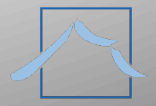
Informatics II for engineering sciences (MSE)

From C to Java: An Introduction into Object Oriented Programming



Goal

- A gentle Introduction in OO Programming
- Assumption: You know C
  - C is an imperative Language
  - you can even write object oriented code in C
  - We use Java

First Challenge – From C to Java

Session Outline

Session #1

- Getting Started (1)
  - Hello World
  - Primitive Data types
- Getting Started (2)
  - Simple Input / Output
  - Control Structures
- Getting Started (3)
  - Classes in Java, Initialization, Class vs. Instance
  - Information Hiding (public, private, protected)

Session #2

- Getting Started (4)
  - Built-In Classes
  - Type Casting vs. Generics
- Getting Started (5)
  - Java's Object Hierarchy
  - Inheritance vs. Polymorphism
  - Abstract Classes / Interfaces
- Getting Started (6)
  - Parameter Passing
  - Exception Handling

Session Outline

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  - Exception Handling

Session #1 – Detailed Outline

Getting Started (1)

- Writing your main-Method - Hello World
- Primitive data types in Java

- Exercise #1:
  - Setup your Development Environment
  - Create your first Project
  - Create and run your main() method

From C to Java: Getting Started (1) Main method

In C you learned how write your main method and compile it using gcc.

```
#include <stdio.h>
int main(int argc, char **argv, char **envp)
{
printf( "\nHello World\n\n" );
return 0;
};
```

gcc main.c -o main

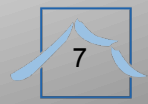
From C to Java: Getting Started (1) Hello World

In Java your main method looks pretty similar

```
public class Main {

    public static void main(String[] args) {
    System.out.println("Hello World!");
    }
}
```

public and static modifiers are explained later during the course

Hint: Can't recall existing specs refer to: http://docs.oracle.com/javase/7/docs/api/



From C to Java: Getting Started (1) Primitive Data Types

Java supports many different data types (1):

```
 // 8 bit signed integer -128 to 127 (inclusive)
byte b = 127;

//16-bit signed integer. It has a minimum value of -32,768 and a maximum value of 32,767 (inclusive)
short shortnumber = 10;

//32-bit signed two's integer, which has a minimum value of -2pow(31) and a maximum value of 2pow(31)-1
int i = 10;

//is a 64-bit two's complement integer. The signed long has a minimum value of -2pow(63) and a max. 2pow(63)-1
long longNumber = 10;

//is a single-precision 32-bit IEEE 754 floating point
float  singlePrecision = 2000;

//is a double-precision 64-bit IEEE 754 floating point
double doublePrecision = 20.0;

//The boolean data type has only two possible values: true and false
boolean bool = true;

//is a single 16-bit Unicode character. It has a minimum value of '\u0000' (or 0) and a
// maximum value of '\uffff' (or 65,535 inclusive).
char character = 'A';
```

(1) http://docs.oracle.com/javase/tutorial/java/nutsandbolts/datatypes.html

From C to Java: Getting Started (1) Exercise #1

- Setup your Development Environment
- Create your first Project
- Create and run your main() method

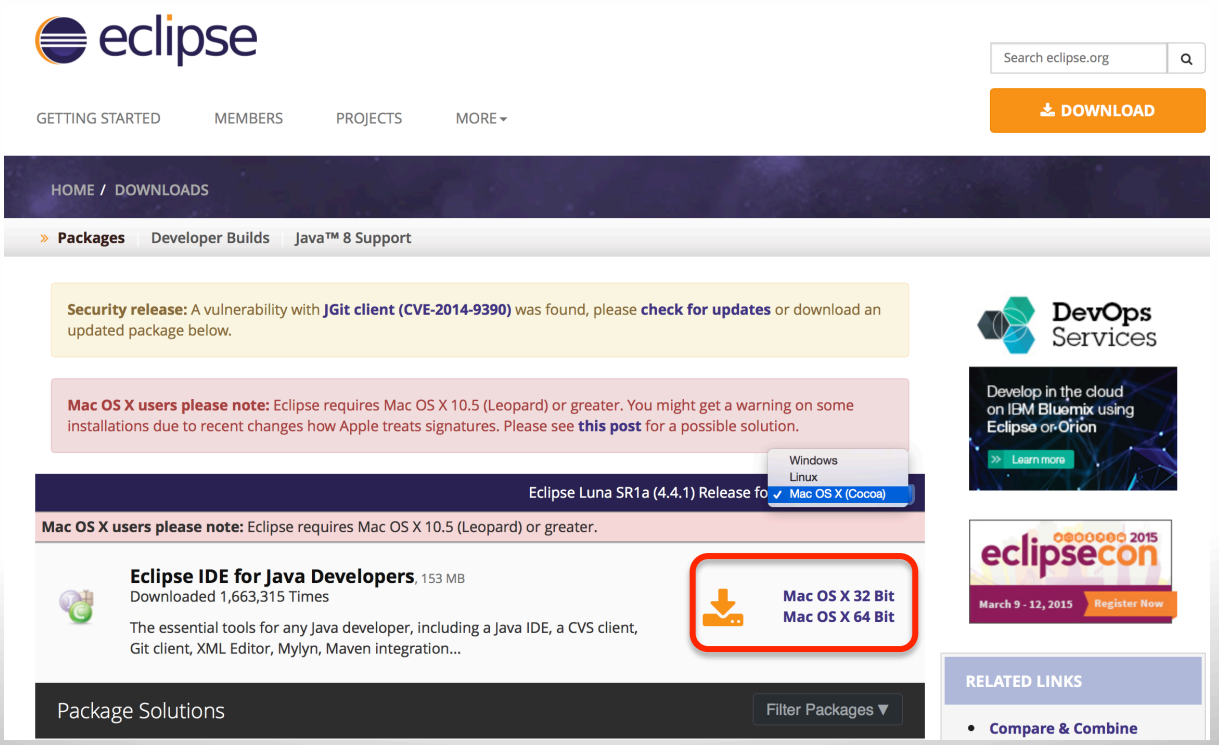
From C to Java: Getting Started (1) Exercise #1

