| Sample | Exam | Solutions |

Name (Capital letters)   Surname (Capital letters)   Matriculation Number

Universität ZürichUZH

Final Exam Requirements Engineering I
(MINF 4204, HS13)

4th November 2013

- You have **90 Minutes** time to solve the final exam. In total, you can accumulate maximum **90 Points**.

The following rules apply to this written final exam:

- Answer the questions directly on the exam sheets. Indicate clearly which answer corresponds to which question. Additional sheets of paper will be distributed upon request. If you use additional sheets, write your matriculation number as well as your name and surname on each individual additional sheet.
- Please check if your exam is complete (12 pages).
- Write your solutions with a pen in **blue** or **black color**. Pens or pencils in other colors are not allowed. The solutions which are written in pencil will not be corrected.
- Always use the **notation** introduced in the **lecture**.
- For the Requirements Engineering I exam, only the following **helping materials** are allowed:
    - One double-sided self-written A4 auxiliary sheet, with handwritten notes. The auxiliary sheets which do not conform to these guidelines will be collected.
    - For students, whose native language is not English: a foreign dictionary. This will be checked by one exam supervisor.
- No additional tools or materials are allowed, particularly pocket calculators, computers, smartphones, audio devices or similar. Any fraud attempt leads to failing the exam (i.e. 0 points).
- Place your student ID („Legi") on your desk.

I certify with my signature that I have **read** and **understood** the guidelines and rules above.

Signature: _____

Please leave empty!

Part	1		2		3		Total	
Max		20		40		30		90

Part 1: Multiple Choice Questions (total 20 Points, ca. 20 minutes of work)

Please check the appropriate box. For each question, there may be multiple right and wrong statements.

Note that the number of points removed for an incorrect check is equal to the number of points granted for a correct check. If the total number of points for a question is negative, then the score for that question is 0.

Question 1.1: Basics (3 Points)

	Correct	Wrong
A stakeholder is a person or organization that directly influences the requirements of the system and actively contributes to the requirements validation activity.	☐	∎
As long as the opinions of various stakeholders do not conflict, there is no need to use requirements engineering practices.	☐	∎
Dealing with multi-level requirements represents one major challenge posed by systems-of-systems to requirements engineering.	∎	☐
When eliciting requirements, one has to consider those both inside and outside the system and context boundaries.	☐	∎
In the waterfall model, it is assumed that all the requirements can be elicited at the beginning of the project.	∎	☐
The effort invested in requirements engineering shall be inversely proportional to the risk one is willing to take.	∎	☐

### Question 1.2: Requirements and shared understanding (2 Points)

	Correct	Wrong
System requirements can be functional requirements, quality requirements or constraints.	∎	☐
Soft requirements use a binary acceptance criterion for expressing the satisfaction level.	☐	∎
Shared understanding refers to specifying all the requirements shared by various stakeholders.	☐	∎
One method to assess shared understanding is validating all explicitly specified requirements.	∎	☐

Question 1.3: Documenting requirements (2 Points)

	Correct	Wrong
The main documentation standards include VOLERE, IEEE Std 830-1998 and enterprise-specific standards.	∎	☐
The reaction time and cultural issues are examples of aspects that should be documented in requirements specifications.	∎	☐
Glossaries represent a method to increase the precision of the requirements documentation.	∎	☐
The three main directions that should be considered when writing a requirements documentation are: precision, depth and correctness.	☐	∎

Question 1.4: Context diagram (2 Points)

Consider the following context diagram:
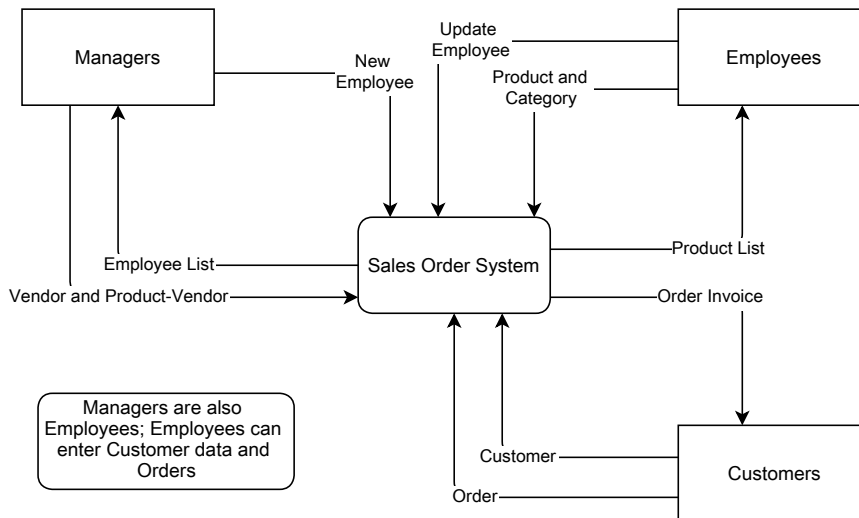
	Correct	Wrong
The context diagram is incomplete since it does not show where the data reside and how they flow.	❏	■
The context diagram is incomplete because it is missing the cardinalities.	❏	■
The context diagram is at the right level of detail, such that all the stakeholders can understand it.	■	❏
The managers, employees and customers can also be modelled using other symbols, other than boxes.	■	❏

