COMP 110-003
Introduction to Programming
More Methods – Constructors, Overloading and Static

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Methods

```
public class Student
{
    private String name;
    private int age;

    public void setName(String studentName) {
        name = studentName;
    }
    public void setAge(int studentAge) {
        age = studentAge;
    }
    public String getName() {
        return name;
    }
    public int getAge() {
        return age;
    }
}
```

Mutators

Accessors

return Statement

- A method that returns a value must have *at least one* return statement
- Terminates the method, and returns a value
- Syntax:
  - return Expression;
- Expression can be any expression that produces a value of type specified by **the return type** in the method heading

Methods

```
public String getMajor()
{
    return major;
}

public void increaseYear()
{
    classYear++;
}
```

returns a String

return type

returns nothing

Methods that Return a Value

As usual, inside a block (defined by braces), you can have multiple statements

```
public String getClassYear()
{
    if (classYear == 1)
        return “Freshman”;
    else if (classYear == 2)
        return “Sophomore”;
    else if ...
}
```


return Statement

- Can also be used in methods that return nothing
- Simply terminates the method
- Syntax:
  - return;

```
public void increaseYear()
{
    if (classYear >= 4)
        return;
    classYear++;
}
```


Methods with Parameters

- Parameters are used to hold the value that you pass to the method
- Parameters can be used as (local) variables inside the method

```
public int square(int number)
{
    return number * number;
}
```

Parameters go inside the parentheses of method header

Calling a Method with Parameters

```
public static void main(String[] args)
{
    Student jack = new Student();
    jack.setName("Jack Smith");
    jack.setClassYear(3);
}
```

Parameters/
Arguments

Methods with Multiple Parameters

- Multiple parameters separated by commas

```
public double getTotal(double price, double tax)
{
  return price + price * tax;
}
```

- When calling a method, the order, type, and number of arguments must match parameters specified in method heading

Today's Topics

- Constructors
- Overloading methods
- Static variables and methods

Constructors

- Create and initialize new objects
- Special methods that are called when (and **only** when) creating a new object

