DUE DATE: **By the end of your lab session**

CSE-271: Object-Oriented Programming

Exercise #6

Max Points: 20

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For your own convenient reference – You should first save/rename this document using the naming convention `MUid_Exercise6.docx` (example: `raodm_Exercise6.docx`) prior to proceeding with this exercise.

Objectives: The objectives of this exercise are to:

1. Review the concepts of inheritance & interfaces
2. Review concepts of polymorphic method calls
3. Gain familiarity with JUnit based testing
4. Gain familiarity with code coverage

Fill in answers to all of the questions. For some of the questions you can simply copy-paste appropriate text from Eclipse output into this document. You may discuss the questions or seek help from your neighbor, TA, and/or your instructor.

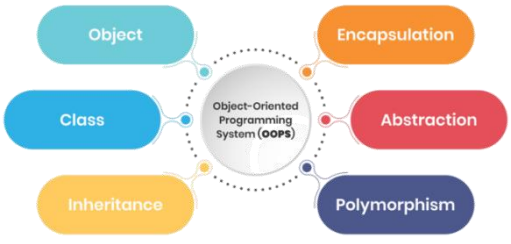
Part #0: One time setup of Eclipse (IDE) – Only if needed

We already configured `Eclipse`'s source formatter and Checkstyle plug-in as part of Lab #1. If your `Eclipse` is not configured (because you are using a different computer) then use the instructions from Lab #1 to configure `Eclipse`.

Part #1: Generic concepts of Object-oriented programming

Estimate time: < 30 minutes

Background: Object-oriented Programming (OOP) is a programming paradigm that is widely used and adopted by several mainstream programming languages, such as: C++, C#, JavaScript, Java, and Python. Hence, understanding the generic concepts underlying OOP is very important for your future careers, immaterial of the programming-language that you may be working with. Moreover, clearly and concisely explaining concepts is a very important skills for your future job-interviews and in your jobs. Hence, the exams also involve such questions, and in the labs, we will practice this style of questions.



Exercise: Briefly (2-to-3 sentences each) respond to the following questions regarding generic concepts of object-oriented programming (OOP).

1. In a Java class, what are the 2 types of methods cannot be overridden to accomplish polymorphism?

   Static and final methods cannot be overridden. This means that these types of methods cannot be redefined in child classes from parent classes.

2. Briefly state at three differences between an `abstract` class and an `interface`?

Abstract class	**Interface**
Can only extend one for each class	Can implement more than one
Can have non abstract methods	Can only have abstract methods
Can have any type of variables	Can only have static and final variables

3. What is a copy constructor? Show an example of a copy-constructor.

   Copy constructors are used to make copies of objects.

```
public Person(Person src) {
this.age = src.age;
this.name = src.name;
}
```

4. Given the adjacent `Student` class, show the source code for a shallow-copy constructor for the `Student` class.

```
public Student(Student src) {
this.name = src.name;
this.scores = src.scores;
}
```

```
class Student {
    private int[] scores;
    private String name;
}
```

5. Given the adjacent `Student` class, show the source code for a deep-copy constructor for the `Student` class.

```
public Student(Student src) {
this.name = src.name;
this.scores =
Arrays.copyOf(src.scores,
src.scores.length);
}
```

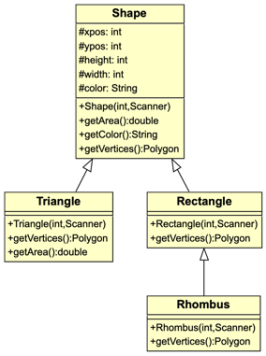
```
class Student {
    private int[] scores;
    private String name;
}
```

6. What is the difference between using a copy-constructor versus the `clone` method?

   A copy constructor creates a second object either with the same references or new values. The clone method creates an exact copy of an object.

7. Given the adjacent UML (that shows all the subclasses of `Shape`), rewrite the following `duplicate` method to use copy-constructors instead of the `clone` method.

```
/**
 * Make a copy of an abstract shape assuming it
 * implements the Clonable interface.
 * @param src The source shape to be duplicate.
 * @return A copy of the source shape.
 */
Public Shape(Shape src) {
    This.xpos = src.xpos;
    This.ypos = src.ypos;
    This.height = src.height;
    This.width = src.width;
    This.color = src.color;
}
```



Part #2: Object-oriented Programming (OOP) in Java

Estimated time: 30 minutes

Background: Different programming languages provide slightly different ways to accomplish OOP. Java's approach requires implementing several standard methods and interfaces for each class, specifically:

- Subclasses are encouraged to override the `equals` method
- It is recommended to implement the `Comparable` interface and implement the `compareTo` method
- It is convenient if `Clonable` interface is implemented by overriding the `clone` method.

Setup: First, you need to setup a Java project in Eclipse, download the starter code. In this part of the exercise, you are given the following set of classes:

File Name	***Description***
`Student.java`	An abstract student class. **Do not modify this class**.

