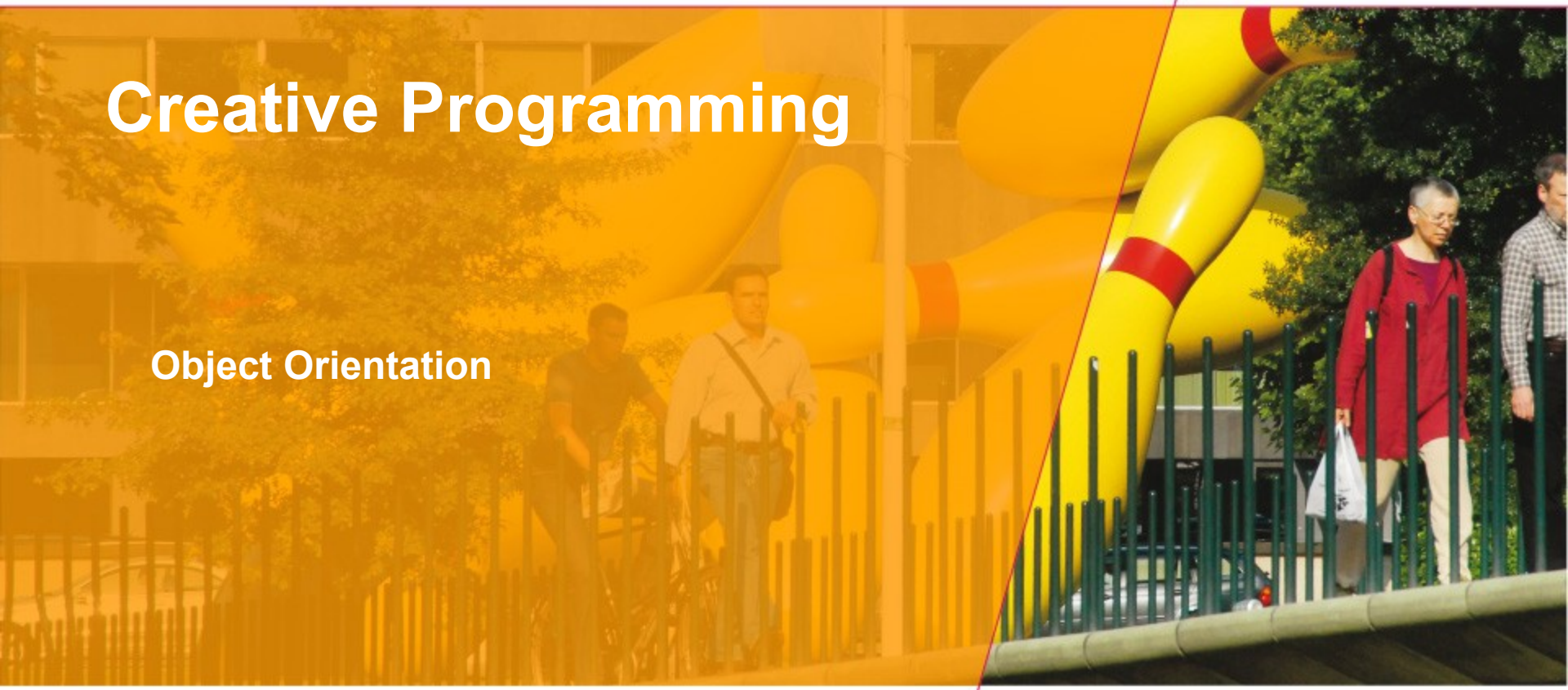
Creative Programming

Object Orientation



TU/e Technische Universiteit Eindhoven University of Technology

Where innovation starts

Overview of this lecture

Thinking Object Oriented:

- **What is Object-Oriented Programming?**
- **Key Elements**

- **Example: Car**
- **Coding of Key Elements:**
  - **Classes**
  - **Methods and Messages**
  - **Inheritance**
- **Common Design Flaws**

