OOP Using JavaScript

Outline

- JavaScript OOP
  - Object Literal using JSON
  - Class-based OOP
  - Prototypal Inheritance
- Prototype Chain
- Modules

JavaScript OOP

Properties & Methods

JavaScript OOP

- JavaScript object is a **dynamic** collection of **properties**
- An object **property** is an association between a **key** and a **value**.
  - **Key** is a string that is unique within that object.
  - **Value** can be either:
    - a **data** (e.g., number, string, object …) or
    - a **method** (i.e., function)
- Classes and objects can be altered during the execution of a program

OOP in JavaScript

JavaScript has 3 ways to create an objects:

- **Object Literal**: create an object using JSON notation
- **Instantiate a Class**: create a class then instantiate objects from the class
- **Create an object based on another object**: prototype-based programming
  - Make a prototype object then make new instances from it (objects inherit from objects)
    - Augment the new instances with new properties and methods

```
const cat = { legs : 4, eyes: 2 };
const myCat = Object.create(cat);
myCat.name  = 'Garfield';
```

Object Literal using JSON

Create an Object Literal using JSON

(JavaScript Object Notation)

```
const person = {
    firstName: 'Samir',
    lastName: 'Saghir',
    height: 54,
    getName () {
        return `${this.firstName} ${this.lastName}`;
    }
};

//Two ways to access the object properties
console.log(person['height'] === person.height);

console.log(person.getName());
```

Creating an object using {}

- Another way to create an object is to simply assigning {} to the variable. Then add properties and methods

```
const joha = {}; //or new Object();
joha.name = "Juha Nasreddin";
joha.age = 28;

joha.toString = function() {
    return `Name: ${this.name} Age: ${this.age}`;
};
```

```
//Creating an object using variables
const name = 'Samir Saghir'; age = 25;
const person = {name, age };
```

Get, set and delete

- **get**

  object.name

- **set**

  object.name = value;

- **delete**

  delete object.name

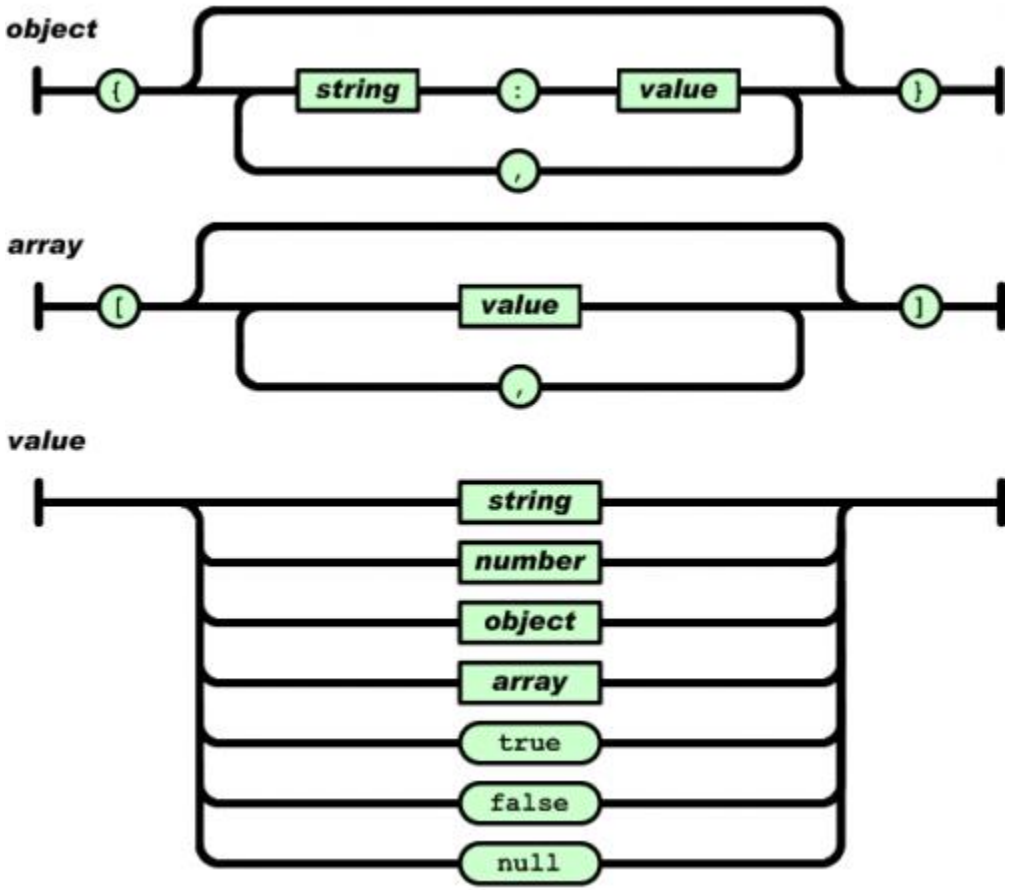
JSON.stringify and JSON.parse

```
/* Serialise the object to a string in JSON format
-- only properties get serialised */
const jsonString = JSON.stringify(person);
console.log(jsonString);

//Deserialise a JSON string to an object
//Create an object from a string!
const personObject = JSON.parse(jsonString);
console.log(personObject);
```