- **Setup your Development Environment (5min)**
- Create your first Project (2min)
- Create and run your main() method (2min)

From C to Java: Getting Started (1) Exercise #1

We use / recommend Eclipse

http://www.eclipse.org/downloads/



From C to Java: Getting Started (1) Exercise #1

Instructions:

- Unpack and Copy Eclipse to your favourite destination
- Start-up Eclipse

From C to Java: Getting Started (1) Exercise #1

- Setup your Development Environment (5min)
- **Create your first Project (2min)**
- Create and run your main() method (2min)

From C to Java: Getting Started (1) Exercise #1

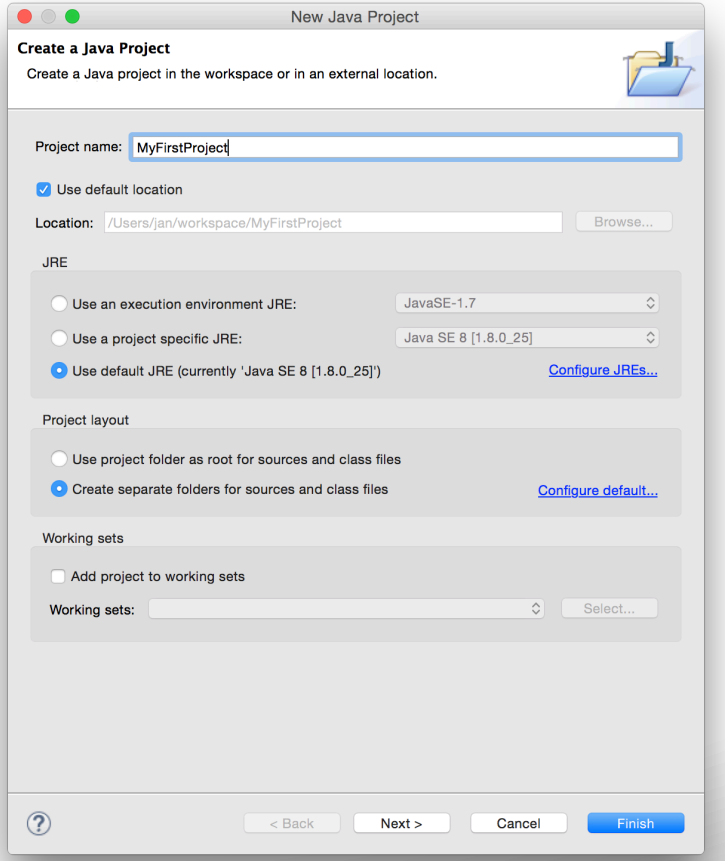
Instructions:

- Create a new Project

(File – New – Java Project)

- Name your Project:

“MyFirstProject”



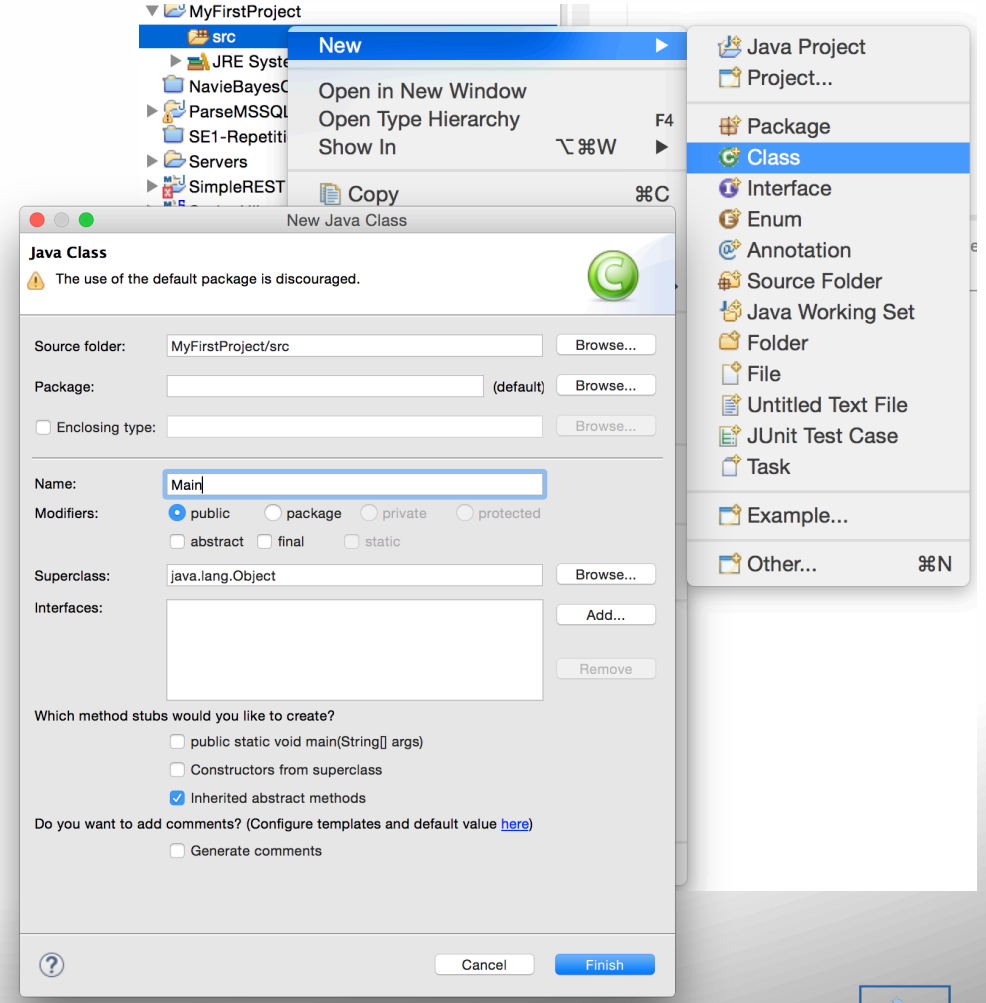
From C to Java: Getting Started (1) Exercise #1

Instructions:

- Create a Class

(File – New – Class)

