Klausur 2 August Summer 2019, Fragen

Einführung in die Softwaretechnik (IN0006) (Technische Universität München)

Problem statement for all exam questions

THE FOLLOWING PROBLEM STATEMENT IS THE BASIS FOR ALL EXAM QUESTIONS:

The city of Munich wants to contribute to a sustainable environment by offering an innovative and easy-to-use means of transport with electronic scooters (also called E-Scooters). A rider (i.e., the user of a scooter) uses a mobile app (either iOS or Android) to rent a scooter at rental stations. All scooters are equipped with a proximity sensor so that the mobile app can detect nearby scooters. A rider can reserve a scooter for later use. A reserved scooter must be rented within 15 minutes, otherwise the reservation will be cancelled. The rental starts immediately when the rider has unlocked the scooter. A rider needs to enter the payment details beforehand and will be charged 1 Euro for every 5 minutes. the rider can either pay with Apple Pay, Google Pay, PayPal, or credit card and will be charged after the ride. Riders can return the scooter anywhere but they get free minutes when they return the scooter to a rental station.
You are a software engineer and part of the development team at the E-Scooter GmbH.

Question 1 Multiple Choice (12 points)

In all multiple choice questions, there can be **multiple** correct answers.

Mark correct answers with a cross ☒
To undo a cross, completely fill out the answer option ■
To re-mark an option, use a human-readable marking ×■

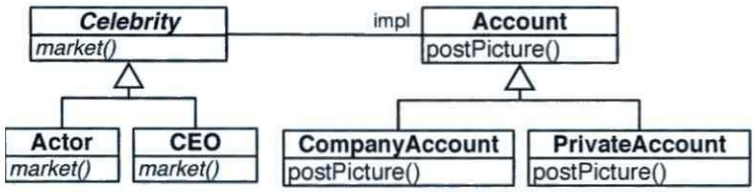
a) **[1p] A colleague in the E-Scooter project proposes to use the client server architectural style which describes ...**

- ☐ a client accesses services provided by a server
- ☐ services that a client offers
- ☐ a special case of the layered architectural style
- ☐ the facade between client and server

b) **[1p] Your new colleague Bob in the E-Scooter GmbH commits his code changes with git. You cannot see his changes in your IDE. What could have gone wrong?**

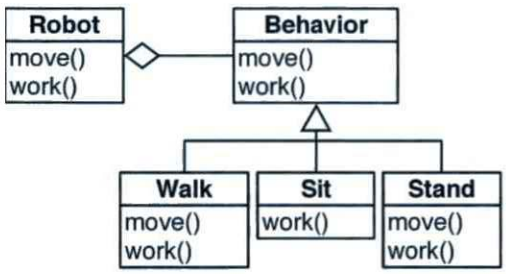
- ☐ Your computer is offline
- ☐ You did not fetch and merge the changes
- ☐ You are working on a different branch
- ☐ Bob forgot to push to the remote repository

c) **[1p] Which pattern is used in the following model?**



- ☐ Bridge Pattern
- ☐ Proxy Pattern
- ☐ Adapter Pattern
- ☐ State Pattern

d) **[1p] Which pattern is used in the following model?**



- ☐ Bridge Pattern
- ☐ State Pattern
- ☐ Strategy Pattern
- ☐ Adapter Pattern

e) **[1p] The E-Scooter project is broken down into activities and tasks. Which statements about the work breakdown structure are correct?**

- ☐ Each activity is a project function
- ☐ Multiple roles can be assigned to one person
- ☐ The composite pattern is used to model work
- ☐ A task can be assigned to multiple roles
- ☐ Deliverables are external work products

f) **[1p] A student complains about a slide in the #lecture channel on Slack and a tutor replies. Which of the following aspect(s) describe this communication event?**

