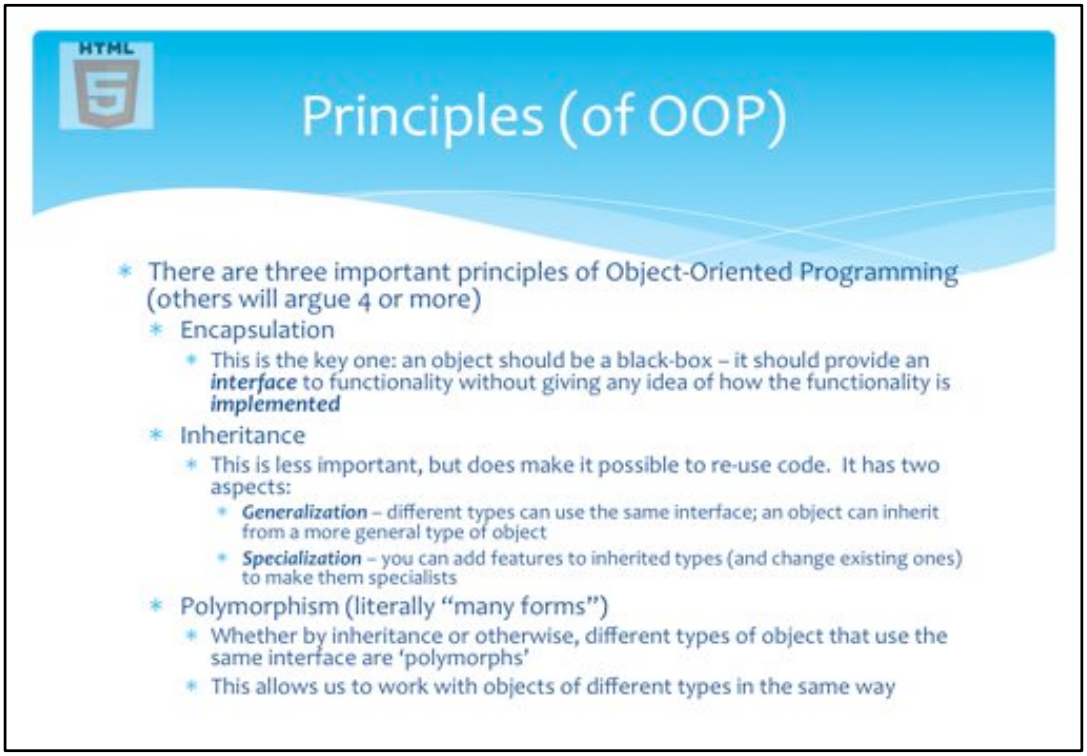

HTML
HTML5 & Javascript
Lecture 3: Object-Oriented Programming

Ta-da!

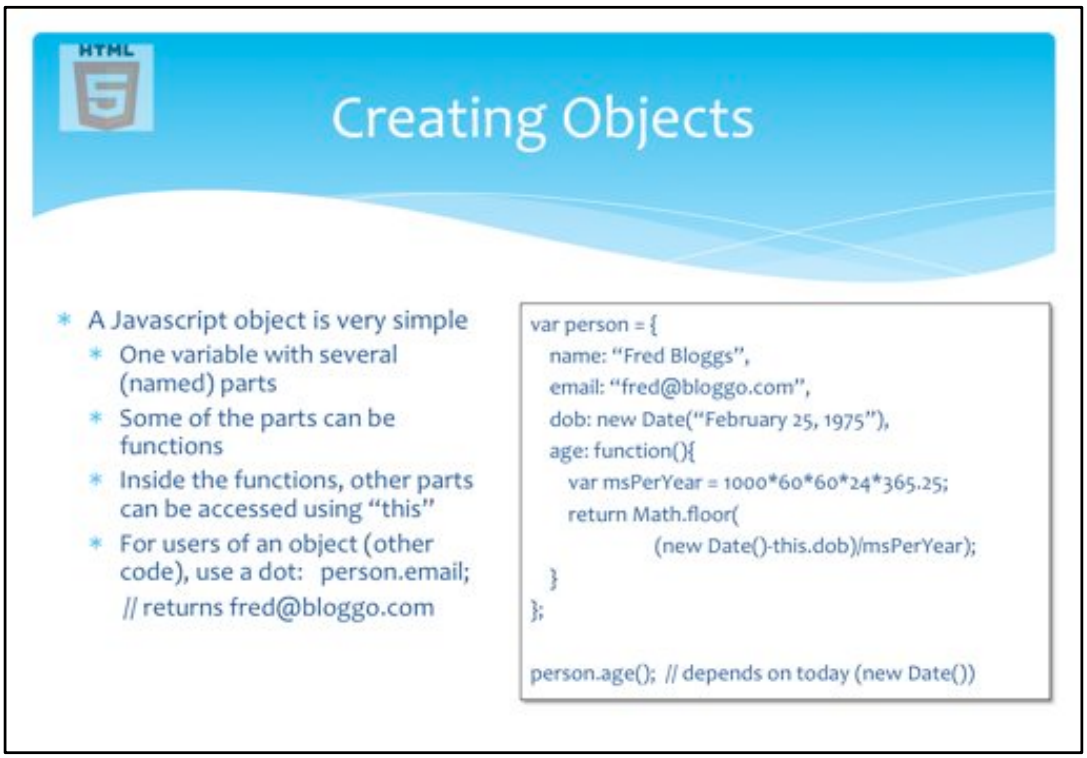


A lot of explaining is needed here – Interface, implementation, generalization, specialization, poly-whatsit. Providing an example of each of these concepts is probably the best approach, so…

"Others will argue 4 or more" – I've seen OOP described as having 4 core principles – encapsulation, inheritance, polymorphism and **operator overloading** - this is obviously oriented towards C++, but it is not a general OOP principle (which I take as the principles embodied in SmallTalk – more or less the prototype for everything since).