- Name it “Main”



From C to Java: Getting Started (1) Exercise #1

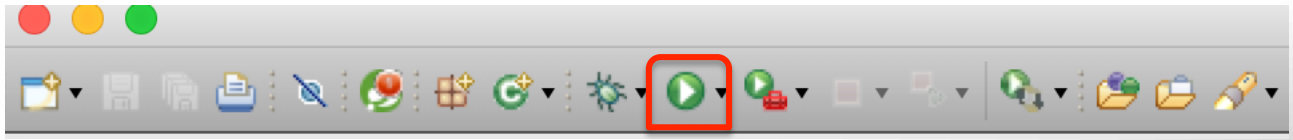
- Setup your Development Environment (5min)
- Create your first Project (2min)
- **Create and run your main() method (2min)**

From C to Java: Getting Started (1) Exercise #1

Instructions:

- Write your main Method
- Click the green “Play” Icon in the Menu bar of eclipse

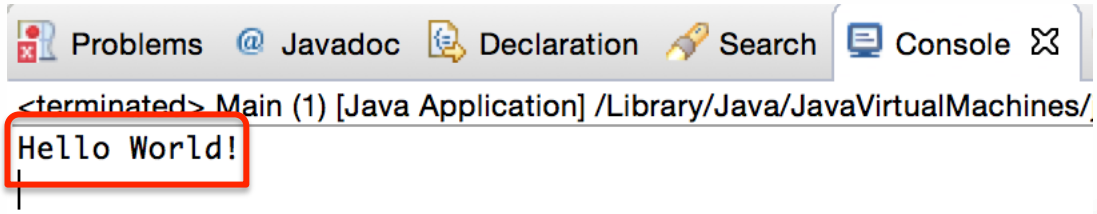
```
public class Main {

    public static void main(String[] args) {
    System.out.println("Hello World!");
    }
}
```



From C to Java: Getting Started (1) Exercise #1

Instructions:

The following Output should appear in the console:



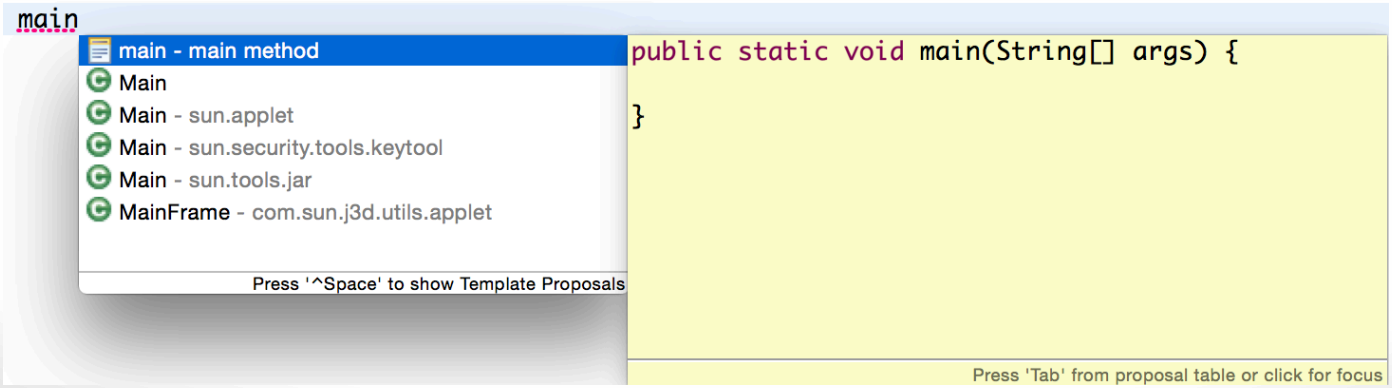
From C to Java: Getting Started (1) Integrated Development Environment

Auto-complete is your best friend ! (Control-Space)

- Well not in the exam. ;-)

Remove your main method and try typing:

- “main” and press Control - Space



Session Outline

Session #1

- Getting Started (1)
  - Hello World
  - Primitive Data types
- Getting Started (2)
  - Simple Input / Output
  - Control Structures
- Getting Started (3)
  - Classes in Java, Initialization, Class vs. Instance
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Session #2

- Getting Started (4)
  - Built-In Classes
  - Type Casting vs. Generics
- Getting Started (5)
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  - Abstract Classes / Interfaces
- Getting Started (6)
  - Parameter Passing
  - Exception Handling

Session #1 – Detailed Outline

Getting Started (2)

- Simple Input, Output
- Control Structures
- Exercise #2:
  - Read keyboard input and write it to the Console
  - Write a simple countdown using:
    - While
    - For
    - Recursion defining your own method (use the static modifier)

From C to Java: Getting Started (2) Simple Input / Output

You already saw an Output of our “Hello world” program.

```
public class Main {

    public static void main(String[] args) {
    System.out.println("Hello World!");
    }
}
```

The System Class Library provides you with Input and Output capabilities by using System.in.(..) or System.out.(..)

From C to Java: Getting Started (2) Simple Input / Output

There are different printers available, printf() is close to the printf() function in C.

```
System.out.print(“Prints text without linebreak");
System.out.println(“Prints text with a linebreak at the end!");
System.out.printf("String: %s \nFloat: %f \nInteger: %d\n\n", "String", 1.0, 1);
```

Since Java SE5 there is a new Class called Scanner which eases reading Inputs from a keyboard

From C to Java: Getting Started (2) Simple Input / Output

Scanner Example:

```
import java.util.Scanner;
public class Main {

    public static void main(String[] args) {
        System.out.println("Write your name and press Enter");
        Scanner readData = new Scanner(System.in);
        System.out.println("Hello, " + readData.next() + "!");
        readData.close();
    }
}
```

From C to Java: Getting Started (2) Control Structures

For Statement:

Parameters:

(counter init; counter limit; counter increase)

```
for (int i=0; i<10; i++){

// do something

}
```

While Statement:

Parameters:

(counter limit)

```
int c = 10;
while (c >= 0) {

// do something

}
```

From C to Java: Getting Started (2) Control Structures

Switch Statement:

Parameters:

switch(expression), case(constant)

```
int dice=5;
    switch (dice) {
    case 1:
        //if dice is rolled 1
        break;
    case 2:
        //if dice is rolled 2
        break;
    default:
        break;
    }
```

Command Statement:

Parameters:

while(expression)

```
int counter = 10;
        do {
            counter--;
        }while(counter > 0);
```

From C to Java: Getting Started (2) Exercise #2

- Read keyboard input and write it to the Console
- Write a simple countdown using: while, for, recursion

From C to Java: Getting Started (2) Exercise #2

- **Read keyboard input and write it to the Console (5min)**
- Write a simple countdown using: while, for, recursion (5min)

From C to Java: Getting Started (2) Exercise #2

Instructions:

- Use your existing Main Class and main() method to read from the console using the Scanner class and System.in

- Print the Input back to the Console.

