1

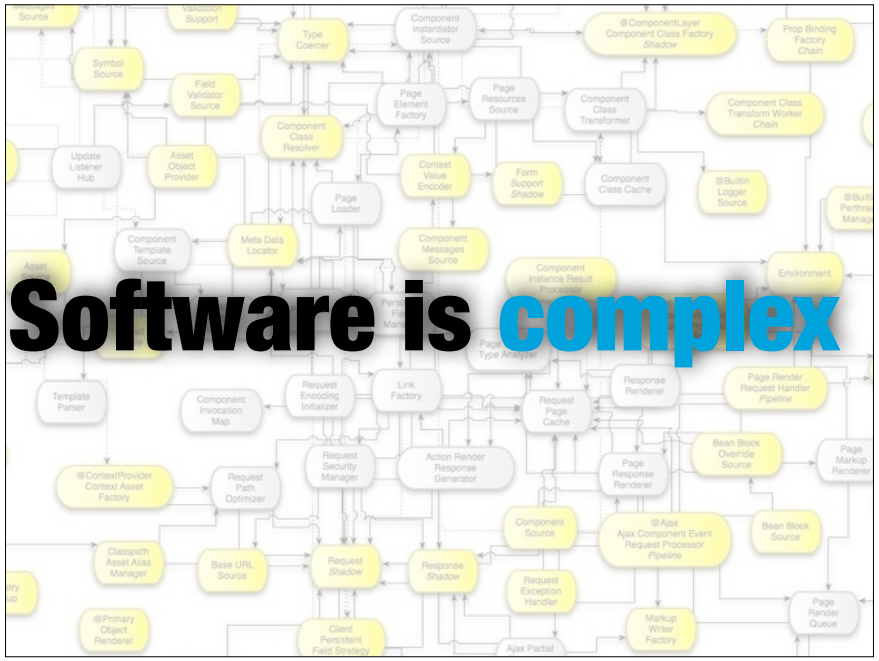
Object vs Structured design

2

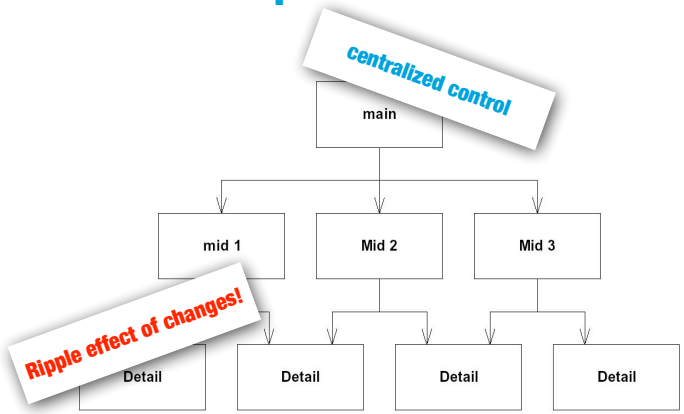
S.O.L.I.D design principles

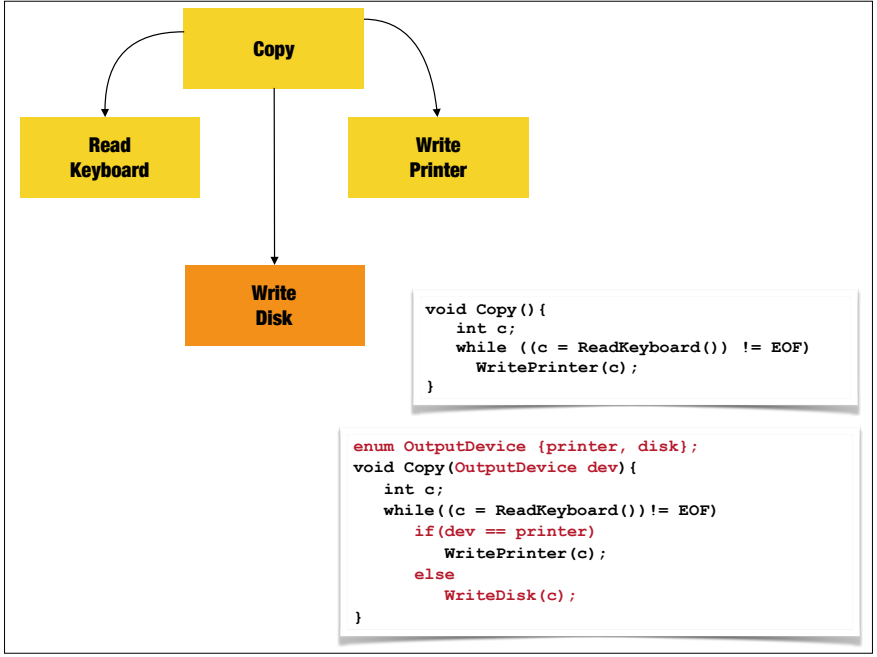
3

Architectural design principles



Functional decomposition doesn't scale!

