Node

JS OOP

Object Literal

```
 let circle = {
 radius: 1,
 border: 2,
 }
// Destructuring
const { radius, border } = circle;
// We have two variables now
```

Object Literal

```
let circle = {
radius: 1,
border: 2,
location: {
  x: 45,
  y: 35
 }
}
```

Object Literal

```
let circle = {
radius: 1,
draw: function () {
console.log('draw');
}
}
circle.draw();
```

Factory Function

FUNCTION

```
function createCircle(radius, border) {
  return {
    radius: radius,
    border: border,
    getArea: function() {
      return Math.PI * this.radius * this.radius;
    }
  };
}
```

USAGE

```
// Usage
let myCircle = createCircle(1, 2);
console.log(myCircle.radius); // 1
console.log(myCircle.border); // 2
console.log(myCircle.getArea()); // 
3.141592653589793
```

Constructor Function

```
function Circle(radius) {
 this.radius = radius;
 this.draw = function () {
  console.log("Draw: r=" + radius);
 }
}
const c = new Circle(5); //new Object
c.draw();
```

Don’t Miss It

this

Referes to the object calling current function

Constructor property

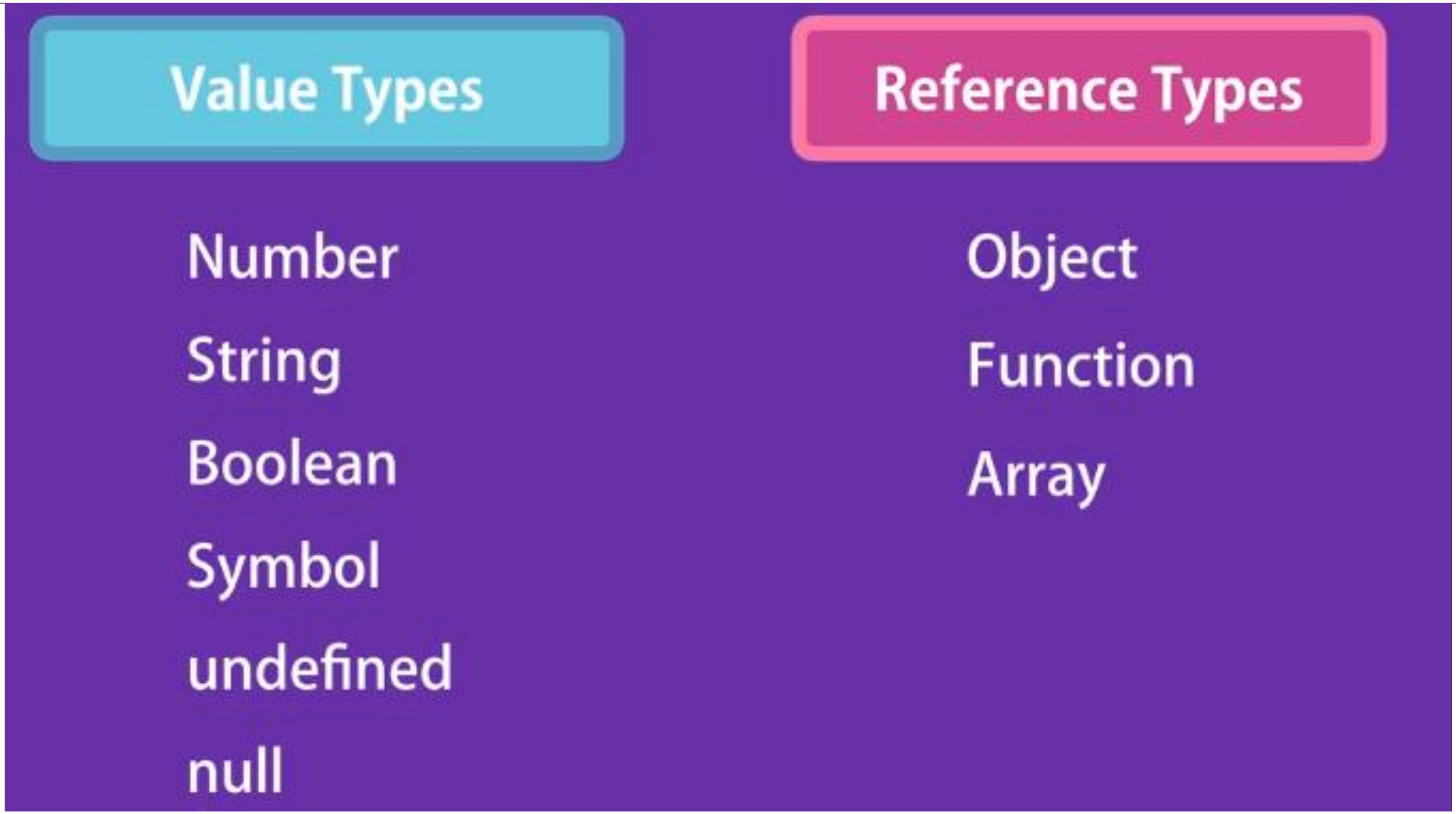
```
let x = {}
// let x= new Object()
```

