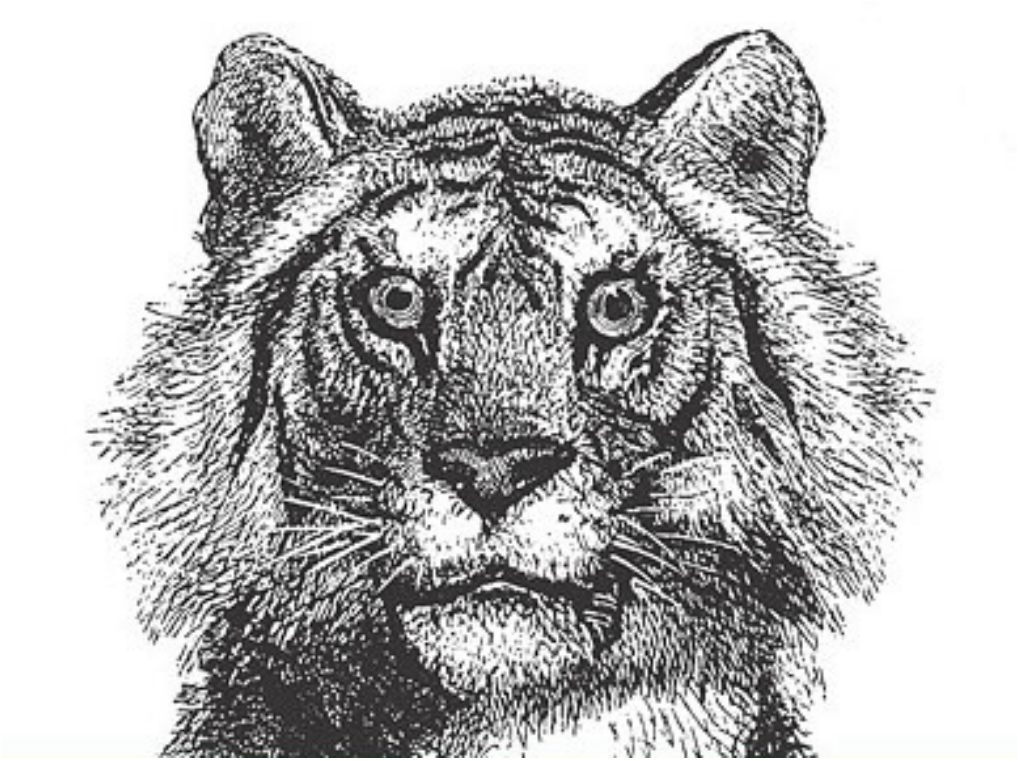
CLASS DESIGN

Today

- Today we will talk about the basics of defining classes in Java.
- In particular we will look at:
  - Class definition
  - Access to data fields
  - Constructors
  - Finalizers
  - Methods
  - Class fields and methods
  - Subclasses



- Again, lots of this material is drawn from *Java in a Nutshell*, David Flanagan, O'Reilly …

A first class

- Here is the definition of a simple class that we can use to hold x and y coordinates.
- As we will see, this can be useful in writing programs that display graphic elements.

```
public class Point{
   public int x, y;
}
```

- This defines a kind of datatype called `Point` which holds two *fields* called `x` and `y` which are both `int`s.

- Once we have defined the class, we can use it.
- The following code creates an *instance* of the class:

```
Point p;
p = new Point();
```

- The first line creates a reference to a `Point`.
- The second creates a `Point` *object* and makes `p` refer to it.
  - Note the syntax: `Point` is followed by a pair of parentheses.
- We can combine the two lines into:

```
Point p = new Point();
```

- Since `x` and `y` are `public`, we can handle them as follows.
- Setting their value:

```
p.x = 3;
```

- Reading their value:

```
System.out.println(p.x);
```

- Changing their value:

```
p.y = p.x + 3;
```

- However, having `public` fields is generally considered bad programming practice.

A second class

- Here is a better `Point` class:

```
public class Point{
   private int x, y;
}
```

- However, making the fields `private` means you can't access them directly.
  - That is what `private` means.
- The solution is to write `public` functions to read and write `private` fields.
  - A simple API

- For example, we can add these functions to the definition of `Point`.

```
public void setX(int x){
    this.x = x;
}

public int getX(){
    return x;
}
```

- For the full definition of `Point` see `Point.java` on the course website.

