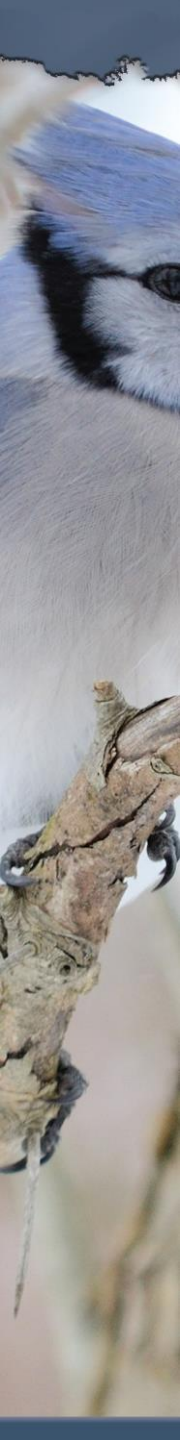
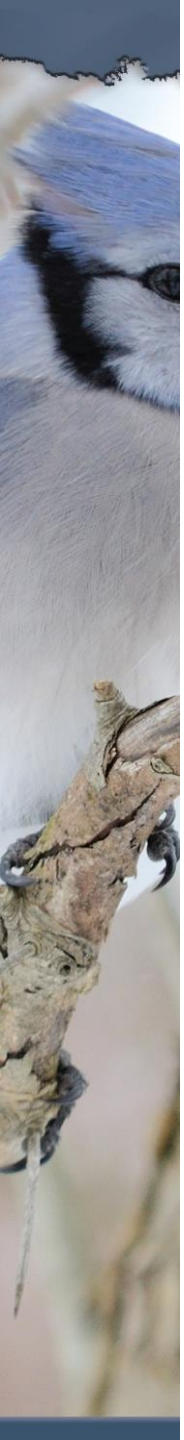


Object interaction

Creating cooperating objects

A digital clock

11:03

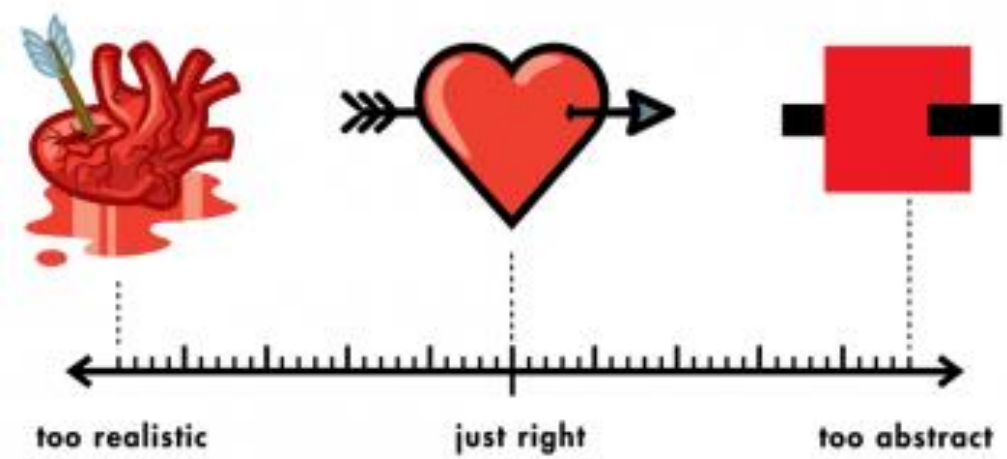


Abstraction and modularization

- **Abstraction** is the ability to ignore details of parts to focus attention on a higher level of a problem
- **Modularization** is the process of dividing a whole into well-defined parts, which can be built and examined separately, and which interact in well-defined ways

Abstraction and modularization

- **Abstraction** is the ability to ignore det[illegible]ntion on a h[illegible]
- **Mo**[illegible]s of div[illegible]fined par[illegible] exa[illegible]ich interact in well-defined ways



Abstraction and modularization

- **Abst** ignore
  deta ention on
  a hig
- **Mod** ss of
  divic efined
  part d
  exar hich
  inte s

Modularizing the clock display

11:03

One four-digit display?

Or two two-digit displays?