//factory functions use default constructor

//check from browser by

object.constructor

Value vs Reference Types

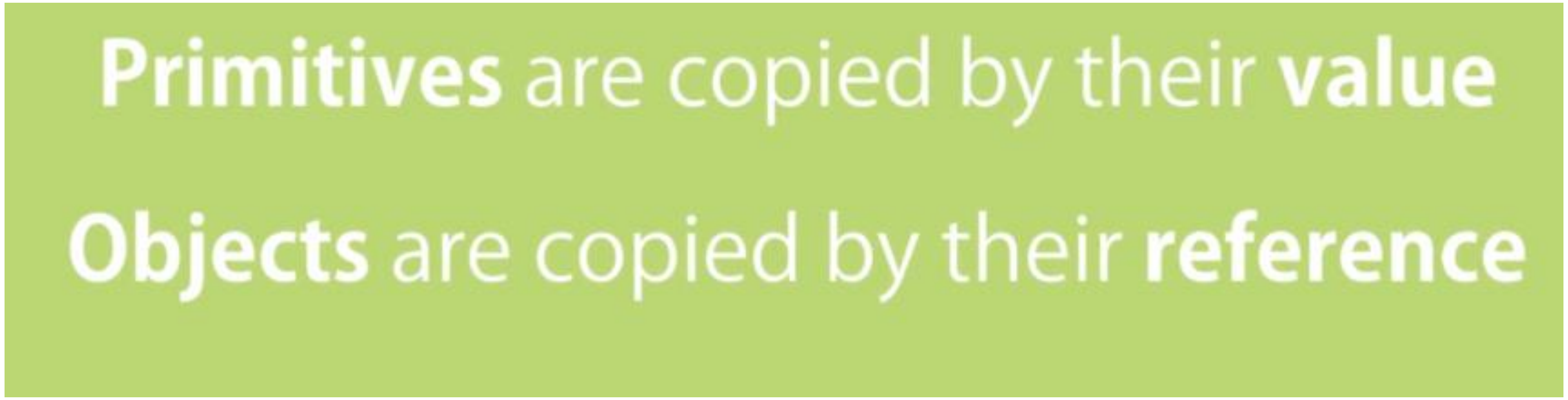


Value Types	Reference Types
Number	Object
String	Function
Boolean	Array
Symbol	
undefined	
null	

Value vs Reference Types

```
let x = 10;
let y = x;
x = 20;
//y will have 10
```

```
let x = {value:10}
let y = x;
x.value = 20;
//y.value will have 20
```



Primitives are copied by their **value**

Objects are copied by their **reference**

What will be the output

```
let x = 10;
function increase(x) {
x++;
}
increase(x);
console.log(x);
//10
```

```
let y = { value: 10 };
function increaseObj(y) {
y.value++;
}
increaseObj(y);
console.log(y.value);
//11
```

Loop Through keys

```
function Circle(radius) {
this.radius = radius;
this.draw = function () {
console.log("Draw: r=" + radius);
}
}
const c = new Circle(5);
for (let key in c) {
console.log(key, c[key]);
}
```