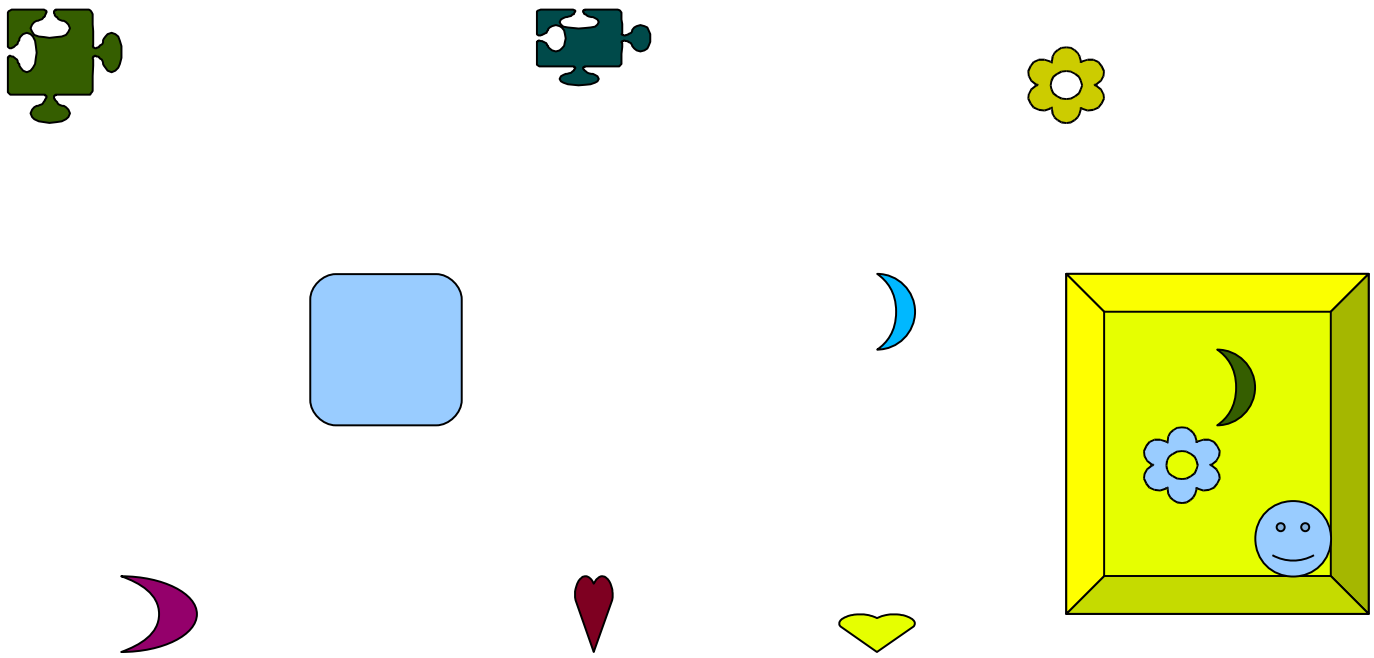
What is Object-Oriented Programming?

- **OOP is a revolutionary extension of programming**
- **OOP extends earlier programming abstractions**
- **It shows similarity to techniques of thinking about problems in other domains (e.g. Architecture) (a way of looking at situations .. to simplify dealing with those situations .... e.g. organizing information)**
- **It is the leading programming paradigm**
- **A paradigm is a set of theories, standards, and methods that together represent a way of organising knowledge – that is, an organised way of looking at and handling certain types of problems..**

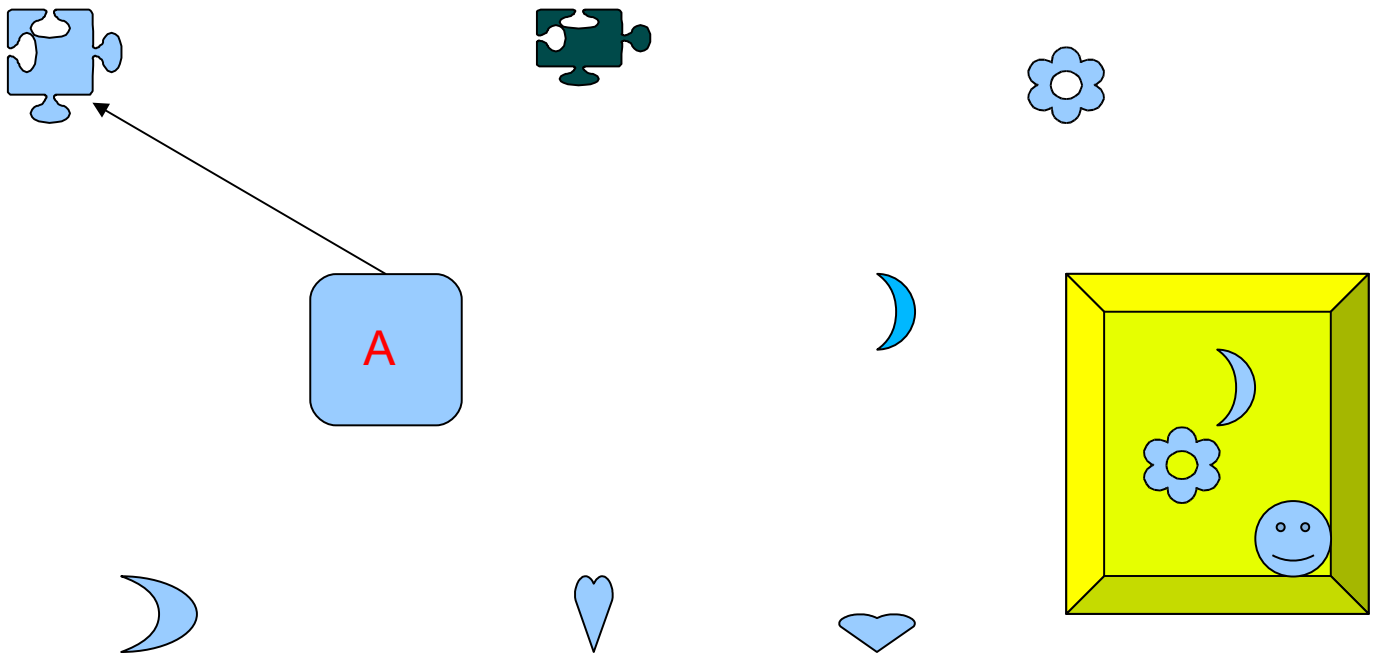
Basic ideas

- 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.

