# Object Orientation

Creative programming team
(today: Loe Feijs)

Technische Universiteit
Eindhoven
University of Technology

Where innovation starts

# Content

- Background
- Encapsulation
- Planet earth example
- Private and public
- EPD example
- Super- and subclass
- Cars example
- Common design flaws

# Background

## Object Oriented Programming

- a revolutionary extension of programming
- extends earlier programming abstractions
- is the leading programming paradigm
- similar to techniques of thinking about problems in other domains e.g. architecture

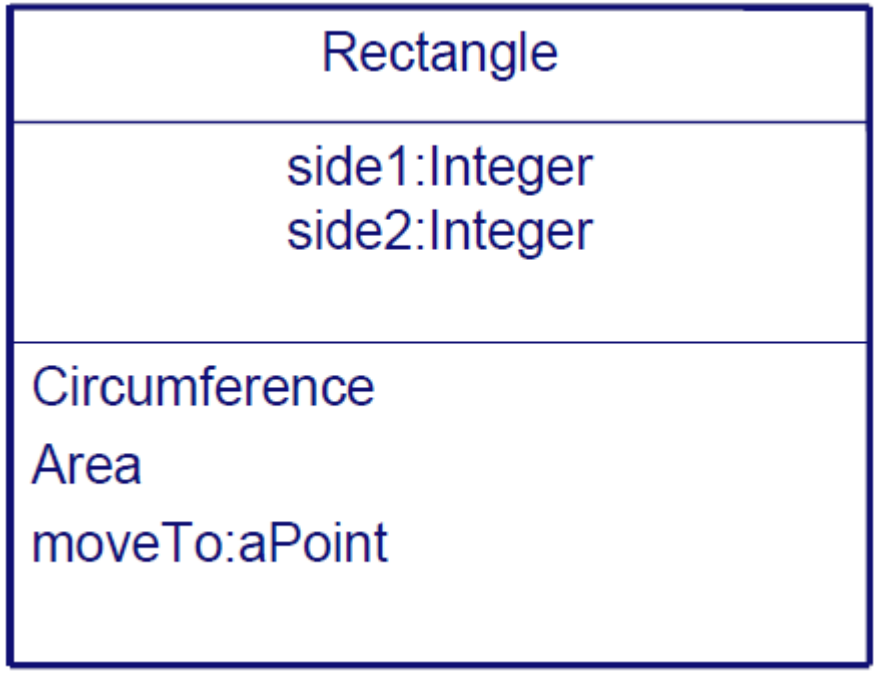
# Background

## Program consist of many “things” (objects)

- there are different kinds of “things”
- objects are created as instances of *classes*
- objects can have an internal state and *components*.
- objects exchange *messages*
- if object A sends message to B then B does something and then returns a result to A
- results can be **`int`**, **`float`** or **`string`** or they can be an object themselves or there is no result (**`void`**).
- there is some main object with a loop that starts everything off

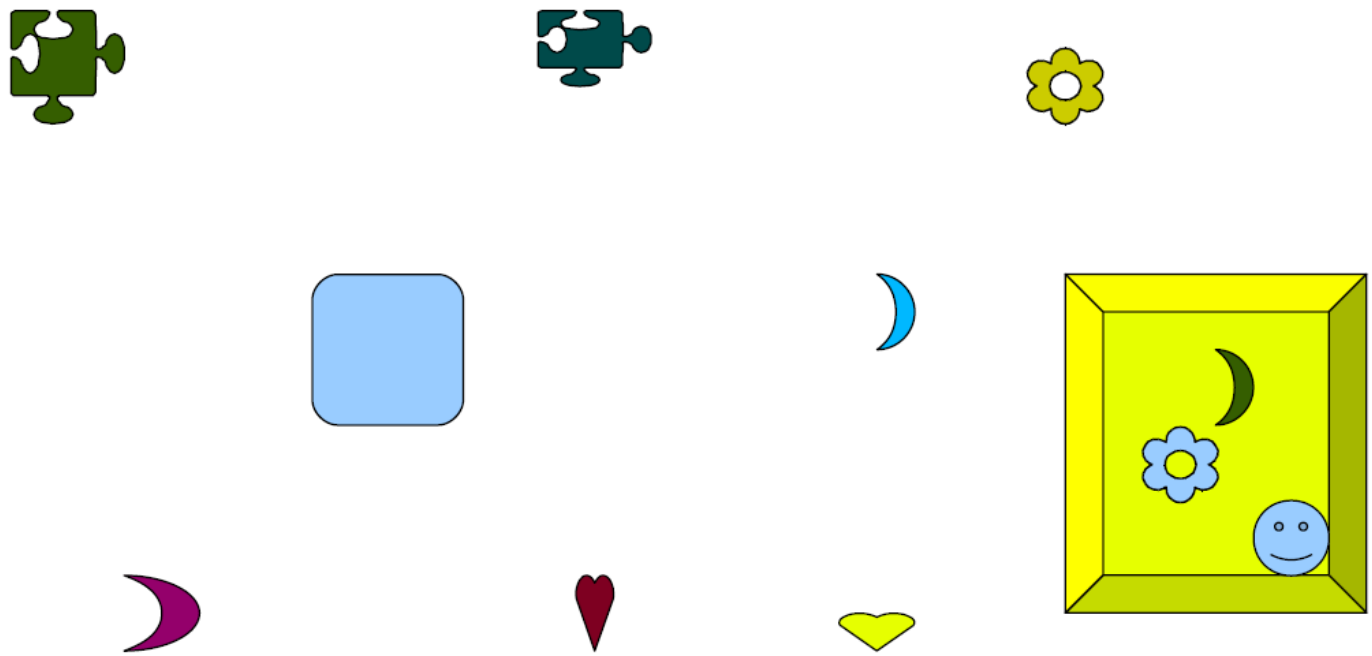
# Background

- Objects encapsulate state as a collection of instance variables
- Objects encapsulate behaviour via methods invoked by messages