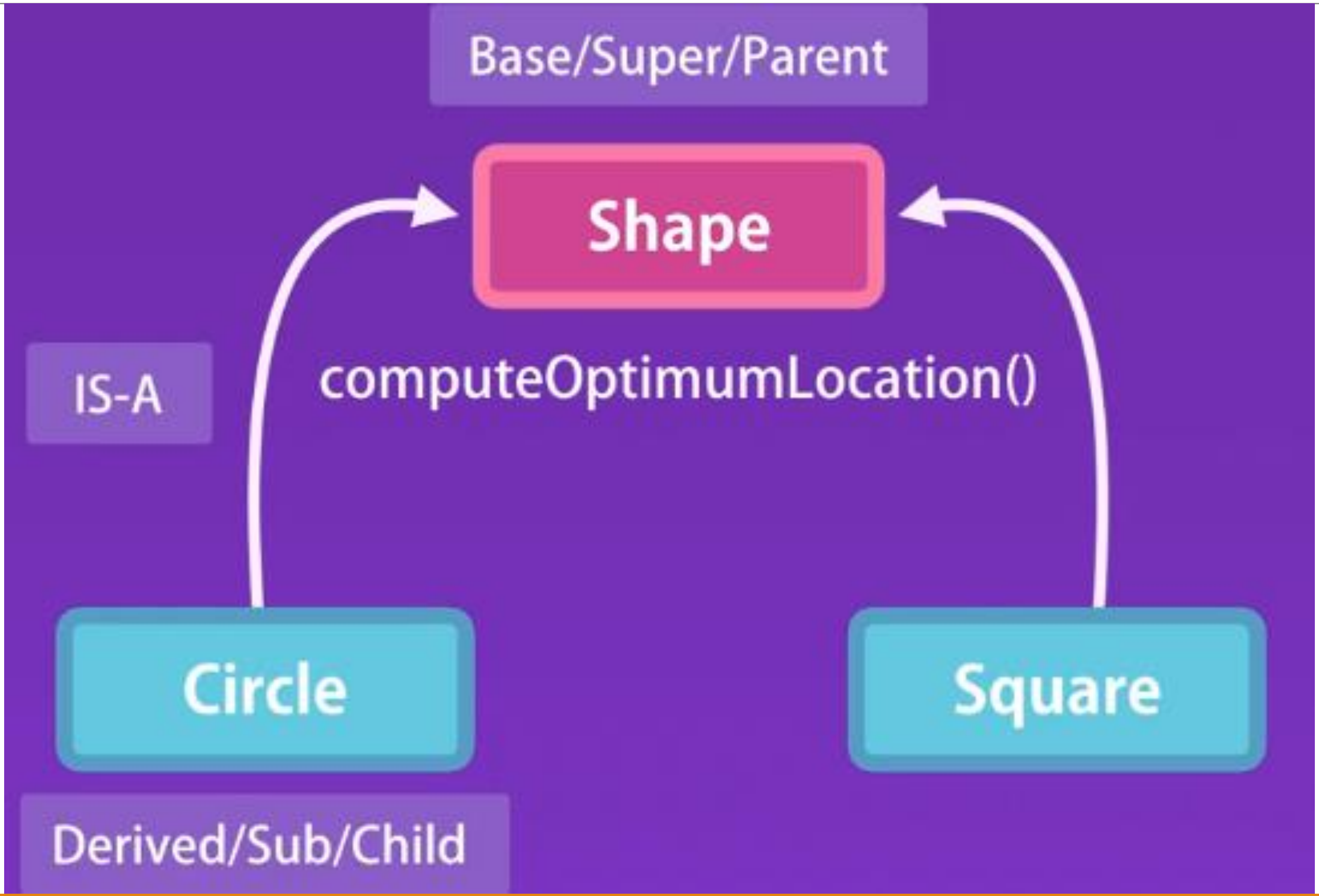
Private Properties And Methods

```
function createCircle(radius, border) {
 // Private variables
 let privateRadius = radius;
   // Public methods
 return {
   getRadius: function() {
     return privateRadius;
   },
};
}
```

```
// Usage
let myCircle = createCircle(1, 2);

console.log(myCircle.getRadius()); // 1
console.log(myCircle.getBorder()); // 2
console.log(myCircle.getArea());   // 
3.141592653589793
```

