‘Objectsville’

covering

** Procedural *versus* Object-Oriented programming

Chapters 2-4 – “Head First Java” book
Chapters 4+6 – “Introduction to Java Programming” book

Concepts: OO programming and objects

What is OO programming?

- Constructing software systems which are structured collections (or sets) of classes.
- These classes produce instances called objects, which communicate with each other using messages.

What is an object?

- An object is a thing; it is a fundamental entity in Java.
- Objects tend to be the nouns in specifications.
- In software terms, e.g.
  - car;
  - bank account;
  - student;
  - employee;
  - complex number;
  - GUI button.

Imagine that you are building a database about cars; you would have a Car object.

OO = Object-Oriented

What is not an object?

- Attributes (or states) of an object: essentially anything that describes or quantifies an object.
  - speed, colour, make, model, and position are all attributes of a car object;
  - number, owner, balance might be attributes of a bank account object.

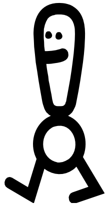
- Operations (or behaviours) of an object: they mostly correspond to verbs in a requirements specification.
  - turn left, speed up, slow down, turn right are all operations of a car object.
  - open, close, deposit, withdraw, are all operations on a bank account object.

What is a class?

- An object is defined by a class.

- The class defines the attributes and operations exposed by one or more related objects

- In Java, a class is to:
  - define a kind of object or in other words, to define a data type



Classes *versus* Objects
An object is an instance of a particular class.

… and things for you to try out!

Real world objects (1/4)

Person

To describe a person: name, gender, age, occupation, …

A person can do: eat, drink, sleep, walk, …

object

Jane
female
19
Student
…

object

Emma
female
45
Doctor
…

object

John
male
30
Engineer
…

Real world objects (2/4)

Car

To describe a car: make, model, year, colour, …

A car can do: accelerate, brake, turn, reverse, …

object	object	object
BMW	Ford	Mini
M3	Focus	Cooper
blue	silver	red
…	…	…
…	…	…

Real world objects (3/4)

What are the attributes and operations of a mobile phone?

Mobile phone

Attributes:

Operations:

object

iPhone
5
Vodafone
…

object

Samsung
Galaxy S3
Orange
…

object

BlackBerry
Curve 8900
O2
…

Real world objects (4/4)

Bank account

Attributes

account number
account name
account type
sort code
address
balance
overdraft limit
…

Operations

view details
print statements
check balance
deposit
withdraw
change address
change overdraft limit
…

Leaving the `main()` line

- In the examples so far, all the code went in the **`main()`** method.

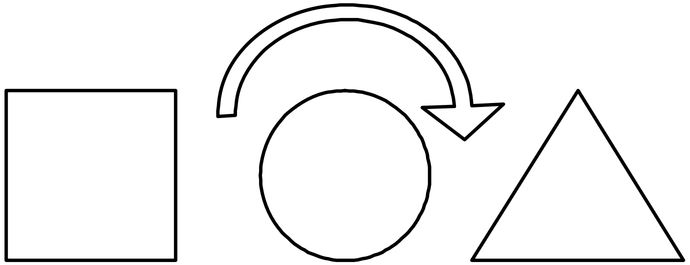
☒ This is not object-oriented!

- How does object-oriented programming change how we do things?
- We can split up code between different objects …

OO *versus* Procedural

The Specification

There will be shapes on a GUI: a square, a circle and a triangle. When the user clicks on a shape, the shape will rotate clockwise 360° (i.e. all the way around) and play an MP3 sound file specific to that particular shape.



- The task: to create a program that fullfils the following specification
  - Procedural approach
    - What does the program have to do?
    - What procedures are needed?
      - **`rotate`** and **`playSound`**

Procedural

```
rotate(shapeNum) {
  // make the shape rotate 360°
}
playSound(shapeNum) {
  // use shapeNum to loop-up which
  // sound to play and play it
}
```

OO: questions to answer (1/2)

- What are the things in this program, i.e. what are the objects?
  - Objects are things or nouns.
  - The main interacting force of this program is of course the shapes.

The Specification

There will be shapes on a GUI, a square, a circle and a triangle. When the user clicks on a shape, the shape will rotate clockwise 360° (i.e. all the way around) and play an MP3 sound file specific to that particular shape.

There are other objects, but this is enough to start with.

