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

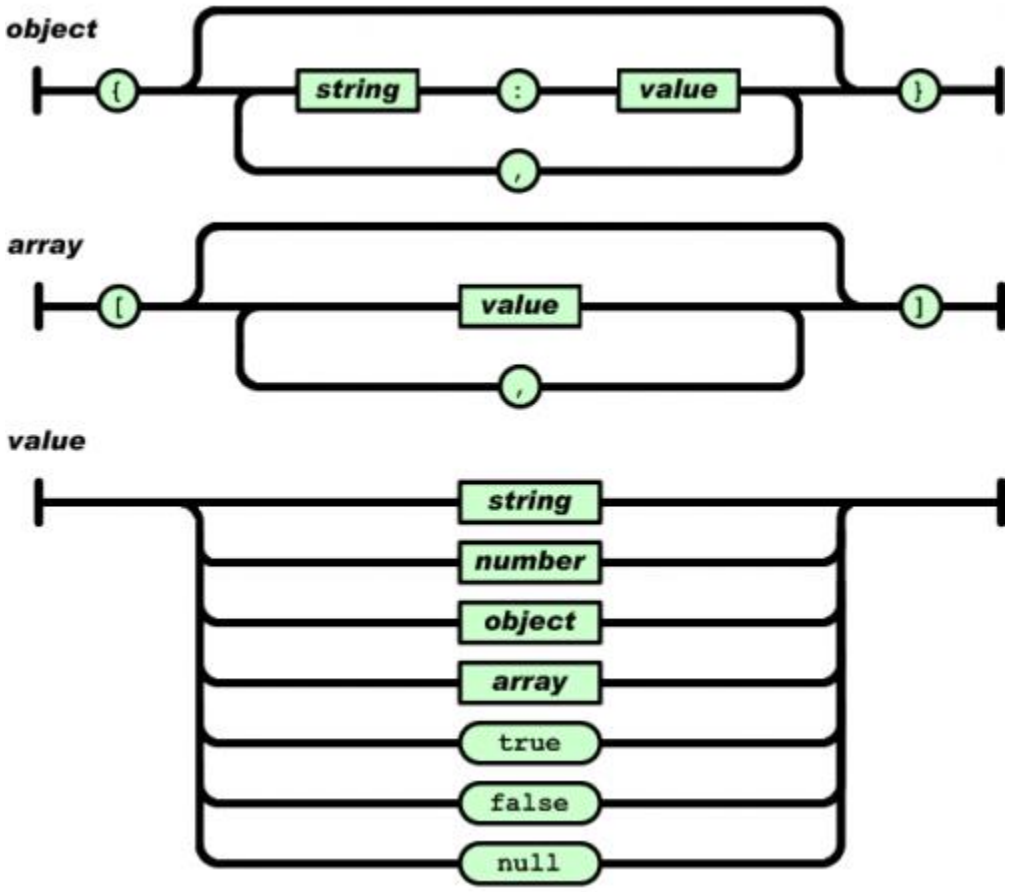
JSON.stringify and JSON.parse

```
/* 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

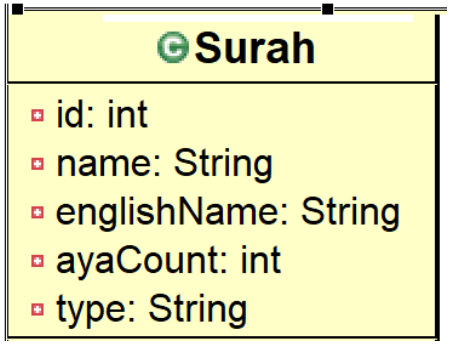
JSON Data Format

- **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 (...)

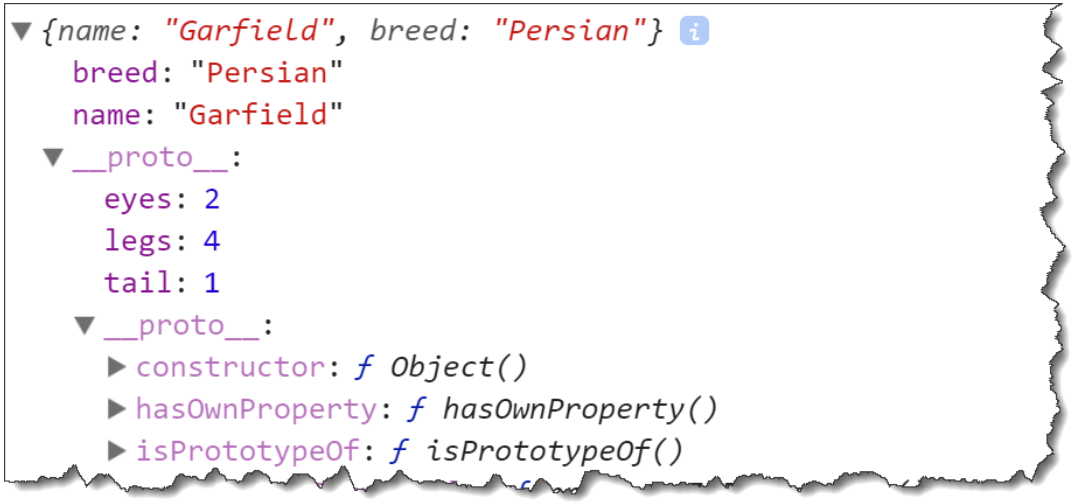