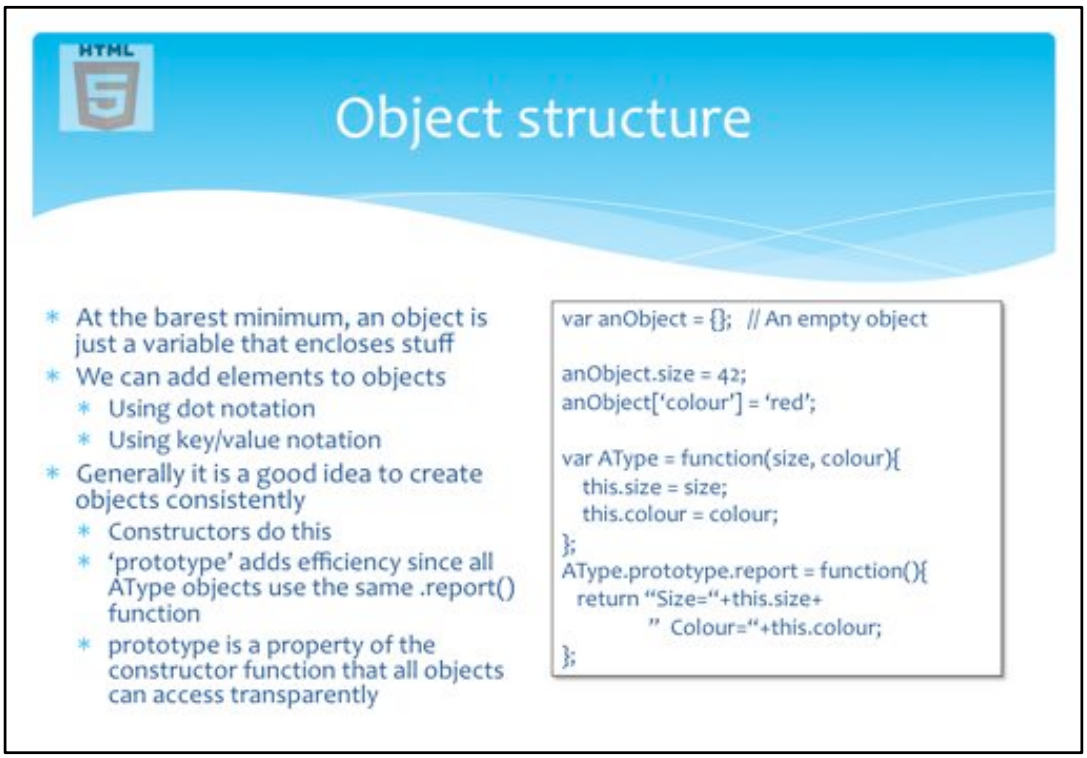
You'll also see people suggesting Abstraction or Data Abstraction as a core principle – what do these guys think Encapsulation is about?? The only point of encapsulation is so that you can create an abstraction – public interface accessing private implementation. It seems to me that is similar to describing the three main principles of motor cars are Go-ey behaviour, an engine and a passenger cabin. The engine is the Go-ey thing. Then again I'm an opinionated sod.

Encapsulation – building an object as a black-box involves providing it with a a number of functions (methods) that can be used to manipulate the object – either by retrieving data from inside it, or changing its data in some way. A good (real-world) example is a car dashboard. Instead of manipulating the various valves and levers directly, a driver uses the steering-wheel, gas pedal, gear-lever, brake pedal etc. to



It will be worth explaining various bits that are taken for granted in this slide.

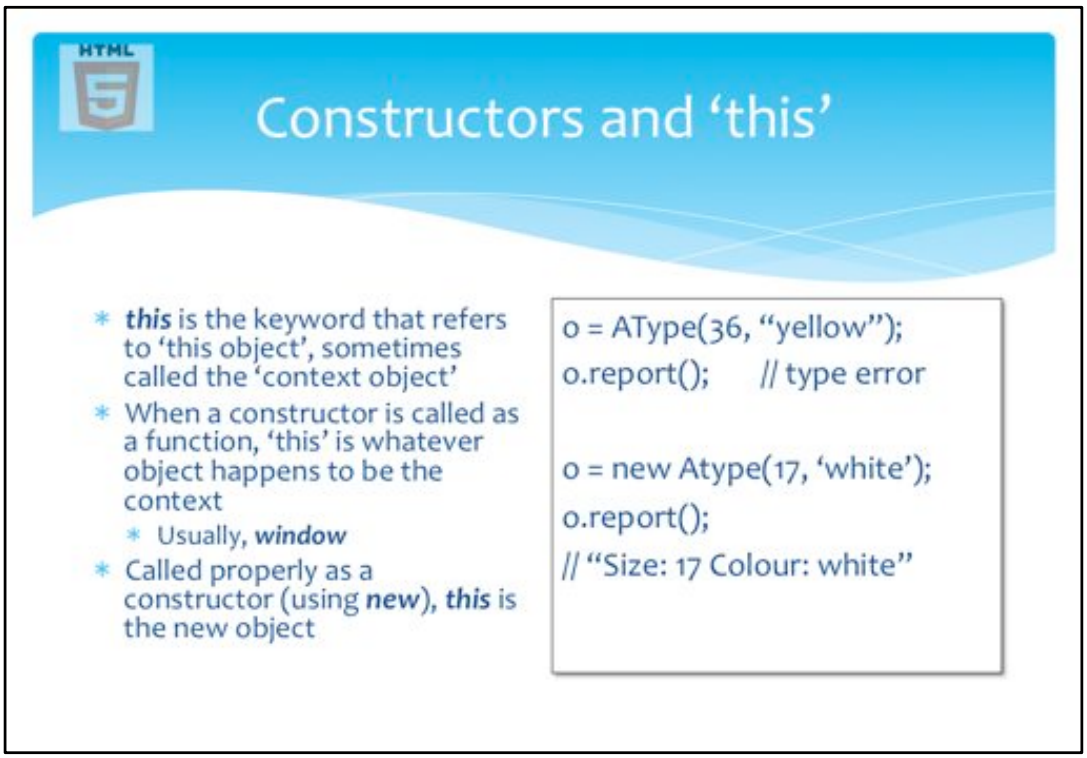
msPerYear is a local variable (more on that later) used inside the function Math.floor() truncates a number (removes the digits after the d.p. person is a package of data and function code – this is very unlike Java, where the person class would be used to generate instances that contained data and **references to** function code. Javascript has the potential to be very inefficient, since adding a function to many object means having many copies of the function – storage inefficient and also a very good source of errors (many copies of a function makes it more likely there can be inconsistencies)