OO: questions to answer (2/2)

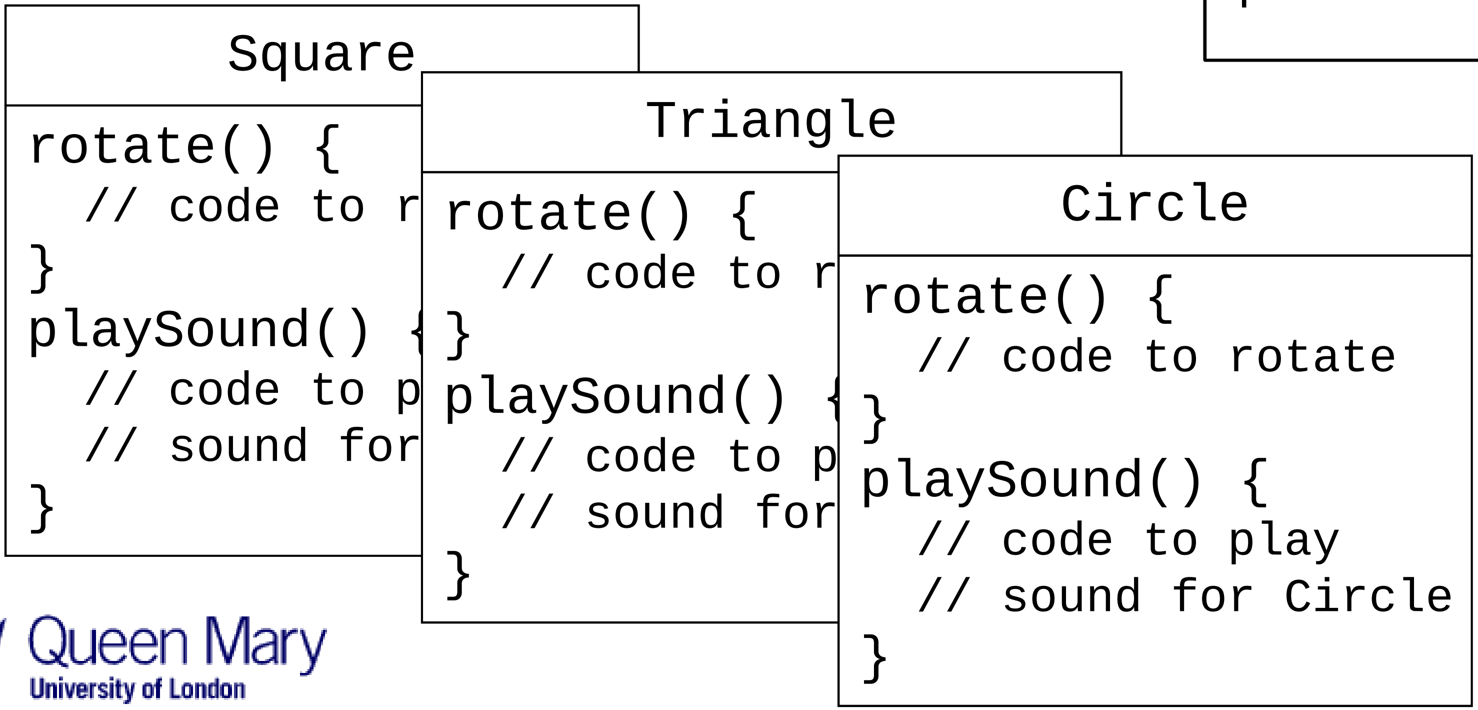
- Verbs indicate the actions of an object.

In Java, objects correspond to classes!

The Specification

There will be shapes on a GUI, a square, a circle and a triangle. When the user clicks on a shape, the shape will rotate clockwise 360° (i.e. all the way around) and play an MP3 sound file specific to that particular shape.

Object-Oriented



Square

```
rotate() {
  // code to r
}
playSound() {
  // code to p
  // sound for
}
```

Triangle

```
rotate() {
  // code to r
}
playSound() {
  // code to p
  // sound for
}
```

Circle

```
rotate() {
  // code to rotate
}
playSound() {
  // code to play
  // sound for Circle
}
```

Changes to the specification … or 'make up your mind'!

Addition to Specification
A fourth shape is needed – a random shape. When the user clicks on the random shape, it will rotate and play a WAV sound file.

- **rotate()** will still work, as the code uses a lookup table to match a shape to a graphic.
- However, **playSound()** has to change!