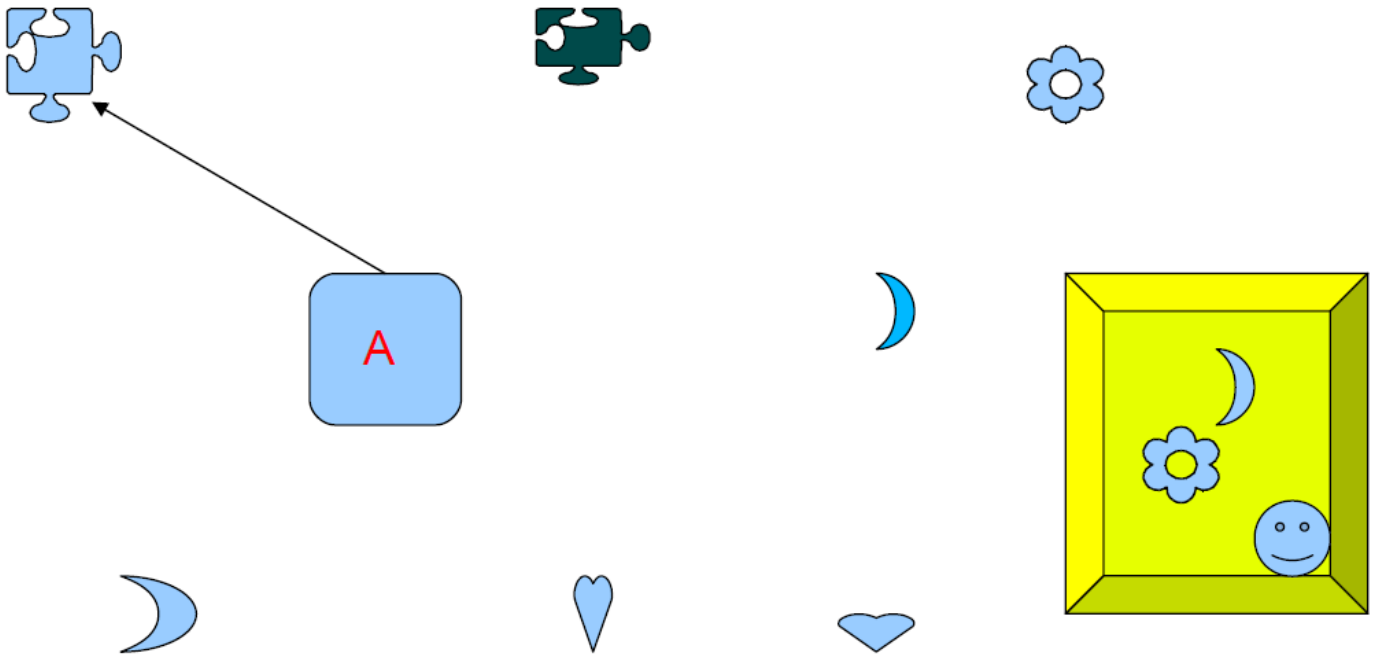
# Background

Program: a world of objects



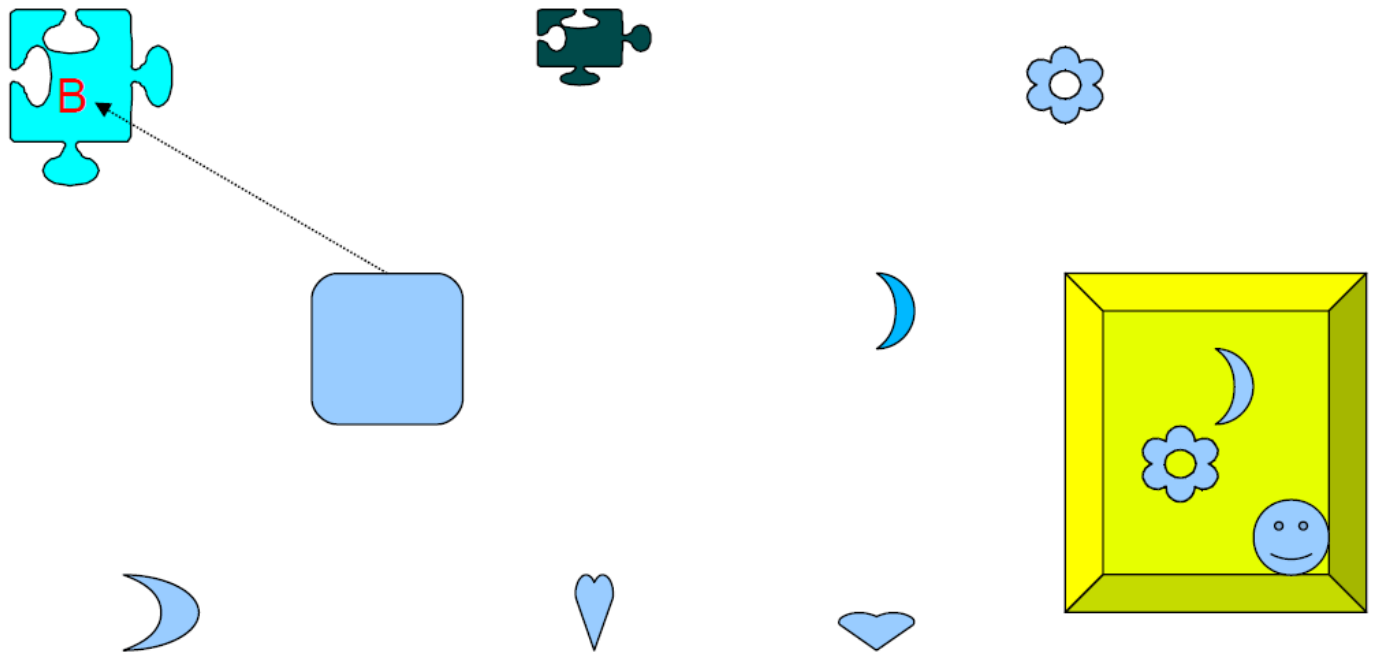
# Background

Active object A sends a message ..



