Maastricht University

Department of Data Science and Knowledge Engineering

Software Engineering 2020/2021
Exam Questions

— *Do not turn this page before the official start of the exam!* —

First Name, Surname: ______________________________

Student ID: ______________________________

Program: Bachelor Data Science and Artificial Intelligence

Course code: KEN1520

Examiner: C. Seiler and T. Pepels

Date/time: Wednesday, June 3, 2019, 9:30–11:30

Format: Closed book exam

Allowed aides: Pens, simple (non-programmable) calculator from the DKE-list of allowed calculators.

Instructions to students:

- The exam consists of 6 questions on 6 pages (excluding the 1 cover page(s)).
- Fill in your name and student ID number on each page, including the cover page.
- Answer every question at the reserved space below the questions. If you run out of space, continue on the back side, and if needed, use the extra blank page.
- Multiple choice questions that allow for multiple answers: We will award a fraction of the points available for each correct answer selection and subtract an equivalent fraction for incorrect answer selection. The lowest score for a question is 0.
- Ensure that you properly motivate your answers.
- Do not use red pens, and write in a readable way. Answers that cannot be read easily cannot be graded and may therefore lower your grade.
- You are not allowed to have a communication device within your reach, nor to wear or use a watch.
- You have to return all pages of the exam. You are not allowed to take any sheets, even blank, home.
- If you think a question is ambiguous, or even erroneous, and you cannot ask during the exam to clarify this, explain this in detail in the space reserved for the answer to the question.
- If you have not registered for the exam, your answers will not be graded, and thus handled as invalid.
- **Good luck!**

The following table will be filled by the examiner:

Question	Points	Score
Testing	18	
Version Control	16	
Specifications	16	
Software Management	12	
Software Architecture	15	
UML	23	
Total:	100	

Question 1 (Testing) (18 points)

Given this specification:

```java
/**
 * @param val another BigInteger
 * @return a BigInteger whose value is (this - val)
 */
public BigInteger subtract(BigInteger val);
```

(a) (10 points) Start implementing a systematic testing strategy for this function by partitioning the input space.

(b) (8 points) Write two test cases.

Question 2 (Version Control) (16 points)

```
On branch master
Your branch is up to date with 'origin/master'.

Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
        new file:   src/main/java/Hailstone.java
        modified:   src/test/java/MathTest.java

Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
        modified:   src/main/java/StringManipulation.java
        modified:   src/test/java/StringManipulationTest.java

Untracked files:
  (use "git add <file>..." to include in what will be committed)
        src/test/java/HailstoneTest.java
```

You type `git status` within your git repository and get the output above. What does this mean for each of these files? Multiple answers are possible. Justify each answer with one short sentence.

(a) (4 points) What is the status of `Hailstone.java`?

○ file has most likely never been committed
○ file has been changed since its last commit
○ file is in staging area

(b) (4 points) What is the status of `MathTest.java`?

○ file has most likely never been committed
○ file has been changed since its last commit
○ file is in staging area

(c) (4 points) What is the status of `StringManipulation.java` and `StringManipulationTest.java`?

○ file has most likely never been committed
○ file has been changed since its last commit

○ file is in staging area

(d) (4 points) What is the status of `HailstoneTest.java`?

○ file has most likely never been committed
○ file has been changed since its last commit
○ file is in staging area

Question 3 (Specifications) (16 points)

```java
/**
 * @return new uppercased String, or this if no characters were uppercased
 */
public String toUpperCase();
/**
 * @param index position of character to return (base 0)
 * @return character located at position index
 */
 public char charAt(int index);
/**
 * @param data the character array
 * @return a String containing the same character sequence as data
 */
public static String valueOf(char[] data);
```

Above is the original JavaDoc for the `String` class. Which Abstract Data Type operation is each of these method? Justify each answer with one short sentence.

(a) (4 points) Which type of operation is `toUpperCase`?

○ creator
○ producer
○ observer
○ mutator

(b) (4 points) Which type of operation is `charAt`?