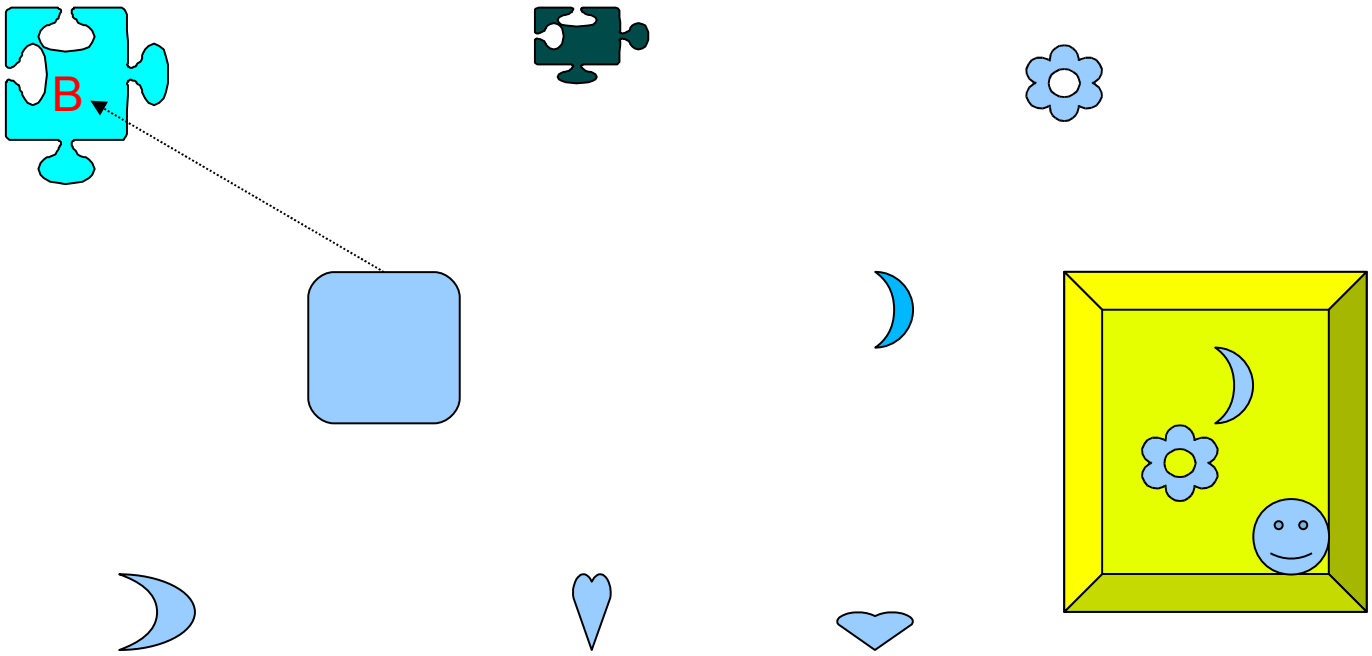
Program : A world of objects



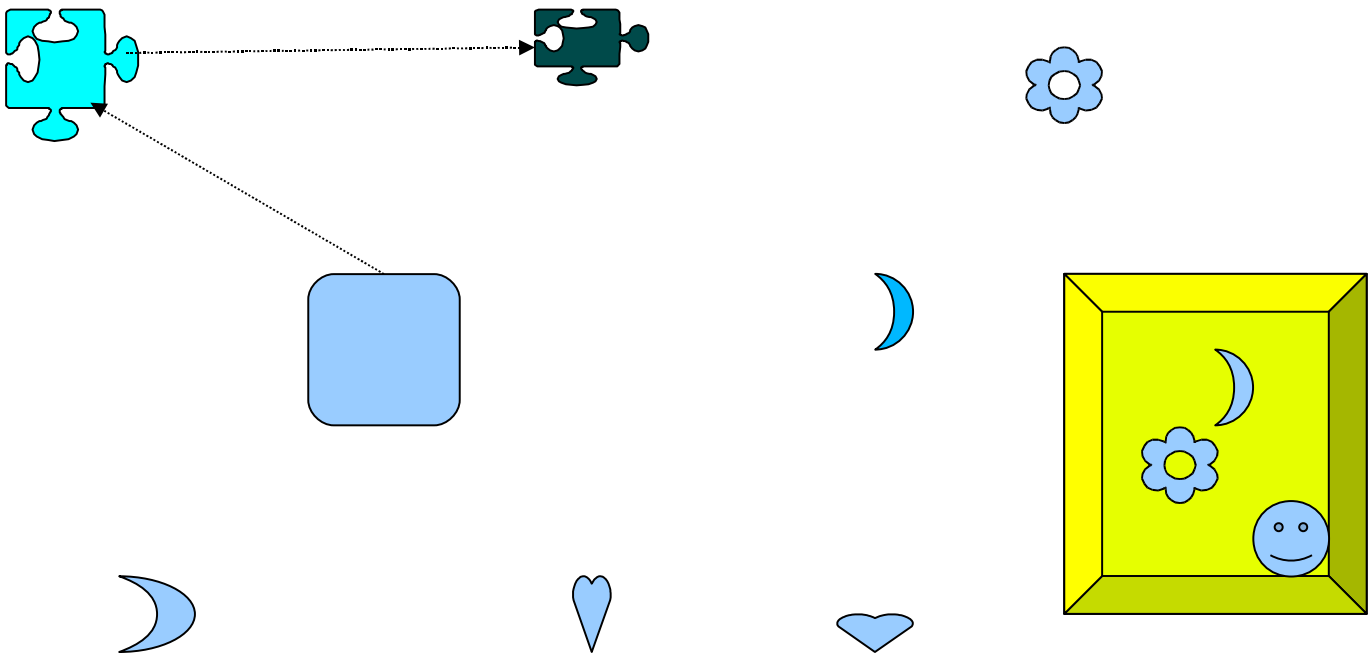
Active object A sends a message ..