11 03

Modeling a two-digit display

- We call the class ***`NumberDisplay`***
- Two integer fields:
  - The current value
  - The limit for the value
- The current value is incremented until it reaches its limit
- It *rolls over* to zero at this point

Implementation - NumberDisplay

```
public class NumberDisplay
{
    private int limit;
    private int value;

    Constructor and
    methods omitted.
}
```

Implementation - ClockDisplay

```
public class ClockDisplay
{
    private NumberDisplay hours;
    private NumberDisplay minutes;

    Constructor and
    methods omitted.
}
```

Source code: NumberDisplay

```
public NumberDisplay(int rollOverLimit)
{
    limit = rollOverLimit;
    value = 0;
}

public void increment()
{
    value = (value + 1) % limit;
}
```

*** value is between 0 --> (limit - 1)**

Source code: NumberDisplay

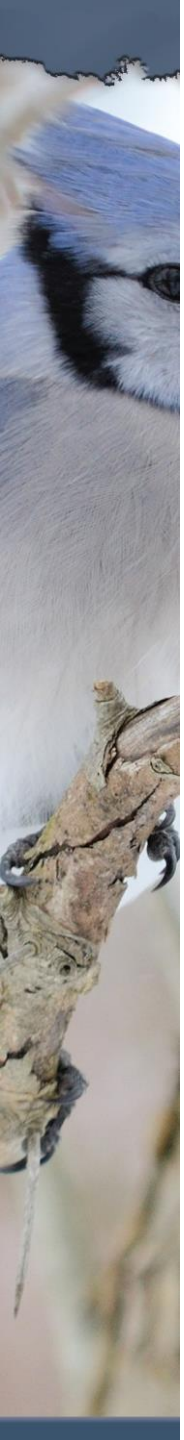
```
public String getDisplayValue()
{
    if(value < 10) {
        return "0" + value;
    }
    else {
        return "" + value;
    }
}
```

Source code: setValue()

```
public void setValue(int replacementValue)
{
    if((replacementValue >= 0) &&
            (replacementValue < limit))
    {
            value = replacementValue;
    }
}
```

Classes as types

- Data can be classified under many different types; e.g. integer, boolean, floating-point.
- In addition, every class is a unique data type; e.g. **`String`**, **`TicketMachine`**, **`NumberDisplay`**.
- Data types, therefore, can be composites and not simply values.



Concepts

- abstraction
- modularization
- classes define types
- class diagram

- object diagram
- object references
- object types
- primitive types

Objects creating objects

```
public class ClockDisplay
{
    private NumberDisplay hours;
    private NumberDisplay minutes;
    private String displayString;

    public ClockDisplay()
    {
        hours = new NumberDisplay(24);
        minutes = new NumberDisplay(60);
        …
    }
}
```

Objects creating objects

in class ClockDisplay:

```
hours = new NumberDisplay(24);
```

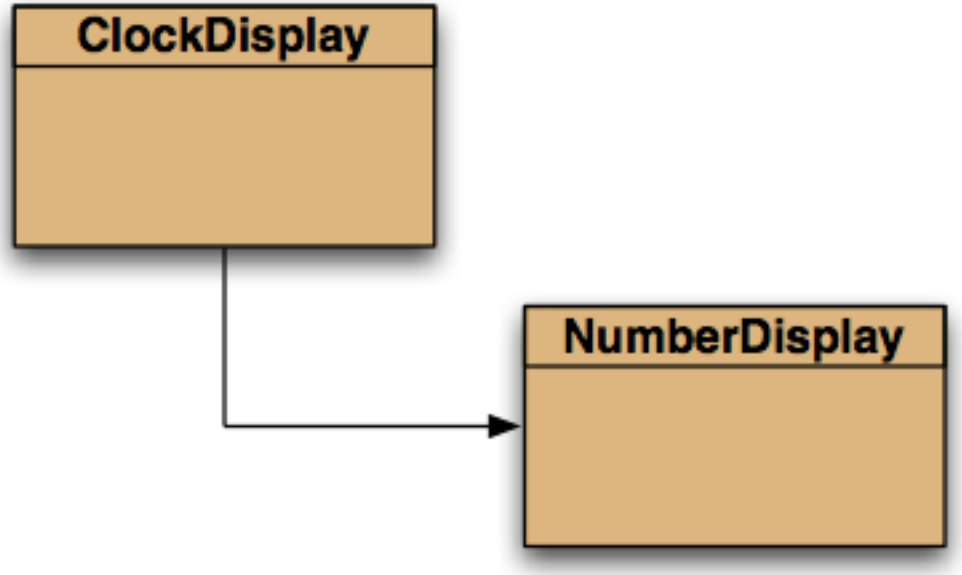
actual parameter

in class NumberDisplay:

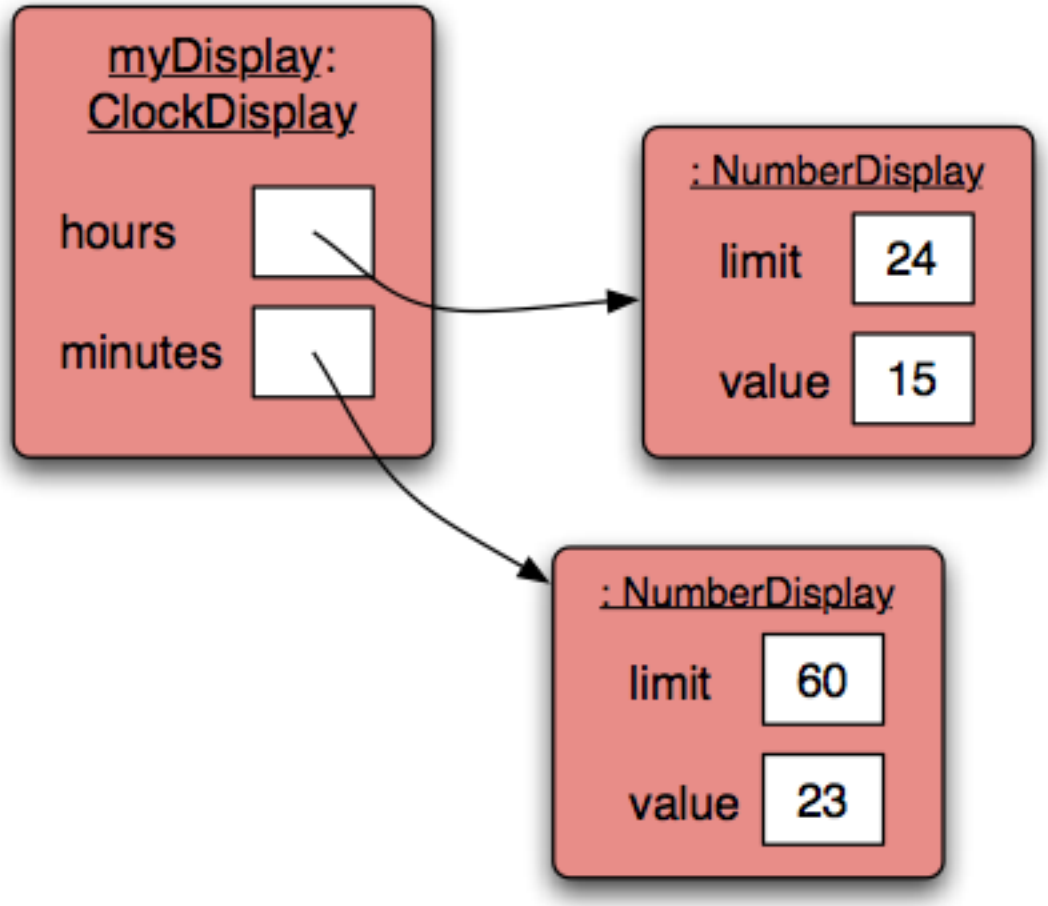
```
public NumberDisplay(int rollOverLimit)
```

formal parameter

Class diagram (static view)



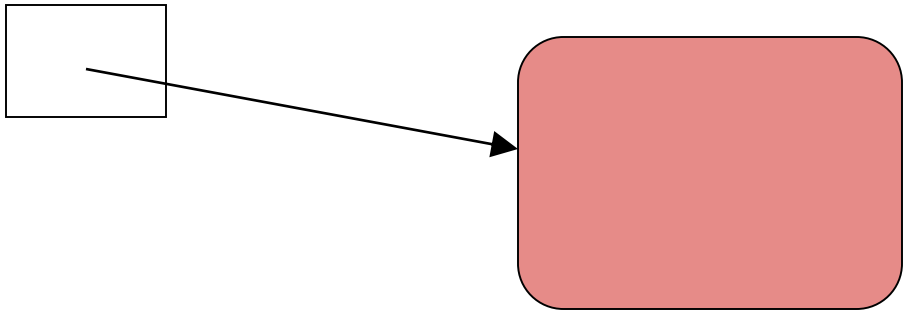
Object diagram (dynamic view)



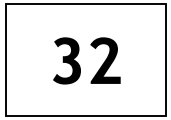
Primitive types vs. Object types

```
SomeObject obj;
```

object type



```
int i;
```



primitive type

Quiz:
What is the output?

