Chapter 13. Object Oriented Programming

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Computer Programming

- The history of computer programming is a steady move away from **machine-oriented views** of programming towards concepts and metaphors that more closely reflect the way in which **we ourselves understand the world**

Computer Programming

- Programming has progressed through:
  - machine code
  - assembly language
  - machine-independent programming languages
  - procedures & functions
  - objects

History of Object-Oriented Programming

- Started out for simulation of complex man-machine systems, but was soon realized that it was suitable for all complex programming projects
- SIMULA I (1962-65) and Simula 67 (1967) were the first two object-oriented languages
  - Developed at the Norwegian Computing Center, Oslo, Norway by Ole-Johan Dahl and Kristen Nygaard
  - Simula 67 introduced most of the key concepts of object-oriented programming: objects and classes, subclasses (“inheritance”), virtual procedures

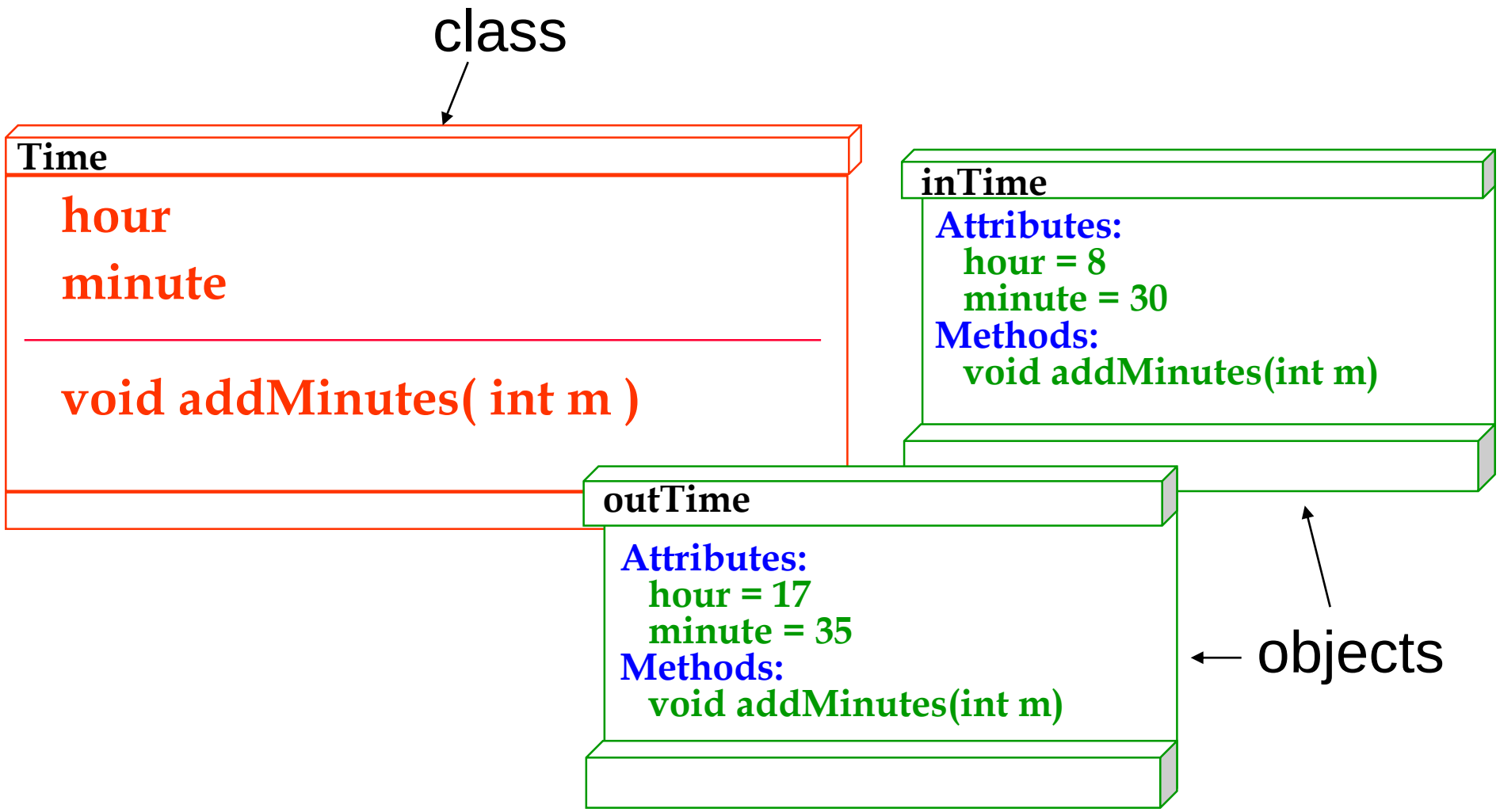
The Ideas Spread

- Alan Kay, Adele Goldberg and colleagues at Xerox PARC extend the ideas of Simula in developing Smalltalk (1970's)
  - Kay coins the term "object oriented"
  - Smalltalk is first fully object oriented language
  - Grasps that this is a new programming paradigm
  - Integration of graphical user interfaces and interactive program execution
- Bjarne Stroustrup develops C++ (1980's)
  - Brings object oriented concepts into the C programming language

Objects

```
class Time {

	private int hour, minute;

	public Time (int h, int m) {
		hour = h;
		minute = m;
	}

	public void addMinutes (int m) {
		int totalMinutes =
			((60*hour) + minute + m) % (24*60);
		if (totalMinutes<0)
			totalMinutes = totalMinutes + (24*60);
		hour = totalMinutes / 60;
		minute = totalMinutes % 60;
	}

}
```

Objects


class
Time
hour
minute
void addMinutes(int m)
inTime
Attributes:
hour = 8
minute = 30
Methods:
void addMinutes(int m)