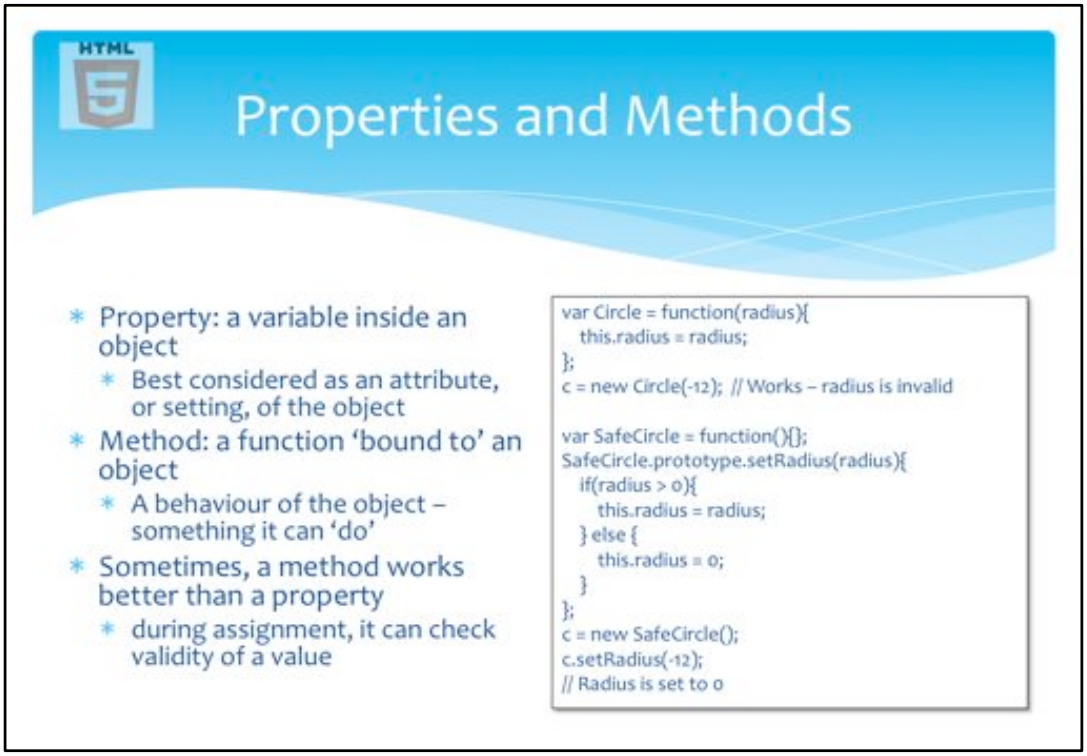
This slide is really about moving from objects to types of object.
It is worth explaining that for a situation where there will be many objects of a type this is a more consistent approach – all objects will be (to some degree) compatible.
In the next slide, we'll be looking at the keyword 'new', so it is worth illustrating at this stage in a console window that using o = AType(15, 'green'); does work, but does not have the effect you expect it to …

```
o = AType(15, 'green');   // returns 'undefined'
                          // inside the constructor, 'this' is the current context object
                          // which is usually 'window' – test by typing window.colour in
the console
                          // o.report() gives a type error

o = new AType(22, 'blue';   // returns AType (an object reference)
                            // o.report() works.
```



As described in notes for the previous slide. It is well worth doing this in class using a console.
When you define the constructor and report function, you can either write all the code on one line (which looks awkward), or use ctrl+Enter to add new lines – the console will treat this like using Enter in an editor.



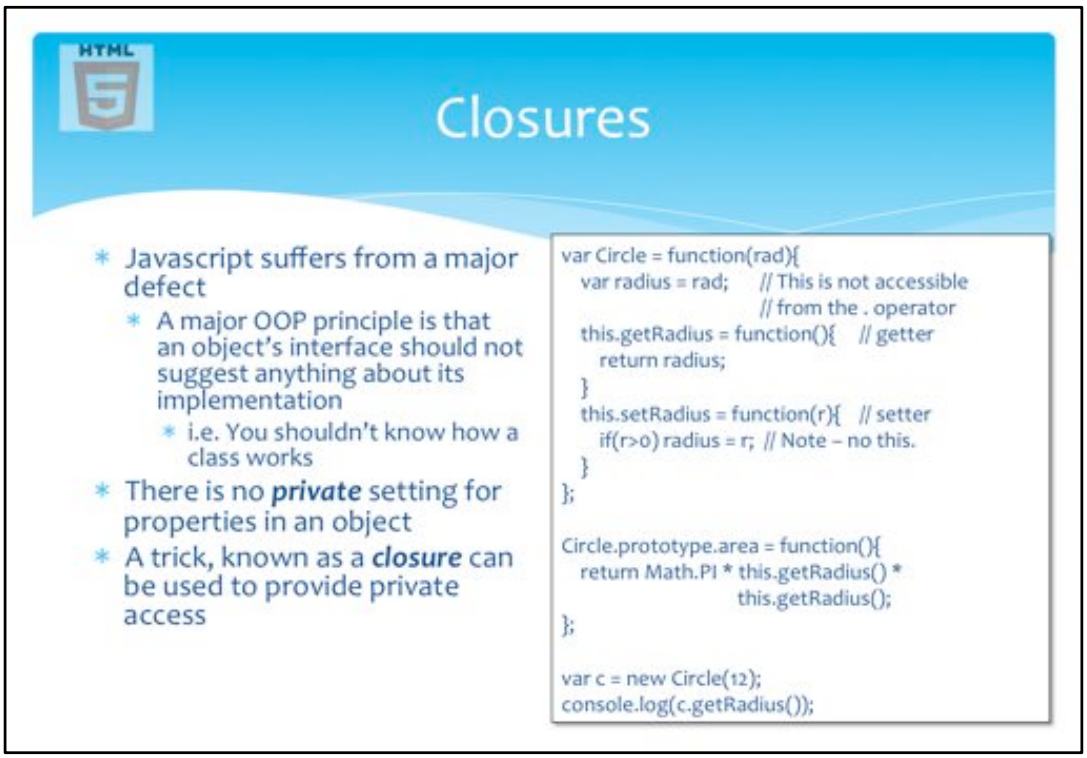
Worth explaining that this style of programming needs more discipline – it is just as easy to change the .radius of a SafeCircle as to call its .setRadius() function. Explain the various strategies for getting around this problem (which is really the problem of not having a Private modifier for JS objects.

