Object interactions
Lecture 5

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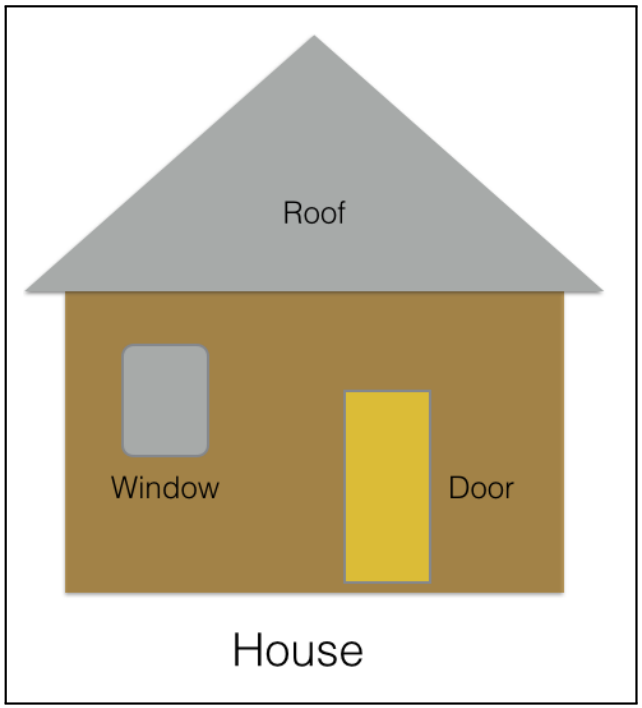
Abstraction and Modularization

Has objects of class types:

- Window
- Door
- Roof

Approach known as *abstraction*

- Abstract from details
- Reduces complexity
- Modularization facilitates specialization
- *Divide and conquer* recommended approach



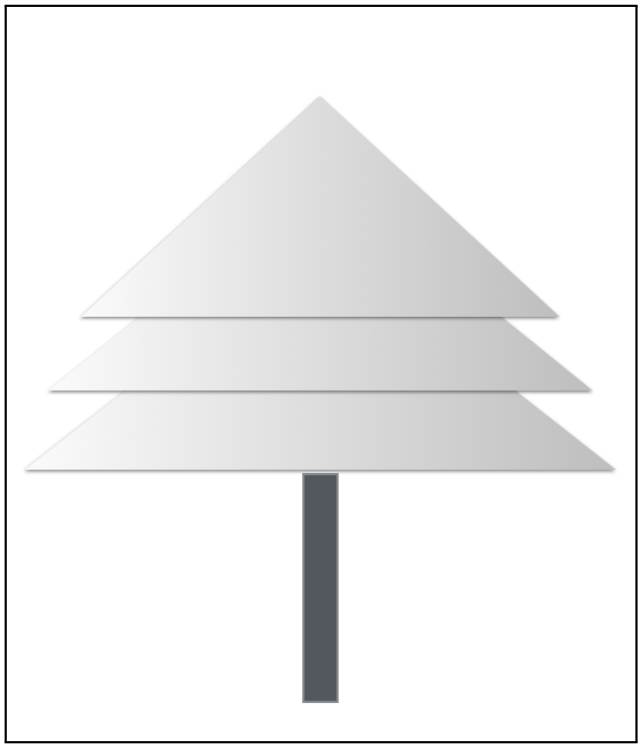
Abstraction and Modularization

Tree object implementable with primitive types only

Better use Tree class

- *Has* objects of class types:
  - Triangle
  - Rectangle

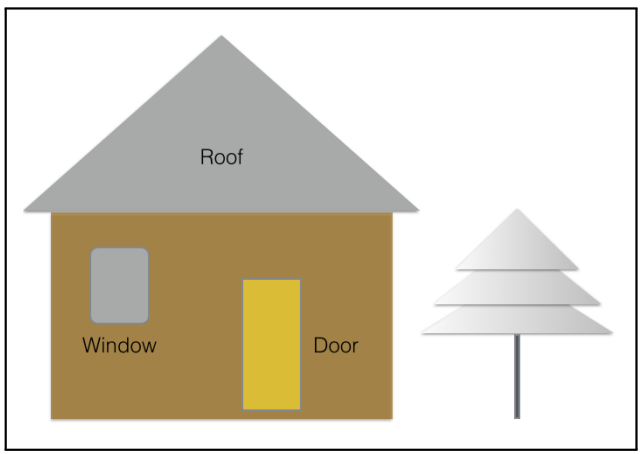
Simple example scaleable to much more complex problems