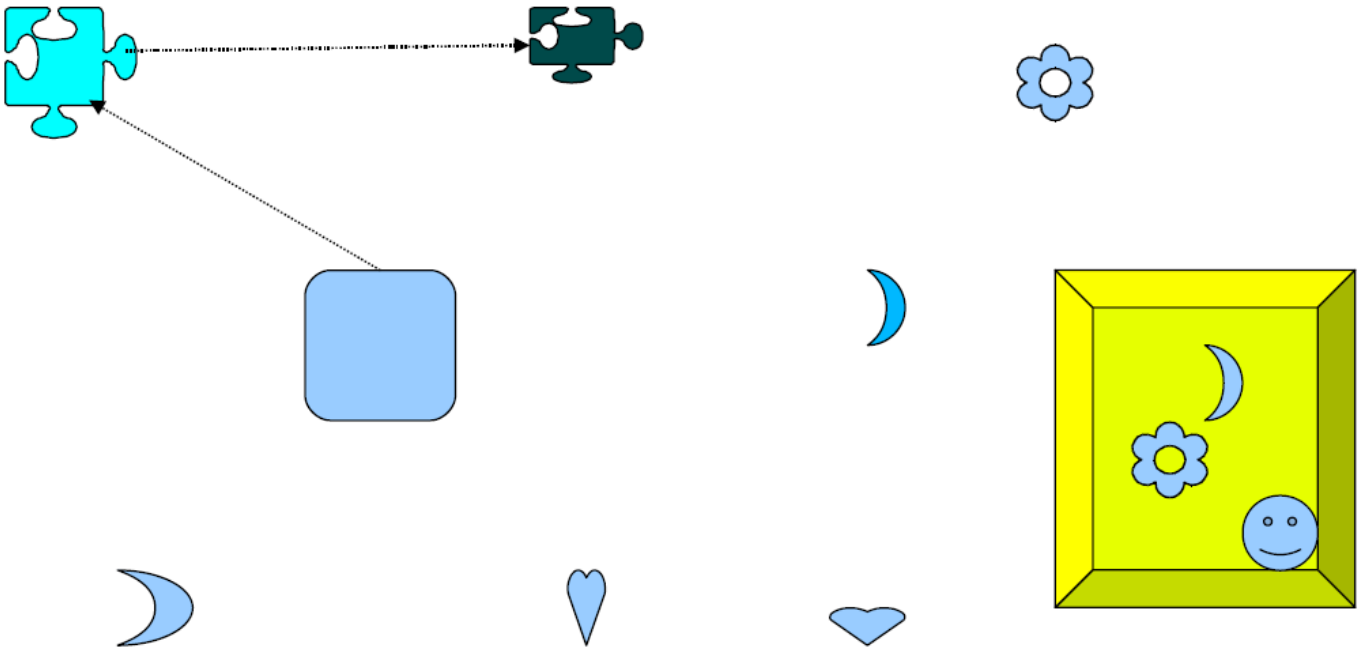
# Background

Receiver B is activated …



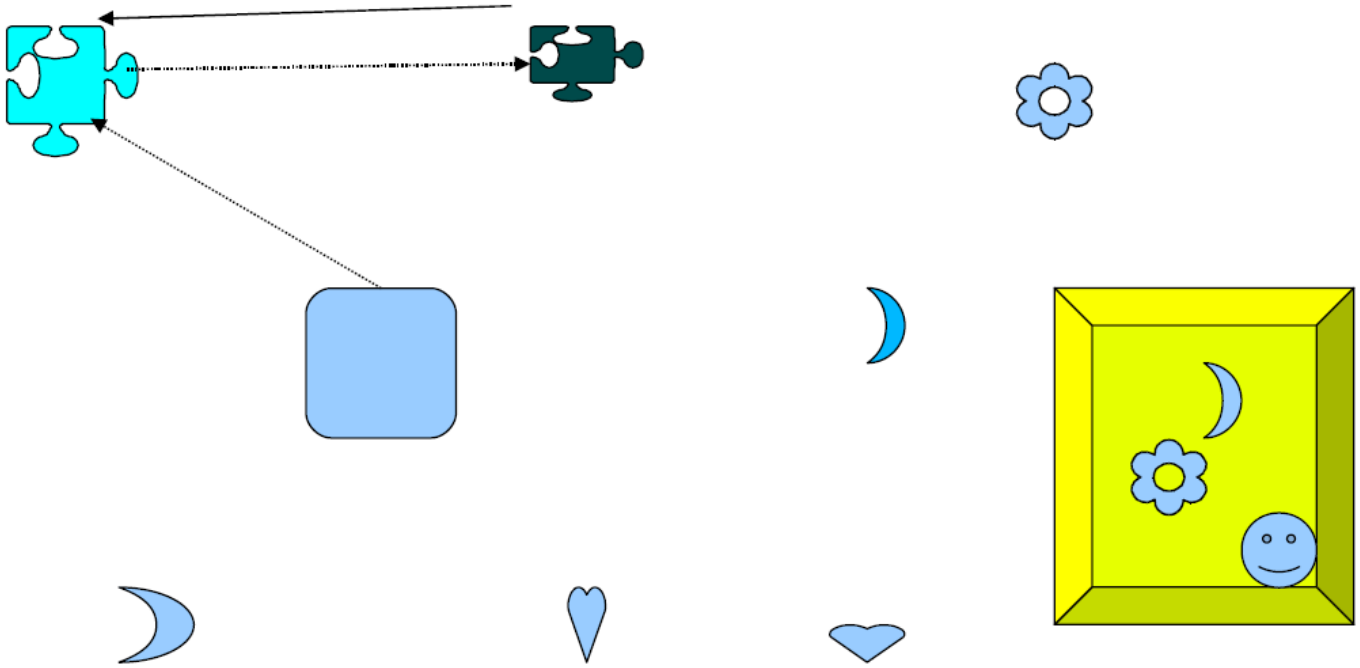
# Background

When active B can send a message …



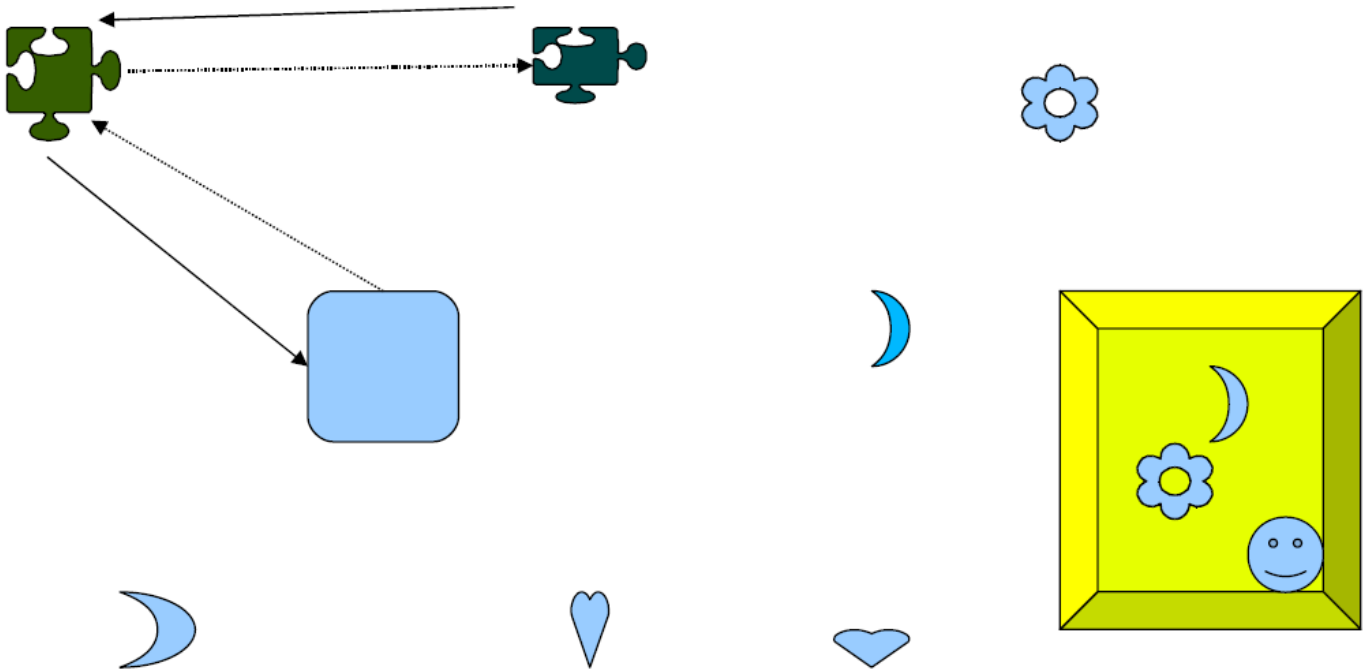
# Background

B gets back result of message …



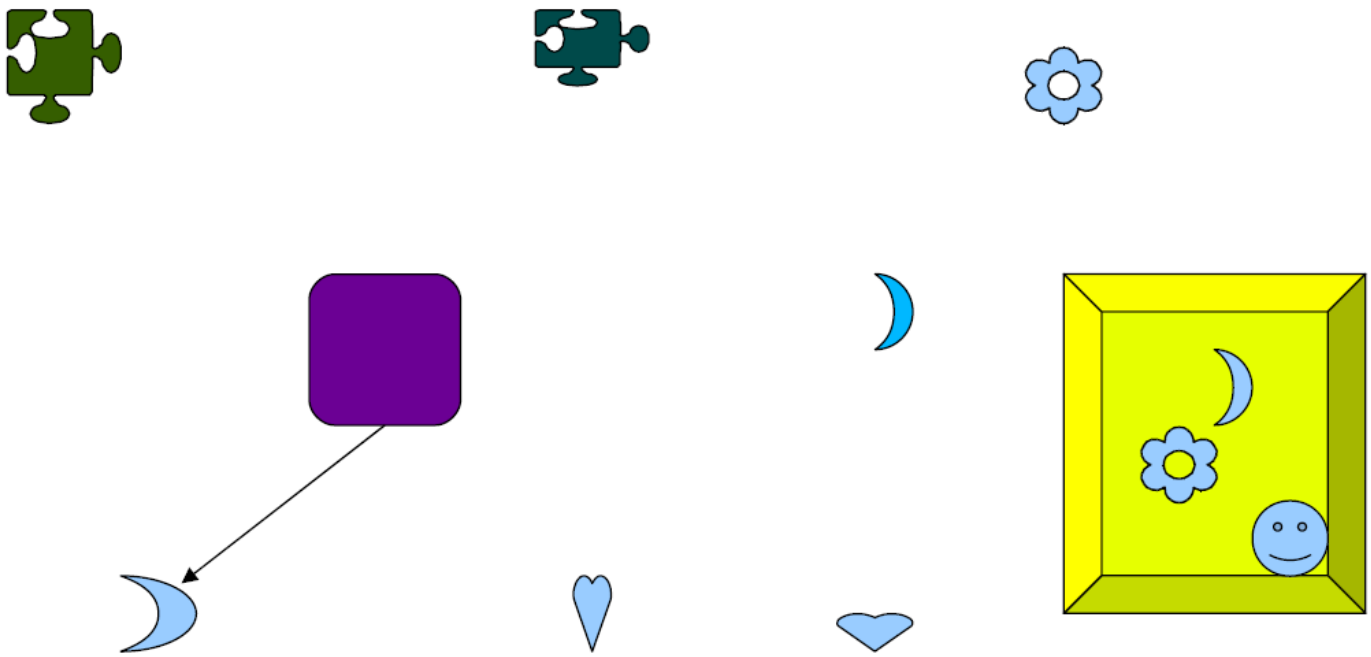
# Background

And eventually returns a result to A



# Background

Object A, now active again …may send new message …

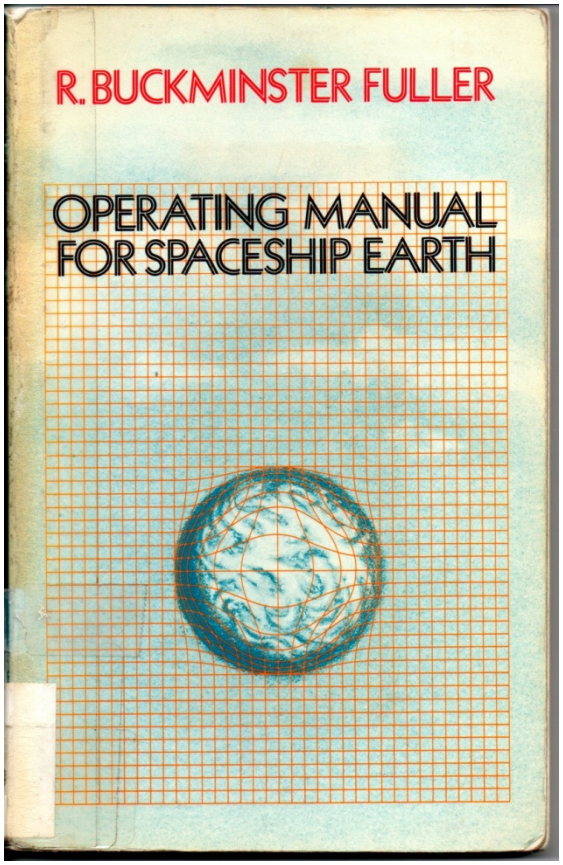


# Encapsulation

Encapsulation is a technique for

- creating for objects with encapsulated state
- and encapsulated behaviour
- hiding implementation details
- protecting the state information of objects
- putting objects in control
- facilitating modularity, code reuse and maintenance

# Example: planet earth



# Encapsulation

```
//planet earth
  float diameter;
  color surface;
  float angle;

void setup(){
  size(800, 600);

//initialize planet earth
  diameter = 12756;     //in 1000km
  surface = #00FF00;    //it's a green planet
  angle = random(350); //it's a new day
}
```

# Encapsulation

```
void orbit(float radiusX, float radiusY, float orbitTime){

    // draw ellipse first, so it's under planet earth
    drawOrbit(radiusX, radiusY);
    float px = cos(radians(angle))*radiusX/2;
    float py = sin(radians(angle))*radiusY/2;

    // draw planet earth next
    fill(surface);
    noStroke();
    ellipse(px, py, diameter/2000, diameter/2000);

    //move forward
    angle += (1/orbitTime);
}
```

# Encapsulation

```
void drawOrbit(float radiusX, float radiusY){

     //make the entire orbit visible
     stroke(255,50);
     float angle=0;