○ creator
○ producer
○ observer
○ mutator

(c) (4 points) Which type of operation is `valueOf`?

○ creator
○ producer
○ observer
○ mutator

(d) (4 points) Are there any mutator operations in the `String` class? Justify your answer.

Question 4 (Software Management) (12 points)

(a) (3 points) You talk to a co-worker whom you have just met at your new job for a software development company, she tells you:

> *"During my workday I make sure that developers and team leaders know when their deadlines are and that all processes are managed such that they are completed on schedule. I also make sure the schedule matches the clients' expectations. Furthermore, I perform a weekly update on the budget, making sure that the current costs match the projected costs as closely as possible and escalating to higher management otherwise. I try to identify bottlenecks and problems as soon as possible."*

What is your co-worker's role in the company?

○ Product Owner
○ Project Manager
○ Business Analyst
○ Software Architect

(b) (3 points) Is the waterfall model an Agile software development process?

○ Yes
○ No

(c) (3 points) The **two main differences** between a plan-based approach to software development and an agile approach are:

○ An agile approach has no plan, clients can request new features at any time, and they will be added, whereas a plan-based approach has a strict plan that cannot be changed during development.

○ A plan-based approach is more in line with software development for the web, whereas agile development focuses more on projects in embedded software and scientific software.

○ An agile approach focuses on designing software in cooperation with clients or users and welcomes changing requirements. Whereas in a plan-based approach, it is more difficult to change requirements during development.

○ During development, when using a plan-based approach all learned innovations can be immediately applied, whereas with an agile approach they need to constantly be discussed with the client or users which takes more time.

○ Plan based approaches use project management as a management structure whereas agile uses scrum.

○ Agile approaches deliver incremental working prototypes of the product during development, plan-based approaches have strict deliverables of production ready software that are delivered at the end of the development phase.

(d) (3 points) Which of the following are causes of technical debt (choose 2):

○ Not using object-oriented design
○ Insufficient planning
○ Business pressure
○ No SOLID programming language
○ Lack of documentation
○ Writing code before drawing all the UML diagrams

Question 5 (Software Architecture) (15 points)

(a) (3 points) In Service Oriented Architecture and in Microservices we talk about the term "Services". In your own words describe what a service is in the context of these architectures. (max 5 sentences)

(b) (3 points) This modifier, when applied to a field or method ensures that the field or method is only accessible from within the declared class:

○ protected
○ static
○ final
○ private

(c) (3 points) In your own words describe the difference between an interface and an abstract class and when you should use which option. (max 4 sentences)

(d) (3 points) Modern REST API's communicate data in the JSON format. Choose 2 of the most important why reasons JSON is used instead of XML or CSV:

○ JSON files can be easily serialized and deserialized from and into objects
○ JSON is more descriptive than XML or CSV
○ JSON is more lightweight than XML and requires less bandwidth
○ With JSON you can transfer more types of information than other formats
○ Sending information in JSON format is the only way of sending messages using a REST interface. Other formats are not compatible

(e) (3 points) In your own words describe the term Loose Coupling (in the context of OOP, GRASP and SOLID) (max 5 sentences)

Question 6 (UML) (23 points)

```
public interface MessageContainer {
        public List<Message> listMessages();
        public void deleteMessage(Message msgToDelete);
}
public class Inbox implements MessageContainer {
        // Messages can only exist within the context of a MessageContainer
private List<Message> messages;
        ...
}
public abstract class Message {
        public String getSender();
        public String getReceiver();
        public Object getContent();
        public Object getAttachments();
        ...
}
public class TextMessage extends Message {
        private String text;
        ...
}
public class VoiceMessage extends Message {
// SoundEffect is a Java standard library class
private SoundEffect audio;
        ...
}
public class GifMessage extends Message {
// Image is a Java standard library class
        private Image gifImage;
        private String text;
        ...
}
```

Given the java classes above, draw a UML Class diagram that shows how a Factory can be used to create message objects (`TextMessage`, `VoiceMessage` and `GIFMessage`).