Question 1.5: Models (3 Points)

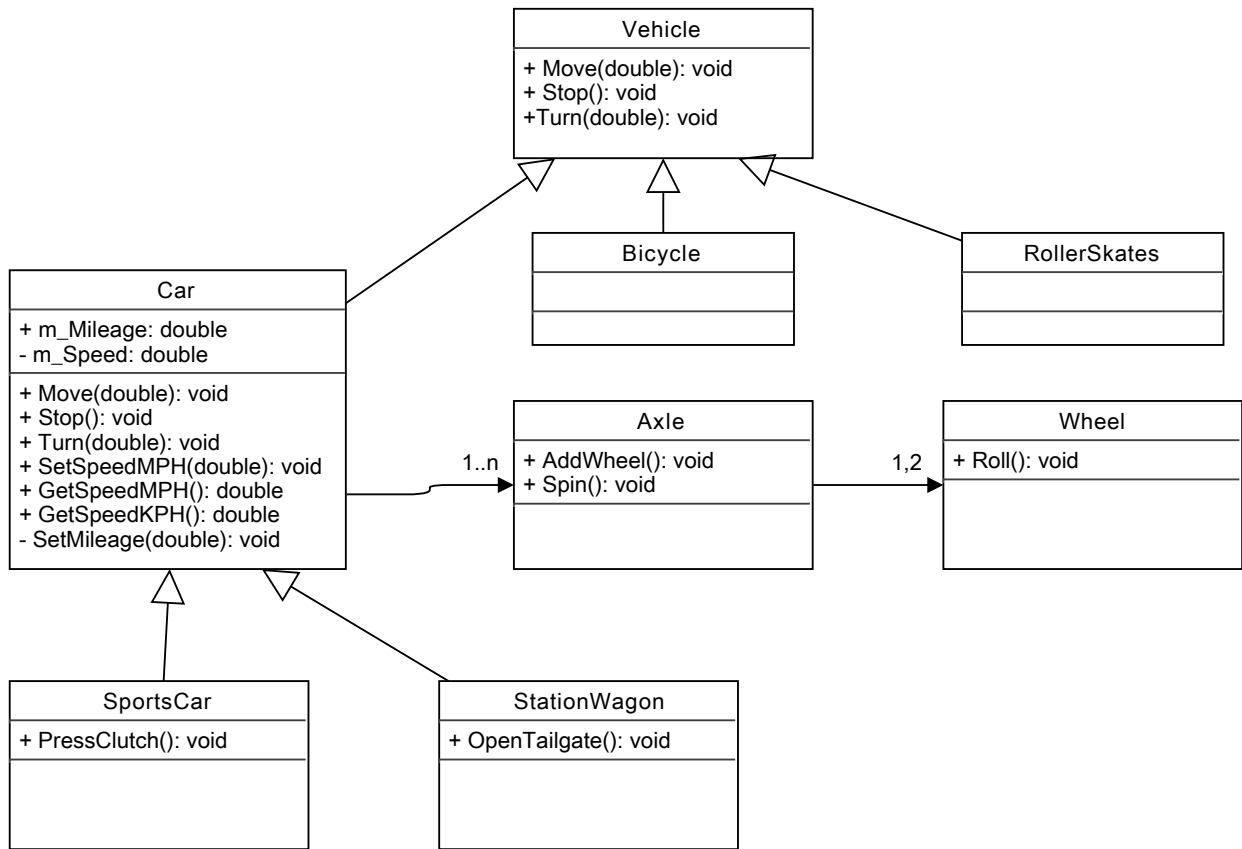|	Correct	Wrong
The Entity Relationship Model (ERM) models an extract of reality with the help of entities, relationships, methods and attributes.	❏	■
Data flow diagrams have the advantage that they support system decomposition.	■	❏
Class and object diagrams model the static structure of a system, together with the behavior of individual classes or objects.	❏	■
In addition to the static structure of the system, an entity relationship diagram also models some parts of the system behavior.	❏	■
The behavior of a system can be modeled with an activity diagram or a state machine.	■	❏
Scenarios can be represented with class diagrams.	❏	■