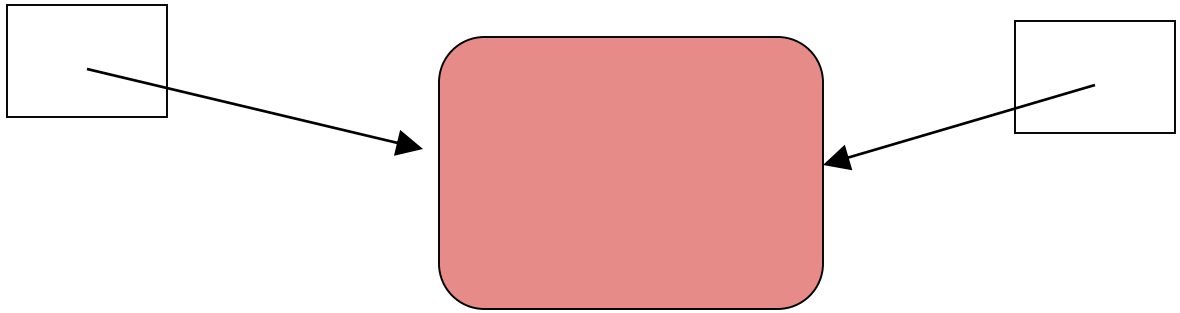
- ```
  int a;
  int b;
  a = 32;
  b = a;
  a = a + 1;
  System.out.println(b);
  ```

- ```
  Person a;
  Person b;
  a = new Person("Everett");
  b = a;
  a.changeName("Delmar");
  System.out.println(b.getName());
  ```

Primitive types vs. object types

```
ObjectType a;
```

```
ObjectType b;
```



```
b = a;
```

```
int a;
```

```
int b;
```

32

32

Object interaction

- Two objects interact when one object calls a method on another
- The interaction is usually all in one direction (*client*, *server*)
- The client object can ask the server object to do something
- The client object can ask for data from the server object

Object interaction

- Two NumberDisplay objects store data on behalf of a ClockDisplay object
  - The ClockDisplay is the *client* object
  - The NumberDisplay objects are the *server* objects
  - The *client* calls methods in the *server* objects

Method calling

'client' method

'server' external methods

```
public void timeTick()
{
    minutes.increment();
    if(minutes.getValue() == 0) {
        // it just rolled over!
        hours.increment();
    }
    updateDisplay();
}
```

internal/self method call

External method calls

- General form of ***external*** method call:

  object . methodName (params)

- Examples:

```
hours.increment()

minutes.getValue()
```

Internal method calls

- No variable name is required for ***internal*** method calls:

```
updateDisplay();
```

- Internal methods often have **private** visibility to prevent them from being called from outside their defining class

- Method is found in *this* same invoking class/object where the call is made

Internal method

```
/**
 * Update the internal string that
 * represents the display.
 */
private void updateDisplay()
{
    displayString =
        hours.getDisplayValue() + ":" +
        minutes.getDisplayValue();
}
```

Method calls

- *Internal* means *this object*
- *External* means *any other object*, regardless of its type
- NOTE: A method call on *another object of the same type* would also be an external call

Method / Constructor Overloading

- **Overloading:**
  with a different set of parameters:

```
public ClockDisplay() {
    hours = new NumberDisplay(24);
    minutes = new NumberDisplay(60);
    updateDisplay();
}

public ClockDisplay(int hour, int minute) {
    hours = new NumberDisplay(24);
    minutes = new NumberDisplay(60);
    setTime(hour, minute);
}
```

Quiz: is this correct ?!

```
private int value;

public void setValue(int value) {
     value = value;
}
```

The `this` keyword

- Used to distinguish parameters and fields of the same name
- *this* could also be used as a reference to the invoking object instead of method calls

```
public ClockDisplay(int limit)
{
    this.limit = limit;
    value = 0;
}
```

null

- **`null`** is a special value in Java
- Object fields are initialized to **`null`** by default
- You can test for and assign **`null`**

```
private NumberDisplay hours;

if(hours != null) { ... }

hours = null;
```

null vs. void

null

- Means undefined or no memory address is being pointed to
- Used in code to represent no object reference exists