Inheritence

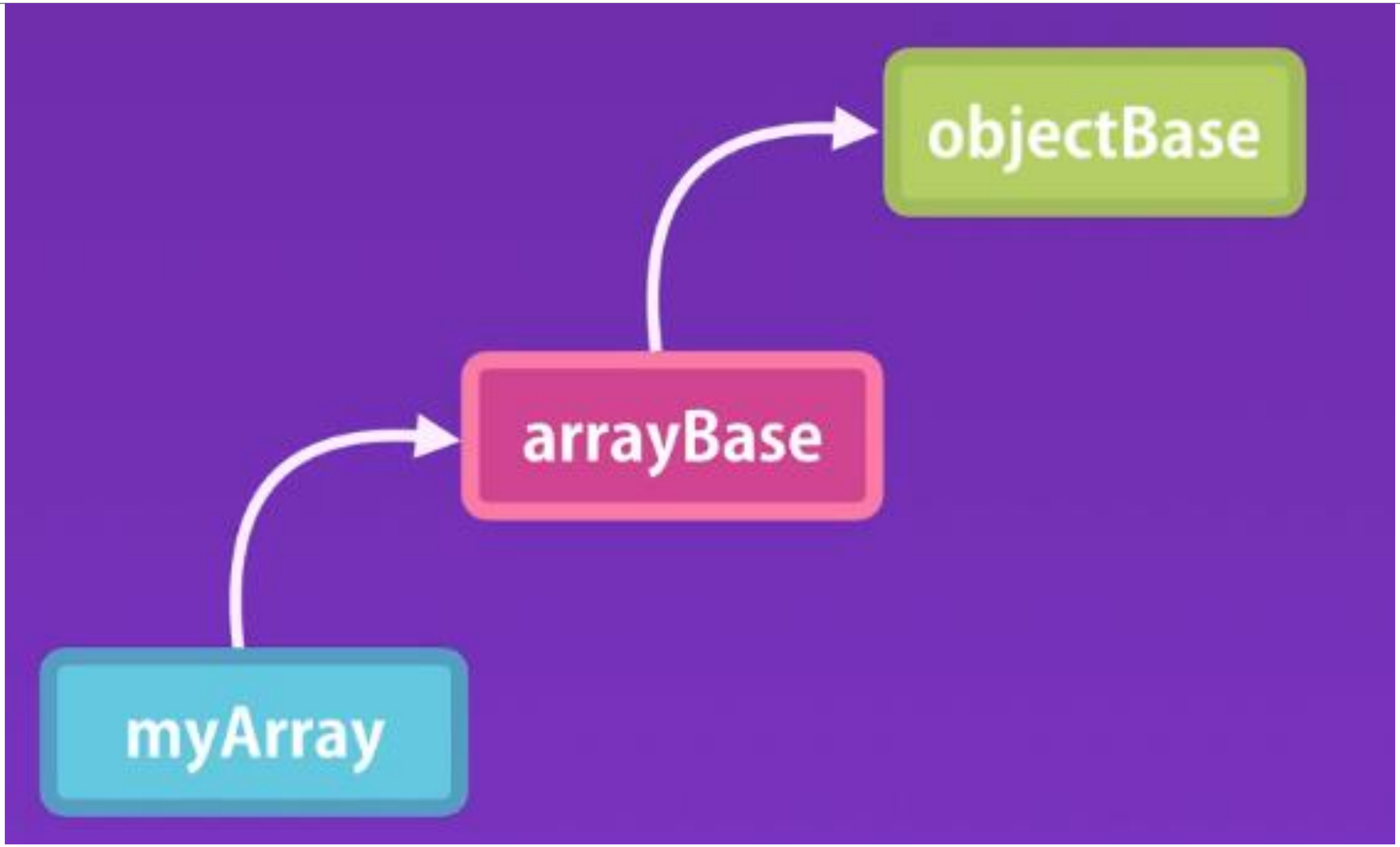


Prototypical Inheritence

```
 //A prototype is an object from which other objects inherit properties
// Every object (except the root object) has a prototype (parent).
// To get the prototype of an object:
Object.getPrototypeOf(obj);

// In Chrome, you can inspect "__proto__" property. But you should
// not use that in the code.
// x.__proto__ === y.__proto__
```

Multi level Inheritence



"prototype" property

```
 // Constructors have a "prototype"
property. It returns the object

 // that will be used as the prototype for
objects created by the constructor.

 Object.prototype ===
Object.getPrototypeOf({})

 Array.prototype ===
Object.getPrototypeOf([])
```

Same Constructor Same Prototype

```
 // All objects created with the same
constructor will have the same prototype.
 // A single instance of this prototype will
be stored in the memory.
 const x = {};
 const y = {};
 Object.getPrototypeOf(x) ===
Object.getPrototypeOf(y); // returns true
```

