Objects First With Java
A Practical Introduction Using BlueJ

Object interaction

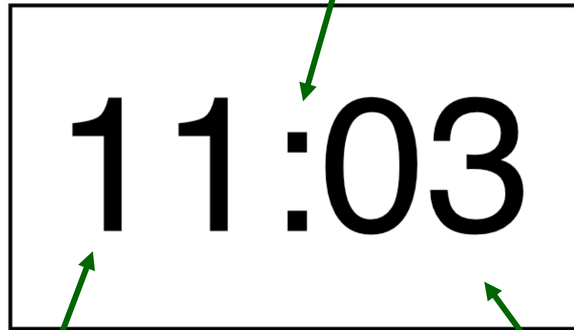
Creating cooperating objects

The next step

- **so far:**
  - what objects are
  - how they are implemented
- **now:**
  - combine classes and objects
  - let objects cooperate
  - how methods call other methods

Project: a digital clock

always the same



hours (European style: 0..23)

minutes

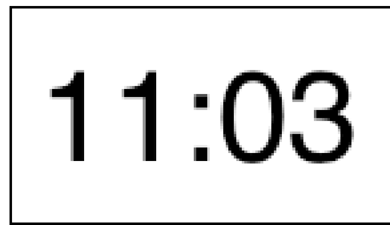
Abstraction

- Why not define the digital clock as one single class?
  - complexity ➔ substructuring (divide and conquer)!
  - effect: “abstract” from a component’s details (not everyone needs to know everything …)
- **Abstraction** is the ability to ignore details of parts to focus attention on a higher level of a problem.

Modularization

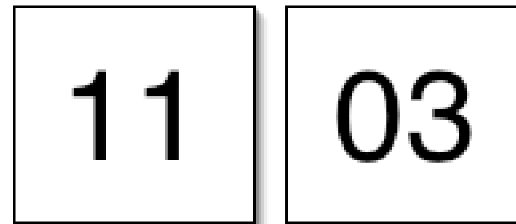
- **Modularization**: process of dividing a whole into well-defined parts, which can be built and examined separately, and which interact in well-defined ways.
- Modularization and abstraction complement each other.
- Both concepts are crucial for object-oriented software (components and subcomponents being objects here).

Modularizing the clock display



One four-digit display?

Or two two-digit displays?



One or two classes?
Differences?

Implementation - NumberDisplay

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

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

    methods omitted.
}
```

fields:

when to roll back to 0?

current value?

Implementation - ClockDisplay

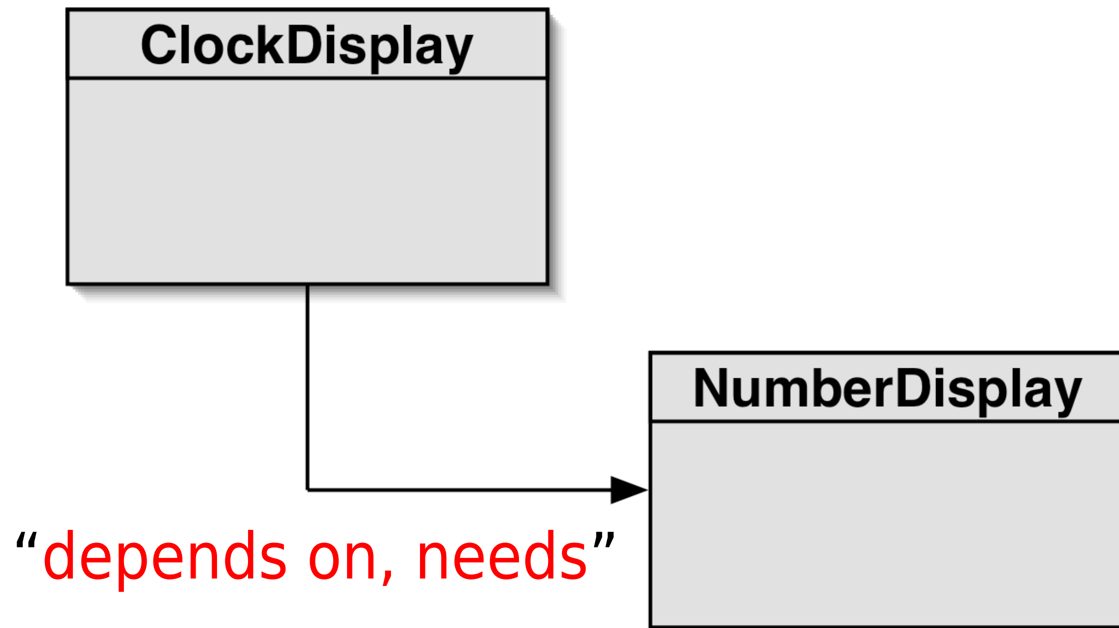
```
public class ClockDisplay
{
    private NumberDisplay hours;
    private NumberDisplay minutes;

