

CS 213 – Software Methodology

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Lecture 11 – Feb 26

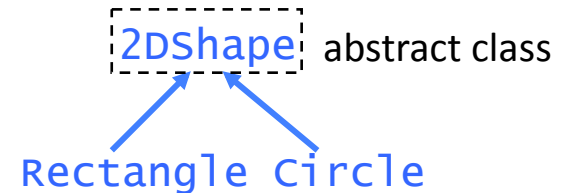
Abstract Classes

Abstract Classes – Introductory Examples

Rectangles and Circles have some common features:

- can be drawn on the 2D plane
- have a perimeter and an area
- it can be checked whether a point is inside or outside

The common features can be “abstracted” out into a superclass, say 2DShape.

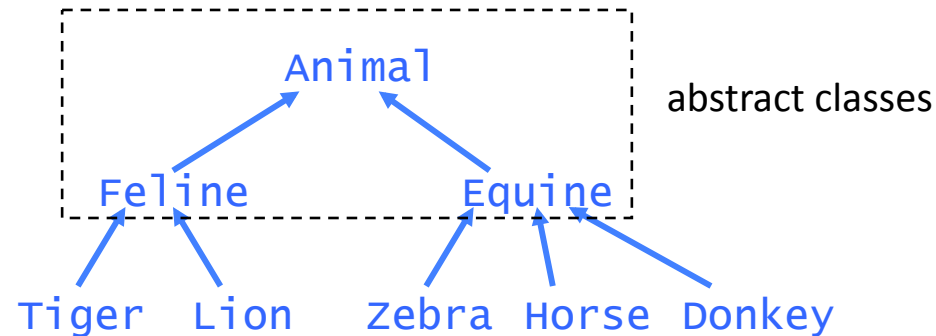


This is called **GENERALIZATION**: gathering properties that are common (general) to related classes into a superclass

But there is no actual 2DShape object: only specific kinds of 2DShape objects.

So the generalized superclass is **abstract**

Abstract Classes – Introductory Examples



If you simulate an ecosystem, and populate it with specific kinds of animals, you cannot have an “Animal” or “Feline” or “Equine” object – you have to have “real” animals: Tigers or Lions, etc.

Abstract Class – Java Definition

When several classes have features, i.e. traits (i.e. fields) and behaviors (i.e. methods), in common, they can be **generalized** into an abstract superclass.

An abstract class MUST have keyword `abstract` in the class header

```
public abstract class 2DShape { ... }
```

An abstract method is one that has no implementation

```
public abstract class 2DShape {  
    public abstract void draw();  
    public abstract float area();  
    ...  
}
```

Abstract Class – Java Definition

An abstract class may have zero or more abstract methods.

```
public abstract class Device {  
    protected String name;  
    protected int widthPixelDensity;  
    protected int heightPixelDensity;  
  
    public String getName() {  
        return name;  
    }  
    public int getWidthPixelDensity() {  
        return widthPixelDensity;  
    }  
    public int getHeightPixelDensity() {  
        return heightPixelDensity;  
    }  
}
```

*This class has NO
abstract methods*

Abstract Class – Java Definition

An abstract class cannot be instantiated even if all methods have been implemented.

```
public abstract class Device {  
    protected String name;  
    protected int horizontalResolution;  
    protected int verticalResolution;  
  
    public String getName() {  
        return name;  
    }  
    public int getHorizontalResolution() {  
        return horizontalResolution;  
    }  
    public int getVerticalResolution() {  
        return verticalResolution;  
    }  
}
```

~~Device device =
new Device();~~

Abstract Class – Java Definition

Will this compile?

```
public class Vehicle {  
    protected int numWheels;  
    protected boolean hasMotor;  
  
    public int getNumWheels() {  
        return numWheels;  
    }  
    public boolean hasMotor() {  
        return hasMotor;  
    }  
    public abstract int getweight();  
}
```

NO, because the class header does NOT have **abstract**, even though one of the methods is abstract

Abstract Class – Java Definition

An abstract class may implement non-default constructors

```
public abstract class Device {  
    protected String name;  
    protected int horizontalResolution;  
    protected int verticalResolution;  
  
    public Device(String name,  
                   int hres, int vres) {  
        this.name = name;  
        horizontalResolution = hres;  
        verticalResolution = vres;  
    }  
    ...  
}
```

So what's the point of having constructors if you can't create objects?