Procedural

```
playSound(shapeNum) {
  // if shape is not a random shape
  // as before..
  // else
  // play random shape
}
```

Always try to minimise altering code you have already tested. Changes could introduce errors!

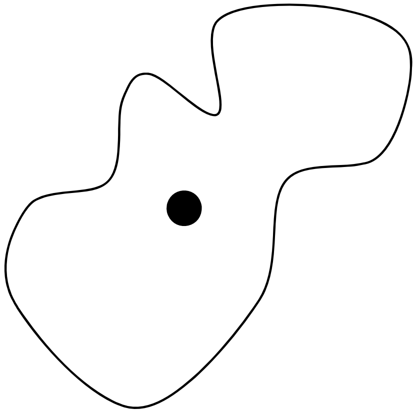
Object-Oriented

```
RandomShape
-----------
rotate() {
  // code to rotate
}
playSound() {
  // code to play
  // sound for RandomShape
}
```

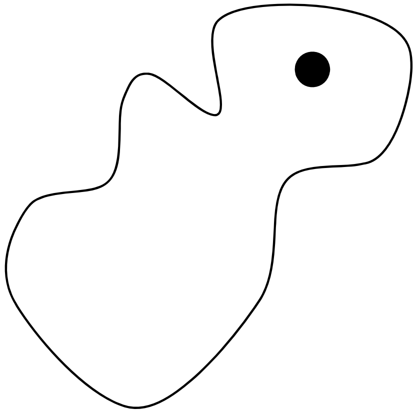
With OO, we do not need to 'touch' any of the code we have already written!

However …

- Random shapes rotate differently from other shapes.
  - – Both the procedural and object-oriented approaches did not take this into account.



Before, all shapes rotated around the centre.



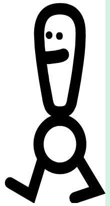
However, the random shape should rotate around the upper point.

Procedural and OO: again

- In order to account for variation in rotation points, we need to add some new arguments in the procedural method.

Procedural

```
rotate(shapeNum, xPt, yPt) {
  // if shape is not a random shape
  // calculate the centre point
  // based on a rectangle and rotate;
  // else use passed in xPt and yPt
  // as rotation offset and rotate
}
```

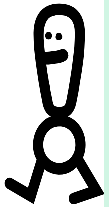


Lots of code has been affected! It will ALL have to be recompiled and tested.

Object-Oriented

new attributes

```
RandomShape
int xPoint
int yPoint
rotate() {
  // code to rotate
}
playSound() {
  // code to play
  // sound for RandomShape
}
```



New rules for rotation are simply put in the **`RandomShape`**’s **`rotate()`** method. No other shape is affected! The old shapes don’t need to be tested again. In fact, the compiled code for **`Circle`**, **`Square`** and **`Triangle`** doesn’t change at all.

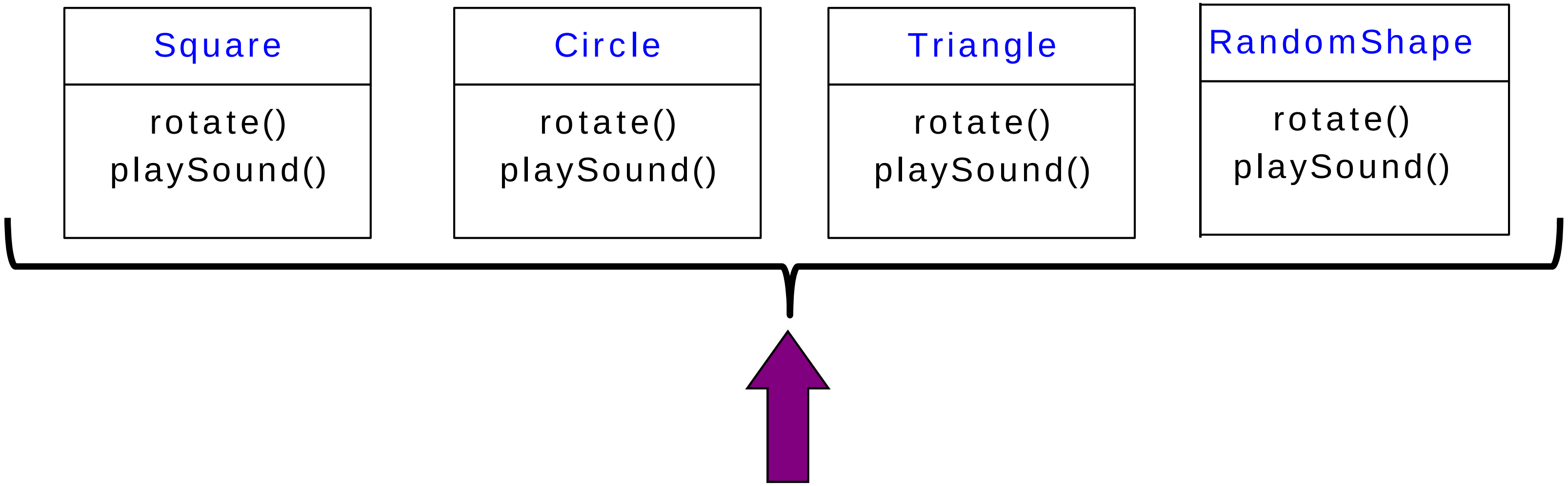
Summary: Procedural *versus* OO Approaches