outTime
Attributes:
hour = 17
minute = 35
Methods:
void addMinutes(int m)
objects

Classes and Objects

- A *class* is a prototype for creating objects
- When we write a program in an object-oriented language like Java, we define classes, which in turn are used to create objects
- A class has a *constructor* for creating objects

A Simple Class, called “Time” (partial)

```
class Time {

        private int hour, minute;

        public Time (int h, int m) {
                hour = h;
                minute = m;
        }

        public void addMinutes (int m) {
                int totalMinutes =
                        ((60*hour) + minute + m) % (24*60);
                if (totalMinutes<0)
                        totalMinutes = totalMinutes + (24*60);
                hour = totalMinutes / 60;
                minute = totalMinutes % 60;
        }

}
```

constructor for Time

Definition of an “Object”

- An object is a computational entity that:
  - **Encapsulates** some state
  - Is able to perform actions, or **methods**, on this state
  - Communicates with other objects via **message passing**

Encapsulates some state

- Set of variables
  - that describe an object's state
  - These variables are sometimes called an object's attributes (or fields, or instance variables, or data members, or …)

```
class Time {

      private int hour, minute;

// . . .
```

Is able to perform actions, or methods, on this state

- An object can also include a group of **procedures/functions** that carry out actions

```
class Time {

        private int hour, minute;

        public Time (int h, int m) {
                hour = h;
                minute = m;
        }

        public void addMinutes (int m) {
                int totalMinutes =
                        ((60*hour) + minute + m) % (24*60);
                if (totalMinutes<0)
                        totalMinutes = totalMinutes + (24*60);
                hour = totalMinutes / 60;
                minute = totalMinutes % 60;
        }
}
```