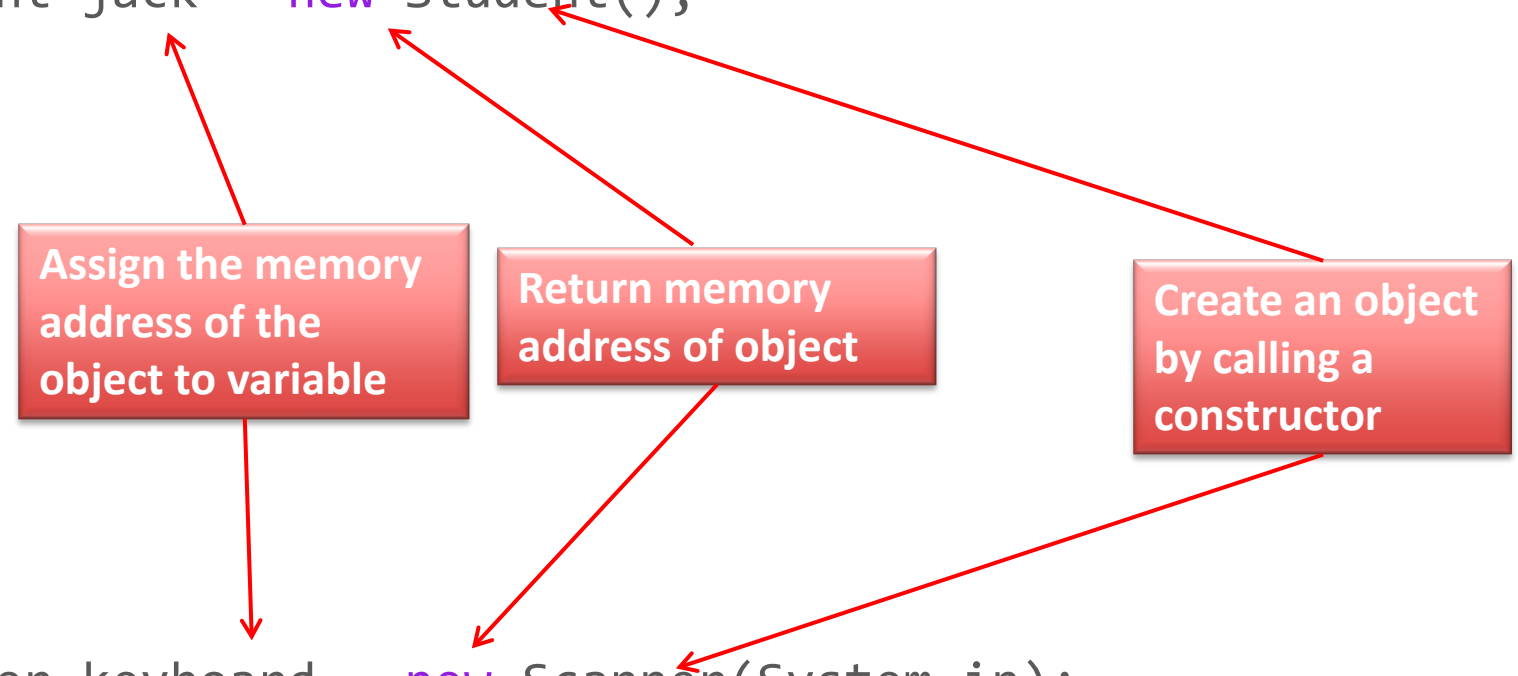
```
Student jack = new Student();
```

Calling a constructor

Creating an Object

Create an object *jack* of class *Student*

```
Student jack = new Student();
```




```
Scanner keyboard = new Scanner(System.in);
```

Create an object *keyboard* of class *Scanner*

Constructors

- Can perform any action you write into a constructor's definition
  - There are no specific rules about what's in a constructor
- Meant to perform initializing actions
  - Usually, initializing values of instance variables by the creator of the object

Similar to Setter Methods

- However, constructors *create* an object in addition to setting the values of instance variables
- Like methods, constructors can have parameters

Example: Pet class

```
public class Pet
{
    private String name;
    private int age;
    private double weight;

    public Pet()
    {
        name = "No name yet.";
        age = 0;
        weight = 0;
    }

    public static void main(String[] args)
    {
        Pet p = new Pet();
    }
}
```

Default constructor

Call constructor

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The Same as Initialization

```
public class Pet
{
    private String name = "No name yet.";
    private int age = 0;
    private double weight = 0;


    public static void main(String[] args)
    {
        Pet p = new Pet();
    }
}
```

Default constructor not declared – but still exists

Call default constructor (so an object is created)

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Default Constructor

- Constructor that takes no parameters

```
public Pet()
{
    name = “No name yet.”;
    age = 0;
    weight = 0;
}
```

- Java automatically defines a default constructor if you do not define any constructors
  - You’ve never written a constructor but you can still create objects

Constructors with Parameters

```
public class Pet
{
    private String name;
    private int age;
    private double weight;

    public Pet(String initName, int initAge, double initWeight)
    {
        name = initName;
        age = initAge;
        weight = initWeight;
    }

    public void setPet(String newName, int newAge, double newWeight)
    {
        name = newName;
        age = newAge;
        weight = newWeight;
    }

}
```

Another version of constructor that has parameters

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A Closer Look

Same name as class name

```
public Pet(String initName, int initAge, double initWeight)
{
    name = initName;
    age = initAge;
    weight = initWeight;
}
```

Body

Parameters

No return type

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Constructors with Parameters

- If you define at least one constructor, a default constructor will **not** be created for you
- Now you **must** create a Pet object like this:
  - `Pet odie = new Pet("Odie", 3, 8.5);`
  - `Pet odie = new Pet(); // WRONG! No default constructors!`

```
public class Pet {
    private String name;
    private int age;
    private double weight;
    public Pet(String initName, int initAge, double initWeight)
    {
        name = initName; age = initAge;   weight = initWeight;
    }
}
```

Multiple Constructors

- You can have several constructors per class
  - They all have the same name, just different parameters
    - Remember that the name is **the same as the class name**
  - The methods (with the same name) will be called according to its parameters

Multiple Constructors

```
public class Pet {
    private String name;
    private int age;
    private double weight;

    public Pet() {
        name = "No name yet.";
        age = 0;
        weight = 0;
    }

    public Pet(String initName, int initAge, double initWeight) {
        name = initName;
        age = initAge;
        weight = initWeight;
    }

    public static void main(String[] args)  {
        Pet p = new Pet();
        Pet q = new Pet("Garfield", 3, 10);
    }
}
```