     for (int i=0; i<360; i++){
         point(cos(radians(angle))*radiusX/2,
               sin(radians(angle++))*radiusY/2);
     }
}
void draw(){
     background(0);
     translate(width/2, height/2);
     orbit(150, 153, 1.00);
     //min and max distance to sun in 1000000km
     //rotation time in years
}
```

# Encapsulation

Now we want not *one* planet but a lot of them

- class concept
- declare variables just like before
- functions are now called “methods”
- and can be invoked by messages using “.” notation

# Encapsulation

```
class Planet{
  float diameter;
  color surface;
  float angle;

  Planet(float diameter, color  surface){
        this.angle = random(350);
        this.diameter = diameter;
        this.surface = surface;
  }
```

# Encapsulation

```
public void orbit(float radiusX, float radiusY, float orbitTime){

    // draw ellipse first, so it's under the planet
    drawOrbit(radiusX, radiusY);
    float px = cos(radians(angle))*radiusX/2;
    float py = sin(radians(angle))*radiusY/2;

    // draw planet next
    fill(surface);
    noStroke();
    ellipse(px, py, diameter/2000, diameter/2000);

    //big planets get a red dot award
    if (diameter > 100000){
        fill(#FF5522);
        ellipse(px, py+20, 10, 10);
    }

    //move forward
    angle += (1/orbitTime);
  }
```

# Encapsulation

```
void drawOrbit(float radiusX, float radiusY){

        //make the entire orbit visible
        stroke(255, 50);
        float angle=0;
              for (int i=0; i<360; i++){
                   point(cos(radians(angle))*radiusX/2,
                         sin(radians(angle++))*radiusY/2);
              }
        }
}
```