1. Mark private members in some way – most common one is one or two underscores at the start or end of a member's name. e.g.

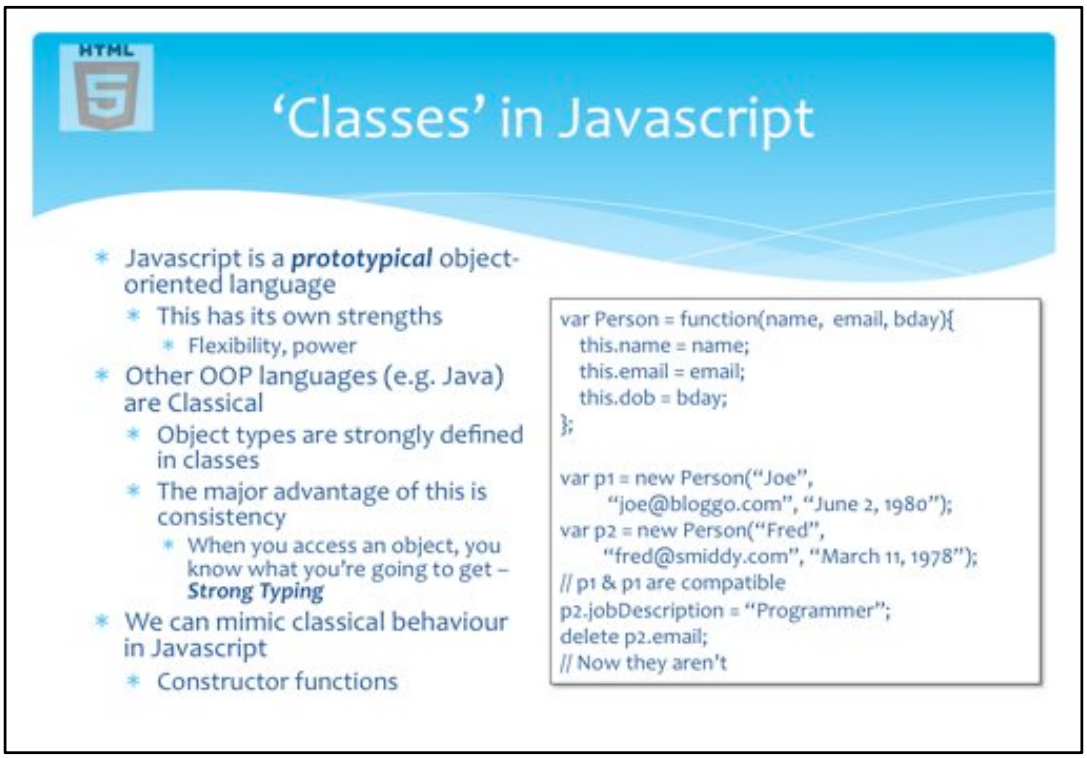
```
var Circle = function(radius){
   this._radius = radius;
};
```

2. Use a closure. Define getX and setX functions within the constructor that access a local variable (declare with var) in the constructor:

```
var Circle = function(rad){
   var radius = rad;                  // This is not an accessible member of a Circle
   this.getRadius = function(){// But this is (and its prototype has a pointer to
radius
      return radius;
   }
```



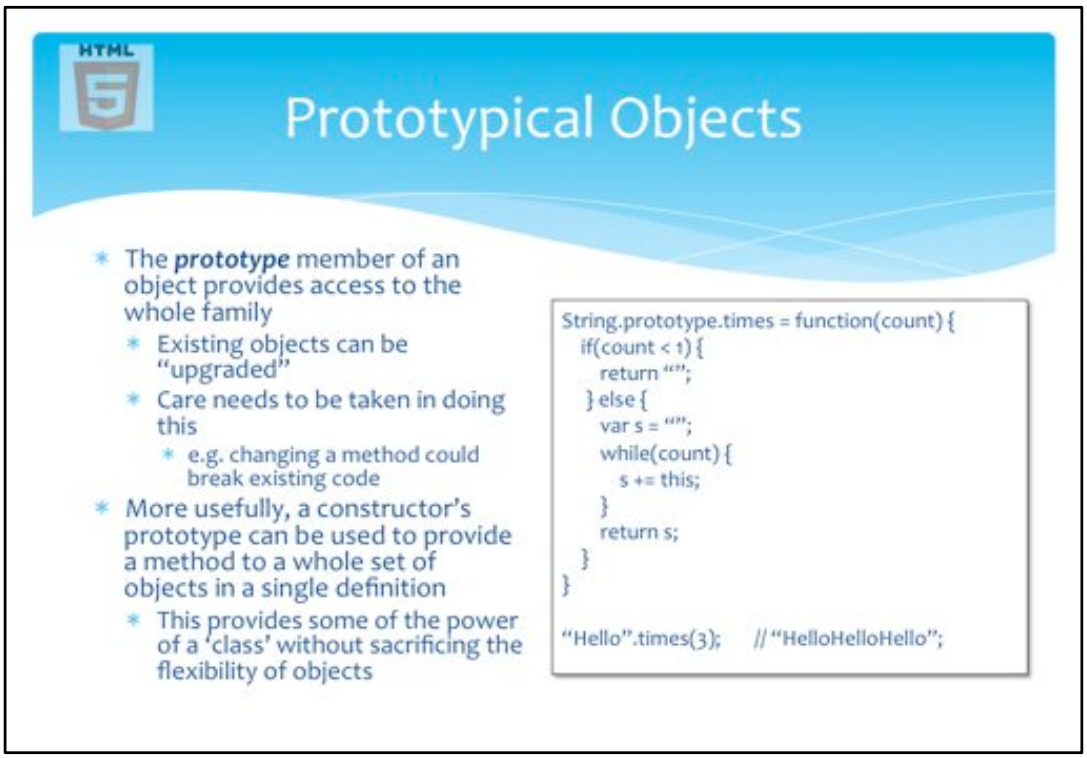
It is worth spending a bit of time making the importance of this clear.
OOP's principle of encapsulation can not be implemented in the standard Javascript mechanisms. However, the trick of creating a closure makes private members (and therefore privileged members) possible.
The actual mechanism is due to an internal pointer to the members of a class within a function. In the Circle constructor, radius is a local variable. In Java or C, this would be an automatic variable, i.e. one that was created as the function was called and destroyed as the function exited. In JS, the inner functions which access radius keep a pointer to it. As a result, the radius variable stays alive outwith function calls and can still be accessed once the constructor call has exited.