- Procedural approach
  - 2 procedures that behave differently based on the shape.
  - If anything about the specification changes, then these 2 methods have to change.

- OO approach
  - 4 classes, with 2 methods each!
    - Many more methods than with the procedural approach!
    - Duplicated code? ← Is this a good thing?
  - However, each object controls its own behaviour.

… and things for you to try out!

Abstraction and Inheritance



Square

rotate()
playSound()

Circle

rotate()
playSound()

Triangle

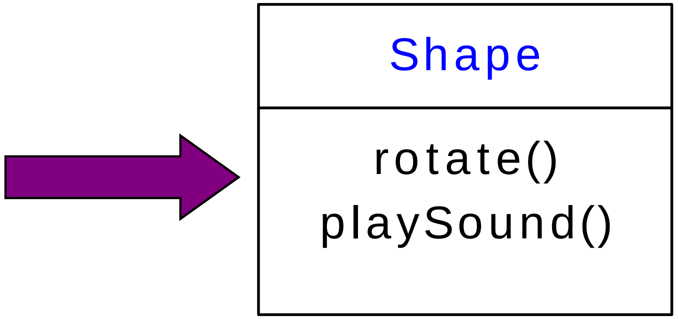
rotate()
playSound()

RandomShape

rotate()
playSound()

Look at what they have in common!