# Encapsulation

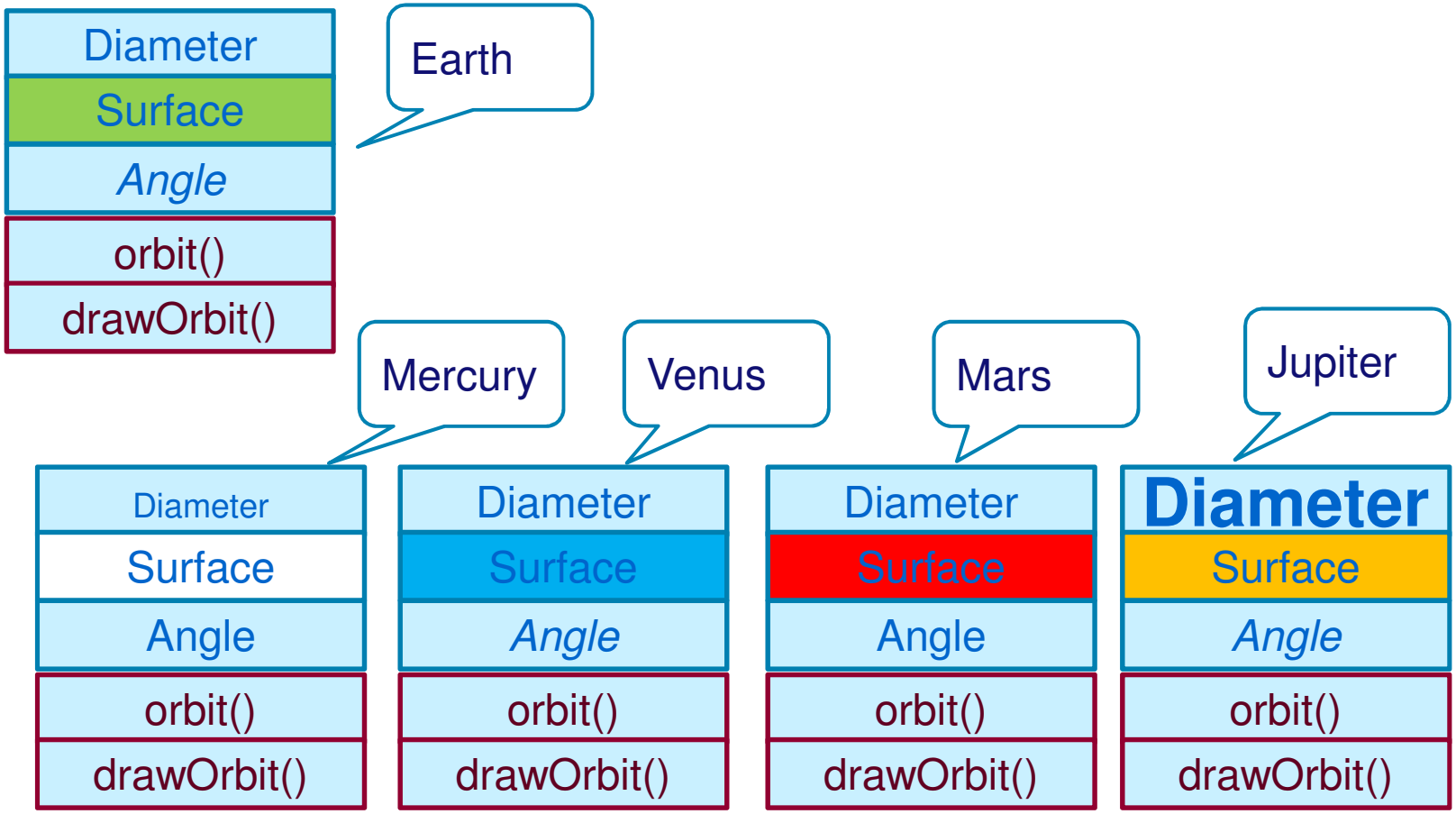
## How do I create an object ?

- each class has a constructor with the same name
- `Planet myfirstPlanet = new Planet();`
- the variable **`myfirstPlanet`** is assigned a reference to the new **`Planet`** object
- uses the first constructor, there may be more complex constructors ..
- `mercury = new Planet(4878, #DDDDDD);`

# Encapsulation

```
//source: http://processing.org/discourse/beta/num_1162399456.html
//posted by ira, (in reply to: Building a graphic of a solar system)
//adapted by (c) 2012 Loe Feijs TU/e

Planet mercury;
Planet venus;
Planet earth;
Planet mars;
Planet jupiter;

void setup(){
     size(800, 600);//,P3D);
     mercury = new Planet(4878, #DDDDDD);
     venus = new Planet(12104, #6688FF);
     earth = new Planet(12756, #00FF00);
     mars = new Planet(6788, #FF0000);
     jupiter = new Planet(142796, #FFEE33);
}
```

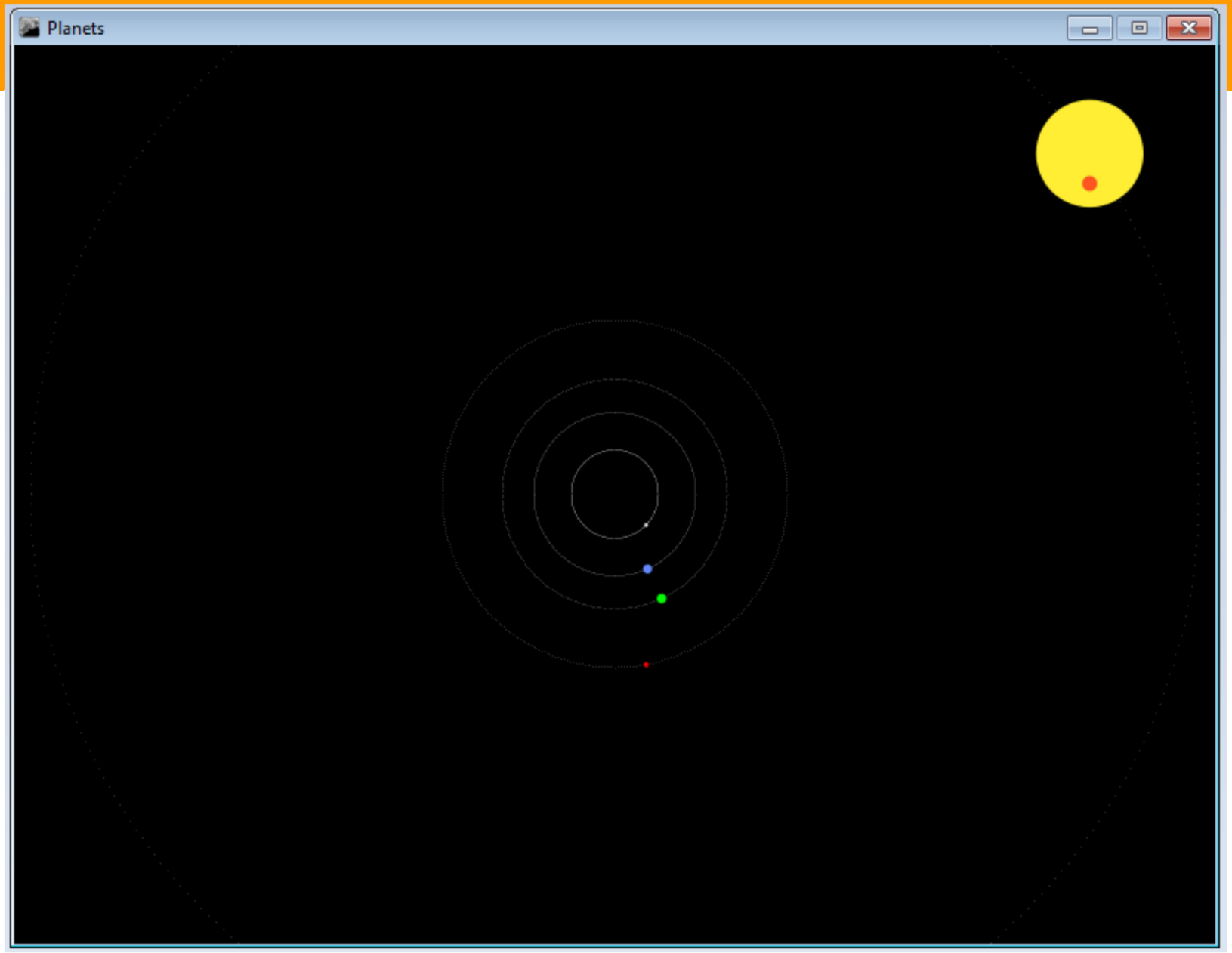
# Encapsulation



# Encapsulation

```
void draw(){
     background(0);
     translate(width/2, height/2);

     mercury.orbit(58, 59, 0.24); //distances in 1000000km
     venus.orbit(108, 109, 0.62); //rotation time in years
     earth.orbit(150, 153, 1.00);
     mars.orbit(230, 232, 1.88);
     jupiter.orbit(778, 782, 11.87);
}
```