- The spread operator (...) is used to merge one or more objects to a target object while **replacing** values of properties with matching names
  - Used for cloning => no inheritance
- Alternative way is to use **Object.assign**

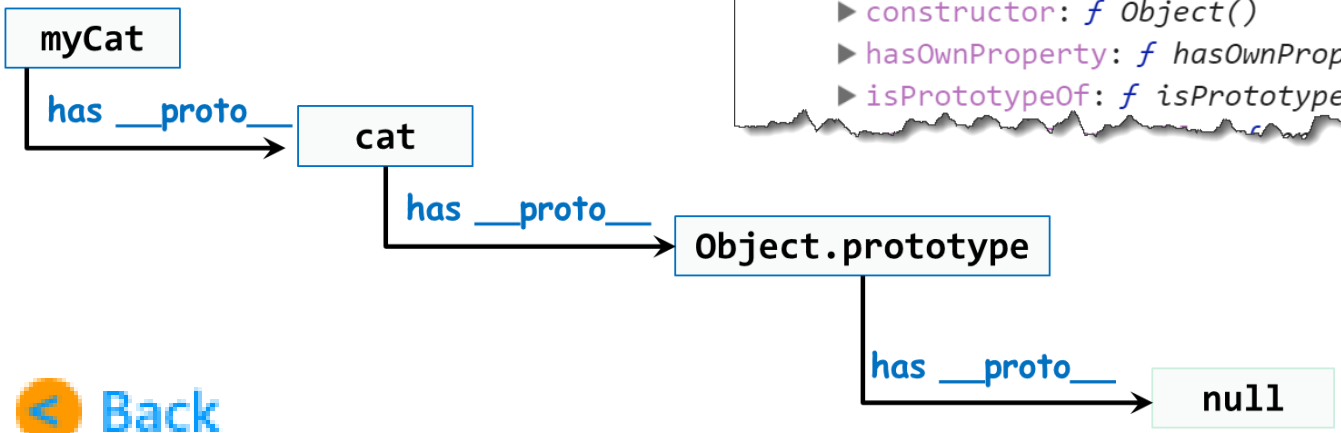
```
const movie1 = {
    name: 'Star Wars',
    episode: 7
};