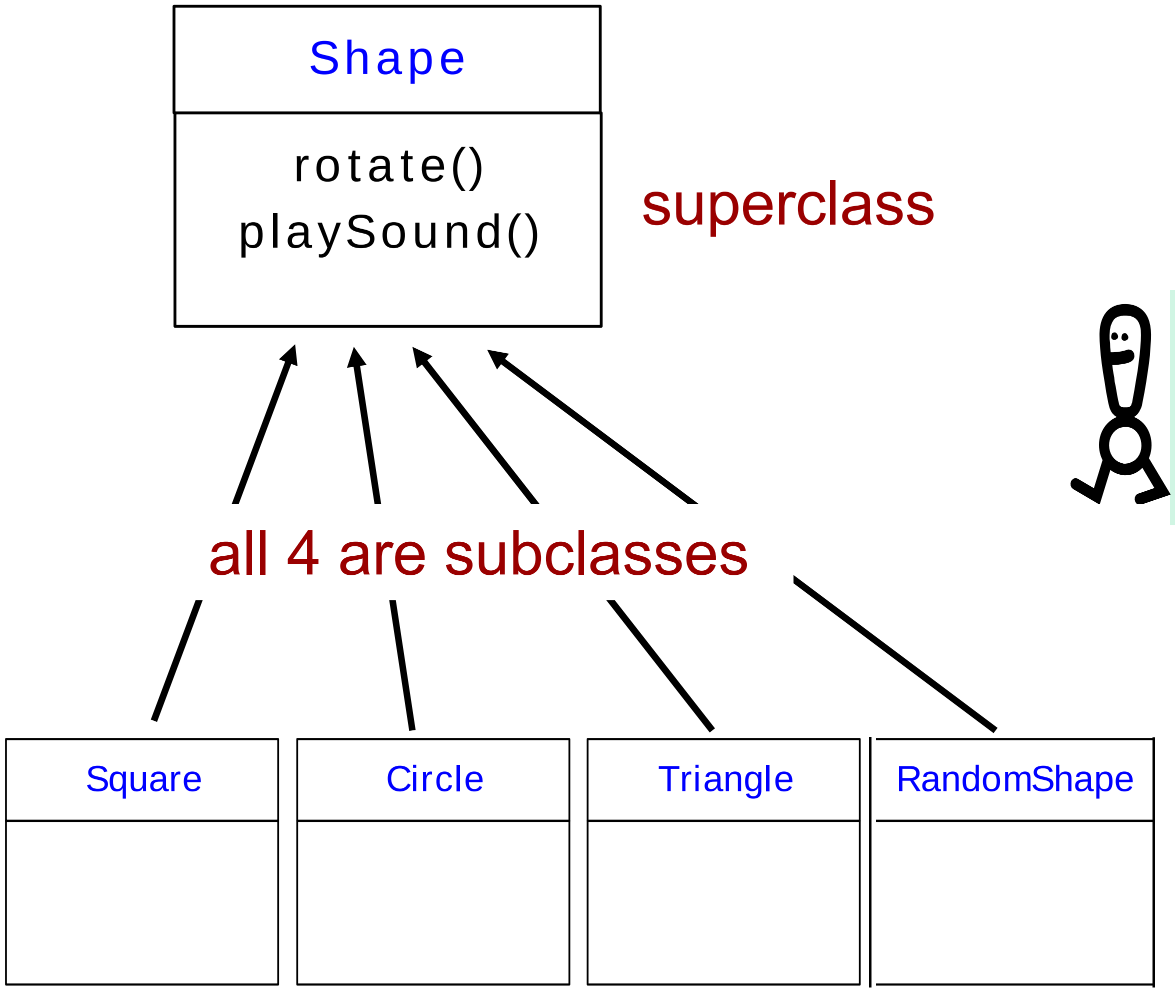
Abstract out the common features



Shape

rotate()
playSound()

Inheritance (1/2)