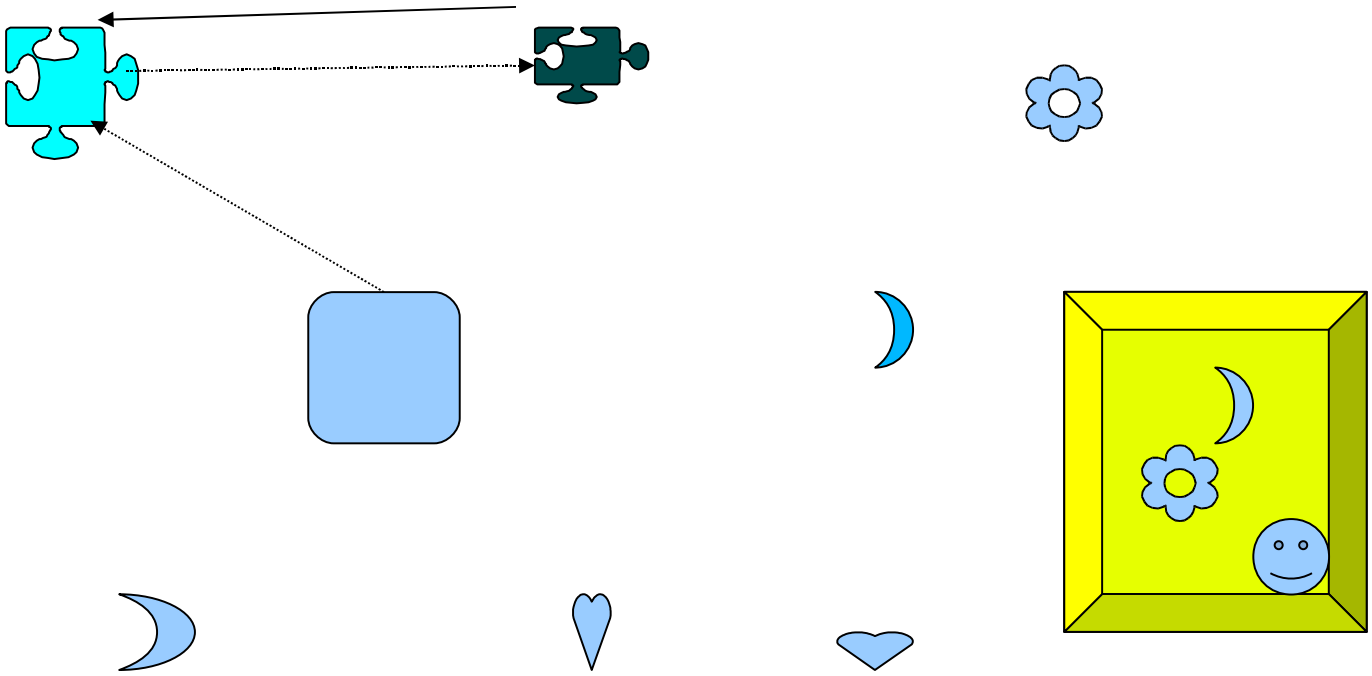
Receiver B is activated …



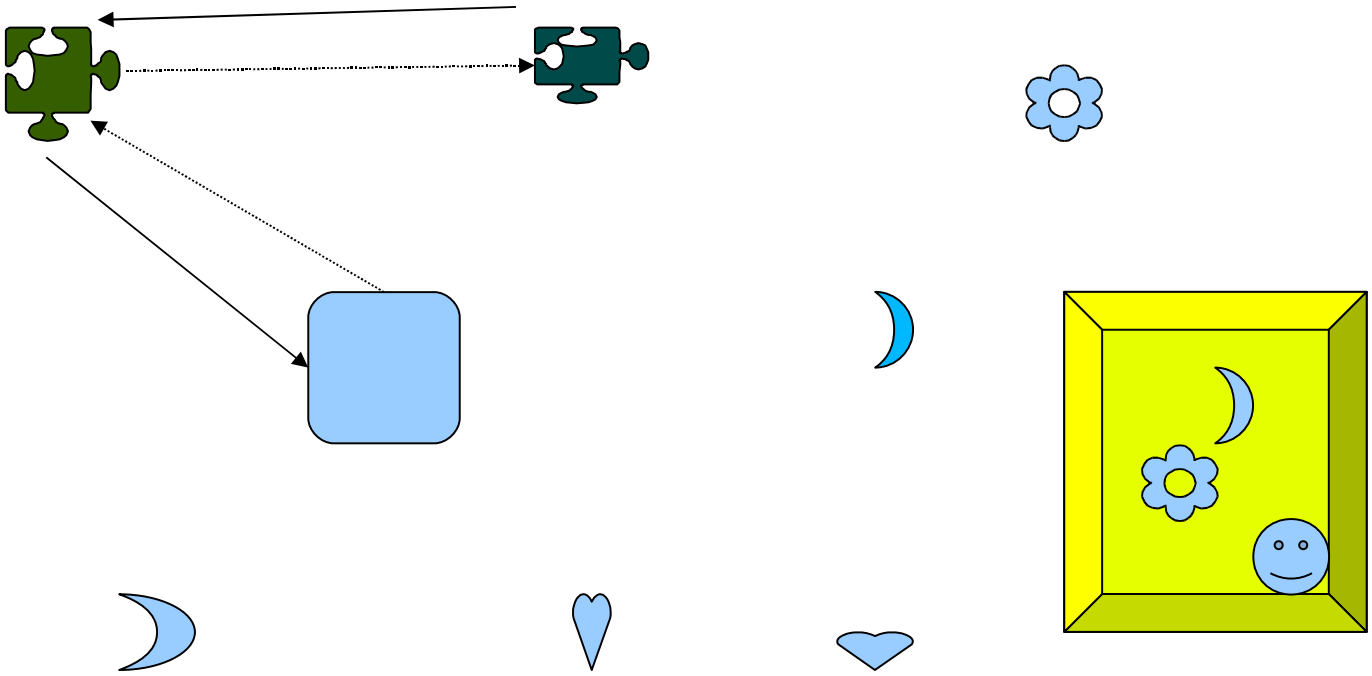
When active B can send a message …



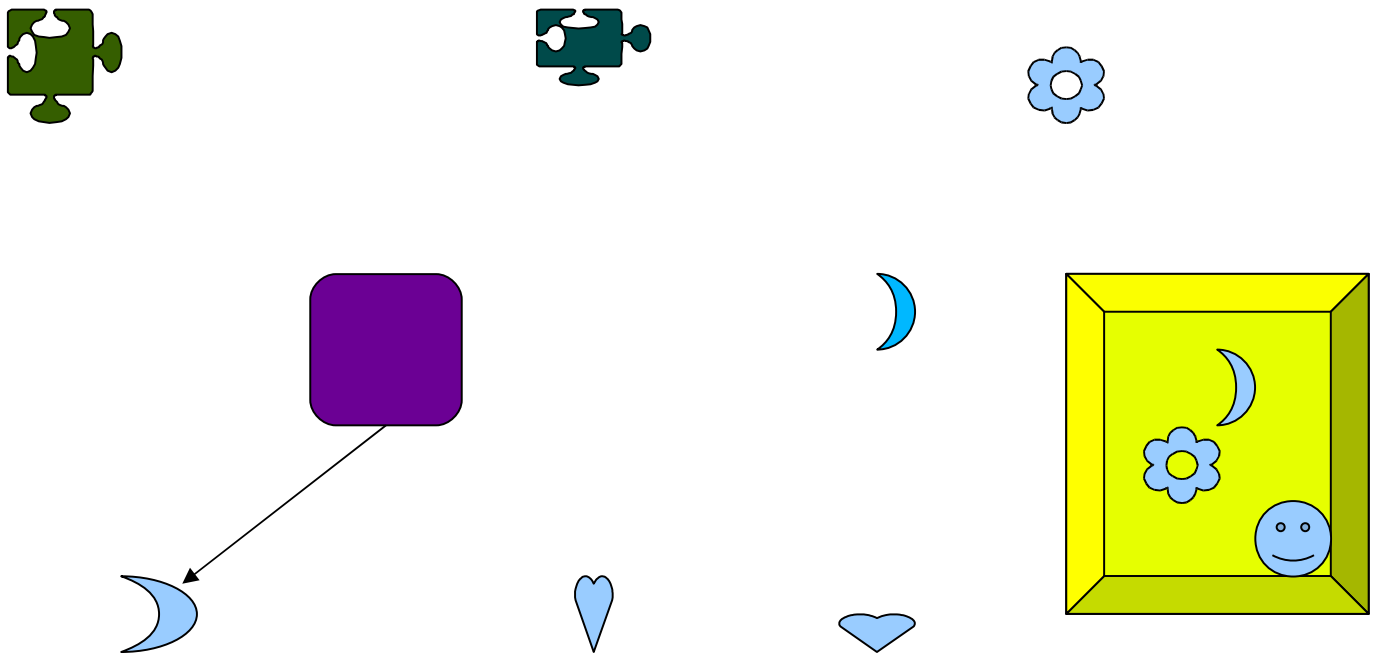
B gets back result of message …



And eventually returns a result to A



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



All about objects and messages ....

- OOP is based on the principle of *recursive design*
  - Every thing is an object
  - Objects perform computation by making requests of each other through the medium of messages
  - Every object has it's own memory, which can consist of other objects

Objects: organised through Classes

- Every object is an instance of a class. A class groups similar objects
- The class is the repository for behaviour associated with an object