Multiple Constructors

```
public class Pet {
    private String name = "No name yet.";
    private int age = 0;
    private double weight = 1; // The instance variables are initialized

     public Pet() {
          name = "No name yet.";
          age = 0;
          weight = 0;
     }

     public Pet(String initName, int initAge, double initWeight) {
          name = initName;
          age = initAge;
          weight = initWeight;
     }

     public Pet(String initName) {
          name = initName;
     }

     public static void main(String[] args) {
          Pet p = new Pet(); // p.weight is 0 – it is overwritten by constructor
          Pet q = new Pet("Garfield", 3, 10);
          Pet w = new Pet("Odie"); // w.weight is 1, as only one constructor
//can be called. Variables will get initial value if not set in constructor.
     }
}
```


Calling a Constructor

- A constructor can be only called once when the object is created
  - `Pet odie = new Pet("Odie", 3, 8.5);`
- You can not invoke a constructor from an object
  - `odie.Pet("Odie", 3, 8.5);`
    `// Wrong! A constructor can not be invoked this way`
  - `odie.setPet("Odie", 3, 8.5);`
    `// Yes. You can use a setter instead`

Call a Setter from the Constructor

```
public class Pet
{
    private String name;
    private int age;
    private double weight;

    public Pet(String initName, int initAge, double initWeight)
    {
        setPet(initName, initAge, initWeight);
    }

    public void setPet(String newName, int newAge, double newWeight)
    {
        name = newName;
        age = newAge;
        weight = newWeight;
    }

}
```

You are allowed to do that so your code is reused. However, it is not acceptable if you are using inheritance.

Initializing and Setting Instance Variables

- Initialization values give values to instance variables that are the same (or commonly the same) for all objects
- Constructors give values to instance variables that should be decided for each object
- Setters give values to instance variables that can be changed during time
  - If a value is never going to be changed, no setter is needed

Example: Initialize, Construct and Set

```
public class Pet {
    private String name;
    private int age = 0;
    // Age is always 0 (assuming newly-born pets are registered immediately)
    private double weight;

    public Pet(String initName, double initWeight){
        name = initName;
        weight = initWeight;
        // Name is given when registering, and can not be changed
    }

    public void setPetWeight(double newWeight) {
        weight = newWeight;
        // Weight changes every time you weight your pet
    }

    public void setPetAge(double newAge) {
        age = newAge;
        // Surely age can change, too
    }
}
```

Summary: Constructor

- A special method with the same name as the class, and no return type
- Called only when an object is created
- It can take parameters to initialize instance variables
- You can define multiple constructors with different parameter lists

Methods Overloading

- We've seen that a class can have multiple constructors. Notice that they have the same name

```
public class Pet {
    public Pet() {…}
    public Pet(String initName, int initAge, double initWeight)
    {…}
    public Pet(String initName) {…}
    public static void main(String[] args) {
        Pet p = new Pet(); // First constructor will be called
        Pet q = new Pet("Garfield", 3, 10); // Second constructor
        Pet w = new Pet("Odie"); // Third constructor
        Pet u = new Pet("Nermal", 2); // Wrong – no matching method
    }
```

Overloading

- Using the same method name for two or more methods *within the same class*
  - It's not only for constructors
- Parameter lists must be different
  - `public double average(int n1, int n2)`
  - `public double average(double n1, double n2)`
  - `public double average(double n1, double n2, double n3)`
- Java knows what to use based on the number and types of the arguments

Overloading

- Java knows what to use based on the number and types of the arguments
  - You've used overloading before
    - `System.out.println("The result is"); // String type parameter`
    - `System.out.println(20); // int type parameter`
- Java makes the decision based on a method's **signature**

Method Signature

- The signature includes a **method's name** and the **number and types** of its **parameters**
  - `Pet q = new Pet("Garfield", 3, 10);`
  - `Pet w = new Pet("Odie");`
- Signature does NOT include return type
  - Cannot have two methods with the same signature in the same class
  - `public double average(int n1, int n2)`
  - `public int average(int n1, int n2) // Wrong overloading`
  - Java won't know what method to call if average(1,2) is invoked

Overloading and Type Conversion

- Java always tries to find an exactly matching method. If it fails, it tries type conversion
  - If a class has the following two methods:
  - `public double average(int n1, int n2)`
  - `public double average(double n1, double n2)`
    - If the method call is average(3,3), the first method will be called
  - However, if a class only have this method:
  - `public double average(double n1, double n2)`
    - If the method call is average(3,3), it will be converted to average(3.0,3.0) and call the (only) method
  - Recall: byte->short->int->long->float->double