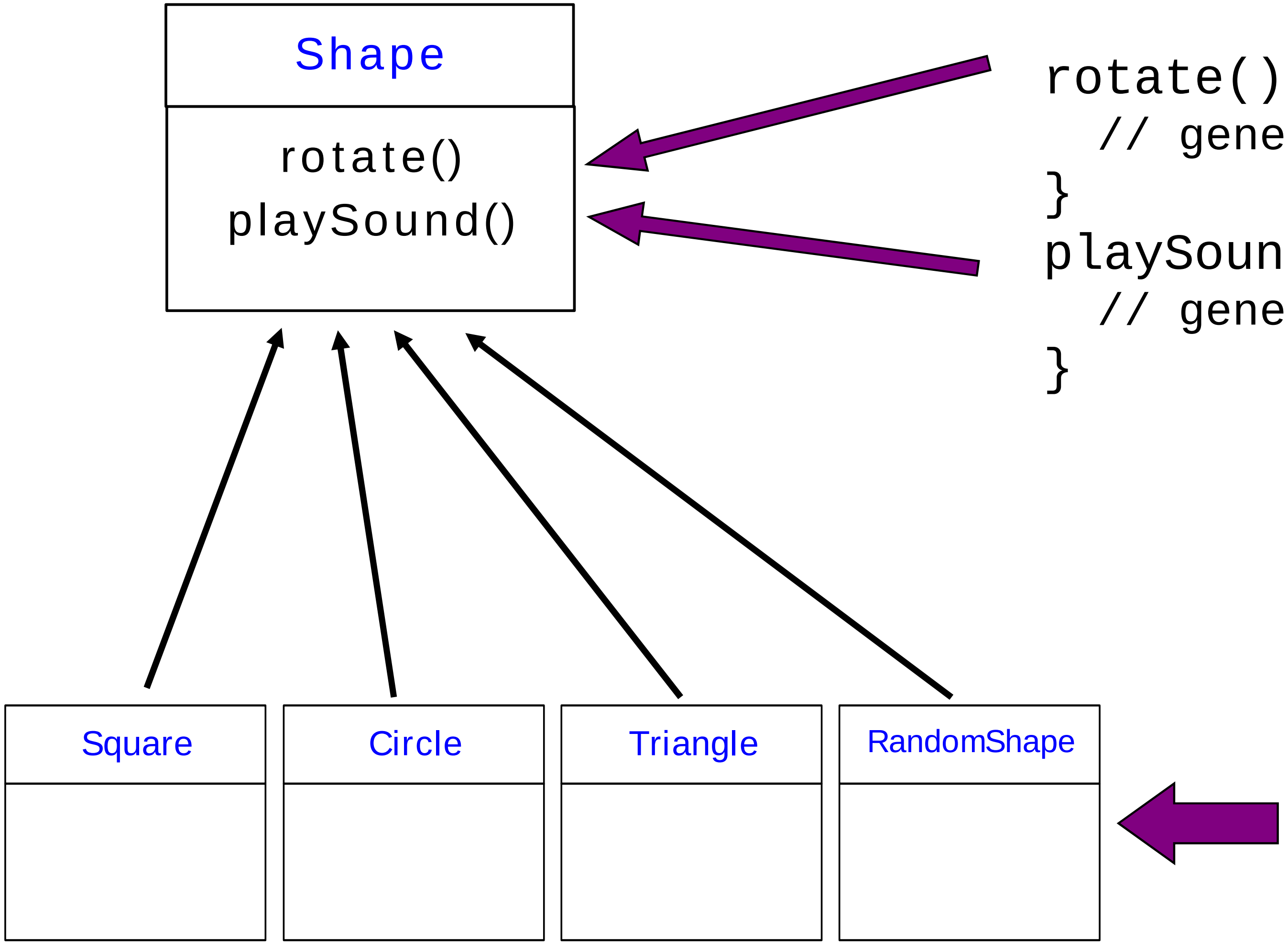


If the **Shape** class has the functionality, then all subclasses or child classes do too!

But how does this help?

“**`Square`** inherits from **`Shape`**”

Inheritance (2/2)

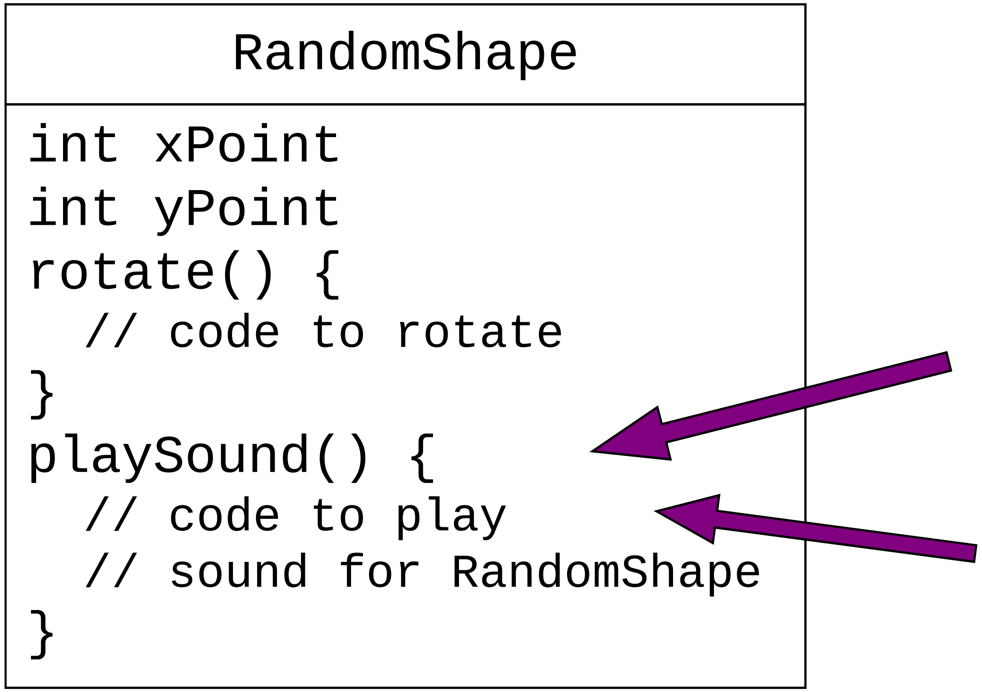


```
rotate() {
  // generic code to rotate
}
playSound() {
  // generic code to play sound
}
```

All these shapes get the generic methods without any additional code!

Specialising

- In the case of the **RandomShape**, we provide our own “random shape” specialisations!



```
RandomShape
int xPoint
int yPoint
rotate() {
  // code to rotate
}
playSound() {
  // code to play
  // sound for RandomShape
}
```

Method Overriding – we redefine the inherited methods!

Every object has its own behaviour!

… and things for you to try out!