From C to Java: Getting Started (2) Exercise #2 - Solution

Read keyboard input and write it to the Console

```
public static void main(String[] args) {
System.out.println("Enter your name and press Enter:");
        Scanner s = new Scanner(System.in);
        System.out.println("Hello, " + s.nextLine() + "!");
    }
```

```
Enter your name and press Enter:
Jan
Hello, Jan!
```

From C to Java: Getting Started (2) Exercise #2

- Read keyboard input and write it to the Console
- **Write a simple countdown using: while, for, recursion (5min)**

From C to Java: Getting Started (2) Exercise #2

- Recall the structure of for- and while-statements
- Write a countdown which counts down to 0 using System.out.() methods

```
for (int i=0; i<10; i++){

// do something

}
```

```
int c = 10;
while (c >= 0) {

// do something

}
```

From C to Java: Getting Started (2) Exercise #2 - Solution

Write a simple countdown using: while, for, recursion

```
for (int i=10; i>=0; i--){
        System.out.println(i);
    }
```

```
int i = 10;
while (i >= 0) {
System.out.println(i--);
}
```

```
public static int recursiveCounter(int i) {
        if (i < 0) {
            return 0;
        }
        System.out.println(i);
        return recursiveCounter(--i);
}
```

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Session #2

- Getting Started (4)
  - Built-In Classes
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- Getting Started (5)
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  - Inheritance vs. Polymorphism
  - Abstract Classes / Interfaces
- Getting Started (6)
  - Parameter Passing
  - Exception Handling

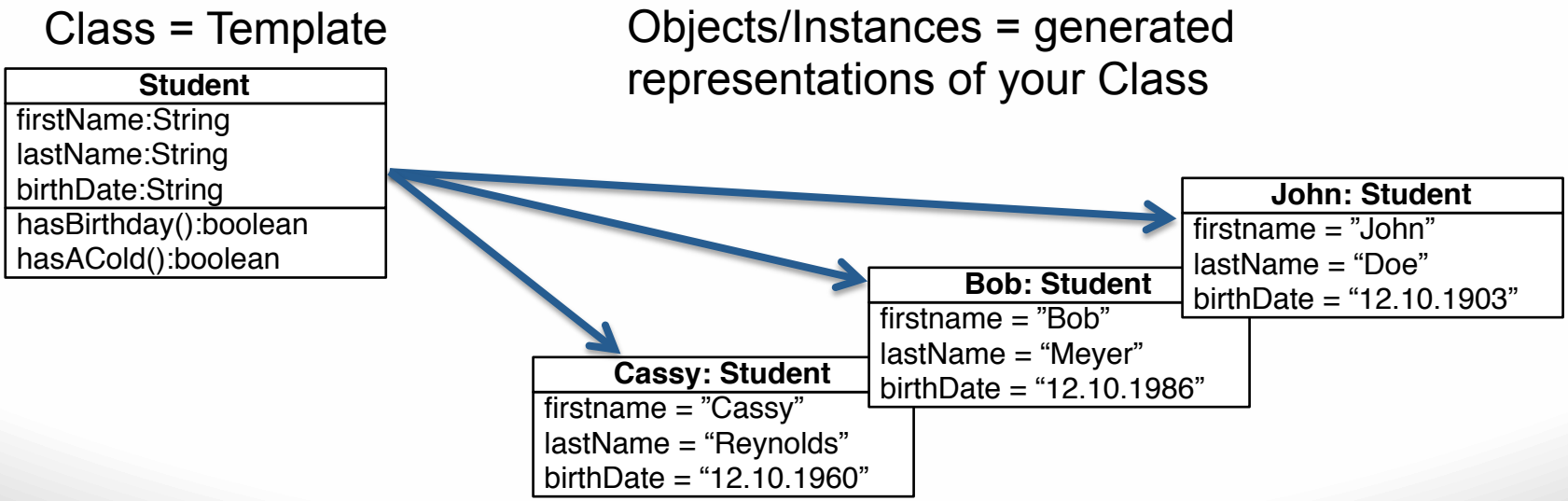
Session #1 – Detailed Outline

Getting Started (3)

- Classes in Java, Initialization, Class vs. Instance
- Information Hiding (public, private, protected)
- Exercise #3:
  - Write your own class (Student)
  - Add Constructor to your class
  - Make sure a birthdate can not be changed after creation

From C to Java: Getting Started (3) Classes in Java

What is a Class? – It's a template to describe your own or existing complex data types



From C to Java: Getting Started (3) Classes in Java

Define a Class

```
public class Student {

    String firstName;
    String lastName;
    String birthDate;
}
```

Create an Instance/Object

In your main() method:

```
Student bob = new Student();
```

From C to Java: Getting Started (3) Classes in Java

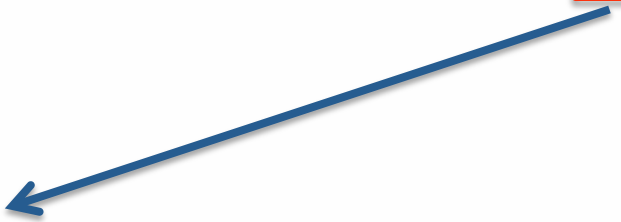
Object initialization by using a „***Constructor***“

The default Constructor is available implicitly

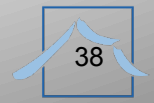
```
public class Student {
    String firstName;
    String lastName;
    String birthDate;

    public Student() {
    //do something in here..
    }
}
```

```
Student bob = new Student();
```



So everything is fine? – What do we miss?



