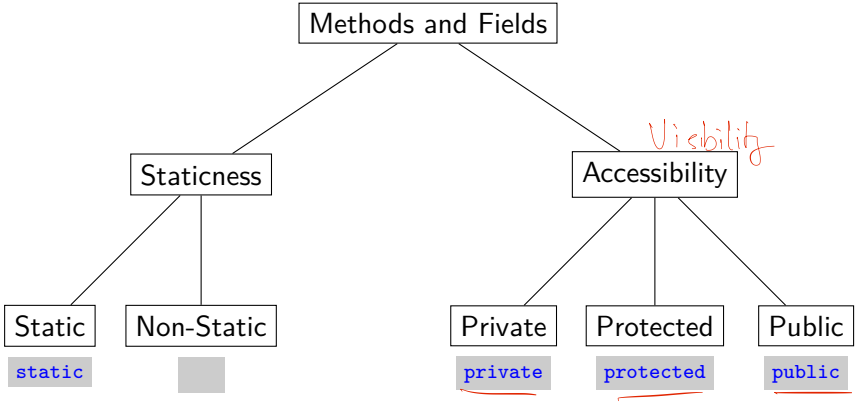
Recap


Methods and Fields
Staticness
Accessibility
Visibility
Static
Non-Static
Private
Protected
Public
static
private
protected
public

Session 9: Inheritance

Softwaretechnologie: Java I

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Section 1

Exercise 8

Section 2

Inheritance

Introduction

Inheritance – “Vererbung”

- Important concept in object-oriented programming
- Classes represent kinds of things, because they show similar behaviour
  - Not all kinds are totally unique
  - Many kinds share certain properties
- E.g. Donkeys move in a similar way as horses do and both are mammals etc.

Introduction

Inheritance – "Vererbung"

- Important concept in object-oriented programming
- Classes represent kinds of things, because they show similar behaviour
  - Not all kinds are totally unique
  - Many kinds share certain properties
- E.g. Donkeys move in a similar way as horses do and both are mammals etc.
- Inheritance allows us to model this
- Many domains have hierarchical structures
  - E.g., animal species, companies, kitchen equipment

Class Inheritance

- A class inherits from another class
- New keyword: `extends`, used in the class declaration:

```
public class Horse extends Animal { ... }
```

- Horse: sub class
- Animal: super class

Class Inheritance

Meaning

- No change in accessibility/visibility rules
  - private fields/methods still not visible, protected only within the same package etc.
- Objects of sub class can execute methods defined in super class
  - E.g., the class Animal can define a walk-method for *all* sub classes

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- Objects of sub class can execute methods defined in super class
  - E.g., the class Animal can define a walk-method for *all* sub classes
- Objects of the sub class can be assigned to variables of the super class
  - `Animal someAnimal = new Horse();`
  - `Animal[] zooAnimals = new Animal[2] { new Horse(), new Donkey() };`
- Casting from sub class to super class ("upwards") always works
  - `Animal someAnimal = (Animal) myHorse;`

demo

Inheritance

Method Overriding

```
1  class Animal {
2    public void step(int size) { /*...*/ };
3  }
4
5  class Horse extends Animal {
6  }
7
8  class Main {
9    public static void main(String[] args) {
10     Horse h = new Horse();
11     h.step(5);
12   }
13 }
```

Inheritance

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- Objects of the sub class can call methods defined in super class

Inheritance

Method Overriding

überschreiben

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Inheritance

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- Methods in sub class override methods in super class
- Calling super method explicitly
  - Outside of sub class by casting: `((Animal)h).step(5);`
  - Inside of sub class with `super`: `super.step(5);`
    - Think of super as `((Animal) this)` (in this case)

Variable Type != Object Type

- Each variable has a type
  - E.g., `int`, `String`, `Horse`, ...
- Each object and value has a type
  - E.g., `int`, `String`, `Horse`, ...

String s = "Hallo";
String

int i = 15;
int

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  - E.g., `Horse h = new Donkey();` ⚠

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  - E.g., `Horse h = new Donkey();` ⚠
- But we can assign a object of a sub class to a variable of a super class
  - E.g., `Animal a = new Horse(); //if Horse extends Animal`

`java.lang.Object`

- All classes inherit automatically from `java.lang.Object`
  - I.e., every object is in an instance of `java.lang.Object` (though maybe indirectly)
- Class provides a few methods

Javadoc

  - `Object clone()` — Kopie des Objekts
  - `boolean equals(Object obj)`
  - `int hashCode()`
  - `String toString()`
  - `void wait()`, `void wait(long timeout)`, `void wait(long timeout, int nanos)`
  - `void notify()`, `void notifyAll()`
  - `void finalize()`
  - `Class<?> getClass()`

Testing Inheritance

- New operator: `isinstance`

```
Horse h = new Horse();

h instanceof Horse;  // true
h instanceof Object; // true
h instanceof String; // false
h instanceof Animal; // true if Horse extends Animal
```

Remarks on Inheritance

- Why inheritance?
  - Model commonalities in our domain
  - The same behaviour can be implement as high as possible in the hierarchy, and only once
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  - In Java: No
    - Because method calls then become ambiguous
  - In C++/Python: Yes!
    - C++: Programmer has to resolve ambiguity with additional syntax
    - Python: Depends on the order in which inheritance has been specified

public class Horse extends Animal, PhysicalBody

Section 3

Exercise