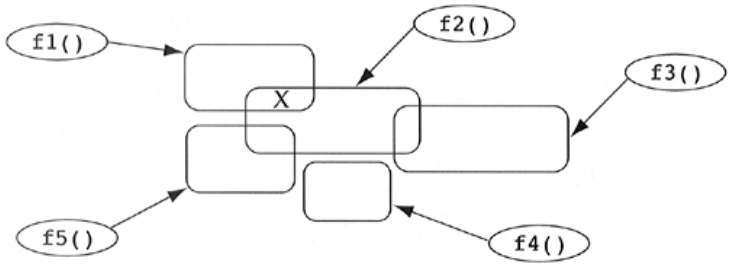





```
void Copy(){
   int c;
   while ((c = ReadKeyboard()) != EOF)
     WritePrinter(c);
}
```

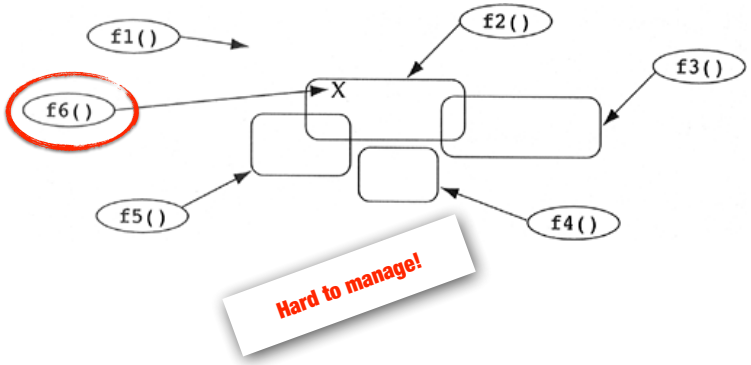
```
enum OutputDevice {printer, disk};
void Copy(OutputDevice dev){
   int c;
   while((c = ReadKeyboard())!= EOF)
      if(dev == printer)
         WritePrinter(c);
      else
         WriteDisk(c);
}
```

Hang procedures on spaghetti data structures



from A. Riel - Object-Oriented Design Heuristics, 1996

Unidirectional relation between code and data



from A. Riel - Object-Oriented Design Heuristics, 1996

How is object-oriented different

Can you use a phone?

Can you build a phone?

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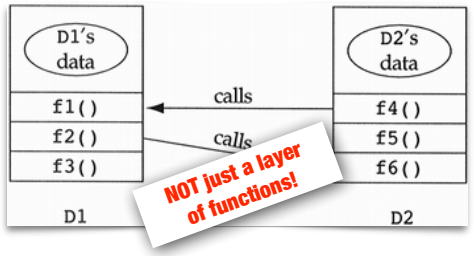
http://www.toddmclellan.com/thingscomeapart

The power of encapsulation

Hiding implementation is about abstractions

Expose **interfaces** that allow users to manipulate the **essence of the data**, **without knowing** its implementation.



from A. Riel - Object-Oriented Design Heuristics, 1996

Let's illustrate the point…

```
public class Square {
   public Point topLeft;
   public double side;
}
```

```
public class Rectangle {
   public Point topLeft;
   public double height;
   public double width;
}
```

```
public class Circle {
   public Point center;
   public double radius;
}
```

```
public class Geometry {
  public final double PI = 3.1415;

 public double area(Object shape) throws NoSuchShapeException {
      if (shape instanceof Square) {
        Square s = (Square)shape;
        return s.side * s.side;
      }
      else if (shape instanceof Rectangle) {
        Rectangle r = (Rectangle)shape;
        return r.height * r.width;
      }
      else if (shape instanceof Circle) {
        Circle c = (Circle)shape;
        return PI * c.radius * c.radius;
      }
      throw new NoSuchShapeException();
   }
}
```

✅ easy to add `perimeter()` ❌ hard to add `Triangle`

from R.C. Martin - Clean Code, 2008

```
interface Shape {
  double area();
}
```

```
public class Circle implements Shape {
   public Point center;
   public double radius;
   public final double PI = 3.1415;
   public double area() {
     return PI * radius * radius;
   }
}
```

```
public class Rectangle implements Shape {
  private Point topLeft;
  private double height;
  private double width;
  public double area() {
    return height * width;
  }
}
```

```
public class Square implements Shape {
  private Point topLeft;
  private double side;
  public double area() {
    return side*side;
  }
}
```

✅ easy to add `Triangle` ❌ hard to add `perimeter()`

from R.C. Martin - Clean Code, 2008

Data/Object Anti-Symmetry

Data structures expose data and have no significant behavior.

easy to add **new behaviors** to existing data structures

hard to add **new data structures** to existing functions.