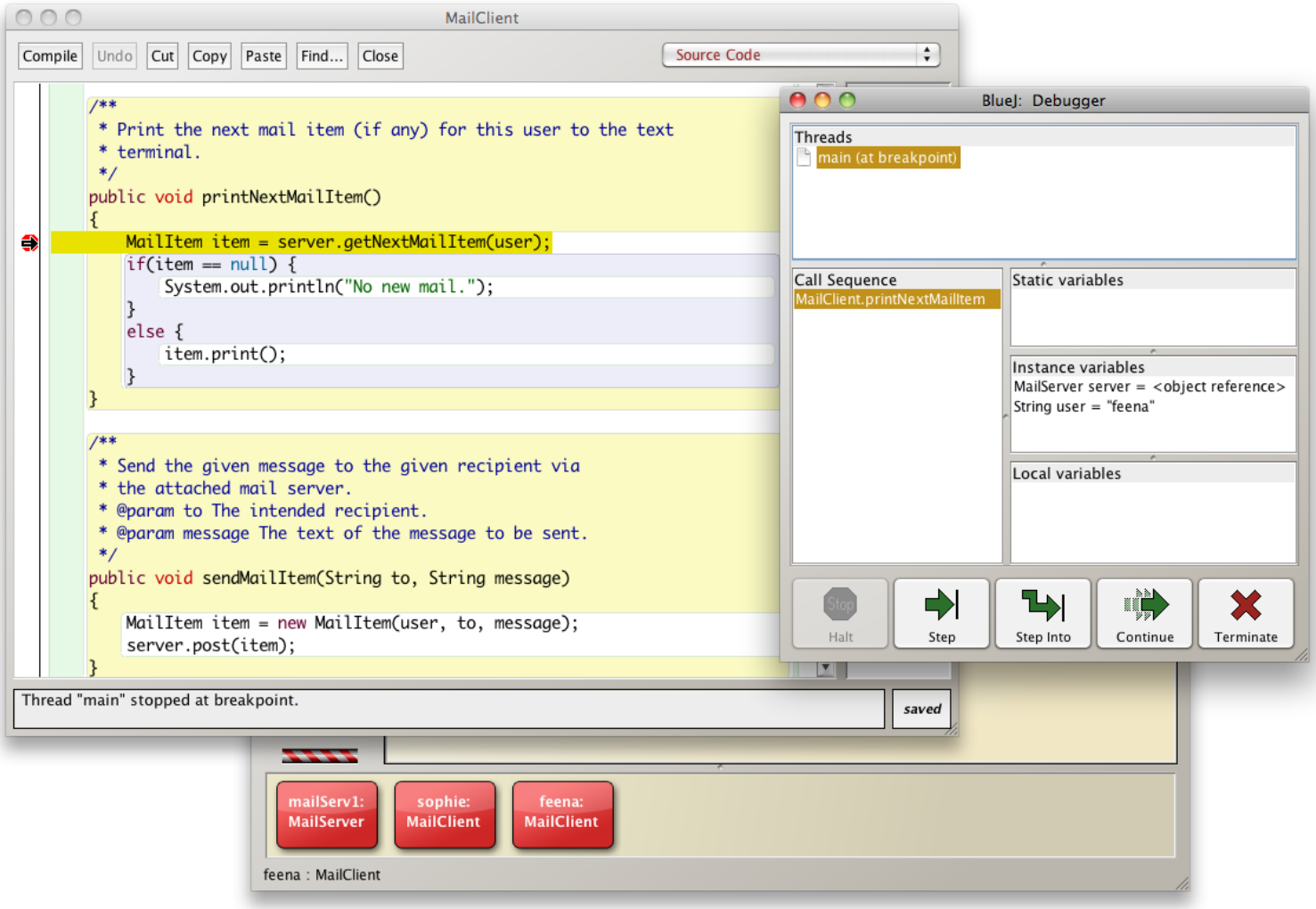
void

- Means empty or no data type
- Used in place of the return type for a method when no value is being returned

The debugger

- Useful for gaining insights into program behavior …
- … whether or not there is a program error
- Set breakpoints
- Examine variables
- Step through code

The debugger



Errors

Syntax

* Errors in the code text itself
* Found when compiling with unrecognizable text
* Fix by editing code

Logic

* Errors in the behavior of the program
* Found when running with unexpected results
* Fix by debugging and observing states

Runtime

* Errors which prohibit program from completing
* Found when executing the program
* Fix by tracing, debugging, observing and editing

شعر امروز

خود گنه کاریم و از دنیا شکایت می‌کنیم!
غافل از خود، دیگری را هم قضاوت می‌کنیم!
کودکی جان می‌دهد از درد فقر و ما هنوز
چشم می‌بندیم و هرشب خواب راحت می‌کنیم!
عمر کوتاه است و دنیا فانی و با این وجود
ما به این دنیای فانی زود عادت می‌کنیم!
ما که بردیم آبرو از عشق، پس دیگر چرا
عشق را با واژه‌هامان بی شرافت می‌کنیم؟
کاش پاسخ داشت این پرسش که ما در زندگی
با همیم اما چرا احساس غربت می‌کنیم؟