- Classes are organised into tree structures, called inheritance hierarchies.

Elements of OOP

1. ***Every thing is an object***

Actions in OOP are performed by active objects.

(…. similar objects are found in the same class)

Elements of OOP-Messages

2. *Objects perform computation by making requests of each other through the medium of messages*

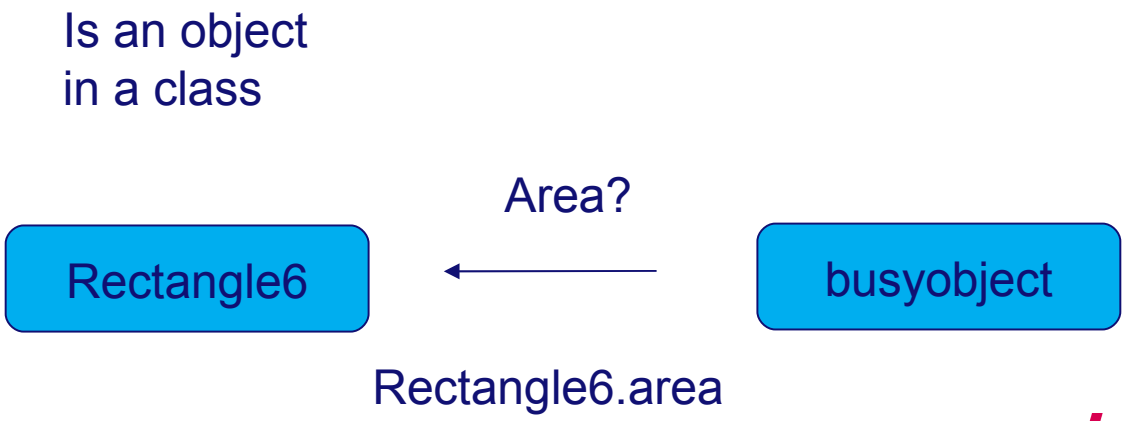
Actions in OOP are produced in response to requests for actions, called messages. An instance may accept a message and in return it will perform an action and return a result.

What vs How

- What: messages
  - Specify what behaviour objects are to perform
  - Details of how are left up to the receiver
  - State information only accessed via messages
- How: Methods (found in objects that handle message)
  - Specify how operation is to be performed
  - Must have access to data
  - Need detailed knowledge of data
  - Can manipulate data directly

Message

- **Sent to receiver object: receiver-object.message**
- **A message may include parameters necessary for performing the action**
- **Message-send always return a result (an object)**
- **Only way to communicate with an object and have it perform actions**



Method

- Defines how to respond to a message
- Depends on class of receiver …
- Has name that is the same as message name
- Is a sequence of executable statements
- Returns a result of execution

Float area
Return side1*side2

Information hiding (behind curtain)