- More info https://developer.mozilla.org/en-US/docs/JSON

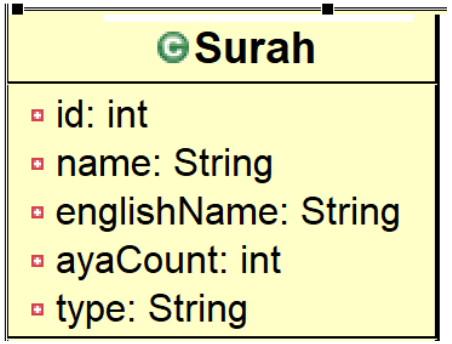

{;}
JSON


object
{
string
:
value
}
,
array
[
value
]
,
value
string
number
object
array
true
false
null

JSON Data Format

- **JSON** is a very popular lightweight data format to transform an object to a **text** form to ease storing and transporting data
- **JSON** class could be used to transform an object to json or transform a json string to an object

Transform an instance of Surah class to a JSON string:




```
const fatiha = {id: 1, name: "الفاتحة",
englishName: "Al-Fatiha", ayaCount: 7, type:"Meccan")
const surahJson = JSON.stringify(fatiha)

// Converting a json string to an object
const surah = JSON.parse(surahJson)
```

```
{    "id": 1,
     "name": ","الفاتحة
     "englishName": "Al-Fatiha",
     "ayaCount": 7,
     "type": "Meccan"
 }
```

Destructuring Object

- Destructuring assignments allow to extract values from an object and assign them to variables in a concise way:

```
const student = {
   firstname: 'Ali', lastname: 'Faleh', age: 18, gpa: 3.6,
   address: {
      city: 'Doha',
      street: 'University St'
   }
}
const { firstname, age, address: {city}, ...otherDetails } = student
```

- const { **nestedObjectProp**: { **identifier** } } = expression; same as const identifier = expression.nestedObjectProp.identifier;

- Rest operator (…) assigns the remaining properties to the ***otherDetails*** variable

Class-based OOP

Class-based OOP

- Class-based OOP uses classes

```
class Person {
    constructor(firstname, lastname){
        this.firstname = firstname;
        this.lastname = lastname;
    }

    get fullname() {
        return `${this.firstname} ${this.lastname}`;
    }

    set fullname(fullname) {
        [this.firstname, this.lastname] = fullname.split(" ");
    }

    greet() {
        return `Hello, my name is ${this.fullname}`;
    }
}
```

Constructor of the class

Getter, defines a computed property

Method

Class-based Inheritance

- A class can extend another one

```
class Student extends Person {
    constructor(firstname, lastname, gpa){
        super(firstname, lastname);
        this.gpa = gpa;
    }
    greet() {
        return `${super.greet()}. My gpa is ${this.gpa}`;
    }
}

const student1 = new Student("Ali", "Faleh", 3.5);
//Change the first name and last name
student1.fullname = "Ahmed Saleh";
console.log(student1.greet());
```

Prototype property can be used to extend a class

- **Classes** has a special property called **prototype**
- It can be used to add properties / methods to a class
  - Change reflected on all instances of the class

```
class Circle {
    constructor(r) {
        this.radius = r;
    }
}
const circle = new Circle(3.5);

//Add getArea method to the class at runtime
Circle.prototype.getArea = function () {
    return Math.PI * this.radius * 2;
}
const area = circle.getArea();
console.log(area);  // 21.9
```

Using prototype property to Add Functionality even to Build-in Classes

- Dynamically add a function to a built-in class using the **prototype** property:

Attaching a method to the Array class

```
Array.prototype.getMax = function() {
    const max = Math.max(...this);
    return max;
}

const numbers = [9, 1, 11, 3, 4];
const max = numbers.getMax();
```

Here **this** means the array

Private Attributes

- Private attributes can only be accessed within the class. They are prefixed with **#**

```
class User {
    // Random number between 0 and 100
    #randomPrefix = Math.floor(Math.random() * 100);
    #id = `${this.#randomPrefix}${new Date().getFullYear()}`;
    constructor(name) {
        this.name = name;
    }
    get userId() {
        return this.#id;
    }
}

const user1 = new User("Juha Dahak");
console.log(user1.userId, user1.name);
// Accessing a private attribute causes a syntax error
console.log(user1.#id);
```

Static properties and methods

- Static methods are used for the functionality that belongs to the class “as a whole”. It doesn’t relate to a concrete class instance.
  - For example, a method for comparison `Article.compare(article1, article2)` or a factory method `Article.createTodays()`
  - They are labeled by the word static
- Static properties are used to store class-level data, also not bound to an instance

```
class Animal {
      static planet = "Earth";
...}
```

Prototypal Inheritance

Prototypal Inheritance

- Prototypal Inheritance (aka Object-Based Inheritance) enables creating an object from another object
  - Instead of creating classes, you **make prototype object**, and then use **Object.create**(..) or **Object.setPrototypeOf**(..) to make new instances that inherit form the prototype object
  - Customize the new objects by adding new properties and methods
- We don't need classes to make lots of similar objects. **Objects inherit from objects!**

Example

```
const cat = { legs : 4, eyes: 2 };

const myCat = { name: 'Garfield' };

Object.setPrototypeOf(myCat, cat);

// Or const myCat = Object.create(cat);


myCat.breed = 'Persian';

console.log( `${myCat.name} is a ${myCat.breed}
              cat with ${myCat.legs} legs
              and ${myCat.eyes} eyes`);
```

Prototypal Inheritance

- Make an object (i.e., prototype object)
- Create new instances from that object
  - Resulting object **maintains an explicit** link (**delegation** pointer) to its prototype
  - JavaScript runtime dispatches the correct method or finds the value of a property by simply following a series of delegation pointers (i.e., Prototype Chain) until a match is found
- Changes in the prototype are visible to the new instances
- New objects can add their own custom properties and methods

The spread operator (...)

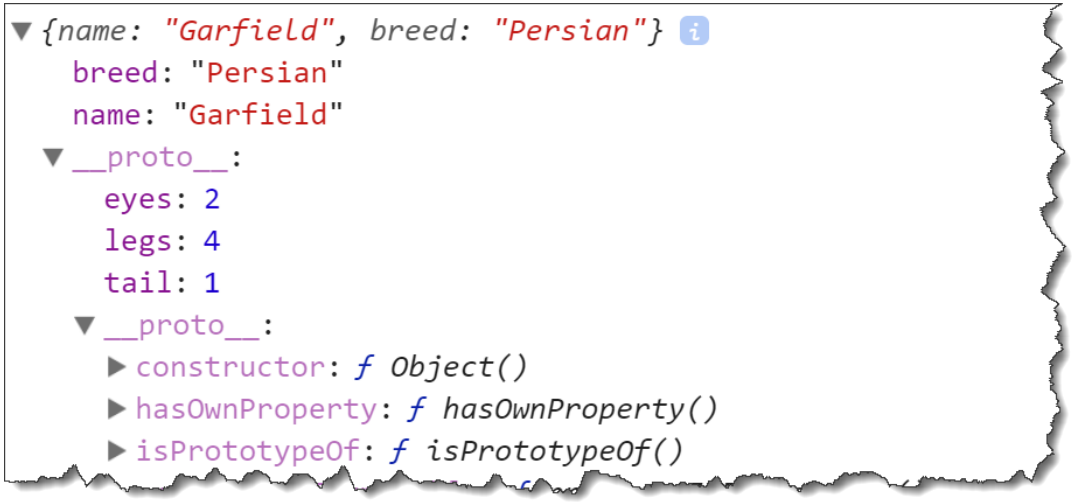
- The spread operator (...) is used to merge one or more objects to a target object while **replacing** values of properties with matching names
  - Used for cloning => no inheritance
- Alternative way is to use **Object.assign**