Best Practice

```
// When dealing with large number of objects, it's better to put their
// methods on their prototype. This way, a single instance of the methods
// will be in the memory.
Circle.prototype.draw = function() {}
```

Prototypical Inheritence

```
 function Shape() {}
 function Circle() {}

// Prototypical inheritance
 Circle.prototype =
Object.create(Shape.prototype);
 Circle.prototype.constructor = Circle;
```

Call Super

```
function Rectangle(color) {
// To call the super constructor
Shape.call(this, color);
}
```

Method Overriding

```
 // Method overriding
 Shape.prototype.draw = function() {}
 Circle.prototype.draw = function() {
 // Call the base implementation
 Shape.prototype.draw.call(this);

// Do additional stuff here
 }
```

Dos & Donts

```
 // Don't create large inheritance hierarchies.
 // One level of inheritance is fine.

// Use mixins to combine multiple objects
 // and implement composition in JavaScript.
```

Resources

https://1drv.ms/f/s!AtGKdbMmNBGdhQmUmPL4RQRrfM1Y

ES6 Classes

Syntactical Sugar to Prototypical Inheritence

Class

```
class Circle {
 constructor(radius) {
  this.radius = radius;
 }
 // These methods will be added to the prototype.
 draw() {
 }
}
```

Static Methods

```
// This will be available on the Circle class (Circle.parse())
static parse(str) {
}
```

Private Symbol

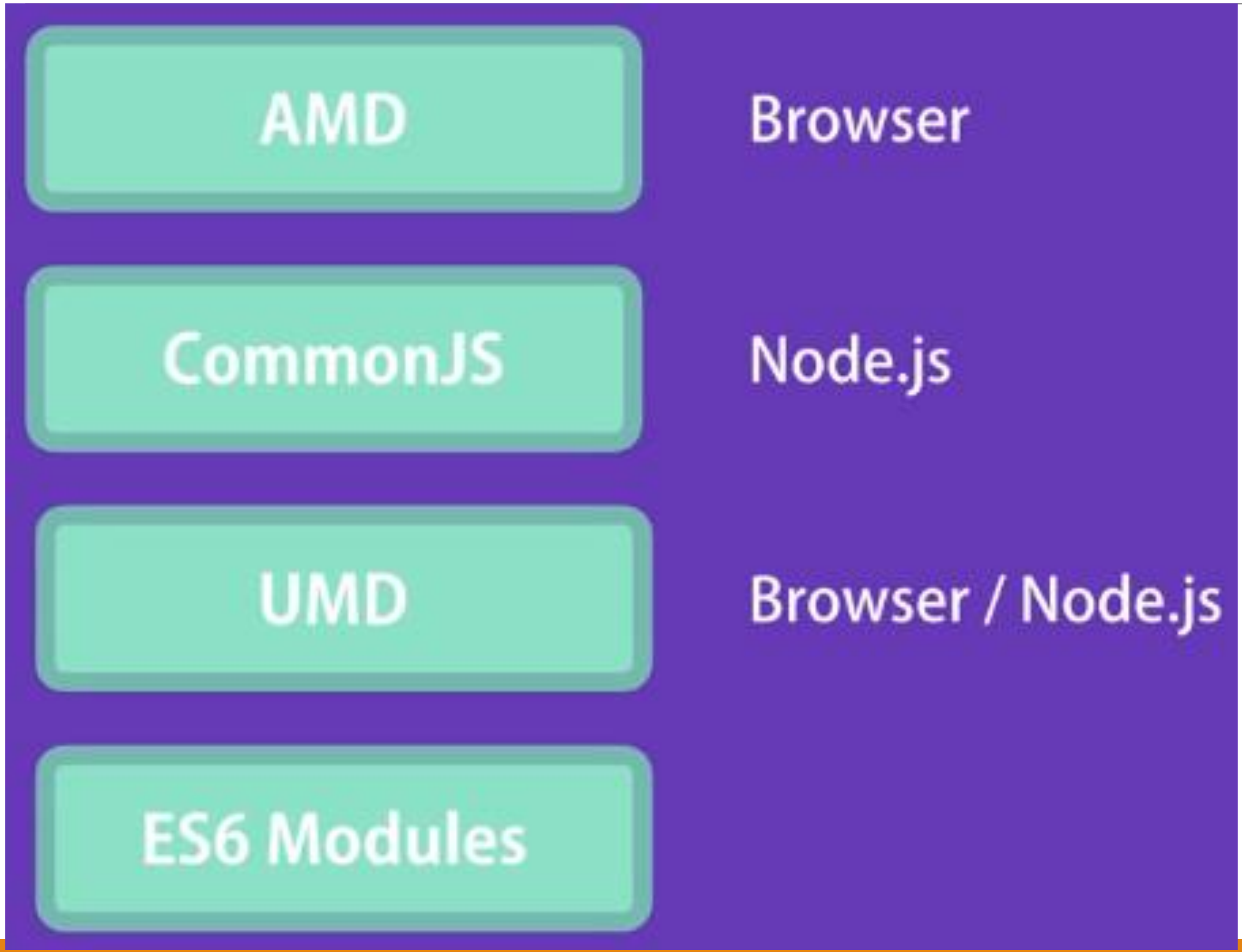
```
 // Using symbols to implement private properties and methods
 const _size = Symbol();
 const _draw = Symbol();
```