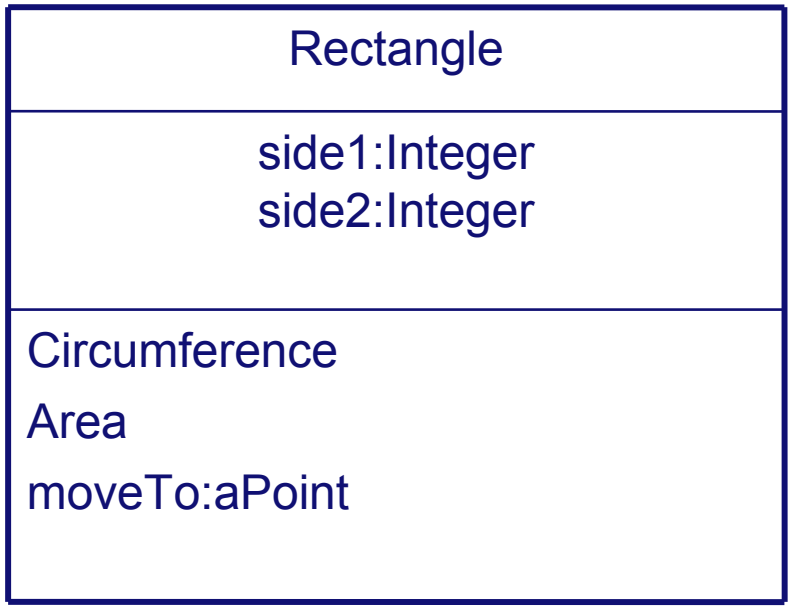
- As a user of a service being provided by an object, I need only to know the set of messages that the object will accept. I need not to have any idea of how the methods are performed.

- Having accepted a message, an object is responsible for carrying it out.

External perspective	Internal perspective
What	How
Message	Method

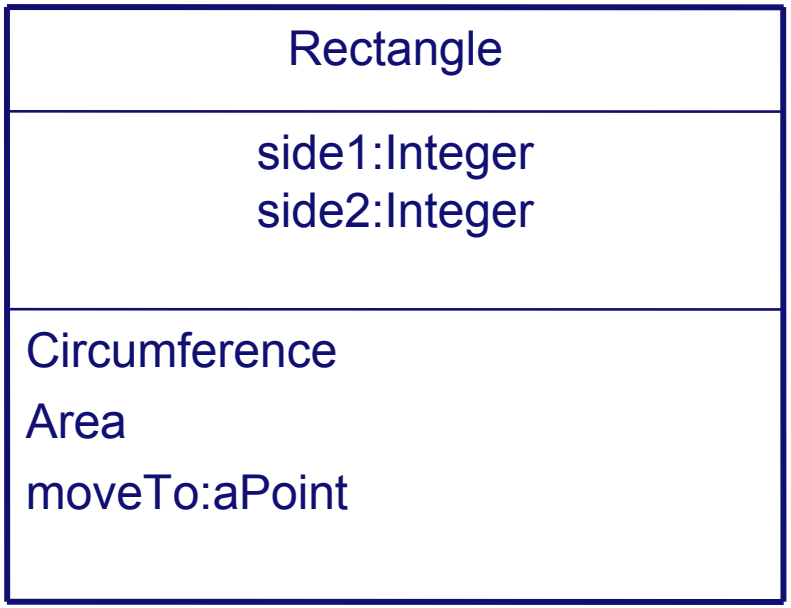
Object Encapsulation

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



Object encapsulation ctd.

- **Technique for**
  - **Creating for objects with encapsulated state/behaviour**
  - **Hiding implementation details**
  - **Protecting the state information of objects**
- **Puts objects in control**
- **Facilitates modularity, code reuse and maintenance**



Elements of OOP-Receivers

- **Messages differ from traditional functions:**
  - **In a message there is a designated receiver that accepts the message**
  - **The interpretation of the message may be different, depending upon the receiver**

- **objects:**
  Florist Flo;
  Secretary Beth;
  Dentist Ken;
- **messages:**
  Flo.sendFlowersTo(myFriend);
  Beth.sendFlowersTo(myFriend);
  Ken.sendFlowersTo(myFriend); (will probably not work)

- **Although different objects might receive the same message, the behaviour they perform will likely be different**

Elements of OOP-Recursive Design

3. 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

"Ask not what you can do *to* your datastructures, but what your datastructures can do *for* you"

Elements of OOP - Classes

4. Every object is an instance of a class. A class groups similar objects
5. The class is the repository for behaviour associated with an object

- The behaviour I expect from Flo is determined from a general idea I have of the behaviour of florists
- We say Flo is an instance of the class Florist
- Behaviour is associated with classes, not with individual instances. All objects of a given class use the same method in response to similar messages

Example : class Car

```
class Car {  // Cars can drive and can be drawn on screen
color c;
int carlength ;
float xpos;
float ypos;
float speed;
int    tirewidth ;

Car(){       //this is a constructor for a default Car
c = color(223,34,45);
xpos = 23;
ypos = 34;
carlength = 120;
tirewidth = 12;
}
```

Card example: instance creation

- How do I create an object with a constructor?