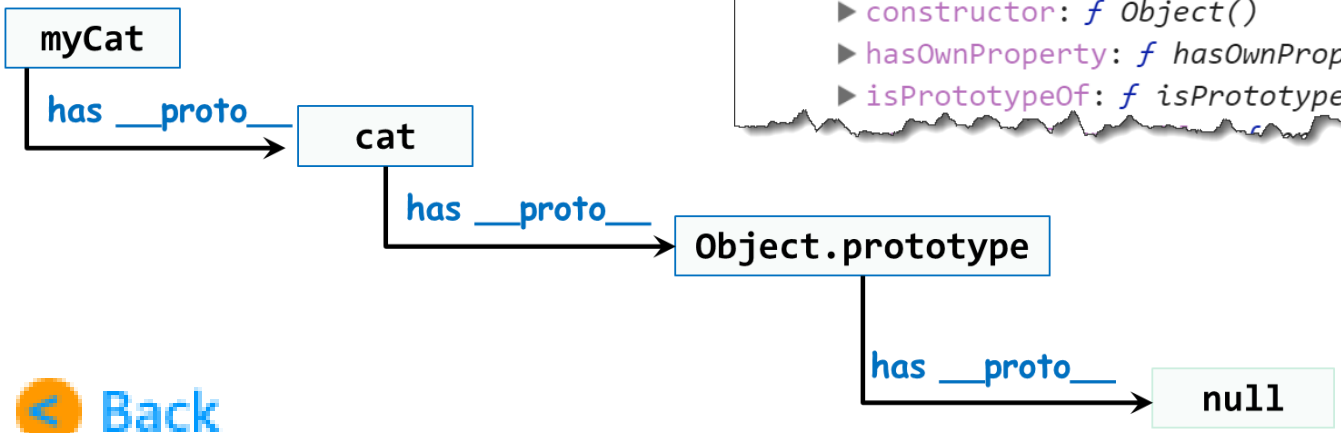
```
const movie1 = {
    name: 'Star Wars',
    episode: 7
};

//We clone movie 1 and override the episode property
const movie2 = {...movie1, episode: 8, rating: 5 };
//Another way of doing the same using Object.assign
//const movie2 = Object.assign({}, movie1, { episode: 8, rating: 5});

console.log('\n');
console.log(movie1.name, "movie1.episode: ", movie1.episode); // writes 7
console.log(movie2.name, "movie2.episode: ", movie2.episode); // writes 8
```

Prototype Chain





Back

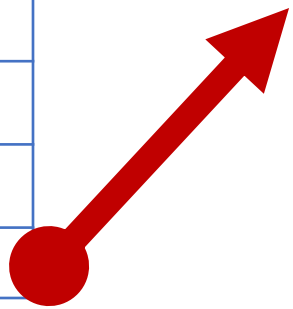
Prototype Chain

- **Prototype Chain** is the mechanism used for inheritance in JavaScript
  - Establish behavior-sharing between objects using **delegation pointers** (called Prototype Chain)
- Every object has a an internal **__proto__** property **pointing** to another object
  - **`Object.prototype.__proto__`** equals null
- It can be accessed using **`Object.getPrototypeOf`**`(obj)` method

```
const cat = {
      name : 'cat',
      legs : 4,
      eyes : 2
};
```