Inheritence

```
// Inheritance
class Triangle extends Shape {
constructor(color) {
// To call the base constructor
super(color);
}
draw() {
// Call the base method
super.draw();

// Do some other stuff here
}
}
```

Module Formats



AMD	Browser
CommonJS	Node.js
UMD	Browser / Node.js
ES6 Modules	

Asynchronous Module Definition

Universal Module Definition

Common JS

```
// CommonJS (Used in Node)
// Exporting
module.exports.Cirlce = Circle;
// Importing
const Circle = require('./circle');
```

ECMAScript 2015 (ES6) include:

- **Arrow Functions:** A more concise syntax for writing functions
- **let and const:** Block-scoped variable declarations.
- **Template Literals:** A new way to create strings using backticks (`).
- **Destructuring Assignment:** Easily extract values from arrays and objects.
- **Default Parameters:** Specify default values for function parameters.
- **Rest and Spread Operators:** Collect remaining parameters or spread elements.
- **Classes:** A more straightforward way to create and work with constructor functions.
- **Promises:** A standard for handling asynchronous operations.
- **Modules:** A standardized system for organizing and importing/exporting code between files.
- **Symbol and Iterators:** New data types and iteration protocols.
- **Map and Set Collections:** New data structures for key-value pairs and unique values.

Arrow Functions

BEFORE

```
hello = function() {
  return "Hello World!";
}
```

Arrow functions allow us to write shorter function syntax:

AFTER

```
hello = () => {
  return "Hello World!";
}
```

```
// Or

hello = () => "Hello World!";

// Or

hello = (val) => "Hello " + val;

//Or

hello = val => "Hello " + val;
```

Let Vs var

VAR

```
 var x = 10;
// Here x is 10

{
var x = 2;
// Here x is 2
}

// Here x is 2
```

LET

```
 let x = 10;
// Here x is 10

{
let x = 2;
// Here x is 2
}

// Here x is 10
```

Template Literals (String with back ticks)

```
let firstName = "John";
let lastName = "Doe";

let text = `Welcome ${firstName}, ${lastName}!`;


// multi line strings

let text1 =
`The quick brown fox
jumps over the lazy dog`;


let price = 10;
let VAT = 0.25;
let total = `Total: ${(price * (1 + VAT)).toFixed(2)}`;
```

Destructring

BEFORE

```
const vehicles = ['mustang', 'f-150', 'expedition'];

// old way

const car = vehicles[0];

const truck = vehicles[1];

const suv = vehicles[2];
```

AFTER

```
const vehicles = ['mustang', 'f-150', 'expedition'];


const [car, truck, suv] = vehicles;
```

Destructure Objects

```
// Sample object
const person = {
  name: 'Alice',
  age: 25,
  city: 'Wonderland'
};
// Destructuring the object
const { name, age, city } = person;
// Using the extracted values
console.log(name); // Output: Alice
```

Default Parameters

BEFORE

```
function myFunction(x, y) {
  if (y === undefined) {
    y = 2;
  }
}
```

AFTER

```
function myFunction (x, y = 2) {
  // function code
}
```

The Spread Operator (...)

```
const numbersOne = [1, 2, 3];
const numbersTwo = [4, 5, 6];
const numbersCombined = [...numbersOne, ...numbersTwo];
```

```
const numbers = [1, 2, 3, 4, 5, 6];

const [one, two, ...rest] = numbers;
```