- Note the use of `this` in `setX` to disambiguate between `x`, the parameter, and `this.x` the field.
- `this` is a reference that refers to the object where the `this` occurs.
- We don't need to use `this` in `getX` because there is no ambiguity.

Constructors

- When we create a new object, we make a call like:

```
Point p = new Point();
```

- The reason for the parenthesese above is that creating the `Point` involves calling a function.
  - Constructor
- Java will create a constructor for every class we define.
- Often we want to make our own.

- Here is a constructor for `Point`:

```
public Point(){
    this.x = 0;
    this.y = 0;
}
```

- The point of constructors is to combine:
  - Object creation
  - Object initialisation.

- We are allowed to write multiple constructors provided that they have different numbers and/or types of parameters.
  - Java uses the combination of parameters to distinguish between constructors.
- Here is another:

```
public Point(int x, int y){
    this.x = x;
    this.y = y;
}
```

- We can invoke one constructor from another, for example:

```
public Point(int x){
    this();
    this.x = x;
}
```

- The second line does what we would expect — it uses the parameter to set the value of the `x` field.
- The first line uses `this()` to invoke the constructor with no parameters.

- We could also have written this:

```
public Point(int x){
    this(5, 5);
    this.x = x;
}
```

  where the first line would have invoked the constructor with two parameters.

- If you are going to use `this` to invoke another constructor in this way, it has to be the *first* line in the constructor it is called in.
- It even has to ge before any local variable definitions.

Finalizers

- In C++ we often need to define destructors to release memory when an object is deleted.
- In Java we don't have to worry about this
  - Garbage collection.
- However, sometimes there are things we need to do when an object is no longer being used.
  - Close a file or a socket.
- We define a function `finalize()` to do whatever is required.
- `finalize()` is always declared `public` or `protected` (We will get too `protected` shortly).

Composition

- *Composition* is using classes as fields within another class.
- For example, here is a class that uses `Point`:

```
public class Circle{
    private Point location;
    private double radius
}
```

- Since the fields are `private`, we have to write API methods for them.
- The ones to access `location` can use the `Point` methods:

```
public void setLocationX(int x){
    location.setX(x);
}
```

and so on.

- Let's also write a constructor for `Circle`:

```
public Circle(){
    location.setX(1);
    location.setY(1);
    radius = 1.0;
}
```

- Note that even in the constructor we have to use the API functions for `location` since its `x` and `y` values are private to it (the `Point`).

Class fields and methods

- When dealing with circles it is helpful to have the value of pi easily accessible.
- So let's add this:

```
public static final double PI = 3.1415927
```

  to `Circle`
- We use `final` because we are defining a constant.
- More important here is the fact that we use the keyword `static`.
- In this context it defines a *class field*.

- That is a field that is associated with the class, not with a specific instance/object.
  - Just one copy of it.
- Since it is associated with the class, it is available to every object in the class.

- In addition, since (in this case) it is `public`, it is available to objects outside the class.
  - A `private` class field would *only* be available to objects of that class.
- For those other objects to access it, they must use its full name: `Circle.PI`.
- Public class fields are rather like global variables.
  - But the need to use the full name ameliorates the name clash problem.

- We can also have class methods, again declared using the `static` modifier:

```
public static double radsToDegs(double radians){
    return radians * 180/PI;
}
```

- Note that class methods can use class fields, but *not* the regular fields (the non-class fields).

Subclasses

- Here is a sub-class of `Circle`

```
public class PCircle extends Circle{
   private Point origin;

   public PCircle(){
      super();
      this.origin.setX(0);
      this.origin.setY(0);
   }

   public PCircle(int x, int y){
      super();
      this.origin.setX(0);
      this.origin.setY(0);
      this.location.setX(x);
      this.location.setY(y);
   }

}
```

- The use of the `extends` keyword defines `PCircle` to be a *subclass* of `Circle`.
- Equally, `Circle` is a superclass of `PCircle`.
- Can create a subclass of any existing class:
  - Java library class
  - User defined

- As a sub-class, `PCircle` *inherits* all of the methods and fields of `Circle`.
  - Hence the references to `location`
- It also contains new fields that are declared in `PClass`.
- Note the use of `super()` in the constructors.
- This is a reference to the constructor for `Circle`.
- Like `this()`, it has to be the first thing in the constructor
  - Before local variable declarations.

Summary

- This lecture introduced the basics of classes and objects:
  - Defining and instantiating a class.
  - Constructors and finalizers
  - Subclasses
- We will cover more advanced topics on classes next week.