//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

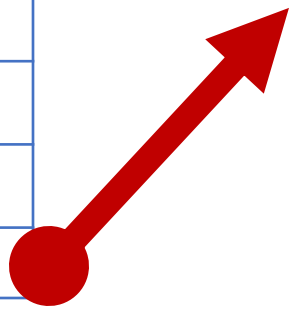
Prototype Chain

- **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
};
```

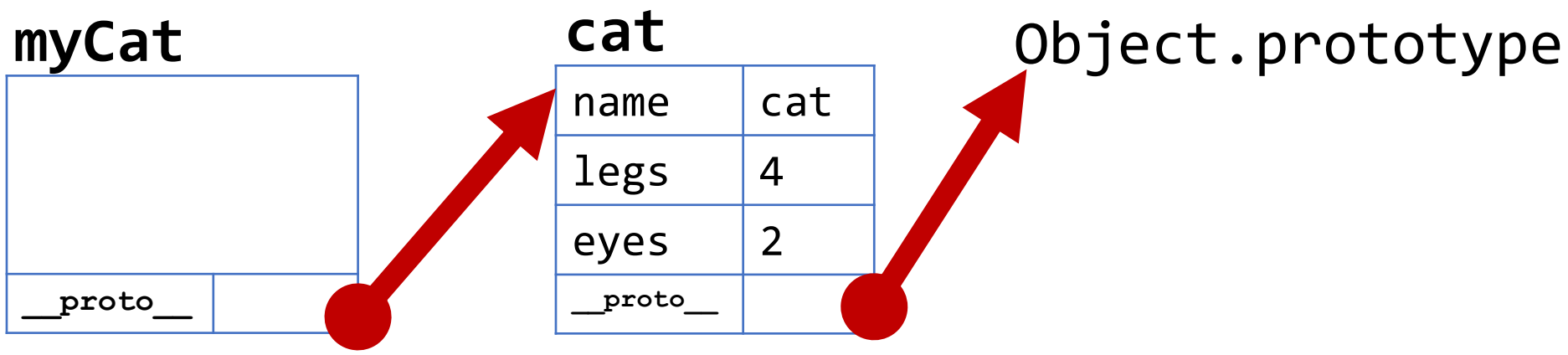
cat

name	cat
legs	4
eyes	2
__proto__	



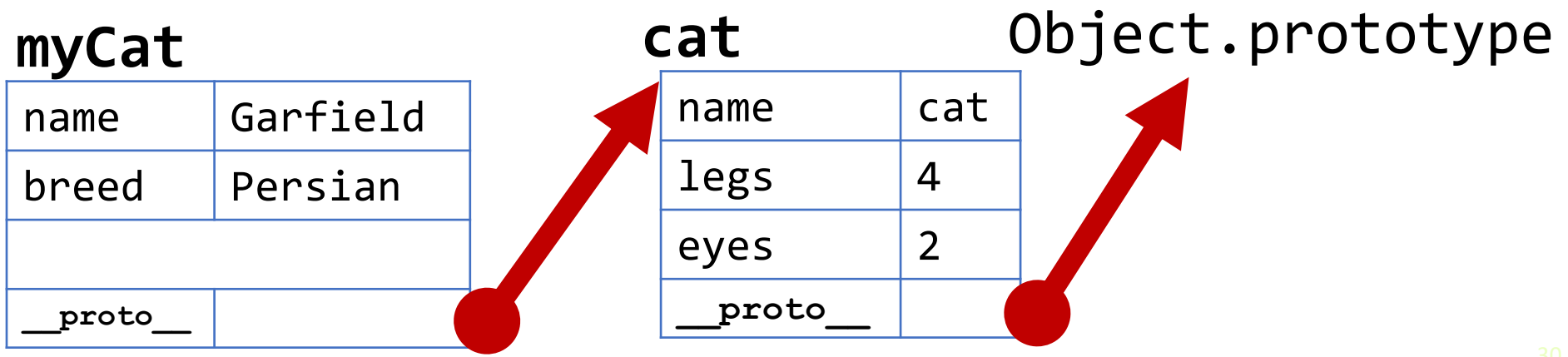
Object.prototype

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

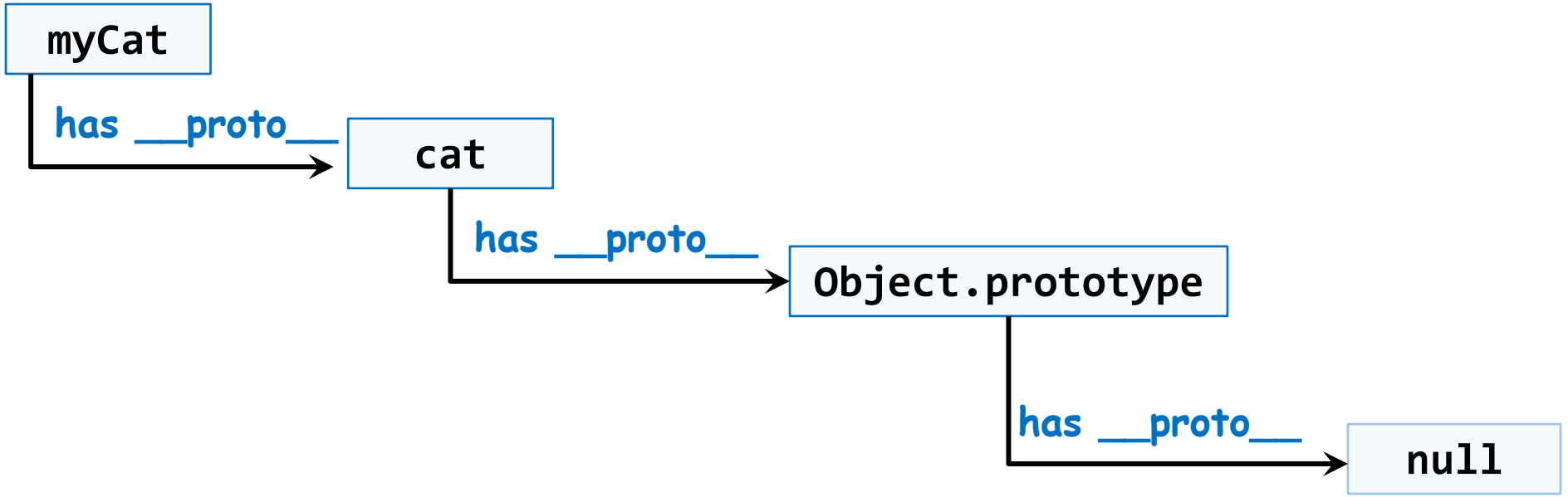