Question 1.6: Class diagram (2 Points)

Consider the following class diagram:

	Correct	Wrong
The class Vehicle does not contain any attributes.	■	❑
The objects of class StationWagon do not have any attributes.	❑	■
The diagram contains a mistake: the direction of the five arrows with empty arrowheads pointing at Vehicle and Car should be reverse.	❑	■
SportsCar has a method called AddWheel().	❑	■

Question 1.7: Functional and quality requirements (3 Points)

Consider an online shop for books. Check if the following statements express functional or quality requirements.

|	Functional	Quality
The system shall be available in English, German and French.	❑	■
The system shall allow the user to search for books by author and title.	■	❑
The system shall provide a list of all previously ordered books to the user.	■	❑
The system shall support minimum 1000 transactions per hour.	❑	■
The system shall be available to all users 24/7.	❑	■
The system shall allow the user to remove books from the shopping cart at any moment.	■	❑

Question 1.8: Use case diagram (3 Points)

Consider the following use case diagram:
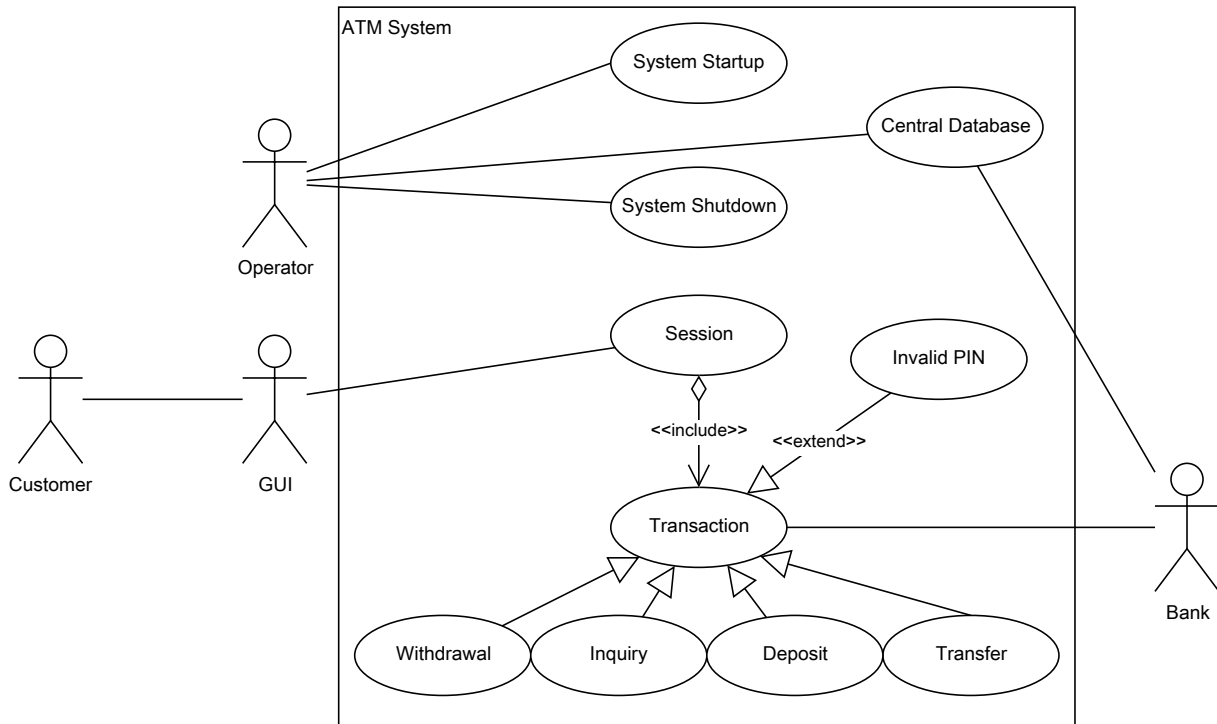
	Correct	**Wrong**
According to the diagram, Transaction is an abstract superclass for Withdrawal, Inquiry, Deposit, Transfer and Invalid PIN.	❏	■
The relation between Invalid PIN and Transaction does not conform to the UML standard.	■	❏
The use case should clarify in what direction data is transferred to and from the Central Database.	❏	■
The Central Database should be moved outside the ATM System box, but the connections should be kept.	❏	■
The relation between the Customer and the GUI is not permitted in UML use case diagram syntax.	■	❏
The relations connecting the Operator, GUI and Bank to the ATM System are missing the arrows.	❏	■