For use by “concrete” subclasses!

```
Device device = new Device(“iPad Air”,2048,1536);
```



Abstract Class – Java Definition

Abstract class may implement non-default constructors for reuse by subclass constructors

```
public abstract class Device {  
    ...  
    public Device(String name,int hres, int vres) {  
        ...  
    }  
    ...  
}  
  
public class iPad extends Device {  
    String os;  
    public iPad(String name,int hres, int vres, String os) {  
        super(name, hres, vres); // abstract superclass cons  
        this.os = os;  
    }  
    ...  
}  
  
Device device = new iPad("iPad Air",2048,1536,"ios 10.2.1");
```

Abstract Classes – Animal Hierarchy

```
public abstract class Animal {  
    public void run() {  
        System.out.println("run");  
    }  
}
```

```
public abstract class Feline  
    extends Animal {  
    public void purr() {  
        System.out.println("purr");  
    }  
}
```

```
public class Tiger extends Feline {  
    public void purr() {  
        System.out.print("Tiger: ");  
        super.purr();  
    }  
  
    public void run() {  
        System.out.print("Tiger: ");  
        super.run();  
    }  
}
```

```
public abstract class Equine  
    extends Animal {  
    public void trot() {  
        System.out.println("trot");  
    }  
}
```

```
public class Zebra extends Equine {  
    public void trot() {  
        System.out.print("Zebra: ");  
        super.trot();  
    }  
  
    public void run() {  
        System.out.print("Zebra: ");  
        super.run();  
    }  
}
```

Class Polymorphism

```
public class Forest {
    public static void main(String[] args) {
```

*Static/
compile-time
type is
Animal*

```
Animal[] animals = new Animal[5];
animals[0] = new Tiger();
animals[1] = new Lion();
animals[2] = new Zebra();
animals[3] = new Horse();
animals[4] = new Donkey();
```

*Dynamic/
run-time
types are
different*

```
for (int i=0; i < 5; i++) {
    animals[i].run();
```

Polymorphism

```
Equine[] equines = new Equine[3];
equines[0] = (Equine)animals[2];
equines[1] = (Equine)animals[3];
equines[2] = (Equine)animals[4];
```

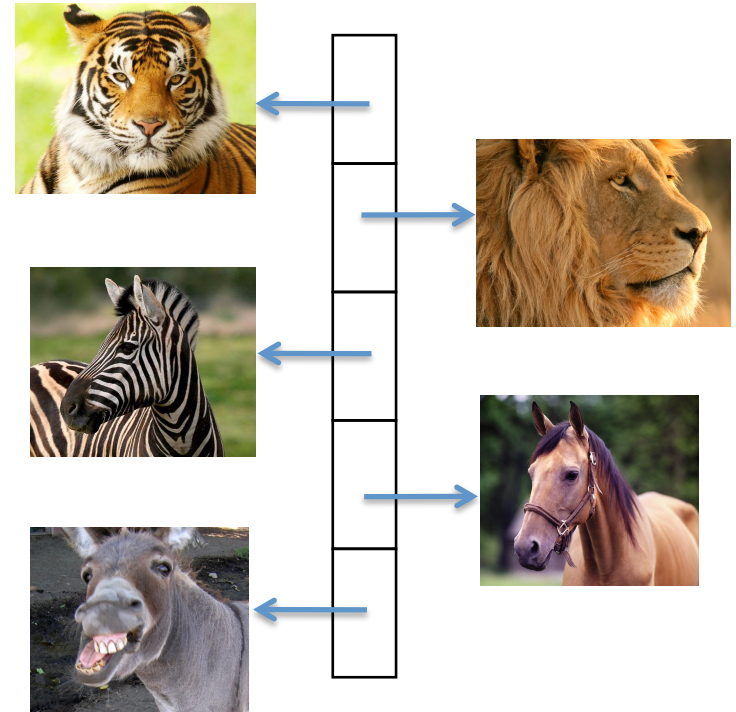
```
for (int i=0; i < 3; i++) {
    equines[i].trot();
```

Polymorphism

```
> java Forest
Tiger: run
Lion: run
Zebra: run
Horse: run
Donkey: run

Zebra: trot
Horse: trot
Donkey: trot
>
```

```
}
}
```



Java FX Example: Application Class

- `javafx.application.Application` is an abstract class with several non-abstract static and instance methods, and a single abstract method, namely `start`
 - `public abstract void start(Stage stage) throws Exception`

Non-GUI Abstract Classes

- Example: `java.util.Dictionary`
 - A dictionary is a data structure that allows insert, search, and delete – **all methods** of `Dictionary` are abstract
 - `java.util.Hashtable` is a concrete subclass of `Dictionary`
 - Any search structure (e.g. AVL tree) can implement `Dictionary`
- The `Dictionary` **class** is now obsolete, replaced by `java.util.Map` **interface** – why?
- The `java.util.HashMap` class implements the `Map` interface, but it also extends the `java.util.AbstractMap` abstract class – why?

Non-GUI Abstract Classes

- Example: `java.util.Calendar`
 - Provides methods to convert between specific instant in time and calendar attributes year, day, month, etc.
 - `java.util.GregorianCalendar` is a concrete subclass of `Calendar`
 - Static method `Calendar.getInstance()` returns calendar instance for current time with default locale (US – Gregorian calendar)

Abstract Class versus Interface?

(Popular Interview Question!!)