# Encapsulation



# Encapsulation

## What we achieved

- every object has it's own memory, which consists of variables and other objects
- each object is like a miniature computer itself – a specialised processor performing a specific task
- every object is an instance of a class. A class groups similar objects
- the class is the repository for behaviour associated with an object
- behaviour is associated with classes, not with individual instances. All objects of a given class use the same method in response to similar messages

# Recap

- Background
- Encapsulation
- Planet earth example
- Private and public
- EPD example
- Super- and subclass
- Cars example
- Common design flaws

# Public and private

## Towards even better encapsulation

- prevent that anyone accesses every variable
- prevent that anyone can invoke every method
- keep the fields of an object inside the class
- distinguish with attributes “public” or “private”

# Public and private

## Public view:

- those features (data or behaviour) that other objects can see and use

## Private view:

- those features (data or behaviour) that are only used within the object.

## Note:

- in java or processing keywords *public* and *private* are applied individually

to every component or method

# Example: EPD

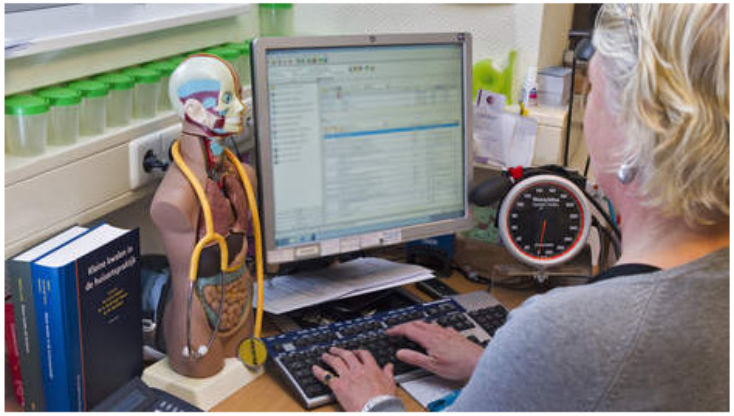
Trouw.nl

Nieuws | Opinie | Groen | Religie & filosofie

Nederland | Buitenland | Politiek | Economie | Sport | Cultuur

## 'Amerika heeft mogelijk toegang tot EPD'

Door: Redactie – 30/11/12, 17:14



© ANP.

**De Amerikaanse overheid kan mogelijk toegang krijgen tot het elektronische patiëntendossier (EPD). Dat stelt het Instituut voor Informatierecht van de Universiteit van Amsterdam. Het bedrijf dat het programma bouwt, CSC, heeft een Amerikaans moederbedrijf en valt dus onder Amerikaanse wetgeving, zoals de Patriot Act.**

Deze wet houdt in dat overheidsinstanties, zoals de FBI, alle gegevens van bedrijven mogen opvragen als de nationale veiligheid in het geding komt. CSC is daarom verplicht om de informatie te geven, dus ook bijvoorbeeld de medische gegevens van Nederlandse patiënten.

Edwin van Velzel, directeur de Vereniging van Zorgaanbieders voor Zorgcommunicatie (VZVZ), eiste vanmiddag bij de NOS dat CSC een verklaring geeft dat ze niet onder de Patriot Act vallen. Als ze dit niet doen dreigt VZVZ de samenwerking op te zeggen en moet er een nieuw programma gemaakt worden.

# Example: EPD

```
class Doctor {
      String clinic;
      Doctor(String c){
             clinic = c;
      }
}

class Test {
      boolean valid;
      boolean result;
      Test(boolean v, boolean r) {
           valid = v;
           result = r;
      }
      String publish(){
             if (valid)
                if (result) return "true"; else return "false";
             else return "INVALID";
      }
}
```

# Example: EPD

```
class Citizen {
      String birthDate;
      private String passWord;
      private String[] conditions;
      private Doctor[] trusted;
      private int nrConditions;
      private int nrTrusted;

      Citizen (String pwd,String date){
              passWord = pwd;
              birthDate = date;
              nrConditions = 0;
              conditions = new String[1000];
              nrTrusted = 0;
              trusted = new Doctor[1000];
      }
```

# Example: EPD

```
public void addCondition(Doctor dr, String condition){
       if (trust(dr))
           conditions[nrConditions++] = condition;
}
private boolean hasCondition(String condition){
        boolean has = false;
        for (int i=0; i< nrConditions; i++)
             if (conditions[i].equals(condition))
                 has = true;
        return has;
}
public void addDoctor(String pwd, Doctor dr){
       if (pwd.equals(passWord))
          trusted[nrTrusted++] = dr;
}
```