The main point being made here is that without the protection of a rigid class, it is not possible to always know what is in an object. If class-like behaviour is to be expected in Javascript, it is necessary to always follow certain rules – the main one being objects created from constructors should not be altered adversely. This does not mean giving up facilities like the ability to add new members and methods to an existing object, but members should never be replaced (at least not without some consideration).

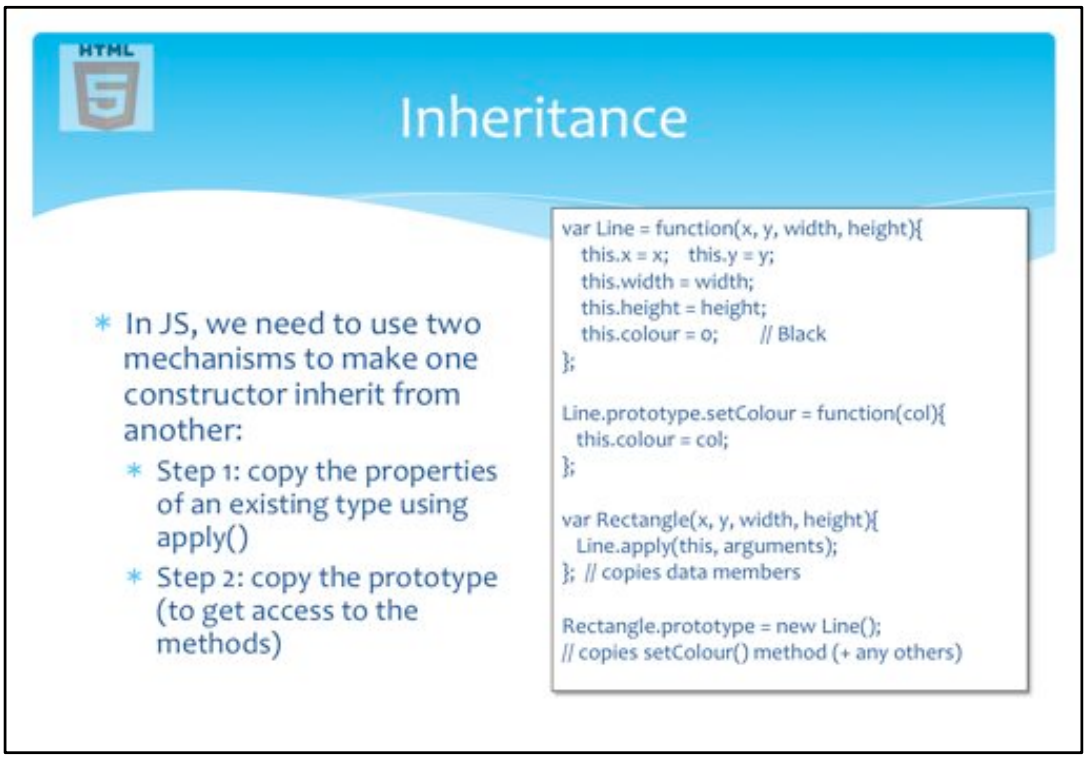
Using a constructor to create a 'class' means accepting certain responsibilities along with the power.

Polymorphism depends on either classical behaviour (i.e. being able to predict that certain methods are available) or "duck-typing", which, for robustness, depends on checking a method exists before calling it.



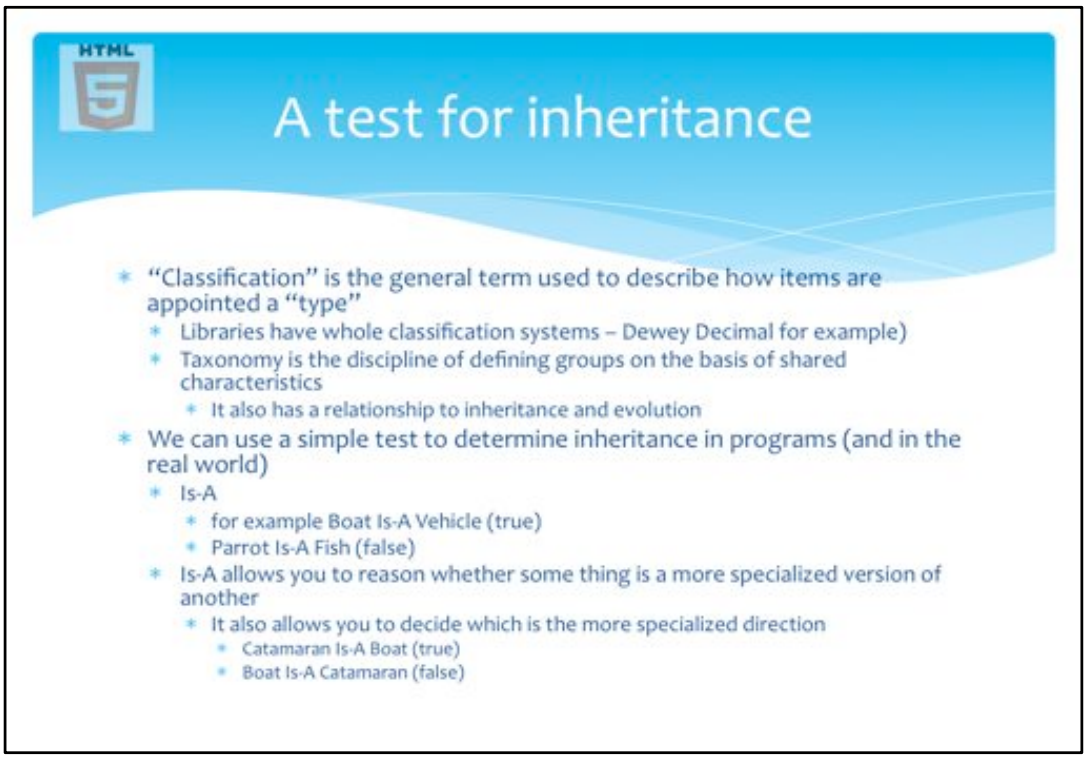
The prototype member provides access to the underlying definition of an object type through its Constructor function.
Generally, prototype is only useful for accessing and/or amending/adding methods – object properties are per-object values. It should only be used with constructors (e.g. see slide) – not with instances.

