JavaScript Object Orientation

Goals

- Review how objects work in JavaScript
- Define classes in JavaScript
- Use classes to create instances that share functionality
- Describe constructor functions and use them to create instances
- Describe inheritance
- Define commonly used OOP (object-orientated programming) terms

JS Objects Review

“Plain Old JavaScript Object” (POJO):

```
let o1 = {};

let o2 = new Object();   // same thing


o1.name = "Whiskey";

o1["name"] = "Whiskey";  // same thing
```

Can add functions as keys:

```
o1.sayHi = function() { return "Hi!" };

o1.sayHi();   // Hi!
```

Can get arrays of keys, values, or [key, val] arrays:

```
Object.keys(o1);    // ["name", "sayHi"]

Object.values(o1);  // ["Whiskey", function () {...} ]

Object.entries(o1); // [["name", "Whiskey"],
                    //  ["sayHi", function () { ... } ]
```

Details You Should Know

- Properties that do not exist in the object register as ***undefined***.

```
o1.elie // undefined
```

(This causes issues when you attempt to invoke `()` or `.` access them)

- All keys get “stringified”:

```
o1[1] = "hello";
o1["1"] = "goodbye";
```

- What is `o1[1]`?

```
o1[1];    // "goodbye"
```

(This gets even more confusing when using things like nested arrays as keys)

Mixing Data And Functionality

Functions and Data

Imagine some useful functions:

demo/triangles.js

```
/* area of right triangle */

function getTriangleArea(a, b) {
  return (a * b) / 2;
}

/* hypotenuse of right triangle */

function getTriangleHypotenuse(a, b) {
  return Math.sqrt(a * a + b * b);
}
```

```
getTriangleArea(3, 4)          // 6
getTriangleHypotenuse(3, 4)    // 5
```

This gets a bit messy, though — all those functions to keep track of!

Using a POJO

demo/triangle-pojo.js

```
let triangle = {
  a: 3,
  b: 4,
  getArea: function() {
    return (this.a * this.b) / 2;
  },
  getHypotenuse: function() {
    return Math.sqrt(this.a ** 2 + this.b ** 2);
  }
};
```

```
triangle.getArea()          // 6
triangle.getHypotenuse()    // 5
```

For now:

```
let triangle = {
  a: 3,
  b: 4,
  getArea: function() {
    return (this.a + this.b) / 2;
  }
};
```

this references to “this object”

So, we can helpfully mix data & functionality!

- This is tidy: related functionality lives together
- Annoying when we want more than one triangle

Classes

Classes are a “blueprint” of functionality:

demo/triangle-oo.js

```
class Triangle {

  getArea() {
    return (this.a * this.b) / 2;
  }

  getHypotenuse() {
    return Math.sqrt(this.a ** 2 + this.b ** 2);
  }
}
```

```
let myTri = new Triangle();   // "instantiation" of triangle
myTri.a = 3;
myTri.b = 4;
myTri.getArea();         // 6
myTri.getHypotenuse();   // 5
```

demo/triangle-oo.js

```
class Triangle {

  getArea() {
    return (this.a * this.b) / 2;
  }

  getHypotenuse() {
    return Math.sqrt(this.a ** 2 + this.b ** 2);
  }
}
```

- Defines the **methods** each instance of ***Triangle*** will have
- Make a new triangle with `new Triangle()`
- Can still add/look at arbitrary keys ("properties")
- ***this*** is "the actual triangle in question"

Class names should be **UpperCamelCase**

Reduces confusion between ***triangle*** (an *actual, individual* triangle) and ***Triangle*** (the *class* of triangles)

A triangle is still an object:

```
typeof myTri;      // 'object'
```

But JS knows it's an "instance of" the ***Triangle*** class:

```
myTri instanceof Triangle;   // true
```

Constructors

Consider how we made an instance of our ***Triangle*** class:

```
let myTri = new Triangle();   // "instantiation" of triangle
myTri.a = 3;
myTri.b = 4;
```

demo/triangle-constructor.js

```
class Triangle {
  constructor(a, b) {
    this.a = a;
    this.b = b;
  }

  getArea() {
    return (this.a * this.b) / 2;
  }

  getHypotenuse() {
    return Math.sqrt(this.a ** 2 + this.b ** 2);
  }
}
```

The method with the special name ***constructor*** is called when you make a new instance.

```
let myTri2 = new Triangle(3, 4);
myTri2.getArea();     // 6
```

What Can You Do in the Constructor?

- Whatever you want!
- Common things:
  - Validate data
  - Assign properties

```
constructor(a, b) {
  if (!Number.isFinite(a) || a <= 0)
    throw new Error("Invalid a: " + a);

  if (!Number.isFinite(b) || b <= 0)
    throw new Error("Invalid b: " + b);

  this.a = a;
  this.b = b;
}
```

(Note you don’t return anything from constructor function).

Methods

```
getArea() {
  return (this.a * this.b) / 2;
}
```

Functions placed in a class are “methods” (formally: “**instance methods**”).