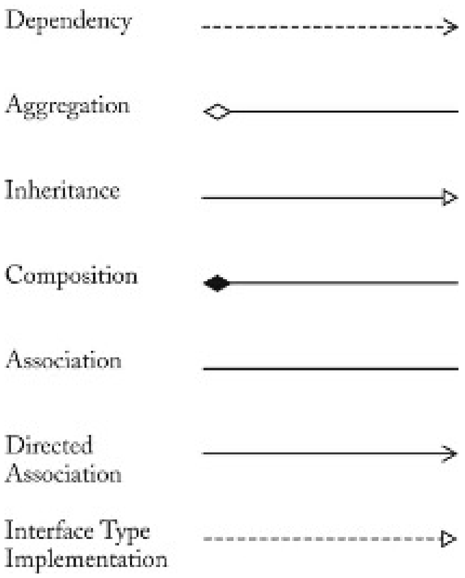
Start by drawing a class diagram that represents the classes and interfaces listed above, then add the required classes/interfaces and methods for the Factory. Do not include the `Image` or `SoundEffect` classes in your diagram.

You may add interfaces, classes, methods and fields to the diagram as you see fit in order for the design of the class-structure to match the Factory Design Pattern (see cheat sheet at the end of the exam).

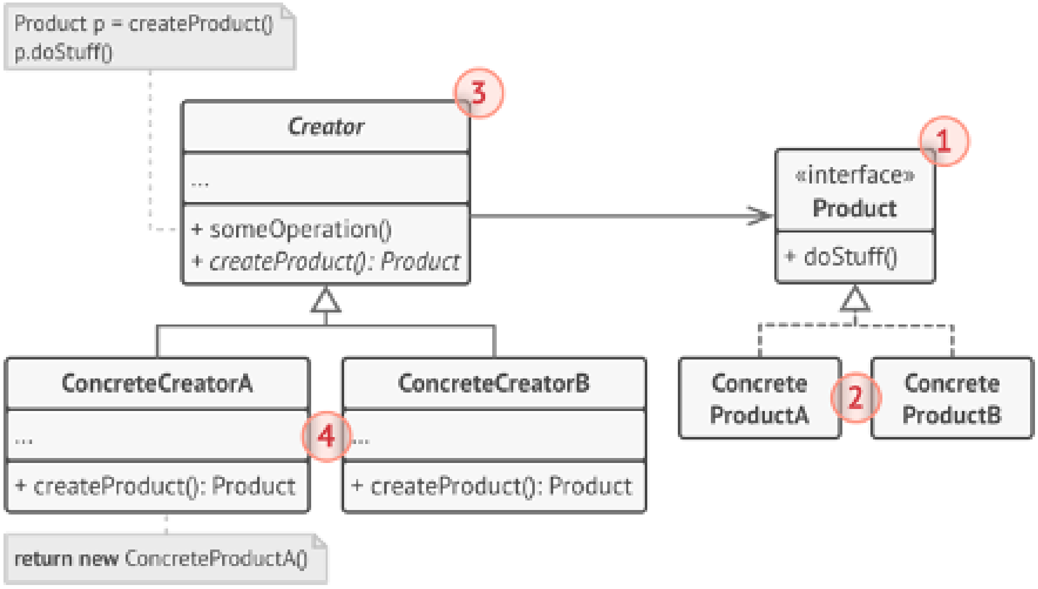
Hint: Take a look at the `getContent()` method in the abstract `Message` class. How would a GIF message return content given that it has two content types? Maybe you need an extra class to manage message content as a part of a message.

Cheat Sheet

UML



The Factory Method


Product p = createProduct()
p.doStuff()
3
Creator
...
+ someOperation()
+ createProduct(): Product
1
«interface»
Product
+ doStuff()
ConcreteCreatorA
...
+ createProduct(): Product
4
ConcreteCreatorB
...
+ createProduct(): Product
Concrete ProductA
2
Concrete ProductB
return new ConcreteProductA()