# Example: EPD

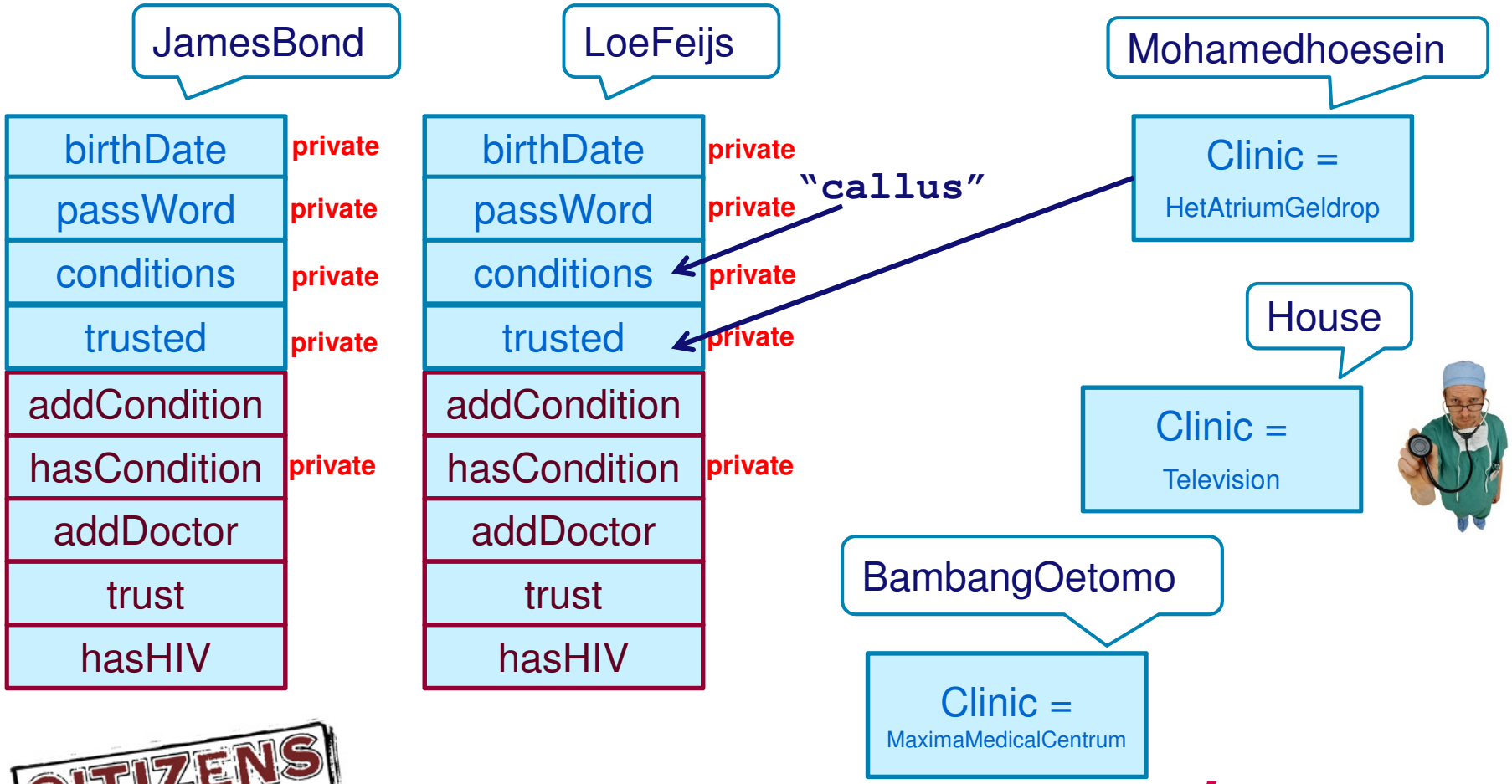
```
        public boolean trust(Doctor dr){
               boolean found = false;
               for (int i=0; i< nrTrusted; i++)
                    if (trusted[i] == dr)
                        found = true;
               return found;
        }

        public Test testHIV(Doctor dr){
               Test tst = new Test(trust(dr),false);
               if (tst.valid)
                   for (int i=0; i<nrConditions; i++)
                           if (conditions[i].equals("HIV"))
                               tst.result = true;
               return tst;
        }
}       //end class Citizen
```

# Public and private

## What we achieved

- the fields **`passWord`**, **`conditions`**, and **`trusted`** are private
- they can only be accessed by **`Citizen`** objects
- or indirectly by invoking methods of the class **`Citizen`**
- the actions of **`addCondition`** and **`testHIV`** include a search to check whether the doctor is trusted

# Public and private





source: www.meteor17.com

# Public and private

```
Citizen LoeFeijs = new Citizen("tokipona","04081954");
Citizen JamesBond = new Citizen("skyfall","03071953");

Doctor House = new Doctor("Television");
Doctor Mohamedhoesein = new Doctor("HetAtriumGeldrop");
Doctor BambangOetomo = new Doctor("MaximaMedicalCentrum");

void setup(){
     LoeFeijs.addDoctor("tokipona",Mohamedhoesein);
     LoeFeijs.addCondition(Mohamedhoesein,“callus");
     LoeFeijs.addCondition(House,"lupus");
     Test t = LoeFeijs.testHIV(Mohamedhoesein);
     println(t.publish());
}
```

```
false
```

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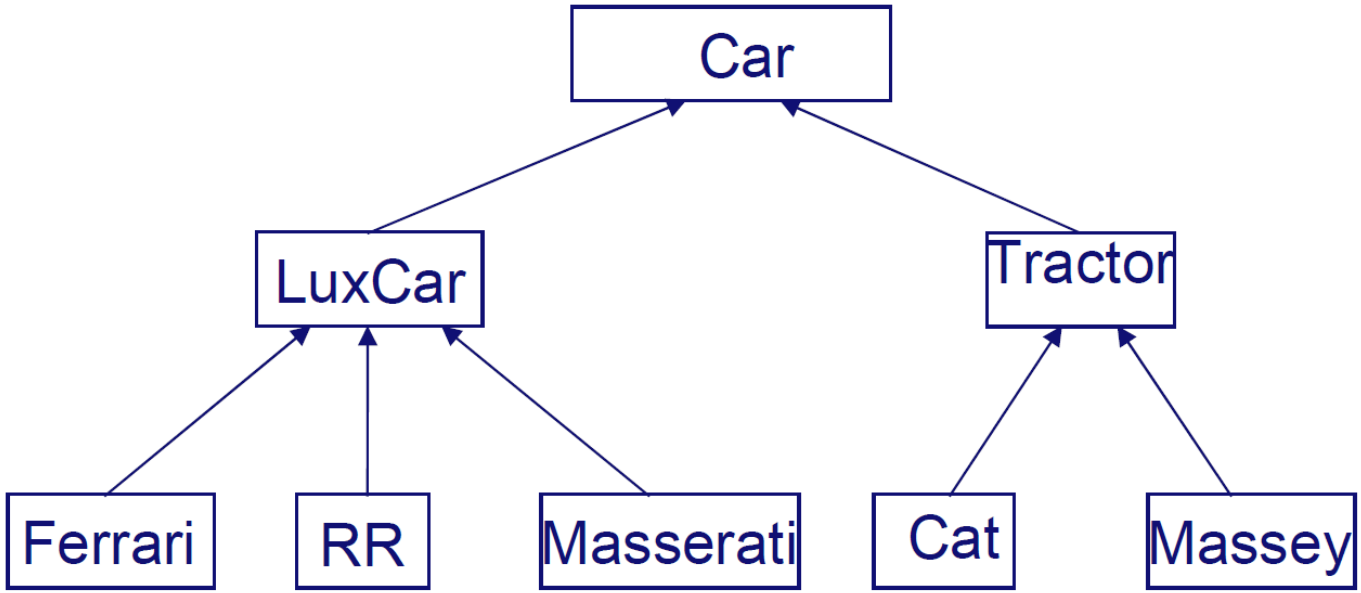
# Super- and subclass

## Classes form a hierarchy

- superclass is the parent and subclass is a child
- subclasses “extend” (i.e. specialize) their superclass



# Super- and subclass

Subclasses can alter or override inherited information

- all mammals give birth to living young
- all fish have gills

# Generic class definition

```
class ClassName extends OtherClass {
        //properties or components
        int property1;
        float property2;
        rectangle component3;

        //constructors
        ClassName(){}
        ClassName(int prop1,float prop2){
                property1 = prop1;
                property2 = prop2;
        }
```

# Generic class definition, continued

```
        //methods
        void setProperty1(int prop1){
             property1 = prop1;
        }
        int getProperty1(){
            return property1;
        }
        …
        other ... specific methods

} //class ends
```

# Inheritance in Java

A note on inheritance in Java:

- a single root class: `Object`
- all classes inherit from some class, default `Object`

# Example: cars

Scooped by **Good Things From Italy** onto **Good Things From Italy - Le Cose Buone d'Italia**

## De mooiste Ferrari's van Sergio Pininfarina

Rescoop

From **www.autoitalia.nl** - November 5, 3:28 PM

Halverwege dit jaar overleed ontwerper Sergio Pininfarina, een naam die iedereen die ook maar îéts met auto's heeft ongetwijfeld zal kennen. Naast de nodige betaalbare auto's ontwierp Pininfarina vooral veel exclusieve auto's waarbij het merk met het steigerende paard een groot deel hiervan voor zijn rekening nam.