a method of Time

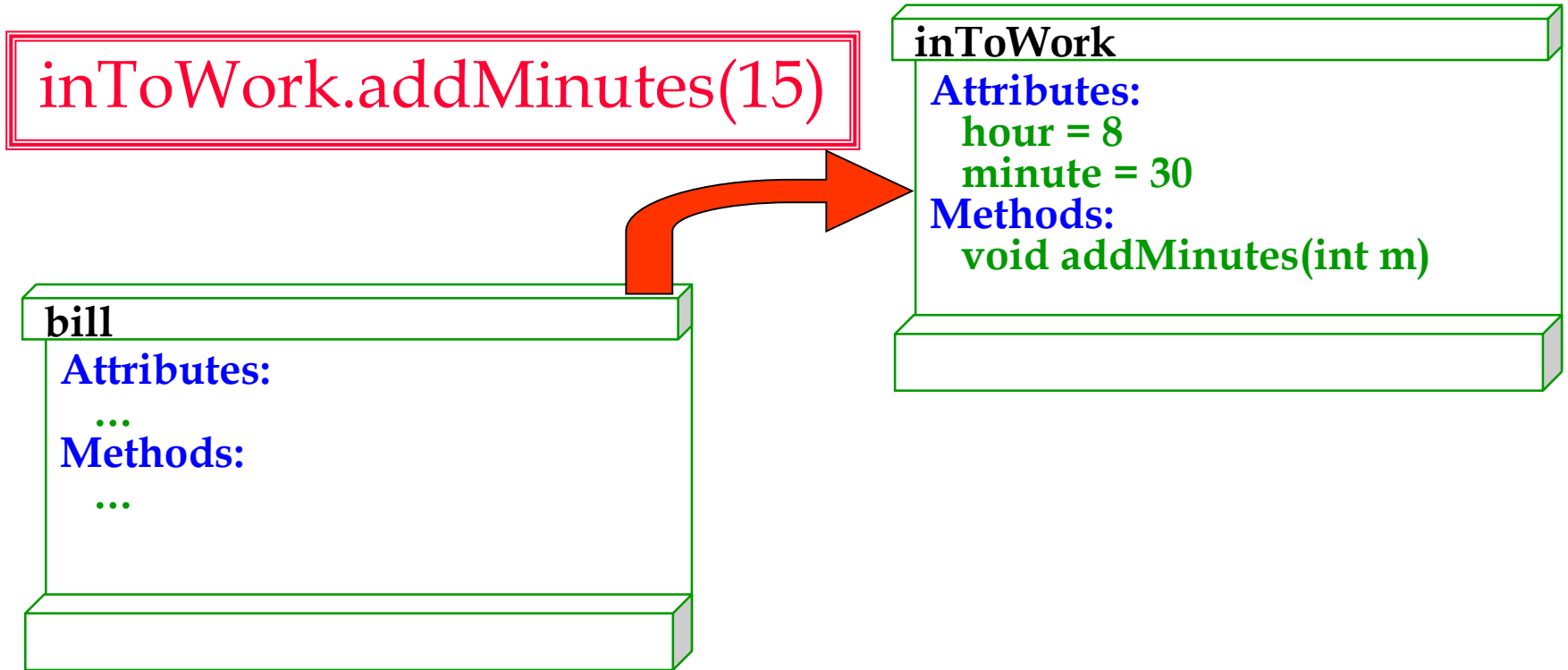
Communicates with other objects via message passing

- Sends messages to objects, triggering methods in those objects

In one of bill's methods, the following code appears:

Time inToWork = new Time(8, 30);

➡ inToWork.addMinutes(15);



Structure of a Class Definition

```
class name {
        declarations

        constructor definition(s)

        method definitions
}
```