They have access to properties of object with ***this***.

They can take arguments/return data like any other function.

A method can call another method:

```
class Triangle {
  getArea() {
    return (this.a * this.b) / 2;
  }

  /* Is this a big triangle? */

  isBig() {
    return this.getArea() > 50;
  }
}
```

Note: to call a method, you need to call it on ***this***

Without ***this***, calling ***getArea*** throws a ReferenceError - it is not in scope!

Inheritance & Super

demo/triangle-duplicate.js

```
class Triangle {
  constructor(a, b) {
    this.a = a;
    this.b = b;
  }

  getArea() {
    return (this.a * this.b) / 2;
  }

  getHypotenuse() {
    return Math.sqrt(
        this.a ** 2 + this.b ** 2);
  }

  describe() {
    return `Area is ${this.getArea()}.`;
  }
}
```

demo/triangle-duplicate.js

```
class ColorTriangle {
  constructor(a, b, color) {
    this.a = a;
    this.b = a;
    this.color = color;
  }

  getArea() {
    return (this.a * this.b) / 2;
  }

  getHypotenuse() {
    return Math.sqrt(
        this.a ** 2 + this.b ** 2);
  }

  describe() {
    return `Area is ${this.getArea()}.` +
        ` Color is ${this.color}!`;
  }
}
```

demo/triangle-extends.js

```
class Triangle {
  constructor(a, b) {
    this.a = a;
    this.b = b;
  }

  getArea() {
    return (this.a * this.b) / 2;
  }

  getHypotenuse() {
    return Math.sqrt(
        this.a ** 2 + this.b ** 2);
  }

  describe() {
    return `Area is ${this.getArea()}.`;
  }
}
```

demo/triangle-extends.js

```
class ColorTriangle extends Triangle {
  constructor(a, b, color) {
    // call parent constructor with (a, b)
    super(a, b);
    this.color = color;
  }

  // will "inherit" getArea, getHypotenuse

  // "override" describe() w/new version

  describe() {
    return super.describe() +
        ` Color is ${this.color}!`;
  }
}
```

Multi-Level Inheritance

demo/triangle-extends.js

```
class ColorTriangle extends Triangle {
  constructor(a, b, color) {
    // call parent constructor with (a, b
    super(a, b);
    this.color = color;
  }

  // will "inherit" getArea, getHypotenus

  // "override" describe() w/new version

  describe() {
    return super.describe() +
        ` Color is ${this.color}!`;
  }
}
```

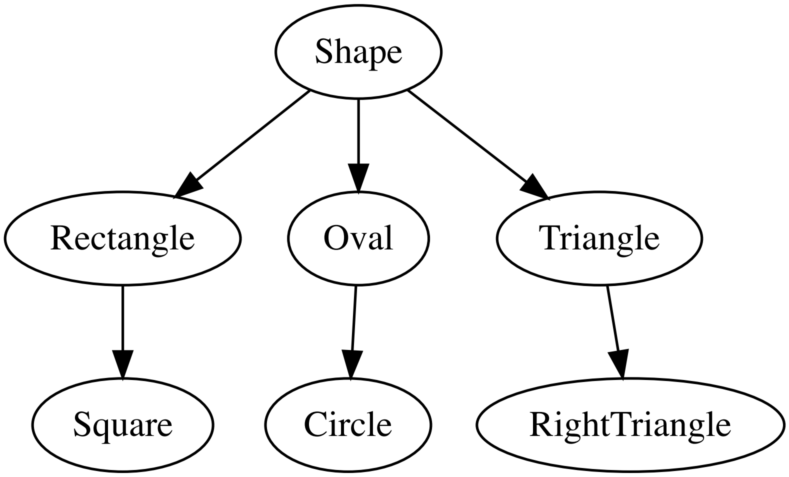
demo/triangle-extends.js

```
class InvisTriangle extends ColorTriangle
  constructor(a, b) {
    // call parent constructor
    super(a, b, "invisible");
  }

  // still inherit getArea, getHypotenuse

  describe() {
    return "You can't see me!";
  }
}
```

Often end up with “class hierarchy”:



Terminology

- Instance
  - an individual instance; an array is “instance” of ***Array***
- Class
  - blueprint for making instances
- Property
  - piece of data on an instance (e.g. `myTriangle.a`)
  - most languages call this idea an “instance attribute”
- Method
  - function defined by a class, can call on instance
  - most accurate to call these “instance methods”
- Parent / Superclass
  - More general class you inherit from
  - ***Rectangle*** might be parent of ***Square***
- Child / Subclass
  - More specific class (a ***Square*** is a special kind of ***Rectangle***)
- Inherit
  - Ability to call methods/get properties defined on ancestors
- Object Oriented Programming
  - Using classes & instances to manage data & functionality together
  - Often makes it easier to manage complex software requirements

Looking Ahead

- More about ***this***
- Additional OO Concepts
- Python OO
- Oldschool JavaScript OOP