Spread Objects

```
// Original object
const person = {
  name: 'Alice',
  age: 25,
  city: 'Wonderland'
};
// Creating a shallow/deep copy using the spread operator
const personCopy = { ...person };

// Modifying the copy
personCopy.age = 26;
// Displaying the original and modified objects
console.log('Original object:', person);
```

Shallow Copy Vs Deep Copy

```
// Original object with nested object
const originalObject = {
  name: 'John',
  details: {
    age: 30,
    city: 'Example City'
  }
};
```

```
// Shallow copy using the spread operator
// spread will not deep copy nested details
//object
const shallowCopy = { ...originalObject };
// Deep copy using JSON.parse and
//JSON.stringify
const deepCopy =
JSON.parse(JSON.stringify(originalObject));
```

JavaScript Iterables

```
for (const x of "W3Schools") {
  // code block to be executed
}
```

```
for (const x of [1,2,3,4,5]) {
  // code block to be executed
}
```

```
const myObject = {
  key1: 'value1',
  key2: 'value2',
};
for (const key in myObject) {
console.log(key); // Outputs: key1, key2
}
```

Non Conventional For Loops

ES6

```
// ES6 Modules (Used in Browser)
// Exporting
export class Square {}
// Importing
import {Square} from './square';
```

Babel

```
 // We use Babel to transpile our modern JavaScript code
 // into code that browsers can understand (typically ES5).
```

Web Pack

```
 // We use Webpack to combine our JavaScript files into a
 // bundle.
```

Arrow Functions

```
Before

hello = function() {
  return "Hello World!";
}
```

```
After Arrow

hello = () => {
  return "Hello World!";
}
```

Arrow Functions Return Value by Default:

```
hello = () => "Hello World!";
```

Arrow Function With Parameters:

```
hello = (val) => "Hello " + val;

hello = val => "Hello " + val;
```

JavaScript Array find()

```
 const ages = [3, 10, 18, 20];

function checkAge(age) {
  return age > 18;
}


  ages.find(checkAge);
```

JavaScript Array splice()

```
 const fruits =
["Banana", "Orange", "Apple", "Mango"];

fruits.splice(2, 0, "Lemon", "Kiwi");
```

Parameter	Description
index	Required. The position to add/remove items. Negative value defines the position from the end of the array.
howmany	Optional. Number of items to be removed.
item1, ..., itemX	Optional. New elements(s) to be added.

JavaScript Array map()

```
const numbers = [65, 44, 12, 4];
const newArr = numbers.map(myFunction);

function myFunction(num) {
  return num * 10;
}
```

Multiply every element in the array with 10:

650,440,120,40

JavaScript Array filter()

```
 const ages = [32, 33, 16, 40];
const result = ages.filter(checkAdult);

function checkAdult(age) {
  return age >= 18;
}
```

//Return an array of all values in ages[] that are 18 or over:

Sync ASync

Problem

```
console.log("Before...");
setTimeout(function () {
 console.log("Reading a user from DB");
 }, 2000);
console.log("After...");
```

// Whats the output

Output of Problem

Before...

After...

Reading a user from DB

ASynchronous

Its not

- Concurrent
- Multi Threaded

It is

- Just a function scheduled to be called in future

Output

```
console.log("Before");
const user = getUser();
console.log(user);
console.log("After");
//Output
//Before
//dummy
//After
//DB Query entertained
```

```
function getUser(){
 setTimeout(function(){
 console.log('DB Query entertained');
 return {id:9,name:'usman'}
 },1000);
return "dummy";
}
```

Patterns for Dealing with Asynchronous Code

Callback

Promises

Async/await

CallBack

```
function getUser(id, callback) {
 setTimeout(function () {
  console.log("Reading User");
  callback({ id: id, name: "Usman" });
 }, 2000)
}
```

CallBack

```
console.log("Before");
getUser(1, function (userObj) {
 console.log("Received User");
 console.log(userObj);
});
console.log("After");
```

Sync Vs Async

ASYNC

```
fs.readdir(__dirname, (err, files) => {
  if (err) console.log(err);
  else {
    console.log("\nCurrent directory filenames:");
    files.forEach(file => {console.log(file);})
  }
})
```

