CSC207 - Review of key concepts

Ilir Dema

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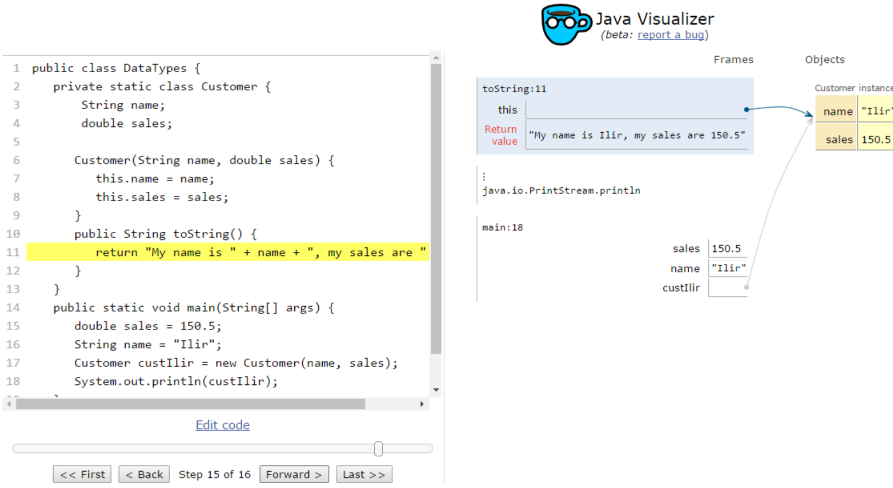
Review Topics

1. Variables and data types
2. Access modifiers
3. Methods and parameter passing
4. Inheritance and abstract classes
5. Collections and generics
6. Interfaces

A sample Java program



Java Visualizer
(*beta:* report a bug)

```
public class DataTypes {
   private static class Customer {
       String name;
       double sales;

      Customer(String name, double sales) {
         this.name = name;
         this.sales = sales;
      }
      public String toString() {
         return "My name is " + name + ", my sales are "
      }
   }
   public static void main(String[] args) {
      double sales = 150.5;
      String name = "Ilir";
      Customer custIlir = new Customer(name, sales);
      System.out.println(custIlir);
```

Frames

```
toString:11
  this
  Return value  "My name is Ilir, my sales are 150.5"

:
java.io.PrintStream.println

main:18
  sales     150.5
  name      "Ilir"
  custIlir
```

Objects

Customer instance

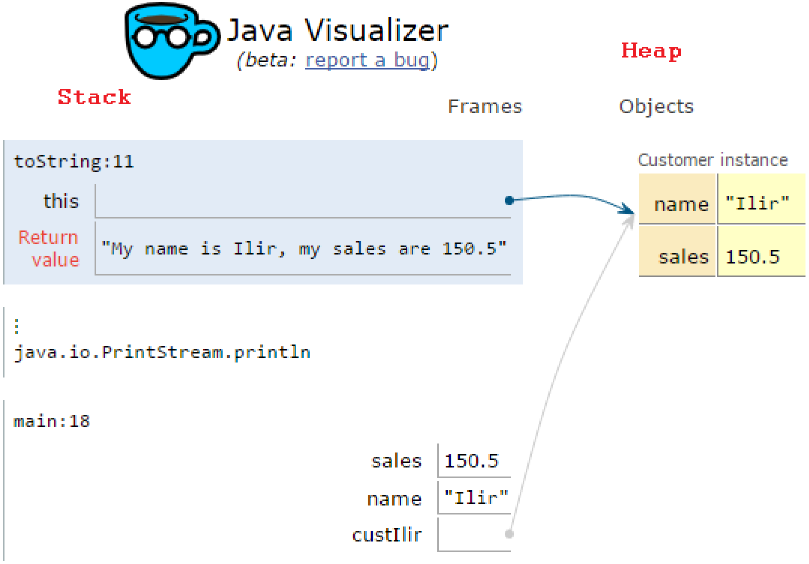
name	"Ilir"
sales	150.5

Variables and data types

Based on the data type, a variable can belong to a:

- Primitive Data Type:
  - `boolean`, `char`, `byte`, `short`, `int`, `long`, `float`, `double`
  - A primitive variable is stored on the frame stack of the current thread (process)
  - That means the cell referred by variable name contains the actual value of the variable
- Reference Data Type:
  - `Customer` (see previous slide - `Customer` is a custom data type
  - Data type declared in some Java package (`Scanner`, `JFrame,...`)
  - The cell referred by the reference variable contains the address of some object on the heap.