From C to Java: Getting Started (3) Classes in Java

Drawback of using the default Constructor:

Attribute values are not assigned during Instance/Object creation

Example:

```
...
Student bob = new Student();
System.out.println(bob.firstName);
// -> returns „null“
...
```

Hint: Access class attributes by using the dot-Notation. (className.attributeName)

From C to Java: Getting Started (3) Classes in Java

The Solution: Write your own Constructor

```
public class Student {
    String firstName;
    String lastName;
    String birthDate;

    public Student(String firstName, String lastName, String birthDate)
    {
        this.firstName = firstName;
        this.lastName  = lastName;
        this.birthDate = birthDate;
    }
}
```

class attributes — method parameters

What is “this”? – Why do we need it?

From C to Java: Getting Started (3) Information Hiding

Information Hiding is a very important principle in Object Oriented Programming:

Modifiers:

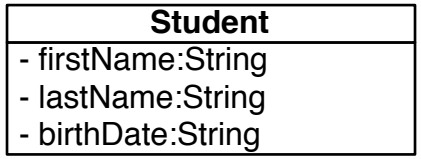
public:	access from every class
private:	no access outside class
protected:	access from specialisations
package:	access inside a package
default:	access inside a package

From C to Java: Getting Started (3) Information Hiding

Example Code:

```
public class Student {
 private String firstName;
 private String lastName;
 private String birthDate;
}
```

Corresponding Diagram:



From C to Java: Getting Started (3) Information Hiding

Access methods (Getter/Setter) help to access your Attributes even if they are private:

```
public class Student {
    private String firstName;
    private String lastName;
    private String birthDate;

    public String getFirstName() {
        return firstName;
    }
    public void setFirstName(String firstName) {
        this.firstName = firstName;
    }
    ...
    }
}
```

Student
- firstName:String - lastName:String - birthDate:String
+ getFirstName():String + setFirstName(firstName:String):void + getLastName():String + setLastName(lastName:String): void + getBirthDate():String + setBirthDate(birthDate:String) : void

From C to Java: Getting Started (3) Information Hiding

Access methods vs. public parameters:

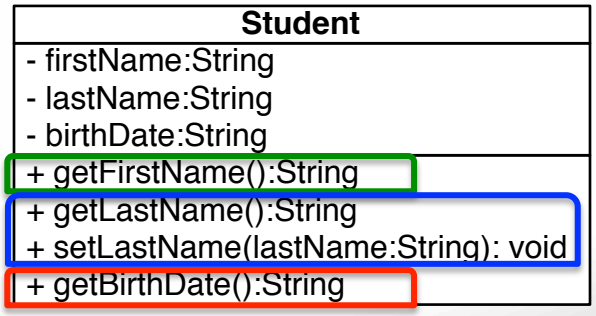
Access methods are more fine granular according to read and write access

e.g.

read firstName

read/write lastName

read birthDate



From C to Java: Getting Started (3) Exercise #3

- Write your own Class (Student)
- Add a Constructor to your Class
- Make sure the “birthDate” parameter can not be changed after the Student Instance has been created.

From C to Java: Getting Started (3) Exercise #3

- **Write your own Class (Student) (2min)**
- Add a Constructor to your Class (2min)
- Make sure the “birthDate” parameter can not be changed after the Student Instance has been created. (3min)

Refer to the following model to create your Student class:

Student
firstName:String lastName:String birthDate:String

From C to Java: Getting Started (3) Exercise #3 - Solution

Write your own Class (Student)

```
public class Student {
    String firstName;
    String lastName;
    String birthDate;
}
```

From C to Java: Getting Started (3) Exercise #3

- Write your own Class (Student) (2min)
- **Add a Constructor to your Class (2 min)**
- Make sure the “birthDate” parameter can not be changed after the Student Instance has been created.(3min)

From C to Java: Getting Started (3) Exercise #3 - Solution

Add a Constructor to your Class

```
public class Student {
    String firstName;
    String lastName;
    String birthDate;

    public Student(String firstName, String lastName, String birthDate) {

        this.firstName = firstName;
        this.lastName  = lastName;
        this.birthDate = birthDate;
    }
}
```

class attributes method parameters

From C to Java: Getting Started (3) Exercise #3

- Write your own Class (Student) (2min)
- Add a Constructor to your Class (2min)
- **Make sure the “birthDate”parameter can not be changed after the Student Instance has been created. (3 min)**

Hint: Use access methods (getter and setter) to implement different access

From C to Java: Getting Started (3) Exercise #3 – Solution

Make sure the "birthDate" parameter can not be changed after the Student Instance has been created.

```
public class Student {
     String firstName;
     private String lastName;
     String birthDate;

public Student(String firstName, String lastName, String birthDate) {

          this.firstName = firstName;
          this.lastName  = lastName;
          this.birthDate = birthDate;
     }

     public String getBirthDate() { // birthDate read access
          return birthDate;
     }
     // getters and setters for firstName and lastName
}
```

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Session #2 – Detailed Outline

Getting started (4)

- Built-In Classes:
  - LinkedList, HashMaps, Stacks, Queues
- Type Casting vs. Generics
  - Runtime errors vs. Compile time errors
- Exercise #4:
  - Write a LinkedList for your own Class (Student)
  - Add Elements to LinkedList and Iterate over them to print out each firstName

From C to Java: Getting Started (4) Build-in Classes

In C you already learned how to write a Queue and Stack. Java provides various different build-in classes for reuse:

java.util.Stack,	methods: push(), pop(), peek()
java.util.Queue,	methods: poll(), add(), peek()
java.util.LinkedList,	methods: add(), remove()
java.util.HashMap,	methods: put(key,value), remove(key)

...