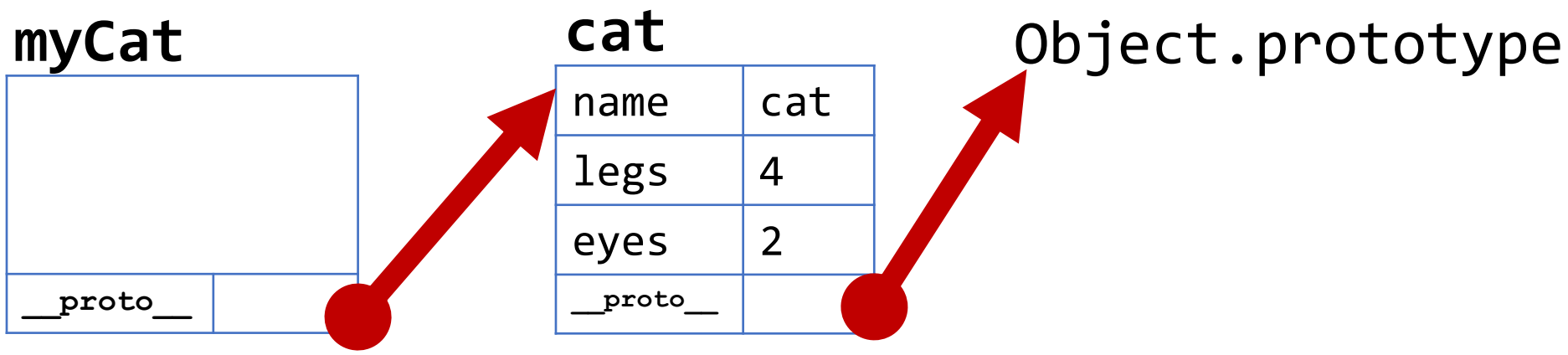
cat

name	cat
legs	4
eyes	2
__proto__	



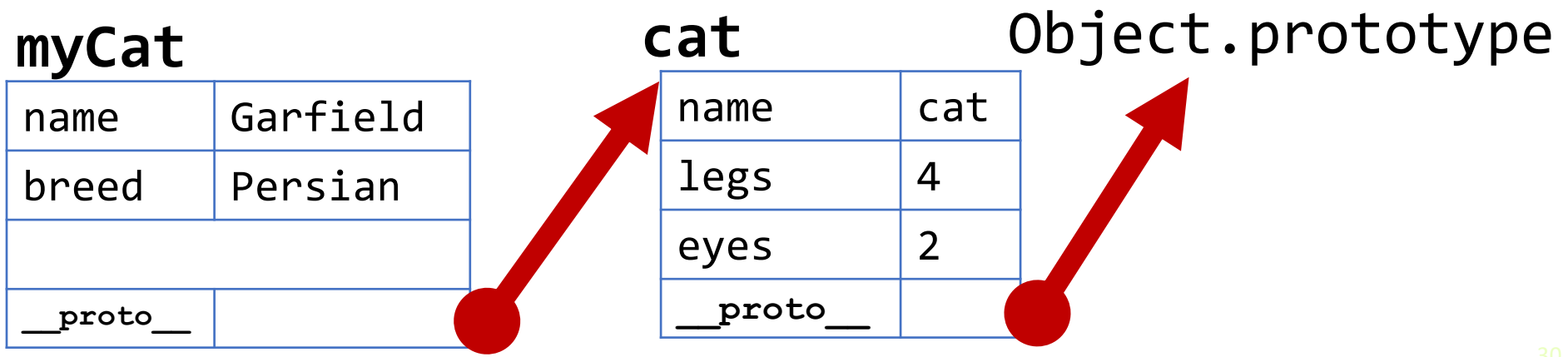
Object.prototype

```
const cat = {
      name : 'cat',
      legs : 4,
      eyes : 2
};
const myCat = Object.create(cat);
```

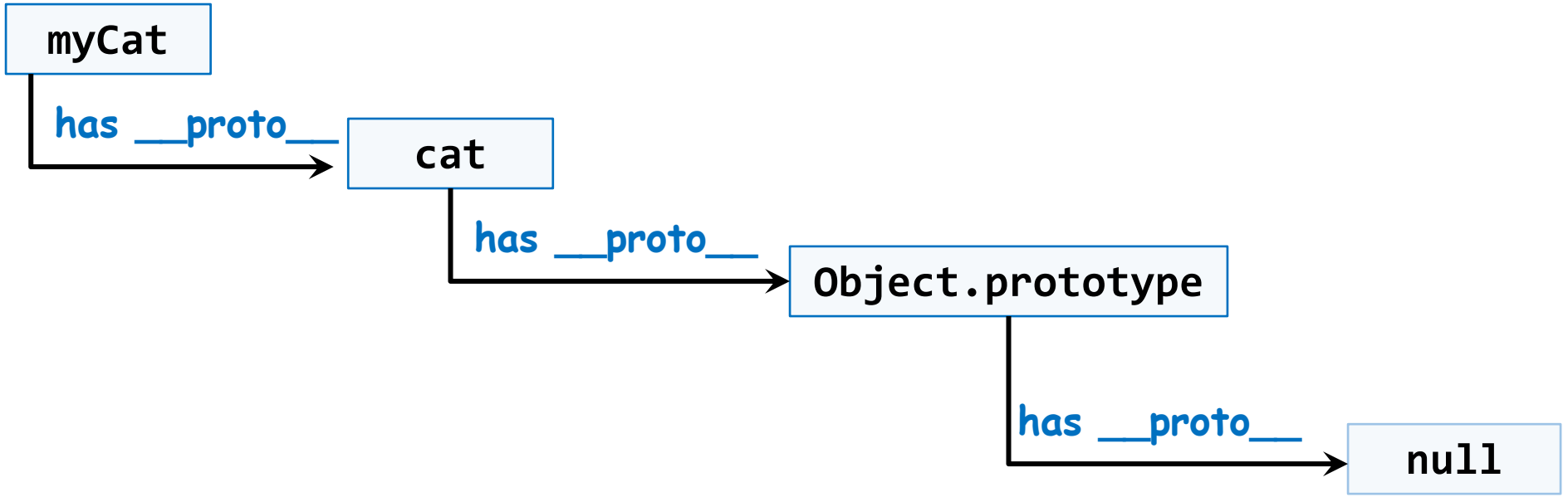


```
const cat = {
      name : 'cat',
      legs : 4,
      eyes : 2
};
const myCat = Object.create(cat);
myCat.name  = 'Garfield';
myCat.breed = 'Persian';
```