Objects expose behavior and hide data.

easy to add **new kinds of objects** without changing existing behavior

hard to add **new behaviors** to existing objects.

from R.C. Martin - Clean Code, 2008

It's a trade-off...

Object-Oriented

add new data types rather than new functions

versus

Procedural

add new functions as opposed to data types

Hybrid Structures

Functionality

\+ CONFUSING!

Public variables

hard to add new functions.

hard to add new data structures.

from R.C. Martin - Clean Code, 2008

Law of Demeter

Inside of a method M of a class C, you can only **access data**, and **call functions** from the following objects:

i. **this** and **base-object**
ii. **data members** of class C [and it ancestors] (in weak form of LoD)
iii. **parameters** of the method M
iv. **objects created** within M
v. **global variables**

Principle of Least Knowledge

An object A can call a method of an object instance B,
but object A **cannot "reach through" object B**
to access yet another object, to request its services.

Law of Demeter (corollaries)

A module should **not know about the innards** of the objects it manipulates

An object should **not expose its internal structure** through accessors

Law of Demeter example

```
class Workstation {
     public void UpVolume(int amount) { mSound.Up(amount); }
     public SoundCard     mSound;
     private GraphicsCard  mGraphics;
};


Worksation sun;

...
sun.UpVolume(1);   // OK!
sun.mSound.Up(1);  // DON'T!
```

Law of Demeter example

```
final String outputDir = ctxt.getOptions().getScratchDir().getAbsolutePath();
```

```
Options opts = ctxt.getOptions();
File scratchDir = opts.getScratchDir();
final String outputDir = scratchDir.getAbsolutePath();
```

still breaks Demeter's law!

from R.C. Martin - Clean Code, 2008

Law of Demeter example

```
class Mechanic {
   Engine theEngine;
   Mechanic (Context context) {
      this.engine = context.getEngine();
   }
};
```

❌ `Mechanic` does not care about `Context`

❌ Can't reuse `Mechanic` without `Context`

❌ `Mechanic` inherits transitively the coupling of `Context`

❌ The JavaDoc is lying! It hides the true dependency of `Mechanic`

❌ Testing requires to create the entire objects' graph

❌ Testing pain is transitive: how do I test `Shop` that needs `Mechanic` ?

Don't dig into collaborators

```
class SalesTaxCalculator {
  TaxTable taxTable;
  SalesTaxCalculator(TaxTable taxTable) { this.taxTable = taxTable; }
  float computeSalesTax(User user, Invoice invoice) {
    Address address = user.getAddress();
    float amount = invoice.getSubTotal();
    return amount * taxTable.getTaxRate(address);
} }
```

❌

```
class SalesTaxCalculator {
  TaxTable taxTable;
  SalesTaxCalculator(TaxTable taxTable) { this.taxTable = taxTable; }
  float computeSalesTax(Address address, float amount) {
    return amount * taxTable.getTaxRate(address);
} }
```

✅

from J.Wolter, R.Ruffer, M.Hevery - Guide: Writing Testable Code, http://misko.hevery.com/code-reviewers-guide/

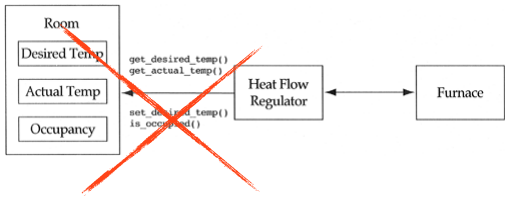
WHY is it needeed?

```
String outFile = outputDir + "/" + className.replace('.', '/') + ".class";
FileOutputStream fout = new FileOutputStream(outFile);
BufferedOutputStream bos = new BufferedOutputStream(fout);
```

```
BufferedOutputStream bos = ctxt.createScratchFileStream(classFileName);
```

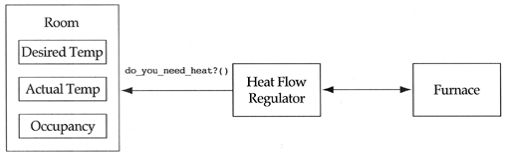
from R.C. Martin - Clean Code, 2008

A brilliant question...



