Objects and Classes

- Reference types and their characteristics
- Class Definition
- Constructors and Object Creation
- Special objects: Strings and Arrays

OOAD 1998/99

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Reference Types

- Predefined or user-defined Classes
- String
- Array
- The values of reference types are not manipulated directly.
- Instead handles (references) to the actual values are used.

Reference Type Variables

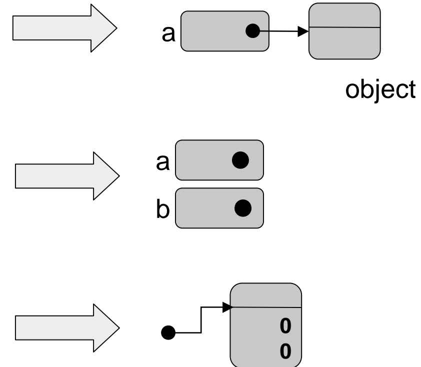
- A variable of a reference type contains a reference to an anonymous object in storage.
- An uninitialized variable contains a null-reference.

```
Point a,b;
```

- Objects are created at run-time.

```
new Point(0,0);
```

- Objects are anonymous.
- They have an immutable identity.



Binding Reference Type Variables

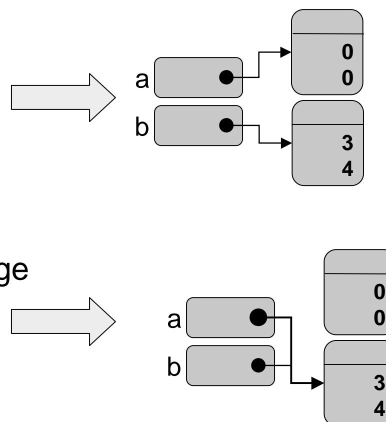
- Assigning an object to a variable, the variable gets a reference to the object as its value.

```
a = new Point(0,0);
b = new Point(3,4);
```

- Assigning values of other variables means assigning the references! The value of the object does not change

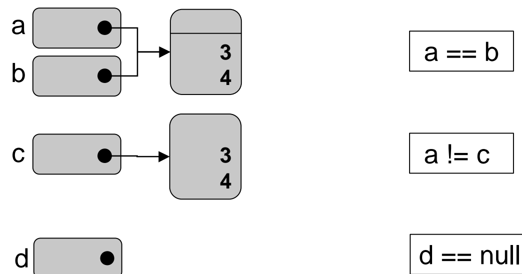
```
a = b;
```

- May be a pitfall, as the object may change



Comparing Objects

- Comparing two reference type variables means comparing the references they contain and, thus, comparing the identity of the referenced objects.



Comparing the Contents of Objects

- The contents of objects belonging to pre-defined classes can be compared using the method *equals*.
- If you define a class of your own, *equals* by default only compares references, as == does.
  => You have to override *equals* for newly defined classes.

Creating New Data Types: class

- Class keyword introduces definition of new data type

```
class ATypeName { /* class body goes here */ }
ATypeName a = new ATypeName();
```

- Data members

```
class DataOnly {
  int i;
  float f;
  boolean b;
}
```

- Each instance of **DataOnly** gets its own copy of the data members
- In a class, primitives get default values.

Methods, Arguments and Return Values

- Methods: “how you get things done in an object“
  - May inspect and change the state of the object
  - Traditionally called “functions”
  - Can only be defined inside classes

```
returnType methodName(/* argument list */) {
  /* Method body */
}
```

- Example method call:

```
int x = a.f(); // For object a
```

The Argument List

- Types of the objects to pass in to the method
- Name (identifier) to use for each one
- Whenever you seem to be passing objects in Java, you‘re actually passing handles

```
void reset(Cell c) {
 c.setValue(0);
}
Cell cell1 = new Cell();
cell1.setValue(4);
reset(cell1);
cell1.getValue();
```


this: Handle to Current Object

```
public class Leaf {
  private int i = 0;
  Leaf increment() {
    i++;
    return this;
  }
  void print() {
    System.out.println("i = " + i);
  }
  public static void main(String args[]) {
    Leaf x = new Leaf();

 x.increment().increment().increment().print();
  }
}
```

- no **this** in static methods

Nuance

- We can deduce meaning from context

"Wash the shirt"
"Wash the car"
"Wash the dog"
Not
"shirtWash the shirt"
"carWash the car"
"dogWash the dog"