Java memory model



```
toString:11
        this
Return value   "My name is Ilir, my sales are 150.5"

⋮
java.io.PrintStream.println

main:18
        sales    150.5
        name     "Ilir"
        custIlir
```

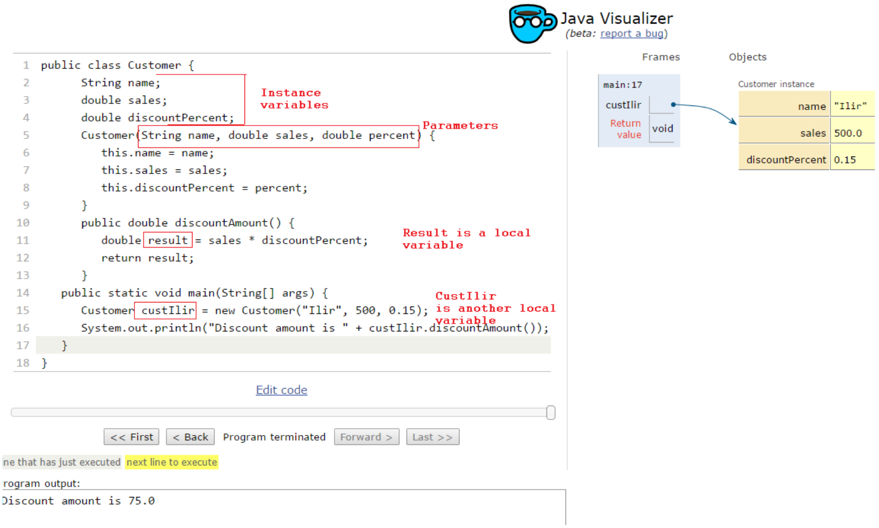
name	"Ilir"
sales	150.5

Instance variables, local variables, constants

- Based on their location on the code, a variable can be:
  - Instance (class) variables
  - Local variables
  - Parameters (also local variables)
- Paremeters and local variables are visible within the segment of code where they are declared.
- Class (instance) variables visibility can be changed using access modifiers.
- Constants do not change throughout the life of the program. They can be declared using the `final` keyword:

```
public final double NUMBER_PI = 3.14;
```

Instance variables, parameters, local variables

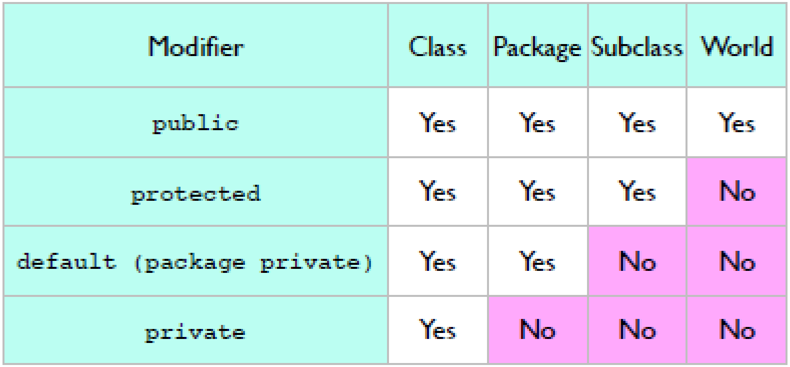


```
public class Customer {
     String name;
     double sales;
     double discountPercent;
     Customer(String name, double sales, double percent) {
        this.name = name;
        this.sales = sales;
        this.discountPercent = percent;
     }
     public double discountAmount() {
        double result = sales * discountPercent;
        return result;
     }
  public static void main(String[] args) {
     Customer custIlir = new Customer("Ilir", 500, 0.15);
     System.out.println("Discount amount is " + custIlir.discountAmount());
  }
}
```

```
Discount amount is 75.0
```

Access Modifiers

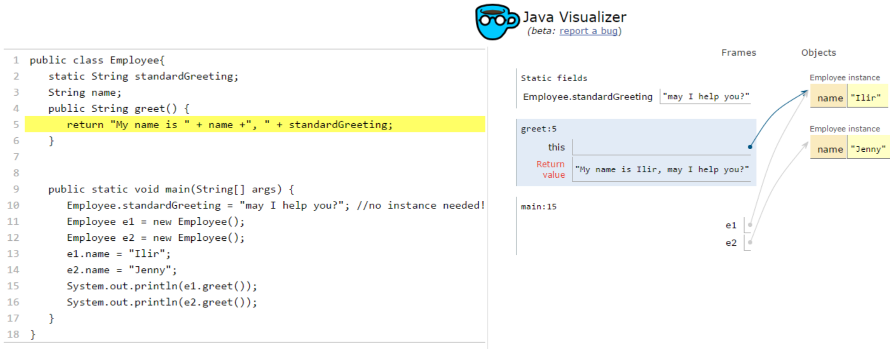
- Class members (variables/methods) can be declared public, protected, package-protected, or private.



