Informatik II (D-ITET)

Tutorial 6

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Outlook

- Exercise 5: Solution discussion
- More Java insights (Inheritance and Interfaces)
- Exercise 6: Overview (Inheritance, Polymorphism, Interfaces)
Exercise Sheet 5: Solutions and Remarks

Variables and Methods

- `beginWithLowerCase`
- `areVeryDescriptiveAnd`
- `upperCaseSeparated`
- `aMethodWhichHasAVeryLongName()`
- Classes with capital letters: `class MyClass{ ... }`
- `C++ notation: attributes start with m
  (mValue, mNext), not the case with temporary and passed parameters (int tmp)`

Please, comment more! important @author: your names
Solution Ex5.Q1, Q2, Q3 - A Simple Linked List
Solution Ex5.Q4 – List with Stack
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Java Inheritance and Interfaces

Outline

- Person class example
- Inheritance
- Type compatibility
- Polymorphism
- instanceof
- Visibility rules
- Constructor and super()
- Final methods and class
- Abstract classes and methods
- Interfaces
- Abstract classes vs. interfaces
Class Person

Attributes

Accessors

Mutators

Getter and Setter Methods

Person

Name
Age
Address
PhoneNumber

toString

getName
getAge
getAddress
getPhoneNumber

setAddress(newAddress)
setPhoneNumber(newPhoneNumber)
public class Person {
    private String m_name;
    private int m_age;
    private String m_address;
    private String m_phone;

    public Person(String name, int age,
                   String address, String phone) {
        m_name = name; m_age = age;
        m_address = address; m_phone = phone;
    }

    public String toString() {
        return getName() + " is " + getAge() +
                " old and lives in " + getAddress();
    }

    public String getName() { return m_name; }
    public int getAge() { return m_age; }
    public String getAddress() { return m_address; }
    public String getPhoneNumber() { return m_phone; }

    .....
Class Student

Person
Name
Age
Address
PhoneNumber

toString()
getName()
getAge()
getAddress()
getPhoneNumber()

setAddress(newAddress)
setPhoneNumber(newPhoneNumber)

Student
Name
Age
Address
PhoneNumber

Legi

toString()
getName()
getAge()
getAddress()
getPhoneNumber()
getLegi()

setAddress(newAddress)
setPhoneNumber(newPhoneNumber)
public class Student extends Person {

    private String m_legi;

    public Student(String name, int age, 
            String address, String phone, String legi) {
        super(name, age, address, phone);
        m_legi = legi;
    }

    public String toString() {
        return getName() + " is " + getAge() + "old, lives in " + 
        getAddress() + " and has legi-nr.: " + getLegi();
    }

    public String getLegi() { return m_legi; }
}
public class Student extends Person {

    private String m_legi;

    public Student(String name, int age,
                    String address, String phone, String legi){
        super(name, age, address, phone);
        m_legi = legi;
    }

    public String toString() {
        return getName() + " is " + getAge() + " old, lives in " +
            getAddress() + " and has legi-nr.: " + getLegi();
    }

    public String getLegi() { return m_legi; }
}
public class Student extends Person {

    private String m_legi;

    public Student(String name, int age,
                    String address, String phone, String legi){
        super(name, age, address, phone);
        m_legi = legi;
    }

    public String toString() {
        return getName() + " is " + getAge() + "old, lives in " +
        getAddress() + " and has legi-nr.: " + getLegi();
    }

    public String getLegi() { return m_legi; }
}
Inheritance

- Student extends Person
- Student can:
  - Add new fields
    - m_legi
  - Add new methods
    - getLegi()
  - Override existing methods
    - toString()
- Student cannot:
  - Remove fields
  - Remove methods
Why inheritance?

- Better design
- Code reuse
- Code «maintenance»
- Abstraction of the real world
Static & Dynamic Cast

Person p = new Person(...);
Student s = new Student(...);
Employee e = new Employee(...);

Person ps = s $\rightarrow$ ok
Person pe = e $\rightarrow$ ok
Student sp = p $\rightarrow$ compilation error
Student sps = ps $\rightarrow$ compilation error
Student dsps = (Student) ps $\rightarrow$ ok
Employee deps = (Employee) ps $\rightarrow$ runtime error
Static & Dynamic Cast

```java
Person p = new Person(...);
Student s = new Student(...);
Employee e = new Employee(...);
```

- `p instanceof Person` → true
- `p instanceof Student` → false
- `s instanceof Person` → true
- `s instanceof Student` → true
The Object class in Java

- The Object class in Java
  - Is a superclass for all other classes defined in Java's class libraries, as well as for user-defined Java classes.
  - This does not include primitive types (char, int, float, etc.): they are not classes!
- When a class is defined in Java, the inheritance from the Object class is implicit, therefore:

```java
public class MyClass {
    .......
}
```

is equivalent to:

```java
public class MyClass extends Object {
    .......
}
```
The Object class in Java

Quelle: sun.com
Visibility Rules

- **private members**
  - Private members in the base class are **not** accessible to the derived class, and also not to anyone else

- **protected members**
  - Protected members are visible to methods in a derived class and also methods in classes in the same package, but not to anyone outside

- **public members**
  - Everyone
Final Methods and Classes

- A derived class
  - Can \textit{accept} the base class methods
  - Or can \textit{override} the base class methods

- A method declared as \textit{final} in the base class cannot be overridden by any derived class
- A \textit{final} class cannot be extended!
  - E.g. Integer, Character,...
Abstract Classes

- Abstract method
  - Is a method that all derived classes **must** implement

- Abstract class
  - A class that has at least one abstract method

- If a class derived from an abstract class fails to override an abstract method, the compiler will detect an error
  - Eclipse: 'Hint-Bulb' provides help!
Interface

The interface in Java is the ultimate abstract class.