- ☐ Scheduled, asynchronous and informal
- ☐ None of the given options
- ☐ Scheduled, synchronous and formal
- ☐ Unscheduled, synchronous and formal

g) **[1p] Which of the following are fault handling techniques?**

- ☐ Vertical integration testing
- ☐ System testing
- ☐ Verification
- ☐ Change management
- ☐ JUnit

h) **[1p] You propose to use Scrum for the E-Scooter project. Which statements are correct?**

- ☐ The Scrum master decides how to handle change requests
- ☐ The development team and the Scrum master take part in daily Scrum meetings
- ☐ The sprint backlog is defined before each sprint starts
- ☐ The product owner is responsible for the process

i) **[1p] The E-Scooter GmbH wants to apply change management in the E-Scooter project. Which of the following statements are correct?**

- ☐ In Scrum, change requests only occur in the analysis phase
- ☐ The V-model encourages change requests from the customer in every phase
- ☐ A change request from the city of Munich can also be rejected
- ☐ A change policy can enforce that each promotion conforms to commonly accepted criteria

j) **[1p] Which of the following statements about organizations are correct?**

- ☐ Functional organizations have a high degree of uncertainty
- ☐ Functional organizations require extensive communication
- ☐ Hierarchical organizations simplify communication among project members
- ☐ In functional organizations, projects are pipelined through the departments

k) **[1p] You talk with your team members in the E-Scooter project about software configuration management. Which of the following statements are correct?**

- ☐ A promotion can become a release
- ☐ A release is a version that is formally distributed and approved
- ☐ A promotion is a specific instance of a configuration item that is distributed to the end users
- ☐ A revision can only include new functionality

l) **[1p] Alice develops software for E-Bikes in another company and discusses about reuse between E-Bikes and E-Scooters with you. Which of the following reuse techniques would you recommend?**

- ☐ None of the given options
- ☐ Composition
- ☐ Specification inheritance
- ☐ Delegation

Question 2 Requirements Analysis (10 points)

a) **[3p]** Identify three functional and three nonfunctional requirements using URPS from the E-Scooter problem statement. Define the type of requirement for each of them. For nonfunctional requirements also define the category (e.g. supportability).

b) **[4p]** Model the functionality of the E-Scooter problem statement with a **UML use case diagram**. Include the following exceptions: scooter not available and timeout (the user took too long to rent a scooter).

c) **[3p]** Provide a textual use case description for the payment of one scooter ride by filling out the following table. **Hint:** When you describe the event flow, make sure to use indentation to distinguish between the actor and the system steps.

Use case name
Participating actors
Flow of events
Entry conditions
Exit conditions
Special requirements

Question 3 Analysis (9 points)

a) **[5p]** Create an **analysis object model** for the scooter rental system based on the E-Scooter problem statement. **Hints:** Focus on the core concepts of the system. Include attributes and methods in your model.

b) **[4p]** Create a **UML communication diagram** for the following scenario: Bob uses the E-Scooter iOS app to detect 2 nearby scooters "Emma" and "Carla". He selects the scooter "Emma" and reserves it. After 5 min, he arrives at the scooter's location. Bob unlocks the scooter and rides 18 min to the rental station next to his apartment in Schwabing. He returns the scooter and pays 4€ for the ride via PayPal.

Question 4 System Design (7 points)

a) **[2p]** Discuss two pairs of design goals and their trade-offs in the context of the E-Scooter system.

b) **[5p]** Assume you are the software architect at E-Scooter GmbH. Select an architectural style and justify your decision with respect to system design principles. Model the software components and services based on the functionality of the system as a **UML component diagram**. **Hint:** Use the lollipop-notation.

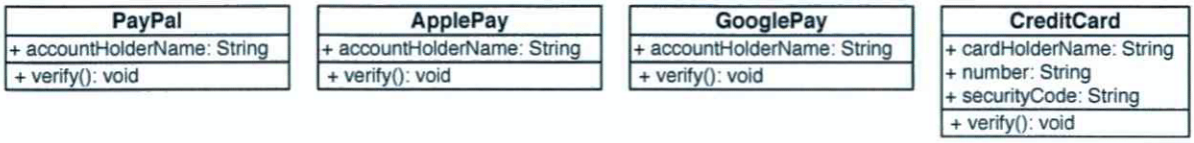
Question 5 Object Design (6 points)

a) **[3p]** Explain the state pattern and the strategy pattern. Use examples to discuss the similarities and differences between these patterns.