Part 2: Applied Tasks (total 40 Points, ca. 40 minutes of work)

Case Study

JazzN!ghts is a famous Jazz festival, held in Zurich every year. Since its first edition in 1986, it has gone through several major changes regarding its structure, length and location, but the tickets have always been sold in a traditional way: through two events agencies. The organizers decided to completely modernize the tickets selling system and created the following concept.

> From this year on, the tickets will be sold in three distinct ways: traditionally, i.e. by the two events agencies, in electronic format directly on the festival website, and through SBB. All parties will have access to the same unique tickets database of the new system, to avoid double selling. A partnership with the SBB railway company needs to be set up, such that SBB can sell combi-tickets including both the festival admission fee and the train ride to the festival venue at reduced price, from anywhere in Switzerland. This way, more music fans would have easier and cheaper access to JazzN!ghts. Moreover, the system will have to be extended to support not only German, but also English, French and Italian. Since tickets will also be sold online, SecurePayment Inc. will be contracted to provide and ensure the security of the online payment service. The JazzN!ghts event manager will take care and negotiate all these details with the involved parties.

> Additionally, upon arrival at the festival venue, each participant has to self-check in at a touch screen terminal, which scans the barcodes on his/her ticket and issues a bracelet with an electronic chip. This can be used to load money, such that whenever (s)he wants to purchase snacks or beverages, (s)he does not have to use cash any more, thus reducing waiting times. This measure was initiated by the program manager and will be deployed by WristSolutions Inc. Lastly, according to the cantonal laws, the way the payment transactions are performed has to be audited by an external company at the end of the festival, since this is a public event, where the municipality of Zurich is also involved - allowing free use of the public space.

a. Identify and name all the stakeholders of the JazzN!ghts new tickets selling system. **(4 Points)**

Musterlösung

List of stakeholders:

1) The organizers of JazzN!ights
2) The event manager of JazzN!ights
3) The customers
4) Two events agencies
5) SBB
6) SecurePayment Inc.
7) WristSolutions Inc.
8) External auditing company
9) Municipality of Zurich
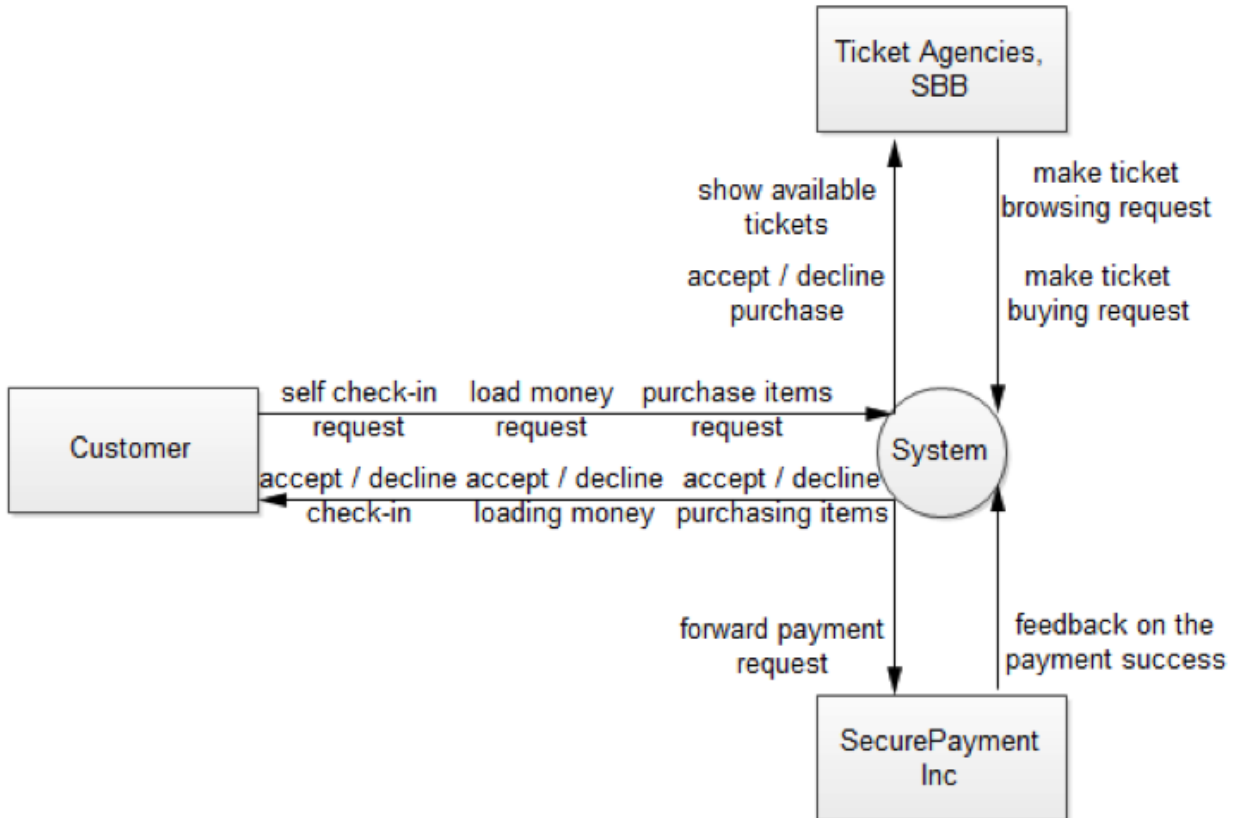
Correction schema:
Students are expected to list at least 8 of the stakeholders above.
0.5 points/stakeholder * 8 stakeholders => 4 points