Abstraction and Modularization

Specialization

- Developer **Tree** class unaware of **House**
- House developed much later than Tree
- House developer not concerned with internals of Tree
- Only interested in interface to Tree
-
  - How to create Tree object
  - Available behaviours, methods Tree



Abstraction

Implementation independence

Here we access Circle's instance variable directly.
Application-wide side effects if implementation of **id** changed.

```
public class Circle {
 String id;
}
```

```
public class Shape {
 Circle circle = new Circle();
 String id = circle.id;
}
```

Abstraction

Implementation independence

Abstraction facilitates implementation change.

Avoids breakage already published code.

```
public class Circle {
 UUID id;
 String getId() {
   return UUID.toString();
 }
}
```

```
public class Shape {
 Circle circle = new Circle();
 String id = circle.getId();
}
```

Creating objects

new operator followed by constructor creates object

- `Tree oakTree = new Tree();`
- `House ourHouse = new House();`
- `House yourHouse = new House(Window w, Door d);`
- `Point origin = new Point(100.34, 200.67);`

These statements have three components

- Variable declaration `Tree oakTree`
- Instantiation using `new Tree()`
- Initialization of object within constructor

Objects create objects

Objects may create objects

```
public class BankAccount
{
    Customer customer;
    public BankAccount(int customerID)
    {
        this.customer = new Customer(customerID);
    }
}
```

Here a Customer object

- Instantiated in BankAccount constructor
- Initialized with actual parameter *customerID*

Mutiple Constructors

Multiple constructors permitted

```
public class Rectangle
{
    private int width = 0;
    private int height = 0;
    private Point origin;

    public Rectangle() {
        setState(100, 200);
    }
    public Rectangle(int width, int height) {
        setState(int width, int height);
    }
    private void setState(int width, int height) {
        this.width = width;
        this.height = height;
        origin = new Point(0,0);
    }
}
```

Internal method calls

Method can invoke other method same class

Class *Rectangle* has

- Two public constructors
  - Default
  - Overloaded
- Private helper method *setState*

```
public Rectangle()
{
    setState();
}

public Rectangle(int width, int height)
{
    setState(int width, int height);
}
```

External method calls

Method can invoke other method different class

Class *Tree* has

- Field *Rectangle treeBase*
- *treeBase* object has *createTreeBase* method
- *setState* invoked within *createTreeBase*
- This an example external method call

```
public class Tree
{
    private Rectangle treeBase;
    ...
    public void createTreeBase(int height, int width)
    {
        treeBase = new Rectangle();
        treeBase.setState(height, width);
    }
```

DRY principle

Do **N**ot **R**epeat yourself

Assemble code into reusable units

```
//verbose code
public class Point
{
    private int x;
    private int y;

    public Point() {
        this.x = 10;
        this.y = 10;
    }
    public Point(int x, int y) {
        this.x = x;
        this.y = y;
    }
}
```

```
//DRY code
public class Point
{
    private int x;
    private int y;
    public Point() {
        setState(10,10);
    }
    public Point(int x, int y) {
        setState(x, y);
    }
    private void setState(int x, int y) {
        this.x = x;
        this.y = y;
    }
}
```

The **null** object

A billion $ mistake

null a Java object

- Object default initialization *null*
- Can test for *null*
- *java.Lang.NullPointerException*
  - Attempt operation on null object

```
private Tree tree;

public void drawTree()
{
    if(tree == null)
    {
        tree = new Tree();
    }
    tree.draw();
}
```

