

Due on 16. November 2018, 10:00, in the respective TA's mailbox

Problem 1 Java-Repetition

15 Points

- (a) Name two Java keywords each that are associated with the object-oriented concepts *encapsulation* and *inheritance*, respectively.
- (b) Name three kinds of *polymorphism* that are implemented in Java and provide a short example for each.
- (c) Describe in two sentences what we mean by *annotations* in Java. What is the `@Override` annotation? Why would you use it?
- (d) What is the difference between the dynamic and the static type of a (reference)-variable in Java.
- (e) Consider the following interface and implementing classes.

```
interface I {
    void a();
}
class A implements I {
    public void a() { System.out.println("A"); }
}
class B implements I {
    public void a() { System.out.println("B"); }
    public void b() { System.out.println("C"); }
}
```

For each line in the following main-method, determine whether it is valid or not. Remove the invalid lines, and provide the output of the remaining program. Moreover, for each variable, give its static and (possibly changing) dynamic type. Try to solve this exercise without the help of a computer.

```
public static void main(String[] args) {
    A a = new A();
    a.a();
    a.b();
    B b = new B();
    b.a();
    b.b();
    I i;
    i = new I();
    i = a;
}
```

```

    i.a();
    i.b();
    i = b;
    i.a();
    i.b();
    b = i;
    b = (B)i;
    a = (A)i;
}

```

(f) Repeat the task from (e) with the following code fragment.

```

public static void main(String[] args) {
    List<?> x = new ArrayList<String>();
    List<Object> y = new ArrayList<Integer>();
    List<? extends Number> y2 = new ArrayList<Integer>();
    Object[] z = new Integer[3];
    z[2] = "ALP3";
}

```

Problem 2 O-Notation

5 Points

For each of the following statements, decide whether it is true or false. Justify your answer with a proof or a counterexample.

- (a) We have $\log n \in O(2^{\log \log^2 n})$.
- (b) We have $f(n) \in O(g(n))$ if and only if $g(n) \in \Omega(f(n))$.
- (c) If $f(n) \in O(g(n))$, then also $2^{f(n)} \in O(2^{g(n)})$.

Problem 3 Amortized Analysis

10 Points

Suppose we have a binary counter with an arbitrarily large number of digits from $\{0, 1\}$, all initially 0. To switch one digit, we require one unit of power. How many units of power do we need in total to count from 0 to n in increments of one?

- (a) Use the accounting method to show that the total power cost is $O(n)$.
- (b) Compute the total power cost exactly, assuming that n is a power of two.