Changes to a child object are always recorded in the child object itself and never in its prototype (i.e. the child's value **shadows** the prototype's value rather than changing it).



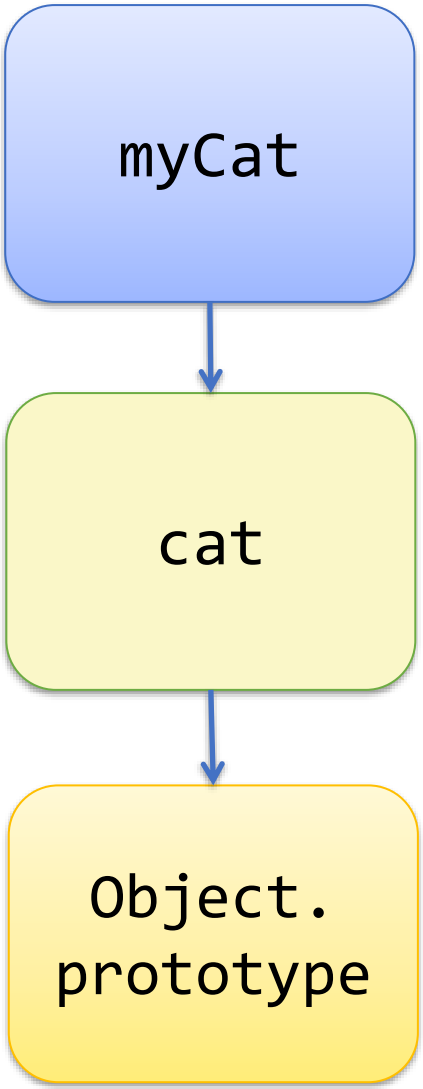
Prototype Chain example



__proto__ is the actual object that is used to **lookup the chain** to resolve methods

Prototype Chain

```
const cat = {
      name : 'cat',
      legs : 4,
      eyes : 2
};
const myCat = Object.create(cat);
myCat.name  = 'Garfield';
myCat.breed = 'Persian';
```



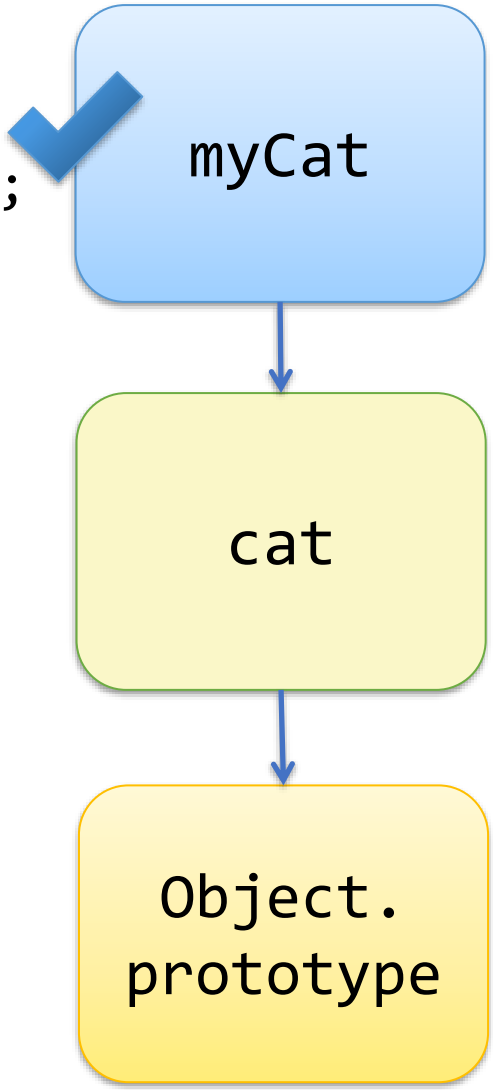
Prototype Chain (lookup myCat.name)

```
const cat = { name: 'cat', legs : 4, eyes: 2 };
const myCat = { name: 'Garfield' };
Object.setPrototypeOf(myCat, cat);
myCat.name = 'Garfield';
myCat.breed = 'Persian';


console.log(myCat.name);

console.log(myCat.legs);

console.log(myCat.hasOwnProperty('eyes'));
```