Modifier	Class	Package	Subclass	World
`public`	Yes	Yes	Yes	Yes
`protected`	Yes	Yes	Yes	No
`default (package private)`	Yes	Yes	No	No
`private`	Yes	No	No	No

Static modifier

`static` modifier is used to declare a class variable or method that does not depend/need an instance of the class. It can be combined with access modifiers as needed. Also it is a good idea to make the constants static.



```java
public class Employee{
    static String standardGreeting;
    String name;
    public String greet() {
        return "My name is " + name +", " + standardGreeting;
    }


    public static void main(String[] args) {
        Employee.standardGreeting = "may I help you?"; //no instance needed!
        Employee e1 = new Employee();
        Employee e2 = new Employee();
        e1.name = "Ilir";
        e2.name = "Jenny";
        System.out.println(e1.greet());
        System.out.println(e2.greet());
    }
}
```

Static fields
Employee.standardGreeting "may I help you?"

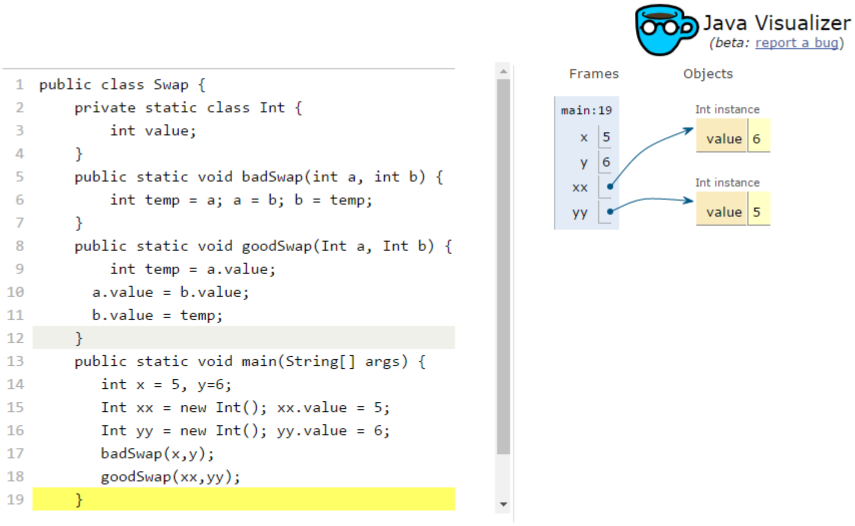
greet:5
this
Return value "My name is Ilir, may I help you?"

main:15
e1
e2

Employee instance
name "Ilir"

Employee instance
name "Jenny"

Passing of parameters by value versus by reference



```
public class Swap {
    private static class Int {
        int value;
    }
    public static void badSwap(int a, int b) {
        int temp = a; a = b; b = temp;
    }
    public static void goodSwap(Int a, Int b) {
        int temp = a.value;
      a.value = b.value;
      b.value = temp;
    }
    public static void main(String[] args) {
       int x = 5, y=6;
       Int xx = new Int(); xx.value = 5;
       Int yy = new Int(); yy.value = 6;
       badSwap(x,y);
       goodSwap(xx,yy);
    }
```

Inheritance

- Inheritance allows one class to inherit the data and the methods of another class.
- In a subclass, `super` refers to the part of the object defined by the parent class.
  - Use `super.‘‘attribute’’` to refer an attribute (data member of method) in the parent class.
  - Use `super(‘‘arguments’’)` to call a constructor defined in the parent class.
- If the constructor of the parent class is intended to be called, the `super(‘‘arguments’’)` must be the first line of code of the constructor.
  - Otherwise the default (no argument) constructor in the parent class is called.

Collections and Generics

- Often is useful to have implementations of certain Abstract Data Types (ADT).
- It is desirable that the implementation of the ADTs be independent of the data type stored in the chosen structure.
- This can be achieved through so called generics - a way of extending static typing to classes when the exact type of data the classes will operate on is unknown.
- For example, we may be interested to create Lists of Strings, Points (recall example from last lecture), etc.
- A type enclosed within angle brackets, for example `ArrayList<T>` means the programmer should replace `T` with the desired data type.
- Example: `ArrayList<Point> polygon = new ArrayList<Point>();`
- Collections are objects that hold other objects.

Java Interfaces

- A java Interface is similar to a Java class
  - can include variable declarations
  - can include methods
- However
  - Variables must be constants
  - Methods must be abstract.
- A Java interface cannot be instantiated.
- Apart from applications that we have seen, an interface can also be used to decouple certain operations from their implementation.

The `Comparable` interface

- Often it is desirable to establish an ordering of elements in a class.
- An ordering relation can be established through a compararison operation which must satisfy:
  - Every two element must be comparable. In addition, the comparaison must be:
  - Reflexive: $\forall a : a \leq a$
  - Antisymmetric: $\forall a, b : a \leq b \wedge b \leq a \implies a = b$
  - Transitive: $\forall a, b, c : a \leq b \wedge b \leq c \implies a \leq c$.
- Java offers the `Comparable<T>` interface that has a single method:

  public int compareTo(T other) which must return:
    - A negative integer if `this` less than `other`
    - Zero of `this` equals `other`
    - A positive integer if `this` greater than `other`