Exercise: In this part of the exercise, you are required to develop a subclass of `Student` called `Undergraduate`. Hence, first briefly review the `Student` class. Next, develop the Undergraduate class (that `extends Student`) with the following methods:

Method	**Description**
Constructor to initialize `name`.	Simply calls constructor in parent class.
Copy constructor	Must perform deep copy.
`equals`	Two `Undergraduate` objects are equal only if `name` and all `scores` are equal.

`compareTo`	Two `Undergraduate` objects are to be compared first based on `name` and (if `name` is equal) then based on average scores.
`clone`	Clones an object

Testing: In the next part of this exercise, you will be developing `JUnit` tests to test the operations of these methods.

Part #3: Unit testing and code coverage

Estimated time: 30 minutes

Background: Software testing is a very important aspect of software development. Testing plays a vital role in ensuring the overall quality and reliability of a software system. Hence, different types of software testing approaches are widely used, including: Unit testing, functional testing, regression testing, performance testing, etc.

The most common form of testing that is performed by programmers is unit testing. Unit testing typically involves testing the functionality of a subset of methods or a class. There are several different frameworks for unit testing. The JUnit framework is one of the most widely used frameworks for unit testing Java classes. Hence, it is important to have familiarity with using JUnit for unit testing.

Exercise: In this part of the exercise, you are expected to develop a `JUnit` testing class named `UndergraduateTest.java` to test the `Undergraduate` and consequently the `Student` classes developed in the previous section. In addition, you are expected to ensure that you have at least 80% test coverage on both of these two classes.

There are videos on Canvas demonstrating the use of `JUnit` via Eclipse along with using code coverage tools in Eclipse. It may be useful to quickly review these videos as part of this exercise.

It is recommended you create 4 separate tests to test the operation of `clone`, `compareTo`, `getLetterGrade`, and addScore (with invalid score) methods. Once you have successfully developed your unit test and verified code coverage, place a screenshot showing at least 80% coverage in the space below. Ensure your screenshot shows coverage for each method in `Undergraduate` and `Student` class as shown in the example screenshot below:

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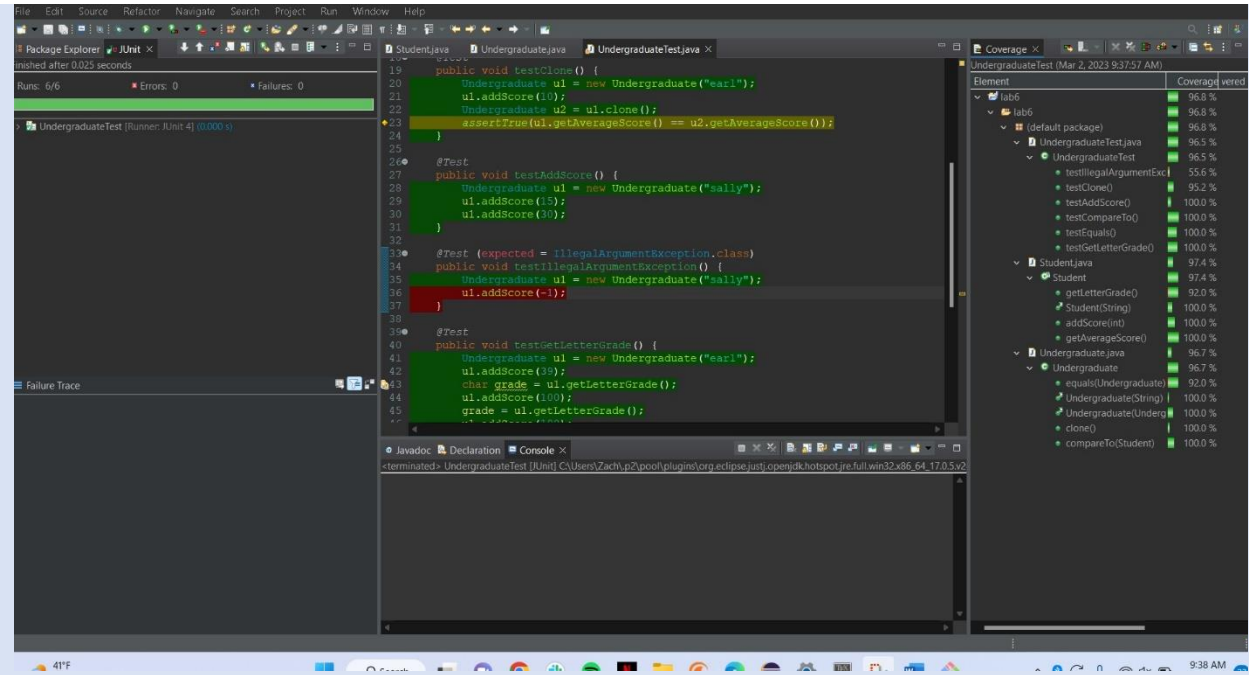

Part #4: Submit to Canvas via CODE plug-in

Estimated time: < 5 minutes

Exercise: You will be submitting the following files via the Canvas CODE plug-in:

1. This MS-Word document saved as a PDF file – **Only submit PDF file**.
2. The Java source files: `Undergraduate.java` and `UndergraduateTest.java`, that you modified in this exercise.

Ensure you actually complete the submission on Canvas by verifying your submission