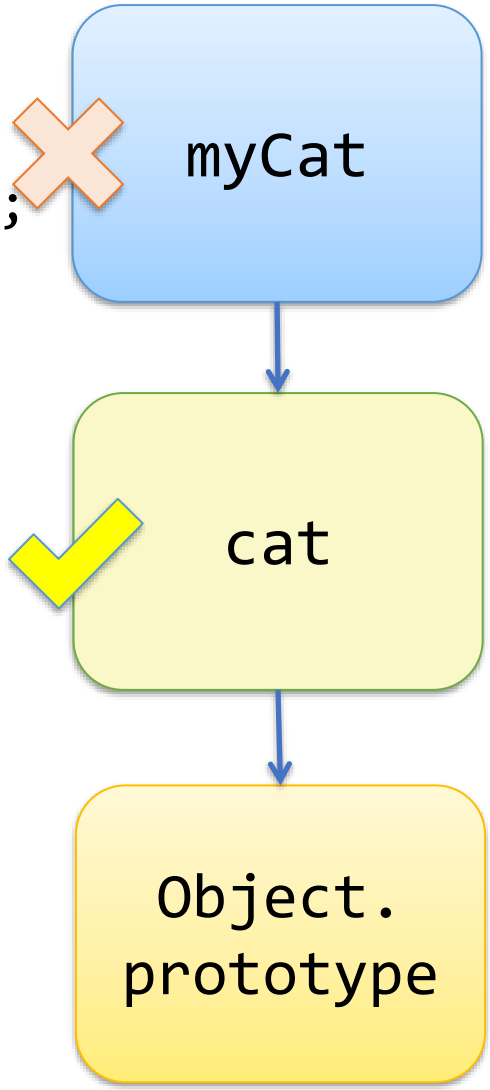
Prototype Chain (lookup myCat.legs)

```
const cat = { name: 'cat', legs : 4, eyes: 2 };
const myCat = { name: 'Garfield' };
Object.setPrototypeOf(myCat, cat);
myCat.name = 'Garfield';
myCat.breed = 'Persian';
```

```
console.log(myCat.name);
```

```
console.log(myCat.legs);
```

```
console.log(myCat.hasOwnProperty('eyes'));
```



Prototype Chain (lookup myCat.hasOwnProperty)

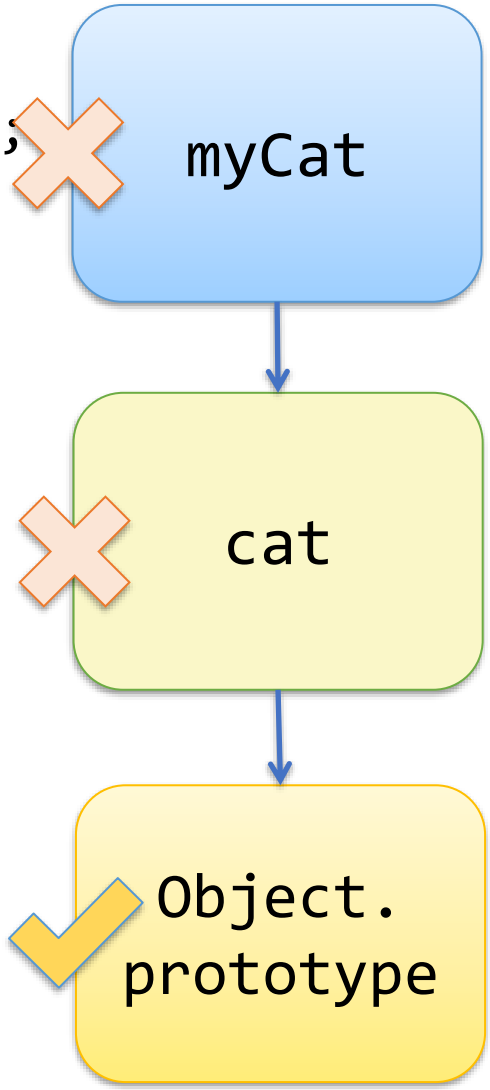
```
const cat = { name: 'cat', legs : 4, eyes: 2 };
const myCat = { name: 'Garfield' };
Object.setPrototypeOf(myCat, cat);
myCat.name = 'Garfield';
myCat.breed = 'Persian';



console.log(myCat.name);

console.log(myCat.legs);

console.log(myCat.hasOwnProperty('eyes'));
```