From C to Java: Getting Started (4) Build-in Classes

Use of existing Classes:

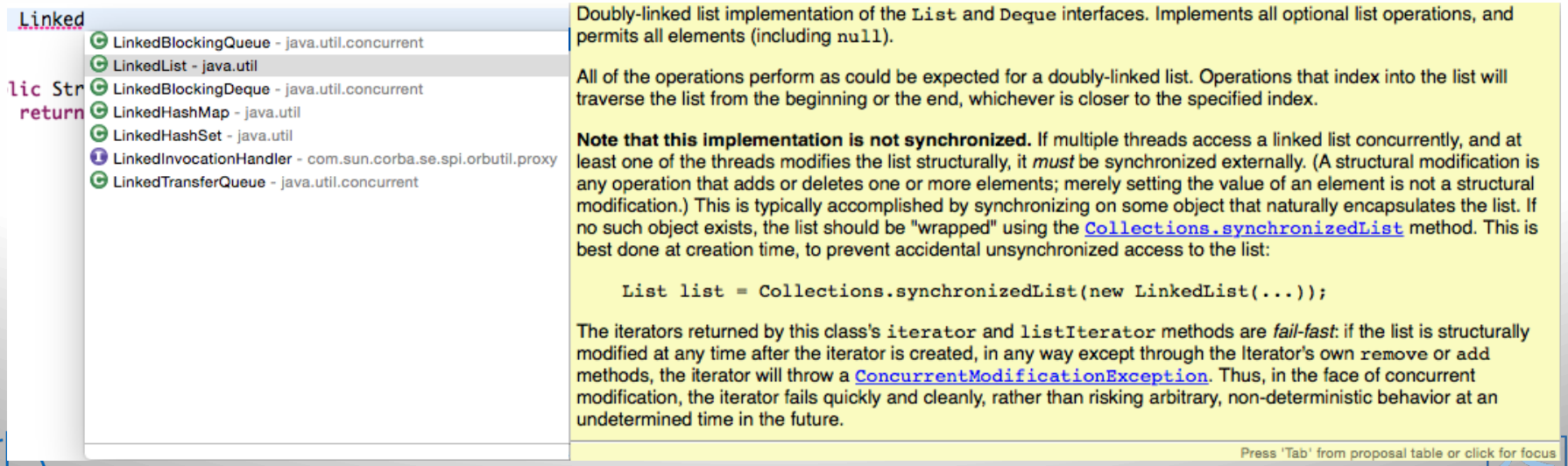
1. Import the needed Classes
2. Initialize the Class using the given Constructor
3. Call methods on the Class using the dot operator

From C to Java: Getting Started (4) Build-in Classes

Example: Implementing a LinkedList:

Start typing: “Linked” use Ctrl + Space

```
import java.util.LinkedList;

public static void main(String[] args) {
LinkedList<String> stringList = new LinkedList<String>();
}
```



From C to Java: Getting Started (4) Type Casting vs. Generics

In Java typed parameters are called Generics:

Typed Parameter: A restriction onto a Parameter which only allows a subset of accepted class types.

Example:

A list which only allows Student Objects to be added.

```
LinkedList<String> stringList = new LinkedList<String>();
```

From C to Java: Getting Started (4) Type Casting vs. Generics

Type-Cast Example:

What will happen if you try compile and run this code?

```
LinkedList genericList = new LinkedList();
Car car = new Car();
genericList.add(car);
Student studentInList = (Student) (genericList.get(0));
System.out.println(studentInList.firstName);
```

Runtime Exception:

java.lang.ClassCastException: X cannot be cast to Y

From C to Java: Getting Started (4) Type Casting vs. Generics

Generics Example:

What will happen if you try compile and run this code?

```
LinkedList<Student> studentList = new LinkedList<Student>();
Car car = new Car();
studentList.add(car);
```

Compile Time Exception:

java.lang.Error: Unresolved compilation problem

From C to Java: Getting Started (4) Exercise #4

- Write a LinkedList for your own Class (Student)
- Add Elements to LinkedList and Iterate over them to print out each firstName

From C to Java: Getting Started (4) Exercise #4

- **Write a LinkedList for your own Class (Student) (2min)**
- Add Elements to LinkedList and Iterate over them to print out each firstName (2min)

Hint: Use <Student> as Generic specification to avoid a typecast

From C to Java: Getting Started (4) Exercise #4 – Solution

Write a LinkedList for your own Class (Student)

```
public static void main(String[] args) {
    LinkedList<Student> studentList = new LinkedList<Student>();
    }
```

From C to Java: Getting Started (4) Exercise #4

- Write a LinkedList for your own Class (Student) (2min)
- **Add Elements to LinkedList and Iterate over them to print out each firstName (2min)**

Hint: Use the for-each construct to easily iterate over your List

for (Student s : studentList) {//access student s}

From C to Java: Getting Started (4) Exercise #4 – Solution

Add Elements to LinkedList and Iterate over them to print out each firstName

```
public static void main(String[] args) {
        LinkedList<Student> studentList = new LinkedList<Student>();
        Student john = new Student("John", "Doe", "12/12/1995");
        Student james = new Student("James", "Bond", "12/10/1983");
        Student sam = new Student("Sam", "Smith", "12/08/1863");
        studentList.add(john);
        studentList.add(james);
        studentList.add(sam);

        for (Student s : studentList) {
            System.out.println(s.firstName);
        }
    }
```

Session Outline

Session #1

- Getting Started (1)
  - Hello World
  - Primitive Data types
- Getting Started (2)
  - Simple Input / Output
  - Control Structures
- Getting Started (3)
  - Classes in Java, Initialization, Class vs. Instance
  - Information Hiding (public, private, protected)

Session #2

- Getting Started (4)
  - Built-In Classes
  - Type Casting vs. Generics
- Getting Started (5)
  - Java's Object Hierarchy
  - Inheritance vs. Polymorphism
  - Abstract Classes / Interfaces
- Getting Started (6)
  - Parameter Passing
  - Exception Handling

Session #2 – Detailed Outline

Getting started (5)