b. Draw a context diagram of the new JazzN!ghts tickets selling system. Make sure you label the actors, the relationships between them as well as their relationships to the system. Note: Do not forget to document your assumptions, if you make any. **(10 Points)**

Musterlösung

Note: This is a sample solution, but other versions that include the same actors and relationships are also acceptable. More than one solution is possible.

Correction schema:
1 point/actor * 3 actors + system => 4 points
1 point/relationship * 6 relationships => 6 points
Total: 10 points

c. Identify one goal, two functional requirements and two non-functional requirements in the case study. **(5 Points)**

Musterlösung

Sample **goal**: Modernize the tickets selling system.
Sample **functional requirements**:
1) The system enables purchasing tickets; 2) The system allows performing a self-check-in by using the barcode of the ticket; 3) The system allows loading money on the bracelet; 4) The system allows purchasing items on the festival venue using the money loaded on the bracelet.
Sample **non-functional requirements**:
1) The system is available in German, English, French and Italian; 2) The online payment service is secure.

Correction schema:
1 point/goal
1 point/functional requirement * 2 functional requirements => 2 points
1 point/non-functional requirements * 2 non-functional requirements => 2 points
Total: 5 points

d. How can you gather further requirements that help you build the JazzN!ghts new tickets selling system? Mention *four* different requirements elicitation methods. For each, explain (i) why you think the method is suitable in the context of the JazzN!ghts case study, (ii) what stakeholders the method is appropriate for, and (iii) how you would implement the method in practice, for JazzN!ghts. **(12 Points)**

Musterlösung

Note: More than one answer is possible. The solution below is an example.

Method 1: Questionnaires
i) Why: Questionnaires can reach a large and distributed audience the system is aimed for, such as the Jazz fans.
ii) Stakeholders: E.g. (potential) customers, i.e. Jazz fans.
iii) How: The link to an online questionnaire can be sent by e-mail to Jazz fans in Switzerland - the data can be retrieved from e.g. Jazz clubs.

Method 2: Interview
i) Why: During an interview with (potential) users, detailed features can be analyzed and the system designer can gain an in-depth understanding of individual needs.
ii) Stakeholders: Sample future users, i.e. Jazz fans,
iii) How: A few Jazz fans volunteers can be contacted and selected through existing Jazz clubs, then invited to take part in structured or semi-structured interviews regarding the new tickets system.

Method 3: Workshop
i) Why: A workshop with the external auditing company would clarify what their needs are, what they need to audit and what kind of information the system should provide.
ii) Stakeholders: External auditing company.
iii) How: Audit company representatives can be invited to participate in the workshop and simulate what an auditing session would look like.