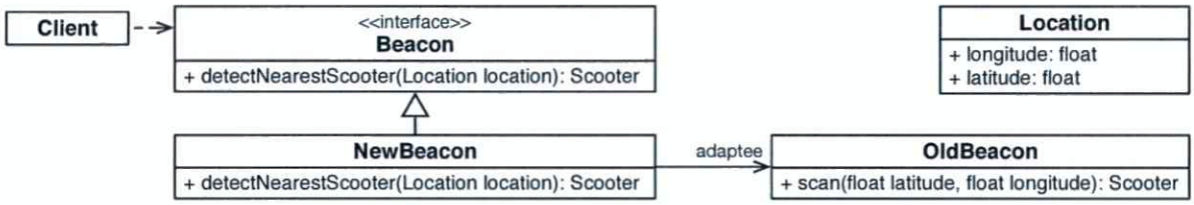
b) **[3p]** A rider stands in front of a scooter and wants to detect it without an internet connection. Explain how the proxy design pattern solves this problem and model it in a **UML class diagram**.

Question 6 Model Transformations (10 points)

a) **[3p]** Refactor the following model into a new **UML class diagram** and explain your refactoring.



b) **[4p]** Map `Beacon`, `NewBeacon` and `OldBeacon` to **Java source code** as shown in the UML class diagram. **Note:** Minor syntax errors are OK. Implement the constructor of `NewBeacon` so that `adaptee` is initialized. Provide the signature for methods and also implement the method `detectNearestScooter` in `NewBeacon`.



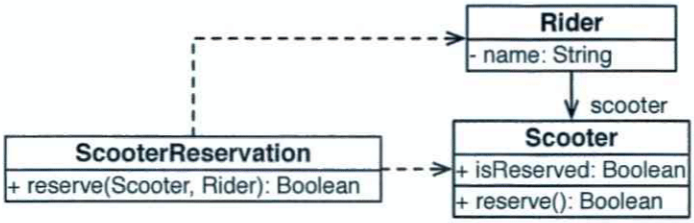
c) **[2p]** In addition to scooters, other means of transportation include driverless trucks, cars, or bikes. You want to model a traffic management system for the three following scenarios: Piggybacking of trucks, convoys of driver-less trucks, and cars with bike carriers that support two bikes. Create an object design model using a **UML class diagram** that covers these three scenarios.



d) **[1P]** Pick one of the scenarios in 6c and instantiate it with a **UML object diagram**.

Question 7 Testing (6 points)

Consider the following object design model for the E-Scooter system:



a) **[3p]** Your colleague has written a unit test for reserving a scooter where parts of the unit test are missing. Complete the JUnit test below based on the UML class diagram shown above following the mock object pattern using the `EasyMock` framework. The scooter is not implemented yet and has to be mocked. To implement the unit test, create a mock object for `Scooter` and specify the expected behavior: when `reserve()` is invoked on the `Scooter` mock, it should return `true`. Verify that the method `reserve(...)` of `ScooterReservation` returns the expected value.

```
1  @RunWith(EasyMockRunner.class)
2  public class ScooterReservationTest {
3
4     @TestSubject
5     private ScooterReservation scooterReservation = new ScooterReservation();
6
7
8
9     @Test
10    public void scooterReservationSuccessfulTest() {
11
12       Rider rider = new Rider("Alice");
13
14
15
16
17
18
19
20
21
22
23    }
24 }
```

b) **[1p]** Explain which classes belong to the SUT.

c) **[1p]** Explain which classes are collaborating objects.

d) **[1p]** Explain which classes belong to the system model and which belong to the test model