```
const cat = {
      name : 'cat',
      legs : 4,
      eyes : 2
};
const myCat = Object.create(cat);
myCat.name  = 'Garfield';
myCat.breed = 'Persian';
```

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).



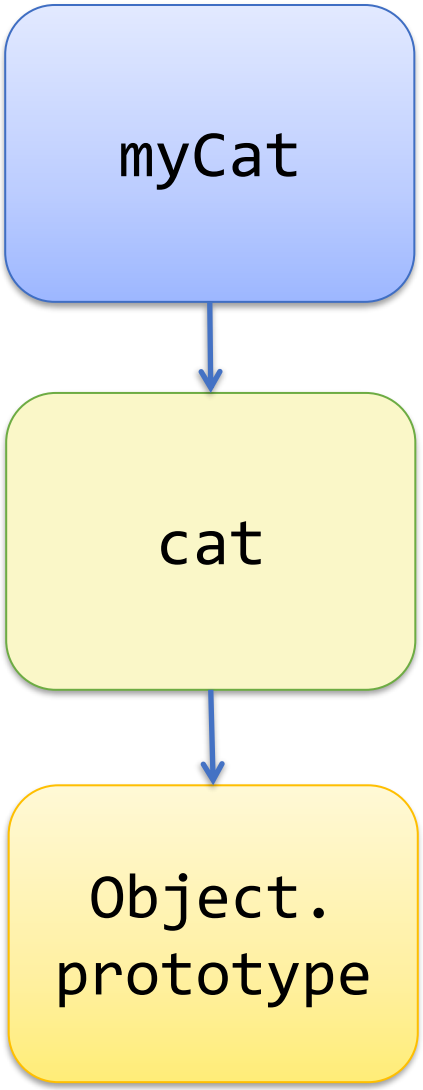
Prototype Chain example



__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';
```



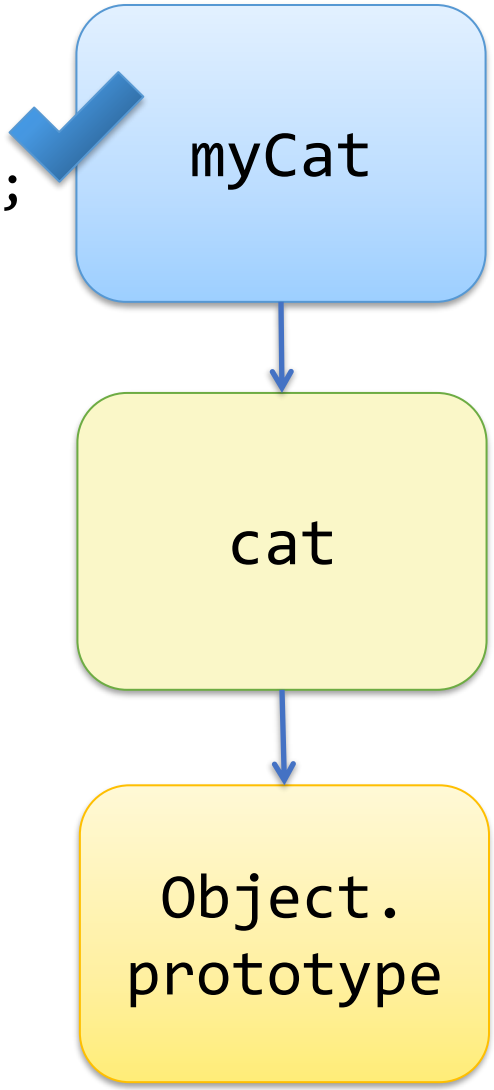
Prototype Chain (lookup myCat.name)

```
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'));
```