When using handles to the internals of a class (getters/setters) ask yourself:

What is it I'm doing with this data, and why doesn't the class do it for me?



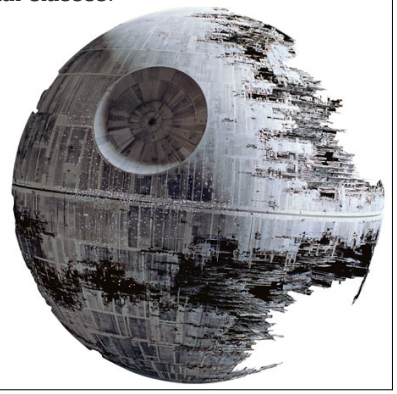
from A. Riel - Object-Oriented Design Heuristics, 1996

God Classes

capture the **central control mechanism** within an object-oriented design.

performs **most of the work**,

leaving **minor details to a collection of trivial classes**.



Avoiding God Classes

Distribute system **intelligence horizontally as uniformly** as possible.

The top-level classes in a design should **share the work uniformly**.

Be very suspicious of a class whose name contains

`Driver`, **`Manager`**, **`System`**, or **`Subsystem`**.

Beware of classes that have many **accessor methods**,

as this implies that **related data and behavior** are not kept in **one place**.

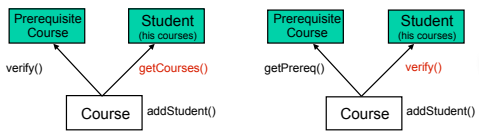
Beware of **non-cohesive classes**, where many methods operate on a proper subset of the data members of a class.

God classes often exhibit much **noncommunicating behavior**.

from A. Riel - Object-Oriented Design Heuristics, 1996

When are accessor methods OK?

1 **Classes defining a collaboration policy**



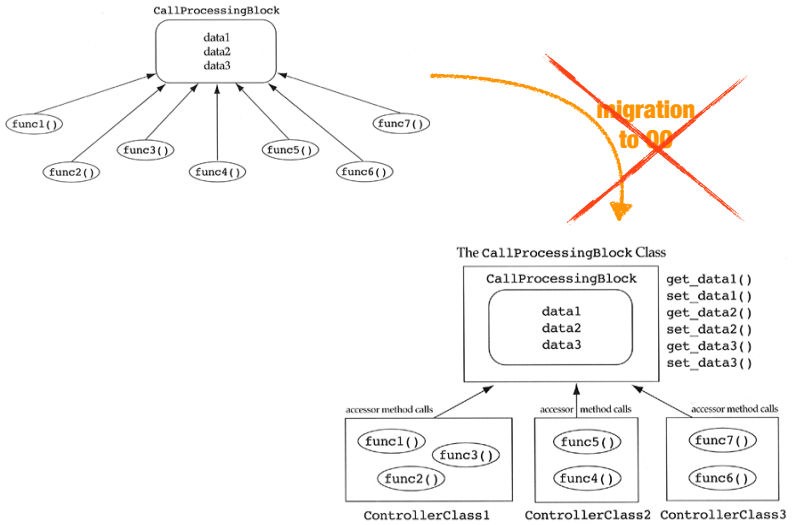
Justifies only getters

2 **Decoupling model from UI**

Justifies both getters and setters

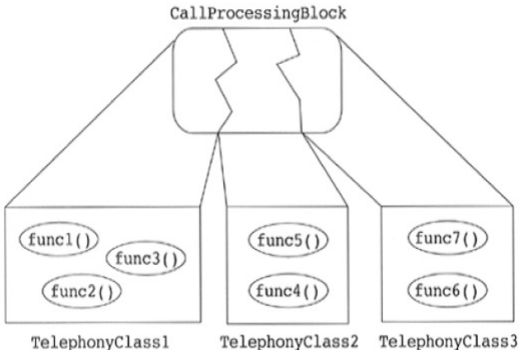
from A. Riel - Object-Oriented Design Heuristics, 1996

God Class (Data Form)



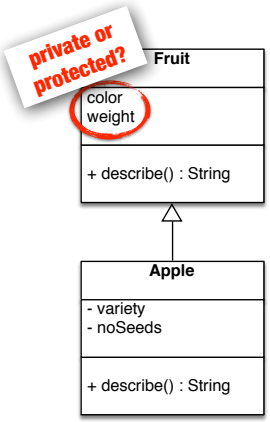
from A. Riel - Object-Oriented Design Heuristics, 1996

Proper migration strategy



from A. Riel - Object-Oriented Design Heuristics, 1996

What about protected data?