Modules

A module = reusable snippets of functionality (functions, classes, objects, variables, constants) that you can include in your application

JavaScript Modules

- JavaScript modules allow reusing code stored in different .js files
  - For Node.js need to add "type": "module" to ***packages.json***

- **Export** the items from a module (named export):

```
// lib.js
export const add = (x, y) => x + y;
export const multiply = (x, y) => x * y;
```

- **Import** the desired module items in another file:

```
// app.js
import {add, multiply} from './lib.js';
add(2, 3);
multiply(2, 3);
```

named export vs. default export

- JavaScript provides two ways to export items (a variable, a function, a class, an object) from a file: **named** export and **default** export
- Named exports allows several exports per file
  - The name of imports must be the same as the name of exports
- Only one **default (unnamed) export** per file is allowed
  - Specify a name when importing a default module

```
// calculator.js
class Calculator {
    add = (x, y) => x + y;
    subtract = (x, y) => x - y;
}
export default new Calculator();
```

```
// app.js
import calculator from './calculator.js';
```

Module Export and Import

- Alternatively, a single export statement can be used
- **import** is then used to pull items from a module into another script:

```
// lib.js
const PI = 3.1415926;

function sum(...args) {
  log('sum', args);
  return args.reduce((num, tot) => tot + num);
}

function mult(...args) {
  log('mult', args);
  return args.reduce((num, tot) => tot * num);
}

// private function
function log(...msg) {
  console.log(...msg);
}

// A single export statement
export { PI, sum, mult };
```

```
// main.js
//One items can be imported
import { sum } from './lib.js';
console.log( sum(1,2,3,4) );


//Multiple items can be imported at
one time:
import { sum, mult } from './lib.js';
console.log( sum(1,2,3,4) );
console.log( mult(1,2,3,4) );

// All public items can be imported by
providing a namespace:
import * as lib from './lib.js';

console.log( lib.PI );
console.log( lib.add(1,2,3,4) );
```

Built-in Modules

- Node.js has a set of built-in modules which you can use without any further installation
  - https://www.w3schools.com/nodejs/ref_modules.asp
- To include a module, use the import statement with the name of the module

```
import path from 'path';
import fs from 'fs';

const currentPath = path.resolve();
console.log(`Files in current path: ${currentPath}`);
fs.readdir(currentPath, (err, files) => {
    files.forEach(file => {
        console.log(file);
    })
})
```

Node Package Management (NPM)

- https://npmjs.com is a huge npm repository to publish and download JavaScript modules
  - **npm** is used to download packages
  - First, `npm init` can be used to initialize a *package.json* file to define the **project dependencies**

```
$ npm init
//enter package details
name: "NPM demos"
version: 0.0.1
description: "Demos for the NPM package management"
entry point: main.js
test command: test
git repository: http://github.com/user/repository-name
keywords: npm, package management
author: ae@qu.edu.qa
license: MIT
```

Node Package Management (NPM)

- Install a package and adds dependency in *package.json* using **`npm install package-name`**

```
npm install fs-extra
npm install mocha -D
//-D for installing dev dependencies (not needed in production)
```

- Do not push the downloaded packages to GitHub by adding ***node_modules/*** to **.gitignore** file

- When cloning a project from GitHub before running it do:

```
$ npm install
```

=> Installs all missing packages from *package.json*

Resources

- Best JavaScript eBook

https://exploringjs.com/impatient-js/toc.html

- Code Camp

https://www.freecodecamp.org/learn/javascript-algorithms-and-data-structures/