    Constructor and
    methods omitted.
}
```

Class names can be used as types!

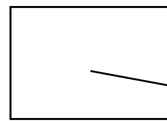
Class diagrams

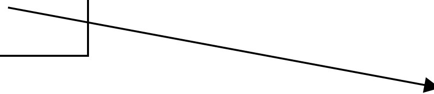
- **class diagrams** show classes and their relationships – hence, a *static* view of a program



Primitive types vs. object types

```
SomeObject obj = new SomeObject();
```

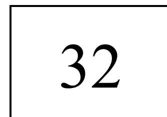




object type
(by classes, given by
Java system or
by programmer)

```
int i = 32;
```

Note different way of storing!
(direct value vs. reference)

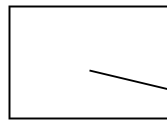


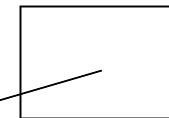
primitive type
(predefined in Java)

Primitive types vs. object types

`SomeObject a;`

`SomeObject b;`





two references of the same type!

`b = a;`

`int a;`

`int b;`

Source code: NumberDisplay

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

constructor!

4 methods: `getValue, setValue, getDisplayValue, increment`

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

Source code: NumberDisplay

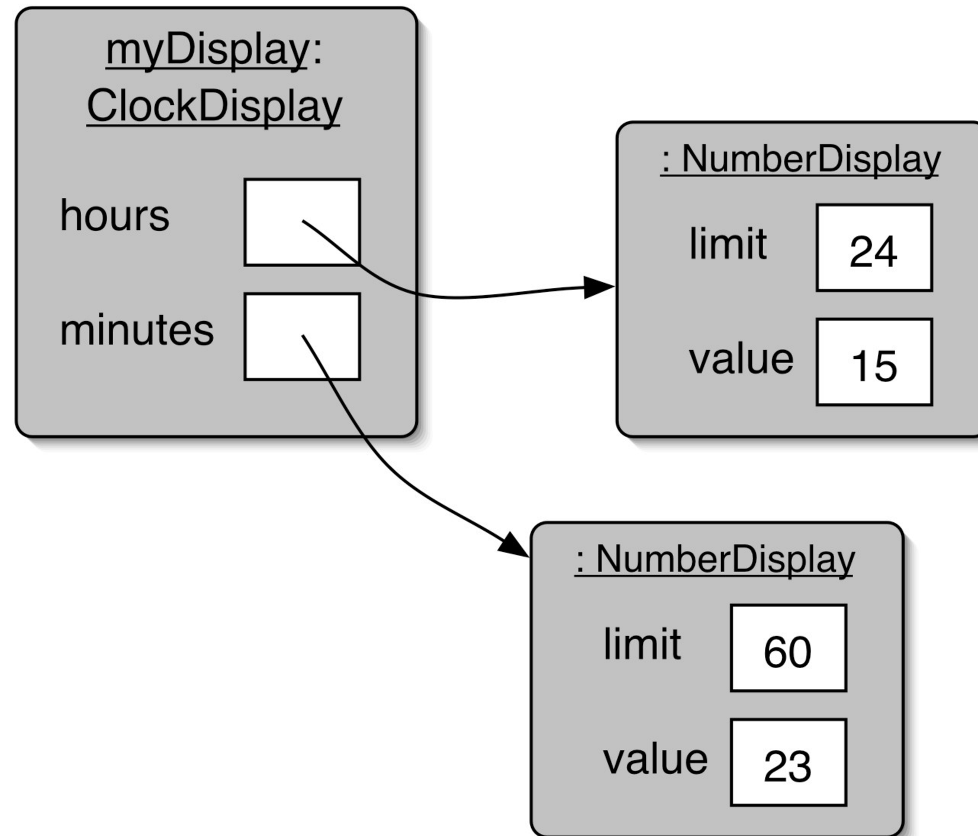
```
public String getDisplayValue()
{
    if(value < 10)
        return "0" + value;
    else
        return "" + value;
}
```

why not directly return value?

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

what happens if replacement value is illegal? OK?

ClockDisplay object diagram



where do the three objects come from?

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);
        updateDisplay();
    }
}
```

Alternative

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

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

multiple constructors in one class possible!

Overloading

Automatic creation

- how and where?
  - in `ClockDisplay`'s constructor
  - automatically executed whenever a `ClockDisplay` object is created
  - explicitly done with `new` command
  - `new` creates an object of the specified class and executes the respective constructor

Method calling

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

Internal vs. external

- internal method calls
  - internal means: called method belongs to calling class (here: `ClockDisplay`)

```
updateDisplay();
```

```
private void updateDisplay()
```

- external method calls
  - external means: called method belongs to other class (here: `NumberDisplay`)

```
minutes.increment();
```

Calling external methods

object . *methodName* (*parameter-list*)

Review: concepts

- abstraction
- modularization
- class diagram
- object references
- primitive types
- object types
- object creation
- overloading
- internal/external method call