SYNC

```
filenames = fs.readdirSync(__dirname);
console.log("\nCurrent directory filenames:");
filenames.forEach(file => {
  console.log(file);
});
```

Imagine this ☹ (CallBack Hell)

```
 getUser(1, (user) => {
  getRepositories(user.gitHubUsername, (repos)      =>
{
    getCommits(repos[0], (commits) => {
    console.log(commits);
    })
   })
 });
 //You can use named Functions but still NOOOOO
```

Promises -a function that returns a promise

```
function doSomething() {
  return new Promise((resolve, reject) => {
    // Simulating an asynchronous operation (e.g., fetching data from a server)
    setTimeout(() => {
      const data = "Some data fetched from the server";
      resolve(data); // Resolve the promise with the data
    }, 2000); // Simulate a delay of 2 seconds
  });
}
```

Using Promise

```
doSomething()
   .then((result) => {
      console.log("Promise resolved with data:", result);
   })
   .catch((error) => {
      console.error("An error occurred:", error);
   })
   .finally(() => {
      console.log("Promise chain completed"); // This block will execute regardless of success or failure
   });
```

Promise

```
const p = new Promise(function(resolve,reject){
if (true) resolve({name:"hareem"});
else reject(new Error("Hareem is naughty"));
});
p.then((result)=>{
console.log(result.name);
});
p.catch((error)=>{console.log("Error
Caught"+error.message)});
```

Promise

```
const p = new Promise((resolve, reject) => {
 // Kick off some async work
 // ...
 setTimeout(() => {
 resolve(1); // pending => resolved, fulfilled
 reject(new Error('message')); //pending => rejected
 }, 2000);
});
```

Using Promise

```
 p.then(result => console.log('Result', result))
 .catch(err => console.log('Error', err.message));
```

Beauty in Code

```
getUser(1)
.then(user => getRepositories(user.gitHubUsername))
.then(repos => getCommits(repos[0]))
.then(commits => console.log('Commits', commits))
.catch(err => console.log('Error', err.message));
```

Async and Await approach

```
async function displayCommits() {
 try {
  const user = await getUser(1); //code execution will halt here
  const repos = await getRepositories(user.gitHubUsername);
  const commits = await getCommits(repos[0]);
  console.log(commits);
 }
 catch (err) {
  console.log('Error', err.message);
 }
}
```

Resolved Promises (For Testing)

```
Promise.reolve(1);
Promise.reject(new Error(''));
```

Running Promses in parallel

```
Promise.all([p1, p2]);// When all promises are resolved

Promise.race([p1, p2]);// When any one finished first
```

Event Loop

A mechanism that allows **non-blocking, asynchronous operations**

- fetching data,
- handling timers, or
- user interactions

Event Loop Working

Call Stack – Where code is executed (one thing at a time).

Web APIs – Provided by the browser (e.g., setTimeout, fetch).

Callback Queue – Where async callbacks wait their turn.

Event Loop – The traffic cop that:

- Checks if the call stack is empty.
- If yes, it takes the first callback from the queue and pushes it to the stack.

Event Loop In Action

```
console.log('1');
setTimeout(() => {
  console.log('2');
}, 1000);
console.log('3’);
// Out Put: 1 3 2
```

Microtasks vs Macrotasks

Feature	**Microtasks**	**Macrotasks**
🔁 Queue	Microtask Queue	Callback (Macrotask) Queue
🧠 Examples	Promise.then, queueMicrotask, MutationObserver	setTimeout, setInterval, setImmediate, I/O, MessageChannel, UI events
🧪 Executes...	Immediately **after current task**, before rendering	**After microtasks**, before the next event loop tick
📦 Use-case	Fine-grained control, chaining async logic	Delayed execution, scheduling background tasks
🏁 Priority	**Higher** (runs first after current task)	Lower (waits for microtasks to complete)

Event Loop Order of Execution

1. **Run current task** (whatever’s in the Call Stack)
2. **Empty the Microtask Queue** (process all microtasks)
3. **Then pick the next Macrotask** from the queue

Order Of Execution

```
console.log('Start');
setTimeout(() => {
  console.log('Macrotask: setTimeout');
}, 0);
Promise.resolve().then(() => {
  console.log('Microtask: Promise.then');
});
console.log('End');
```

Sample Code

https://1drv.ms/f/s!AtGKdbMmNBGd0V1N14IfBGU1Npoi