Chapter 1

Getting started with Node.js

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Outline

- A brief history of JavaScript and Node.js
- Overview of modern Javascript (ES6, ES7, and ES8). TypeScript
- The Node.js Ecosystem
- Node.js architecture
- Installing Node.js
- Running the first application: Hello World!

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A brief history of JavaScript and Node.js

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What is Node.js ?

- Node.js is an open-source and cross-platform JavaScript runtime environment.
- Node.js runs the V8 JavaScript engine, the core of Google Chrome, outside of the browser. This allows Node.js to be very performant.
- Node.js uses the JavaScript language which is used by millions of frontend developers that write for the browser. These are now able to write the server-side code in addition to the client-side code without the need to learn a completely different language

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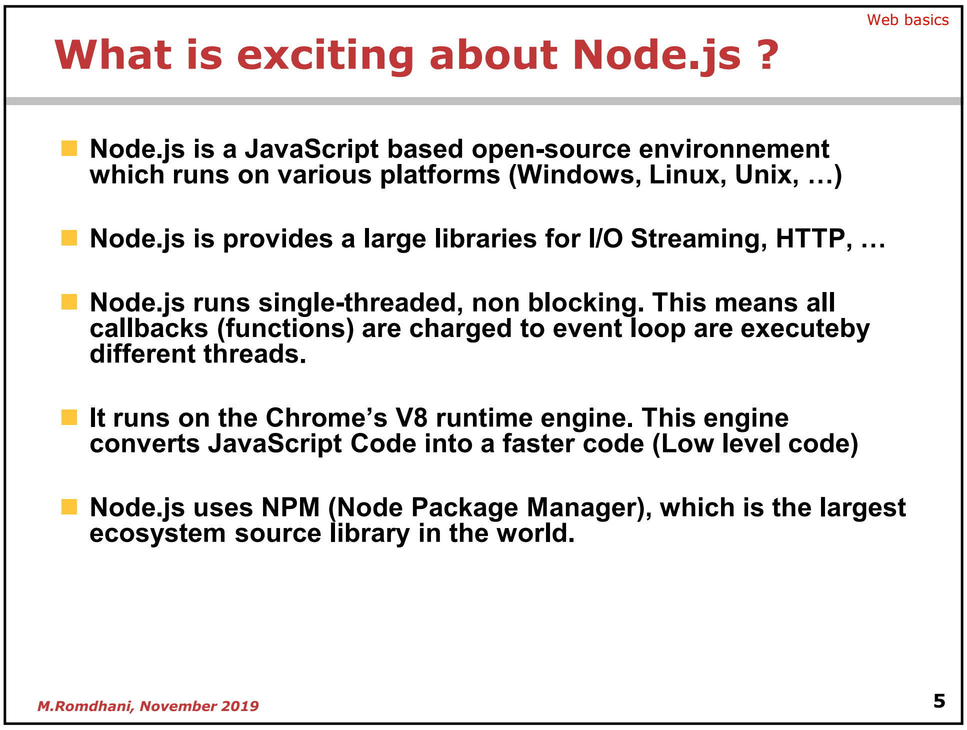
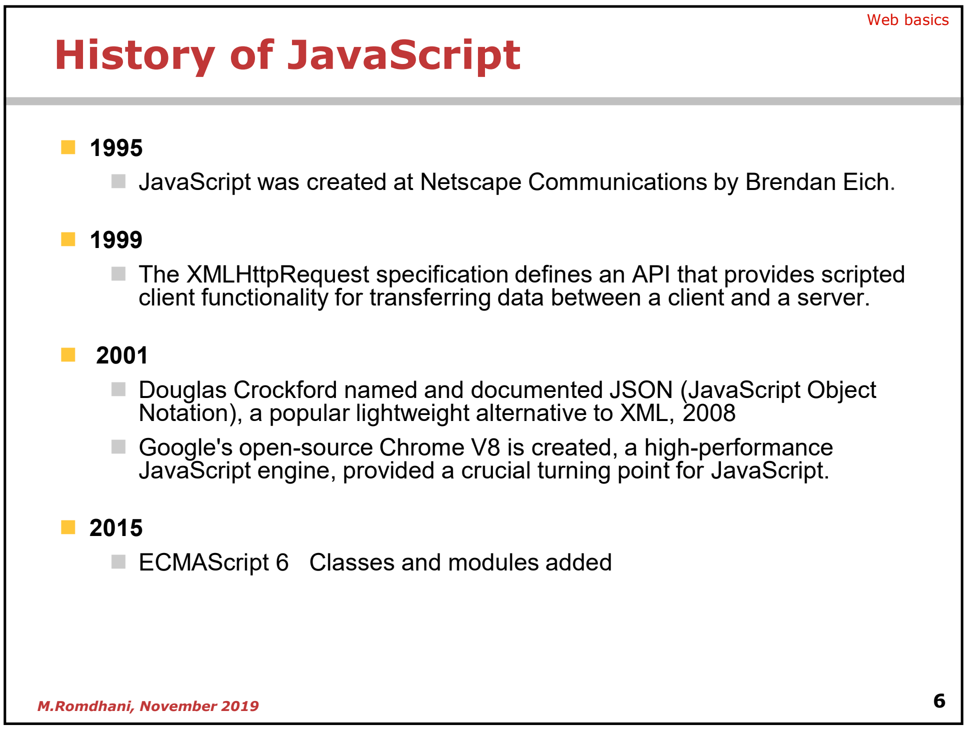


What is exciting about Node.js ?