The MAIN thing about a prototype is that it is the only way to define behaviour for a whole class (meh) of objects. We need to use the prototype of a constructor to give objects compatible behaviour. It has the added side-benefit of ensuring that one function per *type of* object is the norm (not one per object).



It is worth pointing out that Inheritance was an afterthought in JS. V1 of LiveScript did not have the prototype object, so composition would have been the only obvious method for basing one class on another. It is also worth pointing out that Inheritance in JS is mainly a re-use mechanism. In classical languages, Inheritance serves two purposes – re-use and the specification of a system of type. In Java and C++, inheritance frees a programmer from having to cast an object to make it compatible with some code, because the rigid type structures in this language are there to stop programmers calling functions with inappropriate parameters. In Javascript this is irrelevant because the only thing that matters is what the object can do (duck typing). However, this does not help the designer of an application – and IMHO is a crappy underpinning for big polymorphic systems. Interfaces are important in describing objects.

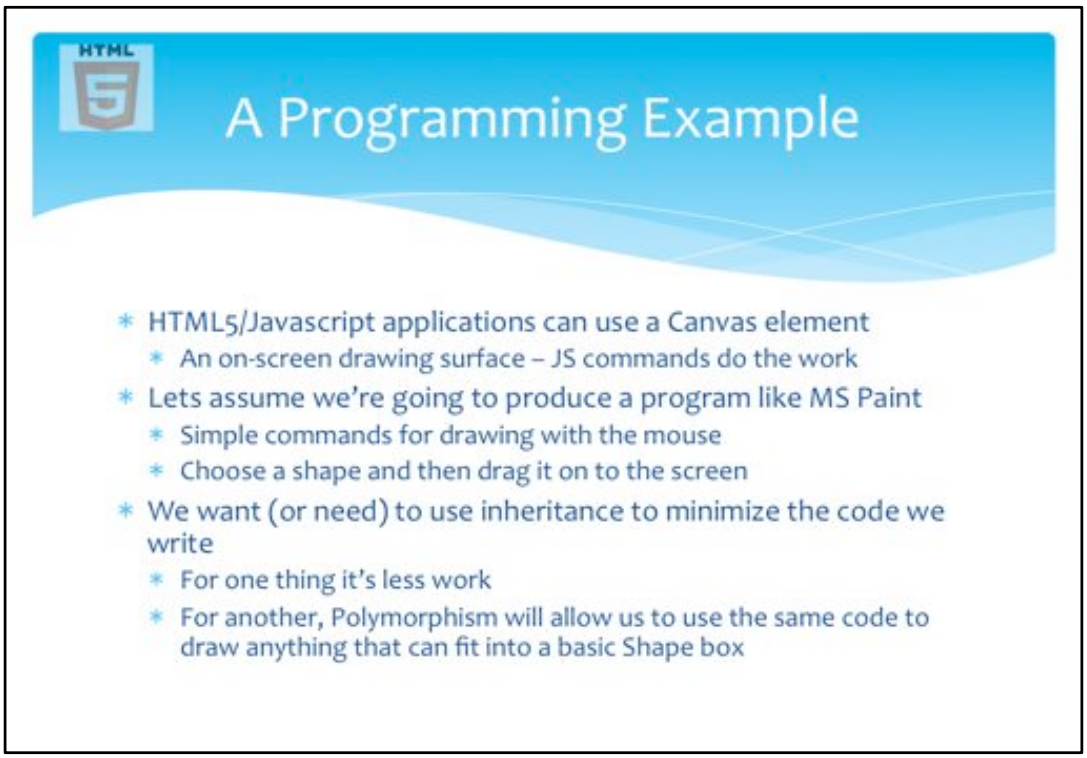
What this slide shows is Javascript mimicing a classical language – the fact that it takes two steps to inherit from an existing constructor is a strong clue, as is the need to call an obscure function (apply) to do it. However, it fits with the mindset of most programmers and is a fairly easy pattern to remember.



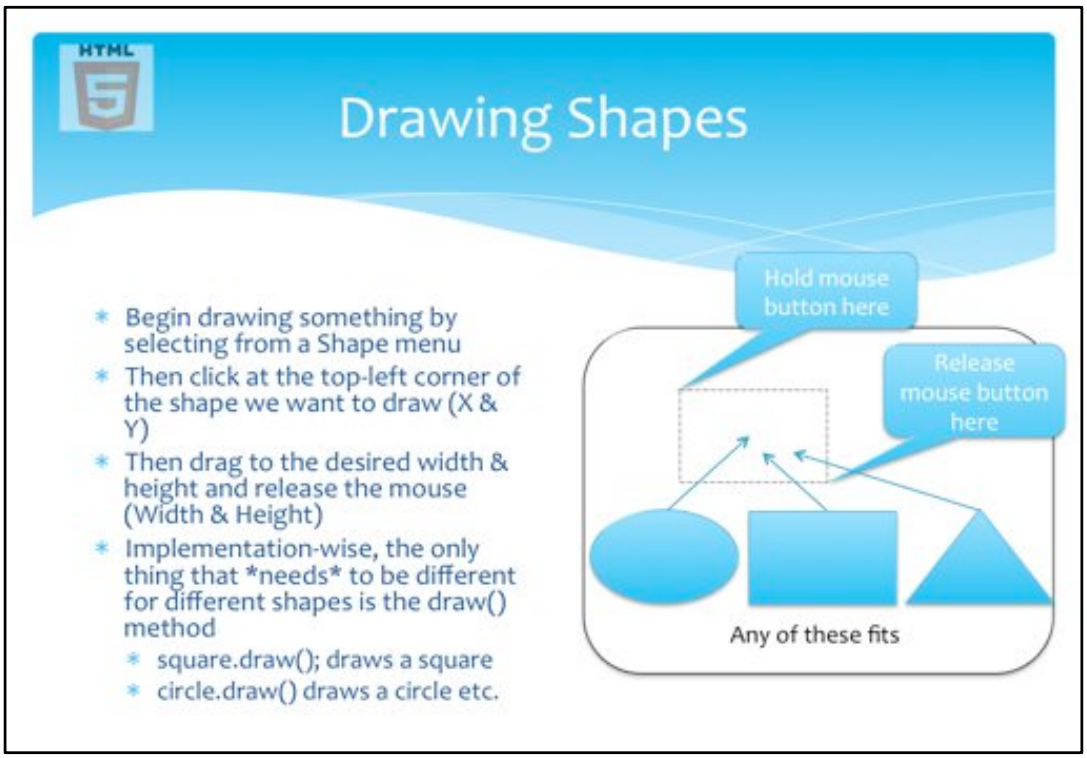
This all seems very abstract, but since the topic of the slide is about how to correctly apply abstractions, I don't see a problem with it.