Method Overloading

```
class SuperWasher{
    void wash(Shirt s) { ... }
    void wash(Car c) { ...}
    void wash(Dog d) { ...}
    ...
}
```

- One word, many meanings: overloaded
- Unique argument type combinations distinguish overloaded methods

Overloading on Return Values

- Why not also use return values in method overloading?

```
void f() {...}
int f() {...}
```

- Then what would this mean?

```
f();
```

Default Constructor

- Constructors are needed to create instances (objects) of a class
- Compiler provides one for you if you write no constructor

```
class Bird {
  int i;
}

public class DefaultConstructor {
  public static void main(String args[]) {
    Bird nc = new Bird(); // default!
  }
}
```

Constructor Definition

```
class Rock {
  Rock() { // This is the constructor
    System.out.println("Creating Rock");
  }
}

public class SimpleConstructor {
  public static void main(String args[]) {
    for(int i = 0; i < 10; i++)
      new Rock();
  }
}
```


Constructor Overloading

- Like methods constructors may be overloaded

```
class Tree {
  int height;
  Tree() {
    System.out.println("A seedling");
    height = 0;
  }
  Tree(int i) {
    System.out.println("A new Tree, "
      + i + " feet tall");
    height = i;
  }
}
```

this in Constructors

- A very common kind to use **this** is in constructors to initialize data members with the constructor's arguments

```
public class Animal {
  private int numberOfLegs;

  Animal(int numberOfLegs) {
    this.numberOfLegs = numberOfLegs;
  }
}
```


Member Initialization

```
void f() {
  int i; // No initialization
  i++;
}
```

- Produces compile-time error
- Inside class, primitives are given default values if you don't specify values

```
class Data {
  int i = 999;
  long l; // defaults to zero
  // ...
```

Constructor Initialization

- Order of initialization
  - Order that data members are defined in class
- Static data initialization

```
class Cupboard {
  Bowl b3 = new Bowl(3);
  static Bowl b4 = new Bowl(4);
  // ...
```

  - **b4** only created on *first* access or when first object of class **Cupboard** is created

Arrays and Array Initialization

- Arrays are objects

```
int a1[];   // this...
int[] a1;   // is the same as this!
```

  Creates a handle, not the array. Can't size it.
- To create an array of primitives:

```
int [] a1 = { 1, 2, 3, 4, 5 };
```

- Bounds are checked, ***length*** produces size of the array `a1.length`
- If you do anything wrong either the compiler will catch it or an exception will be thrown

Arrays of Objects

- An array of class objects:

```
Animal[] a = new Animal[20];
System.out.println(a.length + " animals");
for(int i = 0; i < a.length; i++) {
  a[i] = new Animal((i % 2 + 1) * 2);
```

- Can also use bracketed list (The size is then fixed at compile-time)

```
Integer[] a = {
  new Integer(1),
  new Integer(2),
  new Integer(3),
};
```


Multi-dimensional Arrays

- It is possible to define multi-dimensional arrays.

```
int[][] a;
```

- The brackets even may be distributed between type and identifier.

```
int[] a[];
```

- Initialization can be done directly

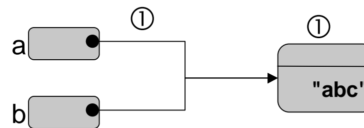
```
int[][] a = { { 1, 2, 3 }, { 5, 6} };
```

- It can also be done by nested iterations over the array and its components.

Strings

- Strings are immutable objects of the class **String**.
- String literals are zero, one or more characters included within double quotes.
- When a binding to a string literal is executed for the first time, a new String object is created.
- If any other bindings to this literal appear, the respective variables will hold reference to the same object.

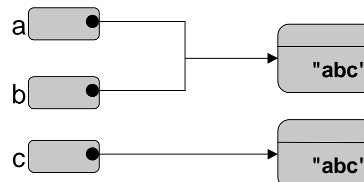
```
String a = "abc";
String b = "abc";
```



String Constructors

- String objects can also be created by calling a constructor.
- String constructors create new objects whenever they are called.

```
String c = new String("abc");
```



- There are several constructors defined for strings.

String Concatenation

- Strings can be concatenated by using +.

```
String c = "A " + "concatenation";
```

- The concatenation also creates a new String object.
- Values of other types can be concatenated to strings, too.
- They are implicitly converted to String.

```
String n = "Number " + 49;
```


Inside the Method Body

- Variable declaration and assignments
- Operations on primitive data types
- Object creation
- Message sending
- Iteration
- Conditionals