 | 3 | 3 | | | | 6 |
| 8 | 2 | 2 | 4 | | | 8 |
| 9 | 3 | 3 | 2 | | | 8 |
| 10 | 3 | 2 | 2 | | | 7 |
| 11 | 3 | 3 | | | | 6 |
| 12 | 7 | | | | | 7 |
| | | | | | | 90 |

$$\text{Grade} = (10 + \text{points})/10$$

- For each of the following design problems, identify (1) the problem context, (2) the artifact, (3) the intended interaction of the artifact with the problem context, (4) some stakeholders. Some of this information is missing from the problem statement; in those cases, supply reasonable examples of the required items.
 - Our organization has a handbook of software engineering methods, but it is so large that no one uses it. Which set of methods and techniques from our "methods cookbook" are relevant for realizing IT-enabled business change?
 - Logistics in our organization is inefficient because it is still organized manually. Select and implement a logistic financial package with an eye to future IT developments
 - There are several wireless communication protocols for health care devices at home. These devices monitor vital data of home-care patients and transmit them to a wireless care station located in the home, which transmits the data to care center where medical personnel has access to the data. Different care stations use different wireless communication protocols, such as Bluetooth and ZigBee. Design an application layer protocol that can run on top of Bluetooth as well as ZigBee.
 - Design a database system for storing annotated sensor data for use in a dike monitoring system
 - Improve the scalability in number of documents of lookup algorithm of web services with distributed hash tables in a P2P network.
- Consider a distributed database running on a P2P network, to be used for storing and searching web service descriptions. The lookup algorithm uses a distributed hash table (DHT).

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- (a) What is the application scenario for the lookup algorithm?
- (b) Formulate the problem of designing the lookup algorithm according to the template for design problems.
- (c) A researcher has designed a new lookup algorithm with a view to improving its scalability in the number of documents (web service descriptions) searched. Formulate the three effect questions for the lookup algorithm.
3. In a thesis about data location compliance for cloud service providers (CSPs), the following research questions are listed.
- RQ1 What are demands regarding data location compliance of the typical customers of a CSP?
- RQ2 What technical solutions do CSPs currently have?
- RQ3 What are the current limitations for CSPs to show compliance to customer demands regarding data location?
- RQ4 How to make agreements about data location demands between customer and CSP?
- RQ5 How can CSPs enforce security policies regarding data location?
- RQ6 How can CSPs show compliance to customer demands regarding data location in public software-as-a-service cloud computing?
- (a) Each these questions is asked in some step of the engineering cycle. For each question, indicate to which step it belongs and reformulate it accordingly.
- (b) Some questions essential to the engineering cycle are missing. Add these questions.
4. (a) Define what it means for desires to be in logical conflict, in physical conflict, and in technical conflict.
- (b) For each of the examples below, indicate whether there is a conflict between goals and if so, identify the goals, and explain whether the conflict is physical, logical or technical.
- Airports want a safe route and a fast route through the network
 - Airports want aircraft to behave in a predictable manner and respond dynamically to changing situations
 - Car owners want to equip their car with TV but have the same car battery life times
 - Car owners want to have a TV in the dashboard so that can watch during driving, and obey the law
5. (a) Define the concept of an architecture. Illustrate your definition with an example.
- (b) Define the concept of an architectural mechanism. Illustrate with an example.
6. What is the difference between desires, goals, requirements and constraints? Illustrate by means of examples.
7. (a) What is the difference between a construct and an indicator?
- (b) Mean time between failure (MTBF) is one indicator of reliability. A high MTBF is interpreted as an indication of high reliability. Does this mean that if MTBF is high, this *causes* reliability to be high? Explain your answer.

8. Scaling up to practice takes place along two dimensions.
 - (a) Describe these dimensions.
 - (b) What role do mechanism simulation experiments and statistical difference-making experiments play in scaling up research?
 - (c) Position expert opinion research, mechanism simulation experiments, technical action research and statistical difference-making experiments in the diagram of slide 61.
9.
 - (a) What are the two characteristics of scientific theories?
 - (b) How are these characteristics maintained in practice?
 - (c) Do these characteristics give empirically validated scientific theories the certainty of mathematical theories?
10.
 - (a) Describe the paradox of idealization and give an example of it.
 - (b) How is the paradox resolved in laboratory science?
 - (c) How is it resolved in engineering science?
11.
 - (a) What are the two components of scientific theories?
 - (b) Are both components mandatory or could we have a scientific theory with one of them missing? If so, what could such a theory be used for?
12. The empirical cycle and engineering cycle are both instances of a rational problem-solving cycle. Describe the rational problem-solving cycle and show how the empirical and engineering cycles are instances of it.