The notion of this slide is that you should be able to apply similar tests to concepts in the arena of the program/system you are developing. In the lab, the students will be working on a graphical program that uses OOP, Inheritance and Polymorphism to minimize the amount of code (and simplify the overall abstraction) for a simple shape-drawing program (it's no accident that almost the first program written for new OOP languages is this type of thing – the abstraction works perfectly and everyone gets it immediately.

So – Shape is a general (generalized) type that has all of the behaviours of any type of shape but none of the specialisms that would make it possible to implement – position, size, colour, drawing style etc. Rectangle Is-A Shape (but certainly NOT the other way round): Circle Is-A Shape etc.



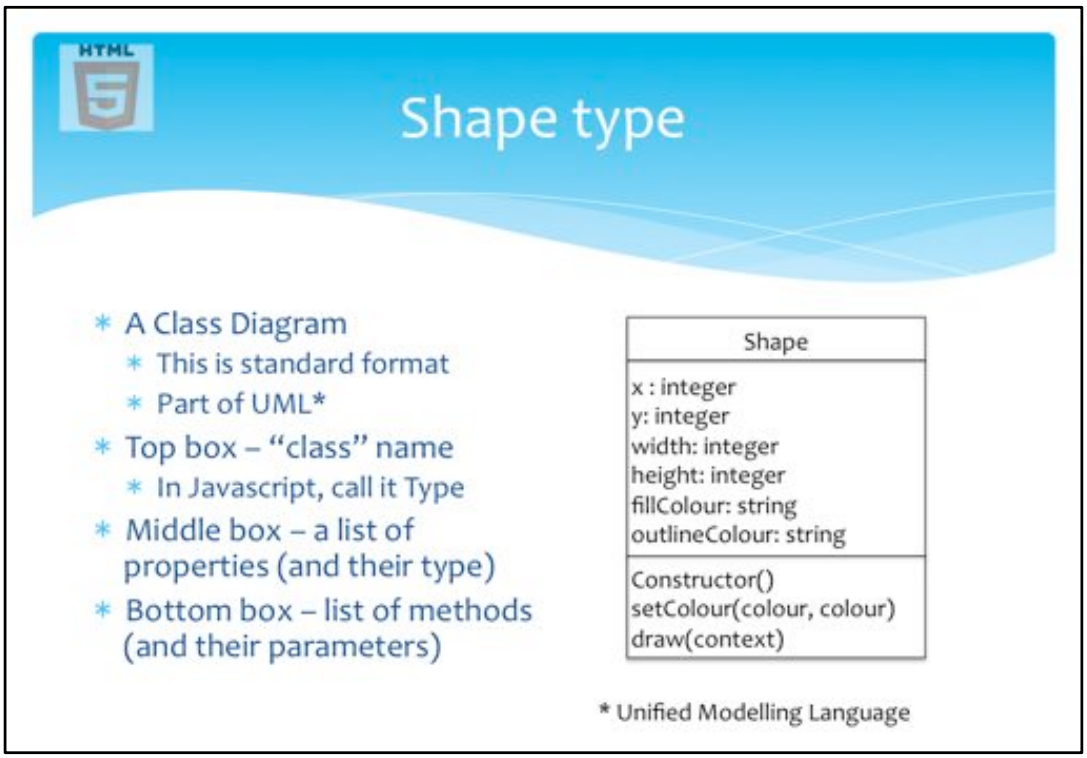
This turns out to be a good example. Because as well as the code, students can actually see the inheritance and polymorphism mechanisms in action is a very small number of lines. I've had lots of students mention that this example make the whole thing clear to them.



This turns out to be a really good example for explaining inheritance (al shapes inherit position, size and colour properties plus associated methods (setColour(), move() etc.), but all need to specialize their drawing code. For explaining polymorphism, the example is even better since you can have code like:

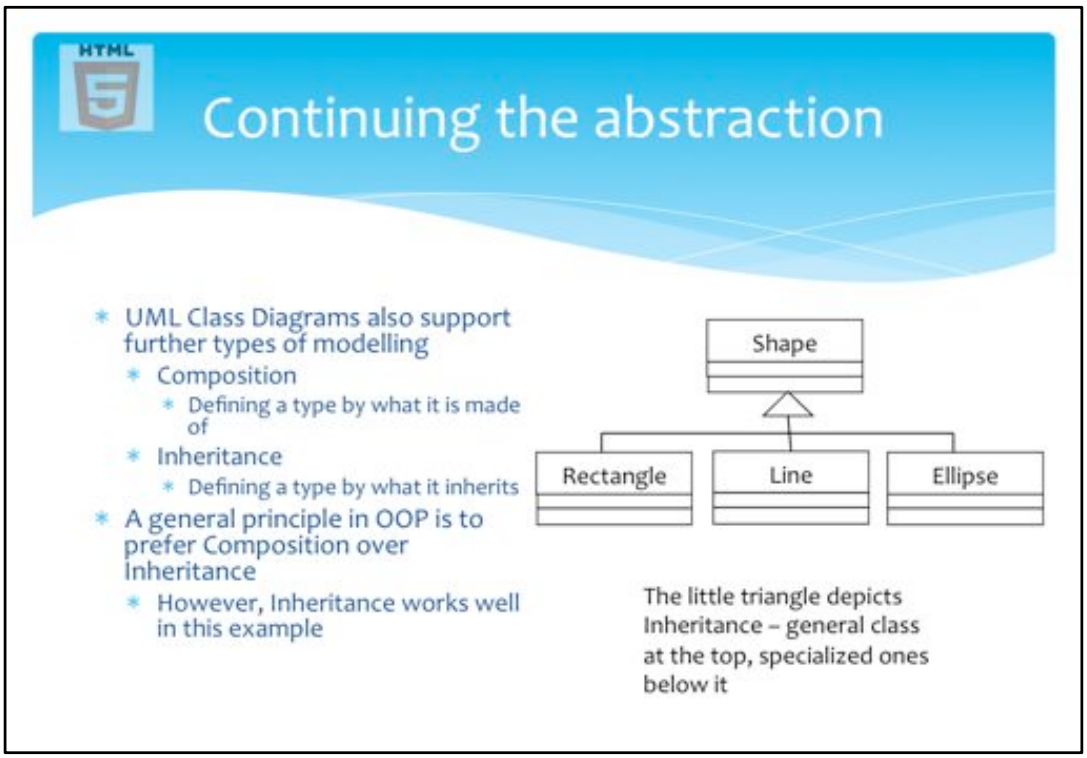
```
for(int i=0; i<shapeList.length; i+=1){
   shapeList[i].draw();
}
```