How to Use Overloading

- Use it only if two or more methods are performing exactly the same function
  - `public void setPet(String newName)`
  - `public void setPet(String newName, int newAge, double newWeight)`
- It is a very bad idea to create methods that have the same name but do different things
  - `public void setPet(int newAge)`
  - `public void setPet(double newWeight)`
  - What happens if we call setPet(3)? What about setPet(3.0)?
    - Use setAge() and setWeight() instead
    - Usually we do not overload methods if parameters can be converted

Summary: Overloading

- Overloading means several methods share the same name but have different parameters
- Java calls the methods according to the parameter numbers and types
  - The name, parameter number and parameter type form the method signature
- Make sure that they do the same thing. Otherwise the user will be confused

Static Variables and Methods

- Instance variables

```
private int age;
private String name;
```

- Methods

```
public int getAge()
{
    return age;
}
```

- Calling methods on objects

```
Student std = new Student();
std.setAge(20);
System.out.println(std.getAge());
```

Static Variables and Methods

- Recall that "classes do not have data; individual objects have data"
- This is not always true – classes can have data, too
  - **static** variables and methods **belong to a class as a whole**, not to an individual object
  - When would you want a method that does not need an object?
    - If the method perform a general function instead of actions on an object

Static Variables and Methods

```
// Returns x raised to the yth power, where y >= 0.
public int pow(int x, int y)
{
    int result = 1;
    for (int i = 0; i < y; i++)
    {
        result *= x;
    }
    return result;
}
```

Do we need an object to call this method?

Static Variables and Methods

- We have seen static variables and methods before
  - `private static final int FACE_DIAMETER = 200;`
    - Recall that “final” means “not changable”
  - `public static void main(String[] args)`
  - Static can describe more than constants and main method
    - Static variables are sometimes referred as “global variables”, which record the global status of all objects in the same class
    - Static methods are used for actions that do not relate to a certain object
      - main method is a static method because if you execute a program, this entrance is not owned by an object

Instance vs. Static

- Instance variables and methods
  - `private int name;`
  - `public void setName(String newName){}`
- Static variables and methods
  - `private static int totalNumber;`
  - `public static int getTotalNumber(){}`

Instance vs. Static

- In an instance method
  - Instance variables/methods can be called
  - Static variables/methods can also be called
    - Eg: you can call a static method pow(x,y) anywhere in a class
- In a static method
  - **Only** static variables/methods can be called
  - Instance variables/methods can be only called if they are invoked from an object
    - Instance variables include "**this**"

Invoking Instance and Static Methods

- From an object, both instance and static variables/methods can be invoked
  - *ObjectName.var;*
  - However, static variables/methods keep the same for the same type objects
- From a class, only static variables/methods can be invoked
  - *ClassName.var;*
  - You are suggested to call static variables/methods this way

Example: Static Variables and Methods

```
public class Pet {
	private String name;
	private static int totalNumber = 0;
	// totalNumber is initialized when the first object is created

	public Pet(String initName) {
		this.name = initName;
		// Recommended: use "this" to call instance variables
		totalNumber++; // totalNumber can be accessed in an instance method
		System.out.println("Total pet number is " + Pet.getTotalNumber());
		// Recommended: use class name to call static variables
	}

	public static int getTotalNumber() {
		return totalNumber;
		// You can not access "name" or "this" in a static method
	}

	public static void main(String[] args) {
		Pet a = new Pet("Odie");
		Pet b = new Pet("Garfield");
		Pet c = new Pet("Nermal");
		// Three objects are created, so totalNumber is increased for three times
		System.out.println("Total pet number is " + a.getTotalNumber());
		System.out.println("Total pet number is " + b.getTotalNumber());
		// You can invoke a static method from an object. However they perform the same.
		// You are recommended to call it as Pet.getTotalNumber();
	}
}
```


Example: The Output

- `Total pet number is 1`
- `Total pet number is 2`
- `Total pet number is 3`
- `Total pet number is 3`
- `Total pet number is 3`

Summary: Static Variables/Methods

- Static variables and methods belong to a class instead of an object
- Every object has its own instance variables; all objects in the same type share the same static variables
- Pay attention to: what can be accessed in different methods