← attributes and symbolic constants

← how to create and initialize objects

← how to manipulate the state of objects

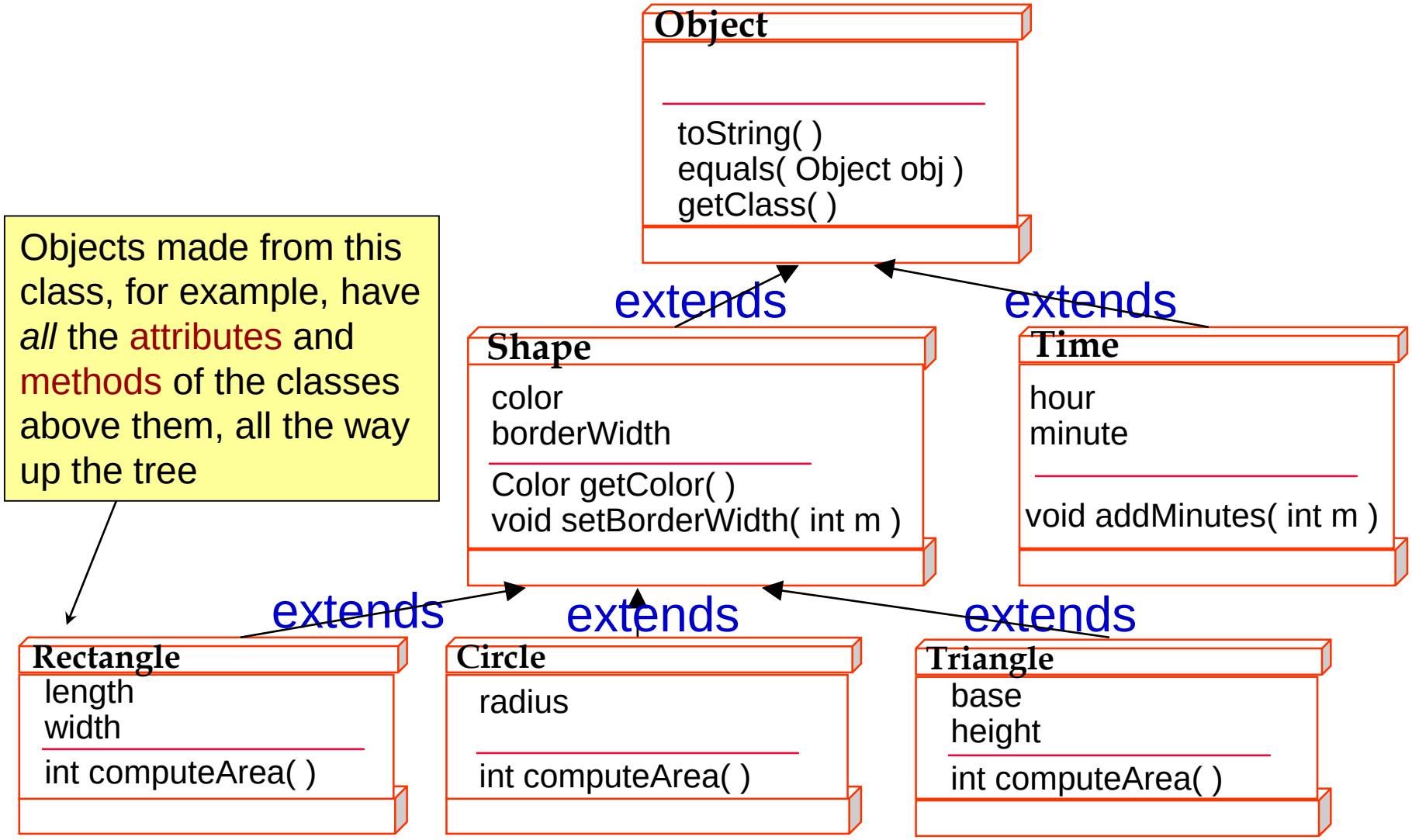
Advantages

- Building the system as a group of interacting objects:
  - Allows extreme modularity between pieces of the system
  - May better match the way we (humans) think about the problem
  - Avoids recoding, increases code-reuse

Inheritance

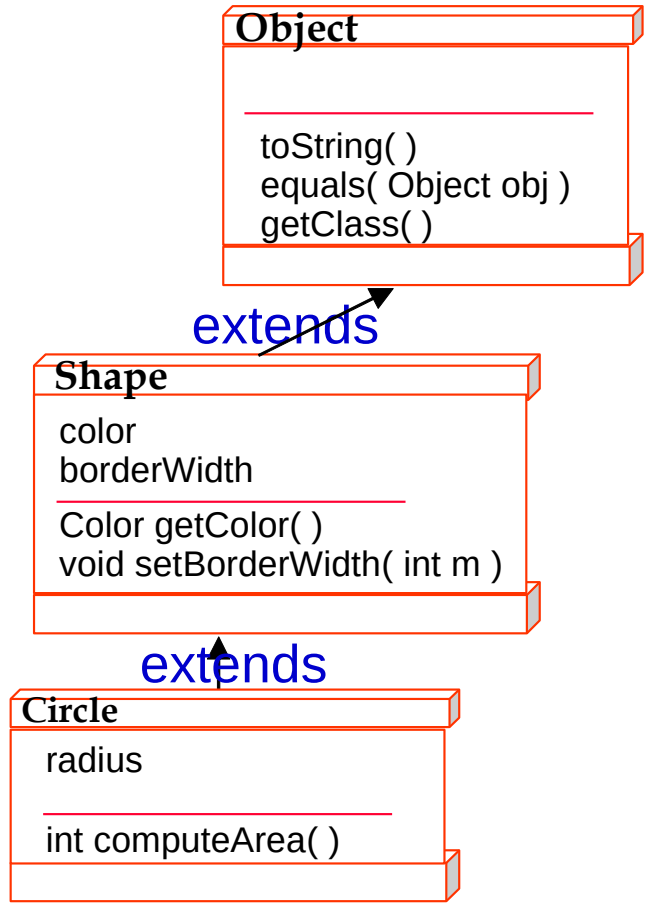
- Classes can be arranged in a hierarchy
- Subclasses **inherit** attributes and methods from their parent classes
- This allows us to organize classes, and to avoid rewriting code – new classes **extend** old classes, with little extra work!
- Allows for large, structured definitions