Error handling

Java uses **exception** event to handle runtime errors

Example of **exception** event

- Tree object declared
- Default initialization **null**
- **new** operator not invoked
- Attempt operation on *null*
  - *java.Lang.NullPointerException*

```
private Tree tree;
public void drawTree()
{
    tree.draw();
}
```

Using BlueJ Debugger

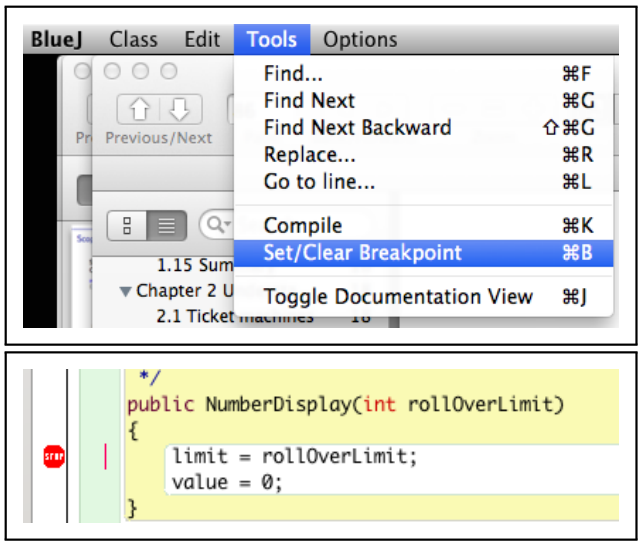
Debugger software application

- Integral to most IDEs
- Step-by-step code execution
- Can step into and out of methods and constructors
- Breakpoints insertable
- Execution halts at breakpoint
- Class, instance and local variable values then available
- Provides information on *call sequence* or *stack*

Using BlueJ Debugger

Debug into object

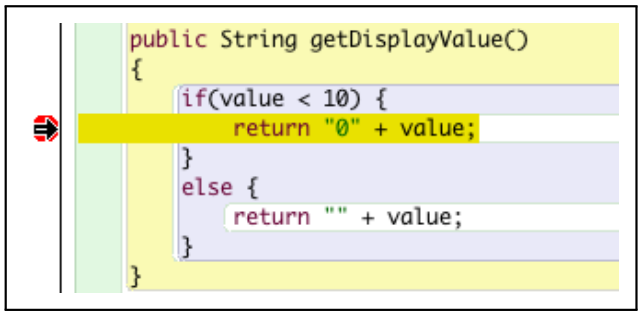
- Open class source code
- Place cursor where breakpoint required
- Tools Set / Clear Breakpoint