Protected data members are **breaking encapsulation**.

Try to avoid them. If absolutely needed **use a protected getter** method.

Three frequent lies about hierarchies…

Data have a highly volatile nature!

1 These data will never change

Hierarchies grow!

2 This hierarchy is so small

Reuse is about interface!

3 Inheritance is about reuse

The Yo-Yo Problem

*… a **long and complicated inheritance graph***

*forces the programmer to keep **flipping between many different class***

definitions in order to follow the control flow of the program.

> Class hierarchies should not be **very deep**.
> The depth should not be more than 6.

from D. Taenzer, David, M. Ganti, S. Podar - Problems in Object-Oriented Software Reuse, ECOOP, 1989

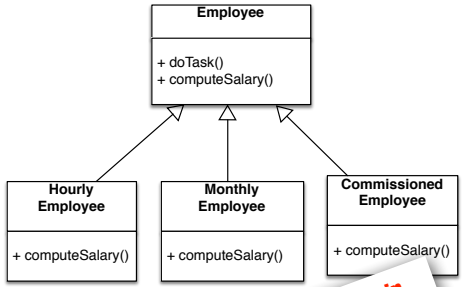
Inheritance is white/glass-box reuse

- ✅ language supported
- ✅ easy to use
- ❌ static bound
- ❌ mixture of physical data representation

Composition is black box reuse

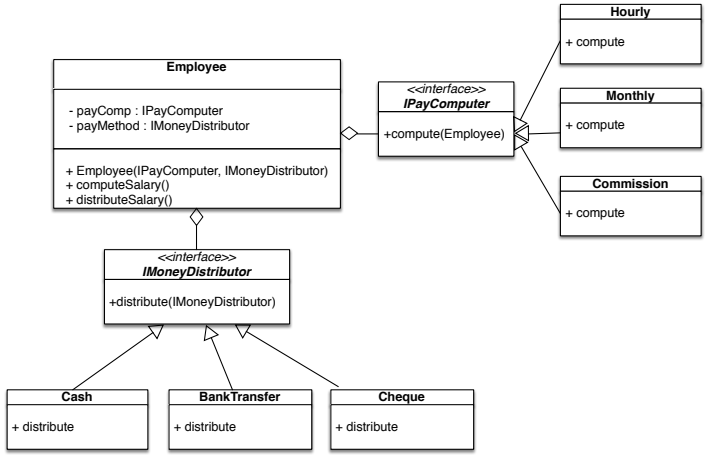
- ✅ encapsulation is preserved
- ✅ dynamic nature

Inheritance is static and rigid



What if salaries could be paid in different ways (bank, cash etc)?

Composition is dynamic and flexible

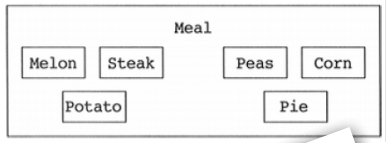


Favour composition, over inheritance.

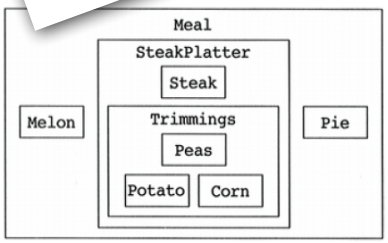
What's the proper shape of

containment hierarchies

Which `Meal` class would you prefer to use?

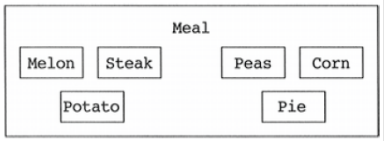


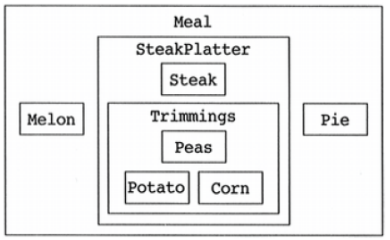
IT DOESN'T MATTER!



from A. Riel - Object-Oriented Design Heuristics, 1996

Which `Meal` class would you prefer to maintain?





from A. Riel - Object-Oriented Design Heuristics, 1996

Containment hierarchies should be **deep and narrow**.