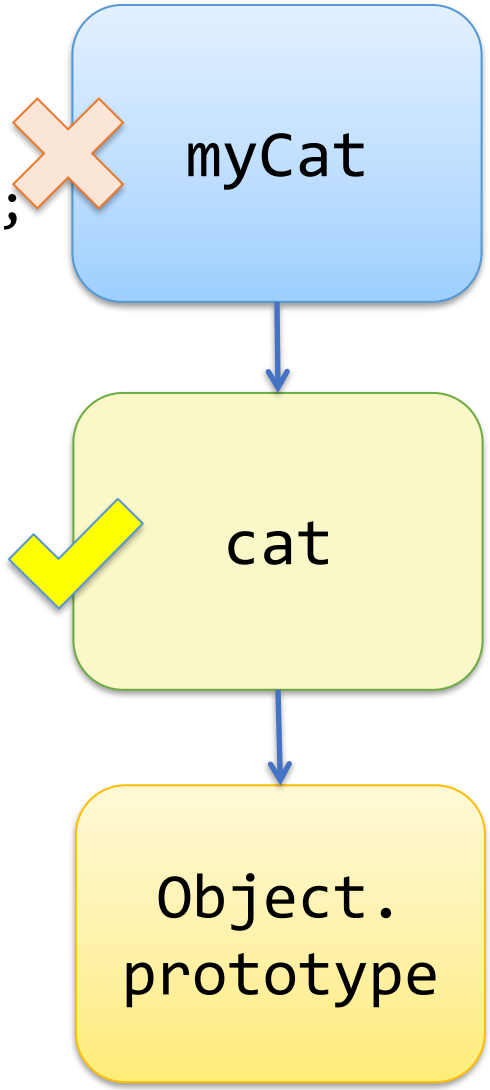
Prototype Chain (lookup myCat.legs)

```
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)

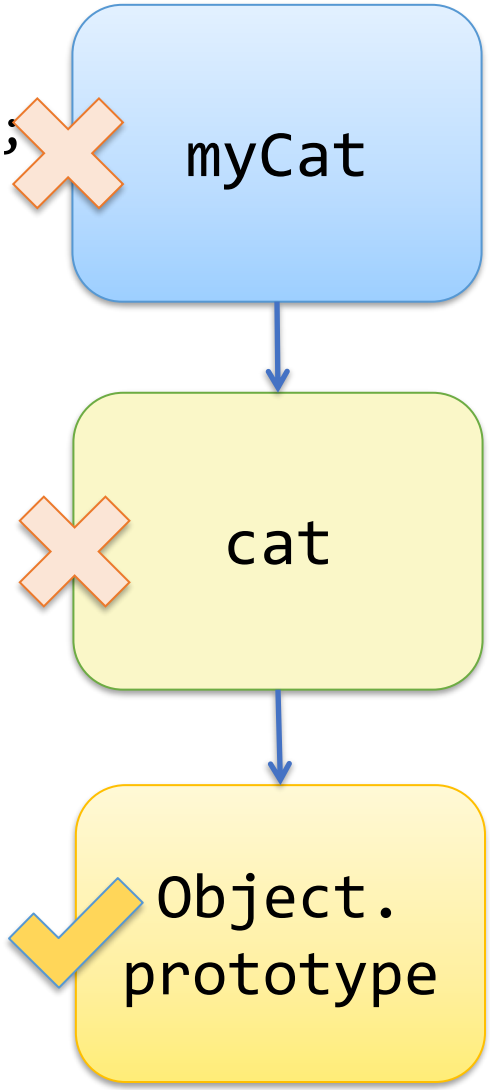
```
const cat = { name: 'cat', legs : 4, eyes: 2 };
const myCat = { name: 'Garfield' };
Object.setPrototypeOf(myCat, cat);
myCat.name = 'Garfield';
myCat.breed = 'Persian';



console.log(myCat.name);

console.log(myCat.legs);

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



Modules

A module = unit of reusable code that encapsulates functionality (such as functions, classes, objects, variables, and constants) and can be imported or exported between files, promoting maintainability, modularity, and code reusability in apps

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/