Example of Class Inheritance

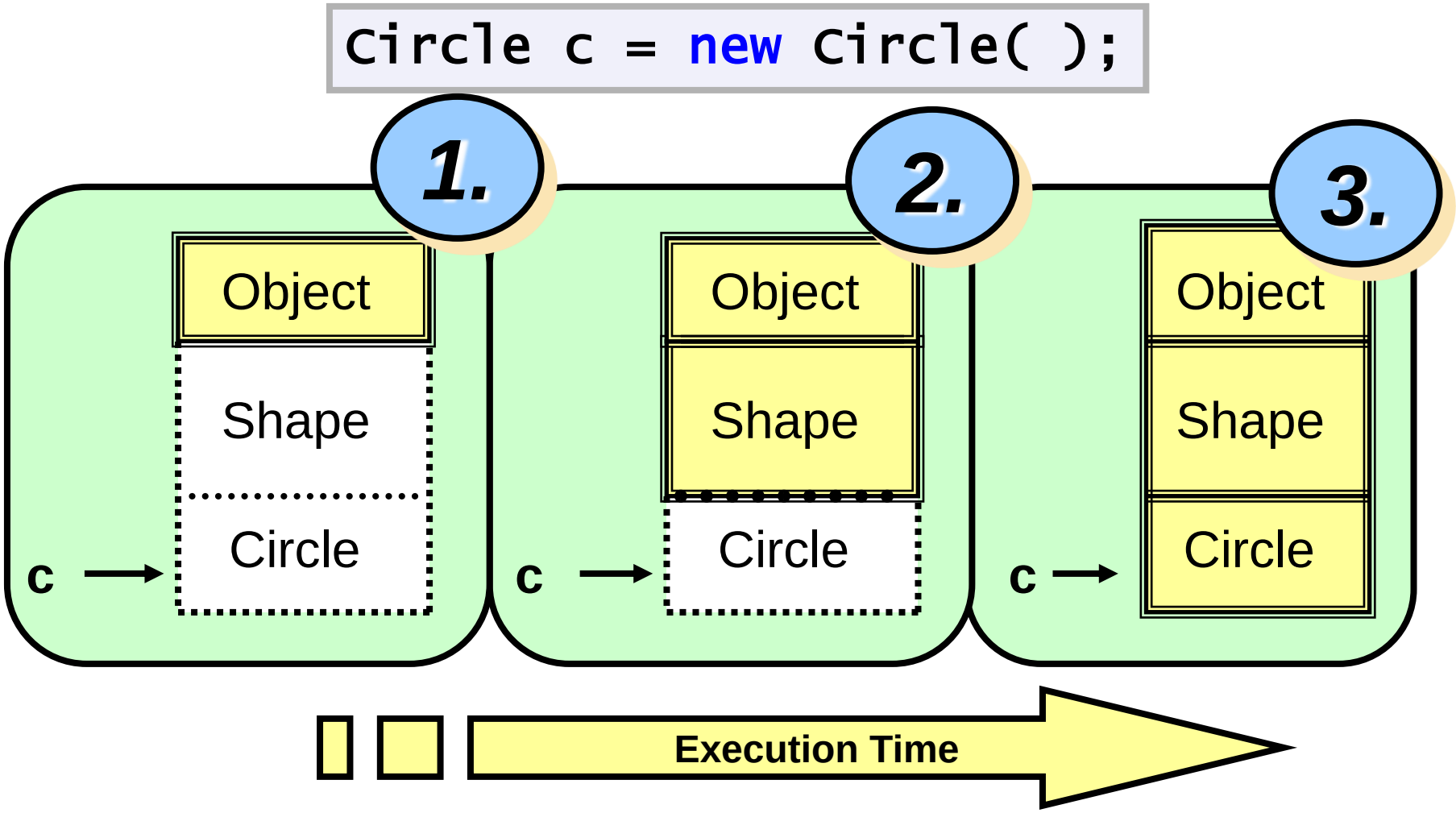


Polymorphism

- An object has “multiple identities”, based on its class inheritance tree
- It can be used in different ways
- A Circle is-a Shape is-a Object