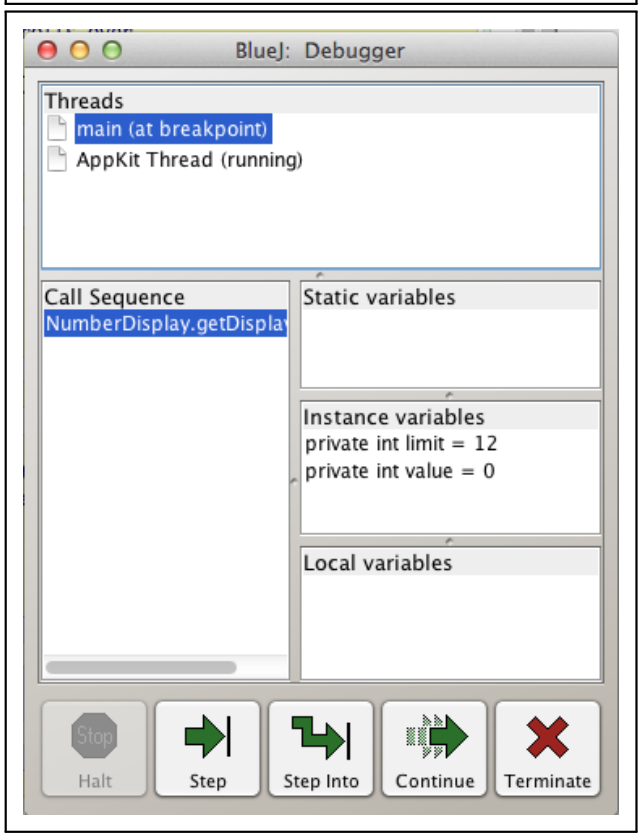


Using BlueJ Debugger

In BlueJ instantiate *new* object

- Invoke method where breakpoint
- Execution halts at breakpoint
- Displays debug window
- Variable data visible

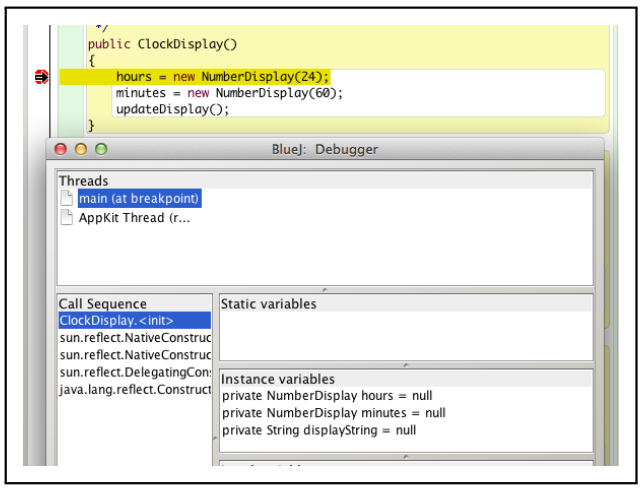




Using BlueJ Debugger

ClockDisplay constructor
Before initialization

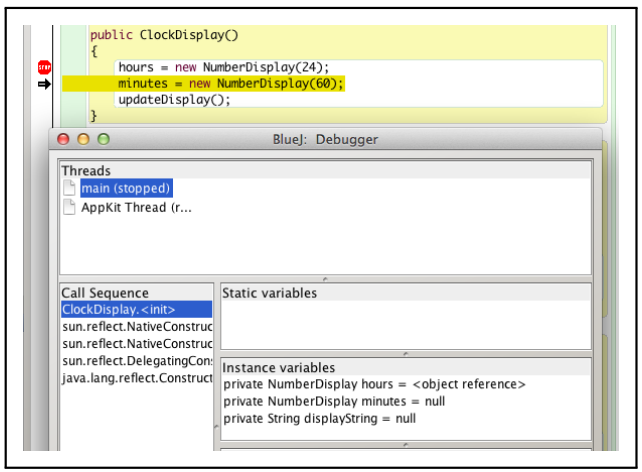
- All instance variables *null*



Using BlueJ Debugger

ClockDisplay constructor
During initialization

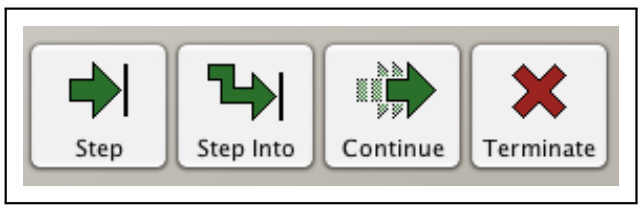
- *hours* new object reference assigned
- *minutes* still default *null*



Using BlueJ Debugger

Debugger options

- **Step:** Execute next statement
- **Step into:** Step into method
- **Continue:** Run to next breakpoint or end
- **Terminate:** Quit debugging



Summary

- Abstraction: hide details, focus on big picture
- Modularization: Decompose system into components
- Instantiation : Using *new* operator
- Instantiation within objects
- Multiple constructors
- Internal & external method calls
- DRY principle
- *null* object
- Error handling
- BlueJ debugger

Referenced material

1. *null* reference: a billion dollar mistake
`http://en.wikipedia.org/wiki/Tony_Hoare` [Accessed 2014-03-26]