A class can implement many interfaces.

A class implements an interface if it provides definitions for all the methods „declared“ in the interface.

So, both abstract classes and interface provide a specification of what subclasses must do.

But....
Abstract Class vs. Interface

Abstract class
- An abstract class can provide complete code, default code, and/or just stubs that have to be overridden
- May declare methods as protected abstract
- A class may extend only one abstract class

Interface
- An interface cannot provide any code, much less default code
- All methods declared are implicitly public abstract
- A class may implement several interfaces

http://java.sun.com/docs/books/tutorial/java/landl/index.html
Example: Interface IStack

```java
public interface IStack {
    int size();
    void push(Object obj);
    Object pop();
    Object peek();
    boolean empty();
}
```

```java
public class MyStack implements IStack {
    private int size;

    public int size() {
        return size;
    }

    public void push(Object obj) {
        ...
    }
    ...
}
```
Example: Abstract Class BaseStack

```java
public abstract class BaseStack implements IStack {
    public abstract int size();
    public abstract void push(Object obj);
    public abstract Object pop();
    public Object peek() {
        Object top = pop(); push(top); return top;
    }
    public boolean empty() { return size() == 0; }
}
```

```java
public class MyStack extends BaseStack {
    private GenericList first;

    public Object peek() {
        return first.value;
    }

    ...
}
```
Factory Classes

- Intuitively: The idea behind interface is, that functionality is replaceable. However: What is the point behind replaceability, if we have to modify code at several different places, in order to replace objects?

- Therefore: Factory-Classes
Factory-Classes: The difference

interface Thing
    getThing(), setThing()

class SimpleThing implements ThingInterface
class ComplexThing implements ThingInterface

- «Traditional» Implementation (at 100x in the code...):
  Thing myThing = new SimpleThing();

- Implementation with «ThingFactory»:
  Thing myThing = ThingFactory.createThing();
Factory-Classes: ThingFactory

class ThingFactory {
    public static Thing createThing() {
        return new SimpleThing();
    }
}
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Tips for Exercise Sheet 6

- Q1: Classes, Interfaces, Casting
- Q2: Interfaces and Implementation
- Q3: Polymorphism
- Q4: Stack (again): Voluntary Exercise Submission
Hints

A keyword represents an interface

Notation for the dependance of the instantiation of the interface. Thermal sensor instantiates the iSensor interface

Section with attributes (detailed representation)

Section with operations (detailed representation)

Private client as a specialized Person

http://de.wikipedia.org/wiki/Klassendiagramm
Hints Ex6.Q2 – Factory Method

A factory method builds an object which implements a certain interface, but the inner functionality of the object is hidden.

→ Programmer 1 implements different lists which implement the *IList* interface.

→ Programmer 2 uses lists but doesn’t want to know about the functionality. When Programmer 1 writes a new implementation, Programmer has to rewrite all lines of *new ListA()* as *new ListB()*.

→ Programmer 1 puts a factory method at disposal and Programmer 2 can always call for example *Factory.giveMeNewList()* and gets an object from the newest implementation of the *IList* interface.
Hints Ex6.Q3 – Generic Lists

- Exercise sheet 5
  - Elements of the list: Integers
    - `int`

- Exercise sheet 6
  - Elements of the list: generic objects
    - `Object`

- Build your own utility class: `ListUtils`
  - `implements IListUtils: manage generic lists`
    - Compare with the utility classes in Q1 and Q3 of Exercise Sheet 5
    - This time the utility class is instantiated (not static)
Hints Ex6.Q3 – Generic Lists

class List {
    int value;
    List next;

    public List(int v, List e){
        value = v;
        next = e;
    }
}
Hints Ex6.Q3 – Generic Lists

class GenericList {
    Object value;
    GenericList next;

    public GenericList(Object v, GenericList e) {
        value = v;
        next = e;
    }
}
Hints Ex6.Q3a and c – Generic Lists

- Methods are not static anymore!
- Ex5.Q1: `toString`, `add`, `size`
  - Can be practically inherited
- Ex5.q3: `sort`
  - Similar (same idea)
  - Small modifications, so it can work with generic object elements
  - Interface Comparable

```java
public interface Comparable {
    boolean smallerThan(Comparable rhs);
}
```

- You are allowed to caste it to Comparable without checking
Hints Ex6.Q3b

- Trivial

- Will be used in your tests for your list!
  - First implement…
  - …then look for errors in GenericLists 😊
Hints for E6.Q4 : A Stack Again (voluntary)

- Non-trivial (that’s why no point)

- Self-test: Whoever can won’t have any programming problems during the exam.
  - Promised 😊

- Combines the efficiency of arrays with the effortless growth of lists

- Implements the IStack Interface
  - Can be used in u6a2.StackFactory.create()
Have Fun!