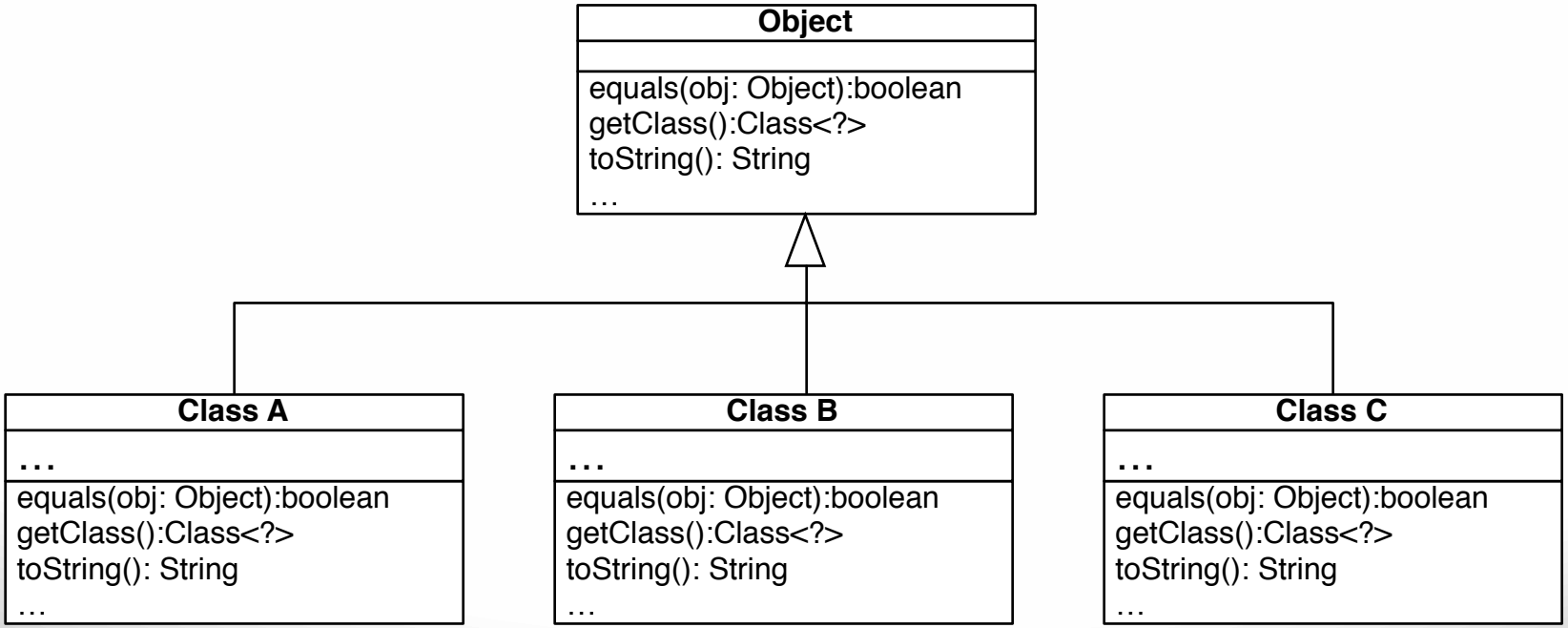
- Java's Object Hierarchy
- Inheritance vs. Polymorphism

- Exercise #5:
  - Create your own class hierarchy for GroundVehicles
  - Override the toString() Method for Car and Motorcycle

From C to Java: Getting Started (5) Java's Object Hierarchy

In Java almost everything is an Object

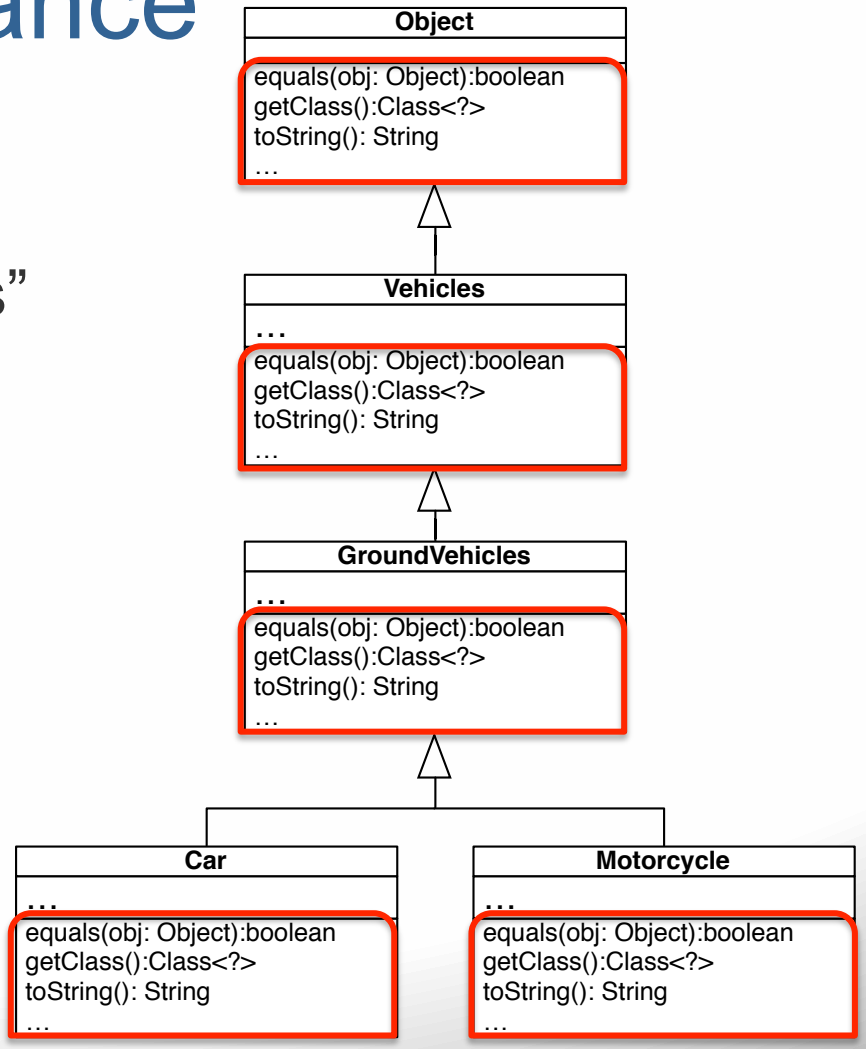
So what is not an Object in Java?