Meer dan 100 verschillende modellen kwamen er uit de pen van de ontwerper en dat vindt Ferrari reden genoeg voor een fraaie expositie van de fraaiste modellen. 22 exemplaren zijn er uitgestald in het Ferrari museum in Maranello voor de expositie die luistert naar de naam 'The Great Ferraris of Sergio Pininfarina Exhibition'.

# Example: class car

```
class Car {
  color carCol;
  int xPos, yPos;
  int tireWidth = 13;

  Car() {
    carCol = color(0, 0, 0);//as Ford said
    xPos = 123;
    yPos = 134;
  }

  void setyPos( int y) {
       yPos = y ;
  }
  void carPaint(color desiredColor) {
       carCol = desiredColor;
  }
```

Source: wallpapersup.net/ford-mustang-v6-black/

# Example: class car

```
  void DrawCar() {
        //body
        fill(carCol)  ;
        ellipse(xPos, yPos, 120, 20);
        //front tires
        fill(0);
        rect(xPos+20, yPos+10, 20, tireWidth);
        rect(xPos+20, yPos-10-tireWidth, 20, tireWidth);
        //rear tires
        rect(xPos-40, yPos+10, 20, tireWidth);
        rect(xPos-40, yPos-10-tireWidth, 20, tireWidth);
  }

  void drive(int s) {
        xPos += s;
        xPos = xPos % width;
        yPos = yPos % height;
  }
} //end class
```

# Example: class car

```
class LuxCar extends Car {

  LuxCar() {
     tireWidth = 24;
  }
}

class CrossCar extends LuxCar {
   int cnt = 0;

   void drive(int s) {
        cnt++;
        cnt%=20;
        if (cnt<10) yPos++; else yPos--;
        xPos += s;
        xPos = xPos % width;
        yPos = yPos % height;
   }
}
```

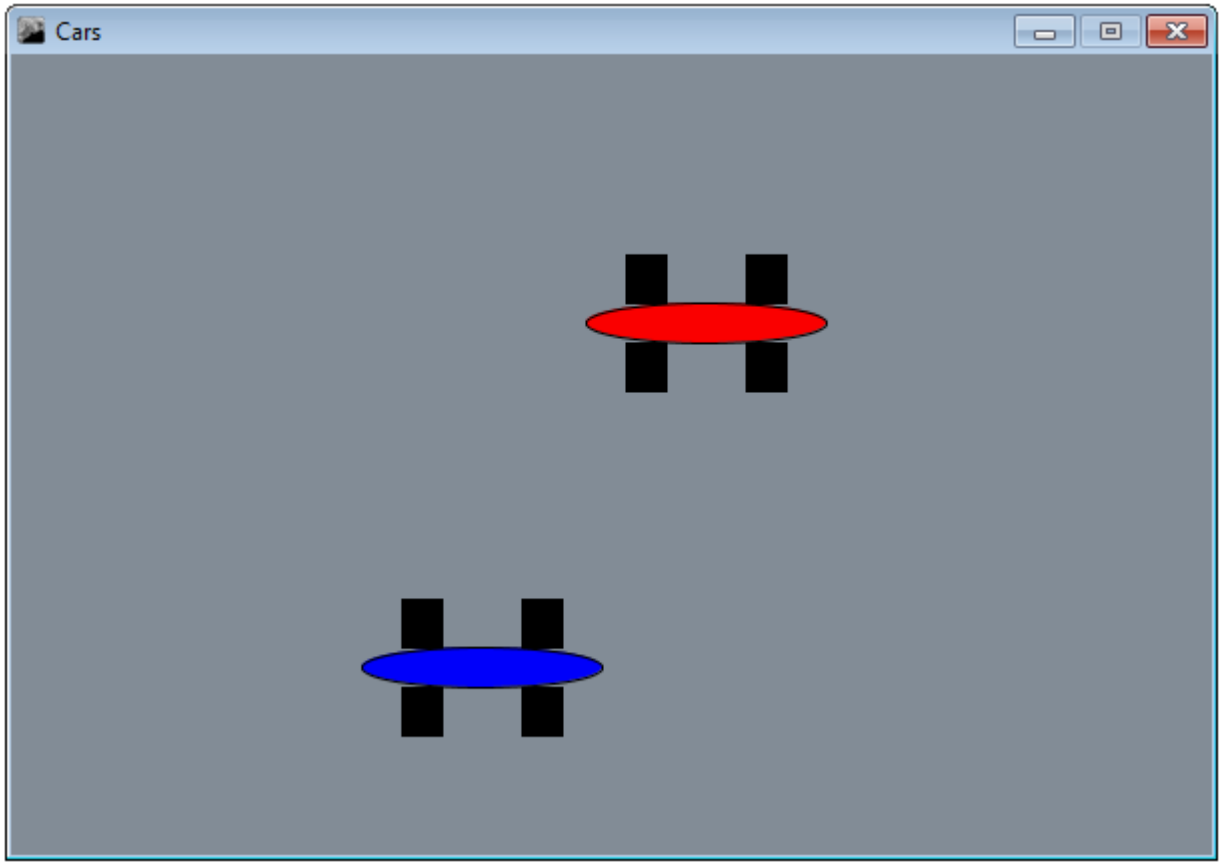
# Example: class car

```
Car mycar;
Car yourcar;

void setup() {
     size(600, 400);
     mycar = new LuxCar();
     yourcar = new CrossCar();
     yourcar.setyPos(300);
     mycar.carPaint( color(250, 0, 0) );
     yourcar.carPaint( color(0, 0, 250) );
}

void draw()  {
     background(130,140,150);
     mycar.DrawCar();
     mycar.drive(2);
     yourcar.DrawCar();
     yourcar.drive(1);
};
```

# Recap



# Encapsulation

## What we achieved

- several types of **`Car`** objects
- easy creation of new **`Car`** objects of these types
- common properties and methods modeled only once
- **`LuxCar`** has a different default value for property tireWidth
- **`CrossCar`** has one additional internal counter variable **`cnt`**
- **`CrossCar`** has different **`drive`** behaviour, overriding the original

# Common Design Flaws

- Direct modification: classes that make direct modification of data values in other classes are a direct violation of *encapsulation*
- Too much responsibility: such classes are difficult to understand and use. Responsibility should be split into smaller meaningful packages
- No responsibility: such classes serve no purpose. Often arise when designers equate physical existence with logical design existence. “Money is no object”
- Classes with unused responsibility: Usually the results of designing software components without thinking about how they will be used
- Misleading names: Names should be short and unambiguously indicate what the responsibilities of the class involve
- Inappropriate inheritance: Occurs when subclassing is used in situations where the concepts do not share an “*is-a*” relationship.

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**thank you for your attention**