Method 4: Ethnography
i) Why: In this case, ethnography would allow observing users while they use a prototype of the future system.
ii) Stakeholders: E.g. (potential) customers, i.e. Jazz fans.
iii) How: Selected future users can be invited to try a prototype of the system. During this time, requirements specialists can observe them, note down their interactions with the system, potential issues, etc.
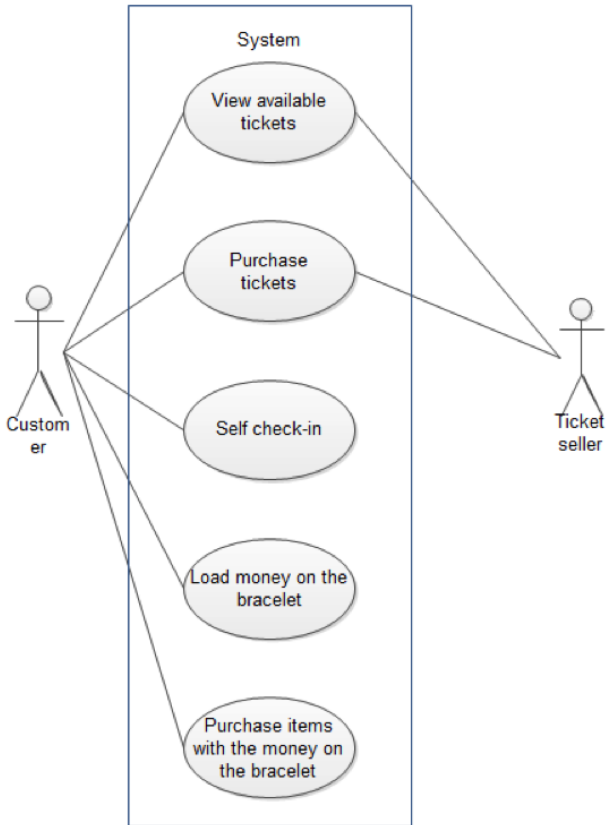
Correction schema:
3 points/method * 4 methods => 12 points (1 point for (i), 1 point for (ii), and 1 point for (iii))

e. Identify all the use cases in the JazzN!ghts case study and represent them in a UML use case diagram. Note: Do not forget to document your assumptions, if you make any. **(9 Points)**

Musterlösung

Note: More than one answer is possible. The solution should contain at least the use cases below.

Correction schema:
1 point/actor * 2 actors => 2 points
1 point/use case * 5 use cases => 5 points
2 points/relations
Total: 9 points

Part 3: Essays (total 30 Points, ca. 30 minutes of work)

Please answer each of the following questions in a short essay, of about 8-16 sentences. For this, you should use coherent text, and not bullet points.

a. Discuss the problems related to eliciting quality requirements and explain how these can be avoided. **(10 Points)**

Musterlösung

Sample problems the students are expected to mention:
- quality requirements are generally ambiguous
- difficult to achieve
- difficult to verify and quantify: e.g. "The system shall be fast" or "We need a secure system"

Classic approach:
- quantification: measurable, but expensive
- operationalization: testable, but implies premature design decisions

New approach: represent quality requirements such that they deliver optimum value

Correction schema:
Students are expected to mention minimum two problems and corresponding possible solutions.
2 point/problem * 2 problems => 4 points
2 point/solution * 2 solutions => 4 points
2 points/writing
Total: 10 points

b. Describe and discuss the requirements validation techniques, and explain in what contexts it is appropriate to use them. **(10 Points)**

Musterlösung

Requirements validation techniques:
1. Review
- walkthrough
- inspection
- author-reviewer cycle
2. Acceptance test cases
3. Simulation/Animation
4. Prototyping
5. Formal verification/Model checking

Correction schema:
2 points/validation technique * 5 techniques => 10 points (1 point for naming the technique, 0.5 points for short description of the technique, and 0.5 points for explaining in what context it is appropriate to use it)

c. Describe and discuss the characteristics of the agile requirements process. **(10 Points)**

Musterlösung

The students are expected to describe and discuss minimum 5 of the following characteristics:
- fixed length increments of 1-6 weeks
- products owner/customer available
- immediate decisions are possible
- only goals and vision established upfront
- loosely specified requirements as user stories
- details captured in test cases
- short feedback cycles
- at the beginning of each cycle, the customer/product owner prioritizes the requirements and the developers select the requirements to be implemented in that increment

Correction schema:
2 points/characteristic of the agile requirements process * 5 characteristics => 10 points

Space for Solutions