From C to Java: Getting Started (5) Inheritance

Inheritance allows us to access attributes and methods of the "Superclass" in the "Child classes"

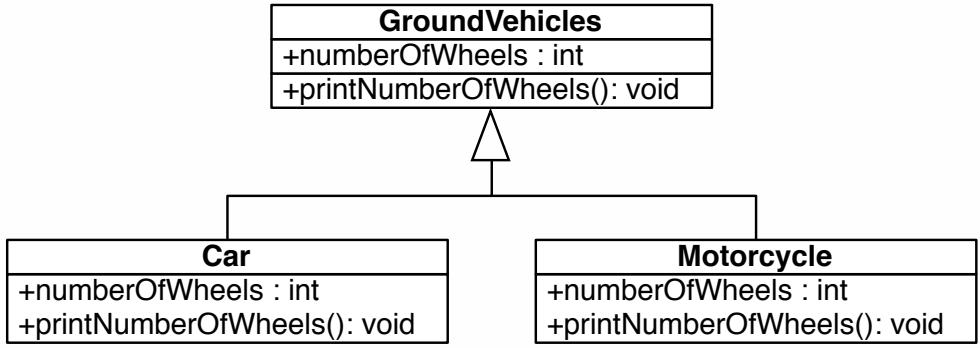
In other words existing behaviour and elements can be reused



From C to Java: Getting Started (5) Inheritance

Lets create our own Class hierarchy:

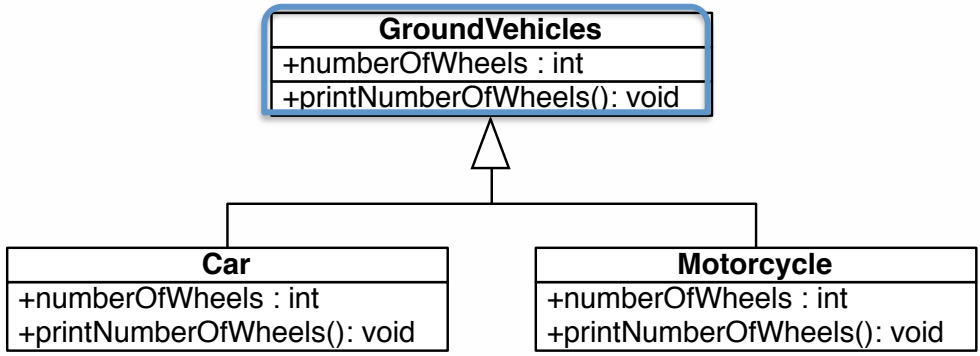
GroundVehicles should be the superclass and Car and Motorcyle should be Child/ Sub-classes



From C to Java: Getting Started (5) Inheritance

Creating our own hierarchy:

1. Create the Superclass

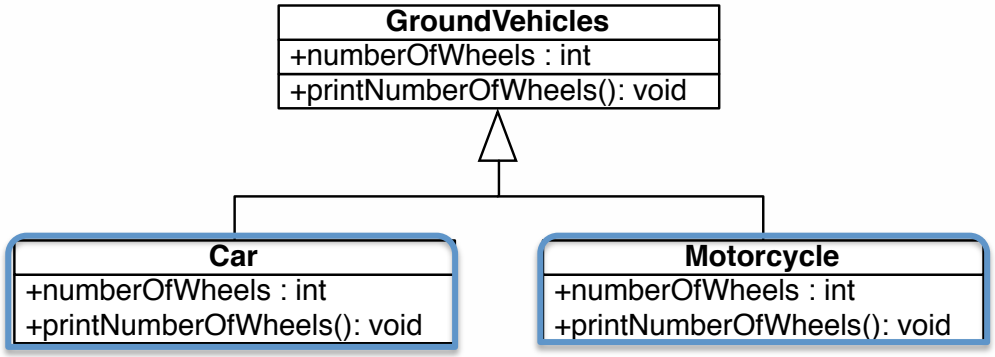



```
public class GroundVehicles {

    int numberOfWheels;

    public GroundVehicles(int numberOfWheels) {
        this.numberOfWheels = numberOfWheels;
    }
    public void printNumberOfWheels() {
        System.out.println("This Vehicle has " + numberOfWheels +
"Wheels!");
    }
}
```

From C to Java: Getting Started (5) Inheritance

Creating our own hierarchy:

2. Create Child/Sub- Classes




```
public class Car {

}
```

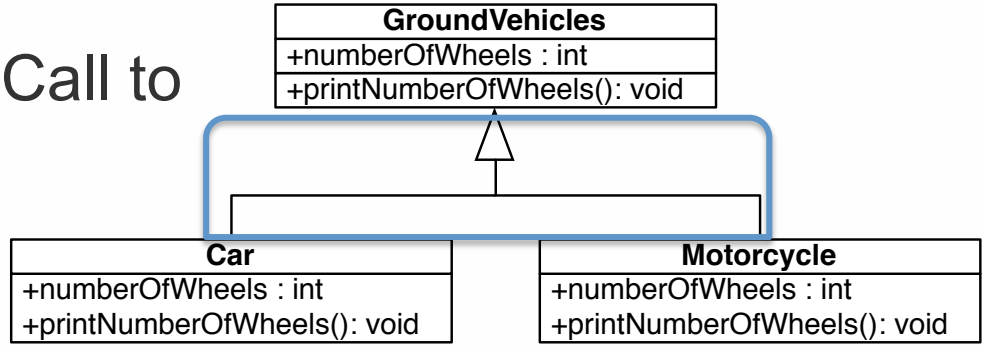
```
public class Motorcycle {

}
```

From C to Java: Getting Started (5) Inheritance

Creating our own hierarchy:

3. Create Relationship using the ***extends*** keyword:

Use a ***super()*** – Constructor Call to pass data to our Superclass




```
public class Car extends GroundVehicles{

    public Car(int numberOfWheels) {
        super(numberOfWheels); //call constructor of GroundVehicles
    }
}
```