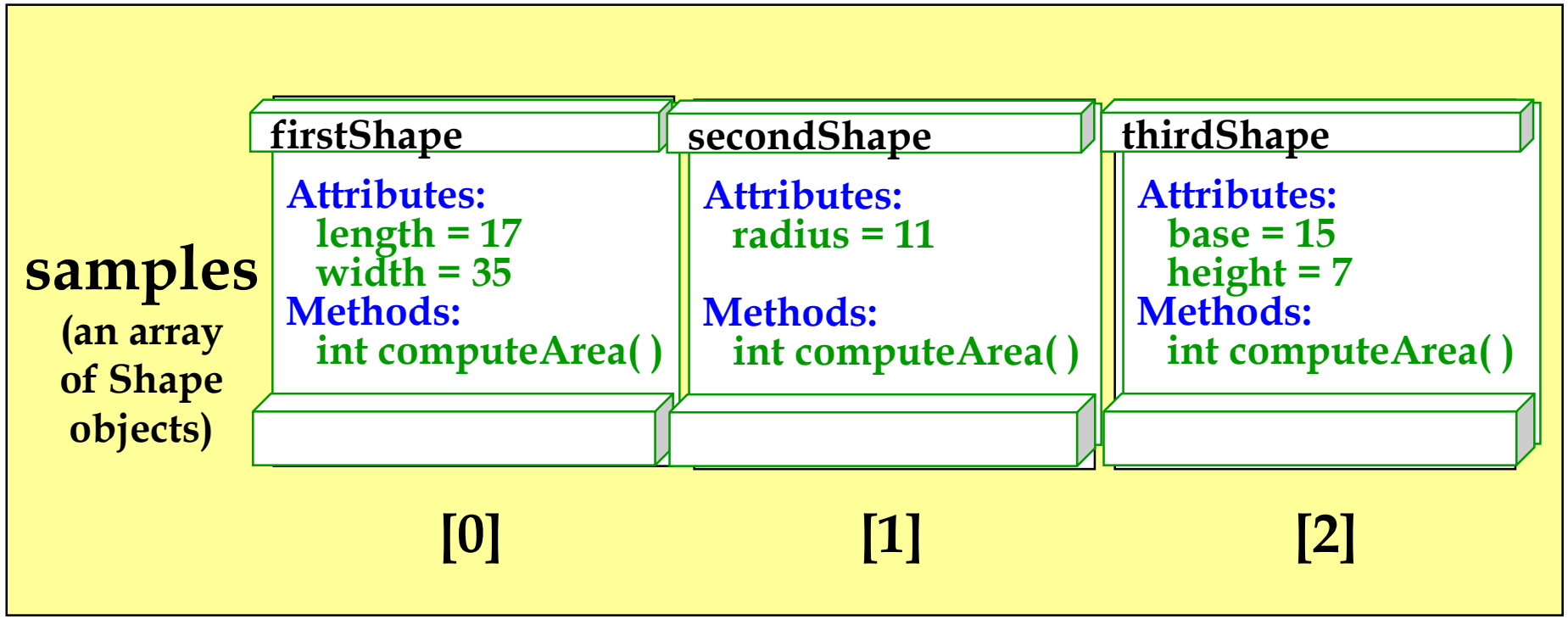


How Objects are Created



Using Polymorphism in Arrays

- We can declare an array to be filled with “Shape” objects, then put in Rectangles, Circles, or Triangles



Using Polymorphism for Method Arguments

- Polymorphism give us a powerful way of writing code that can handle multiple types of objects, in a unified way

```
public int calculatePaint (Shape myFigure) {
    final int PRICE = 5;

    int totalCost = PRICE * myFigure.computeArea( );
    return totalCost;
}
```

Object-Oriented Programming in Industry

- Large projects are routinely programmed using object-oriented languages nowadays
- MS-Windows and applications in MS-Office – all developed using object-oriented languages
- This is the world into which our students are graduating…