and each shape instance will “draw itself” according to its own methods. The visible effect of this on the display (and while using a debugger) is immediate and can often cause the “penny to drop”.



This should be an easy explanation – you might want to cover the origins of UML (from Gang of Three – Jacobson, Yourdon, Rumbagh) and explain that this is simply a way of depicting types (classes) diagrammatically – usually easier to get across that text.

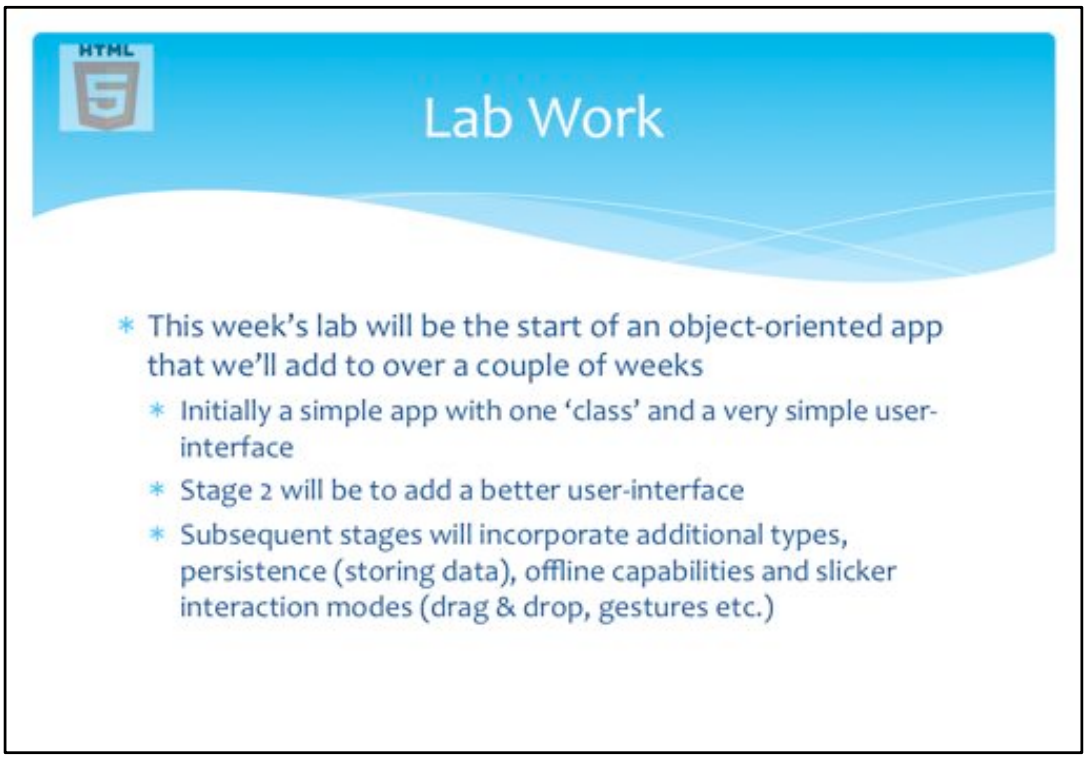
The use of a "Class" diagram can't go un-remarked. Obviously there are not classes in JS, but since most programmers come to OOP via classical languages like C++, Visual Basic, C#, Java etc., then the abstractions fit better into most system descriptions. (I'm quite blinkered in this area – I can't quite see how the benefits of scale a classical paradigm can provide would also work with a prototypical language. Sure, it is more flexible, but much of OOP is about creating types of things that you can then work with in the knowledge that they behave as you expect. Duck typing is OK provided you actually check the types as you go (this is why Test-Driven-Development was developed in the first place), but the general chaos of objects with no set definition scares the crap out of me.)



This diagram only shows Inheritance, and most people agree that Composition is a much more important principle. It might be worthwhile doing a whiteboard diagram of a composition relationship to make that clear too. I don't want to take this module too far down the classical OOP path – the students are not likely to be aspiring software designers.

For example, if you take the colour and style settings of a Shape (line style, line colour, fill style, fill colour), that can be devised as a separate type, then every shape has one of them as a member. I've not implemented the simple example like this, but it would not take much tom change it (a refactoring exercise?).

See the demo HTML-drawing.zip in Moodle.



The lab target is a small Appointments app – I decided on this because it uses a simple type but one that has expansion potential. Over this and next week, it will become an Appointments book with a half-decent UI. Eventually, we ought to be able to bring in PIM type behaviour, local persistence, integration with the cloud (I already have a Google App Engine framework that would suit well) etc.

I'll be putting a fully working version of the graphics app on Dropbox soon – it will still be possible to use it as a lab exercise by adding features (no prizes for adding cool ones but I'd like to see them). Added shapes should be easy – semicircles/ellipses, diamonds, bow-tie shapes etc. Added features, such as text elements (for which a new property and supporting methods will be required, U-I elements (drag & drop, colour palette etc.) would be very nice.

I usually offer a mars-bar type prize for the best solution to an exercise or problem. Nobody's ever interested in the mars bar, but competitive types often get into it anyway.