Car myfirstCar = new Car();

- The variable aCar is assigned a reference to the newly created Car object

- Uses the first constructor, there may be more compelx constructors ..

```
Car( color desiredColor  ){   //  constructor for coloured car
 c =  desiredColor
 xpos = 23;
 ypos = 34;
 Carlength = 120
tirewidth = 12;
}

 void Drawcar(){     // method to draw a car on screen
 ellipse(xpos,ypos, carlength,10);
 rect(xpos, ypos-10, 10,-tirewidth);
 rect(xpos,ypos+10, 10, tirewidth);
}
```

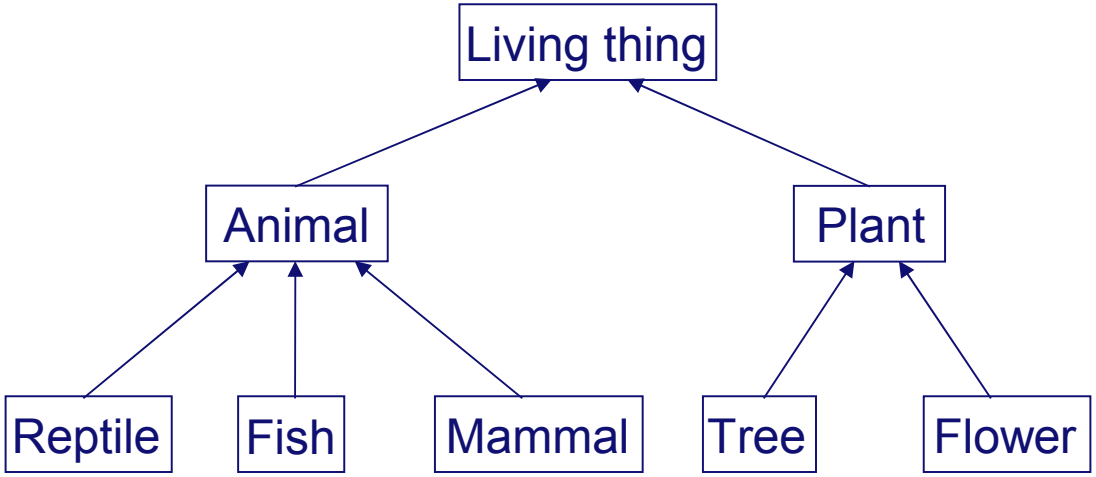
Coding of Key Elements: Classes

- **Elucidate with examples:**
  - **We start with defining Cars in a race game**
  - **Extend Car example to explain *inheritance***

  - ***generic class definition***

Superclass/subclass

- **Classes form a hierarchy**
- **Superclass is the parent and subclass is a child**
- **Subclasses "extend" (i.e. Specialize) their superclass**

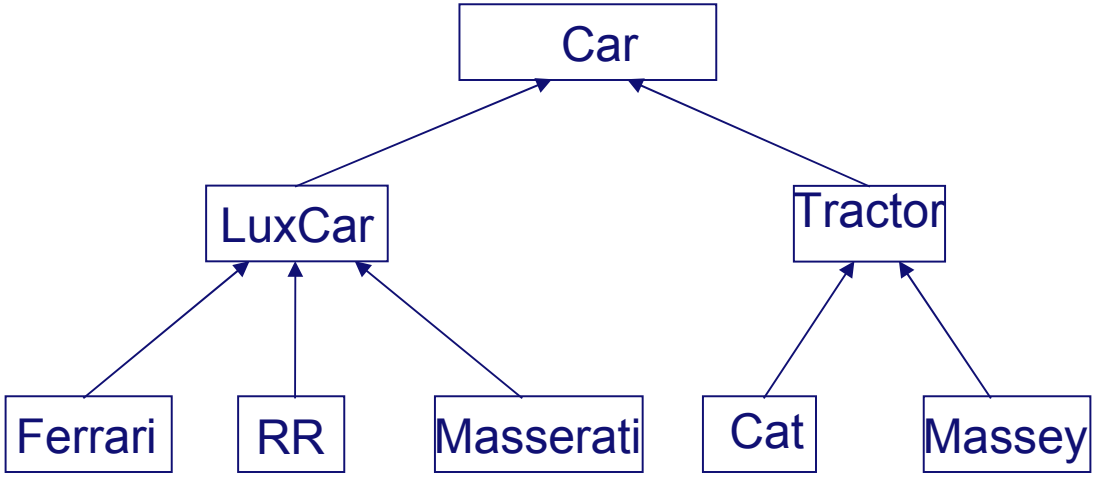


Elements of OOP - Overriding

- **Subclasses can alter or override information inherited from parent classes:**
  - **All mammals give birth to living young**
  - **All fish have gills**

Superclass/subclass

- Classes form a hierarchy
- Superclass is the parent and subclass is a child
- Subclasses "extend" (i.e. Specialize) their superclass



- void drive() // method for Car to drive in x
- // direction
- { xpos = xpos + 3;}

- LuxCar extends Car() // Luxcars are cars with
- // somewhat better properties

- void drive() { xpos = xpos + 4;}

Generic class definition

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

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

Generic class definition,ctd

```
    //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***

Public and Private view

- **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.**
- **In** java **or** processing **keywords *public* and *private* are applied individually to every component or method**

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: **Classes with too much responsibility are difficult to understand and use. Responsibility should be split into smaller meaningful packages.**
- No responsibility: **Classes with no responsibility 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.**