- **Node.js is a JavaScript based open-source environnement which runs on various platforms (Windows, Linux, Unix, …)**
- **Node.js is provides a large libraries for I/O Streaming, HTTP, …**
- **Node.js runs single-threaded, non blocking. This means all callbacks (functions) are charged to event loop are executeby different threads.**
- **It runs on the Chrome's V8 runtime engine. This engine converts JavaScript Code into a faster code (Low level code)**
- **Node.js uses NPM (Node Package Manager), which is the largest ecosystem source library in the world.**



History of JavaScript

- **1995**
  - JavaScript was created at Netscape Communications by Brendan Eich.
- **1999**
  - The XMLHttpRequest specification defines an API that provides scripted client functionality for transferring data between a client and a server.
- **2001**
  - Douglas Crockford named and documented JSON (JavaScript Object Notation), a popular lightweight alternative to XML, 2008
  - Google's open-source Chrome V8 is created, a high-performance JavaScript engine, provided a crucial turning point for JavaScript.
- **2015**
  - ECMAScript 6   Classes and modules added

A brief history of Node.js

- **Node.js is 12 years old! In comparison, JavaScript is 26 years old and the Internet is 32 years old.**
- **In 2009, Ryan Dahl wrote Node.js.**
  - On November 8, 2009 at the inaugural European JSConf, the Node.js project was first demonstrated by Dahl. Node.js is a combination the V8 JavaScript Chrome engine, a low-level I/O API, and an event loop.
- **Web frameworks were developed by the Node.js open-source community to accelerate the development of applications.**
  - These frameworks include Connect, Sails.js, Koa.js, Express.js, Feathers.js, socket.io, Derby, Hapi.js, Meteor, and a lot more.

A brief history of Node.js

- **2009**
  - The beginning of Node.js
  - npm was created
- **2010**
  - The beginning of Express
  - The beginning of socket.io
- **2011**
  - Version 1.0 of npm was released
  - Companies Uber, LinkedIn, etc. started adopting Node.js
  - The beginning of hapi
- **2012**
  - Adoption continues and growing rapidly

A brief history of Node.js

- **2018**
  - Node.js 10 (LTS)
  - ES modules .mjs experimental support
  - Node.js 11
- **2019**
  - Node.js 12 (LTS)
  - Node.js 13
- **2020**
  - Node.js 14 (LTS)
  - Node.js 15

After six months, odd-numbered releases (9, 11, etc.) become unsupported, and even-numbered releases (10, 12, etc.) move to *Active LTS* status and are ready for general use.

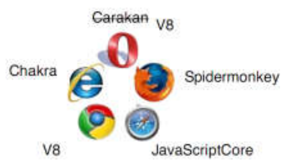
Overview of modern Javascript (ES6, ES7, and ES8) and TypeScript

What is JavaScript ?

- **A lightweight programming language ("scripting language")**
  - Client side processing
    - DOM Processing
    - Event Handling
    - Validation
    - Ajax
    - HTML 5 APIs
  - Server-side development
    - Web applications and mobile applications
    - Micro-services
    - Database Access
- **A web standard (but not supported identically by all browsers)**
  - JavaScript is an implementation of ECMAScript which conforms to the ECMAScript specification.
    - ECMAScript is a programming language itself.
    - The last version is ECMAScript 2020 (ES2020)

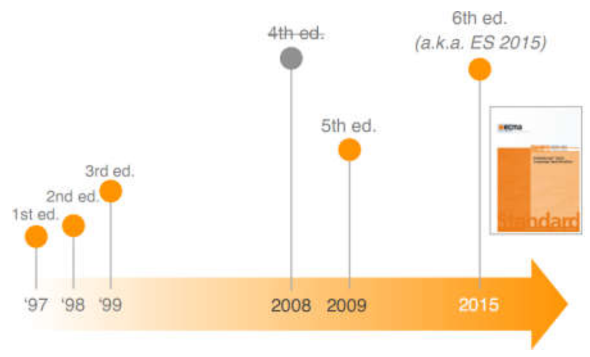
Overivew of JavaScript History

- **JavaScript's origins**
  - Invented by Brendan Eich in 1995, to support client-side scripting in Netscape Navigator
    - First called LiveScript, then JavaScript, then standardized as ECMAScript
    - Microsoft "copied" JavaScript in IE JScript
- **ECMAScript: "Standard" JavaScript**
  - The JavaScript "standardisation committee" has representatives from major Internet companies, browser vendors, web organisations, popular JS libraries and academia. Meets bi-monthly.
  - Current ECMAScript Engines



Overivew of JavaScript History

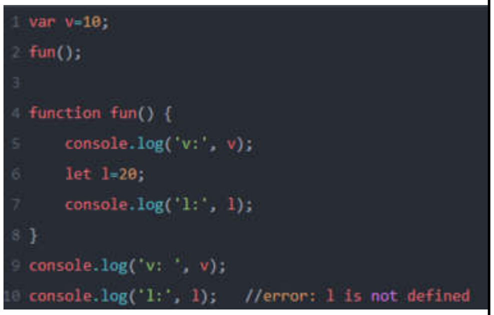
- **A Brief History of ECMAScript Specification**



  - ES 7 : Ecmascript 2016 (June 2016)
  - ES 8 : Ecmascript 2017 (June 2017)
  - ES 9 : Ecmascript 2018 (June 2018)
  - ES 10 : Ecmascript 2019 (June 2019)
  - ES 11: Ecmascript 2020 (June 2020)

ECMAScript 6 new Features

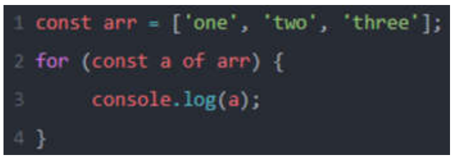
- **let, const :**
  - Till ES5, JS has only function scope and global scope with the introduction of let keyword in ES6, JS can now have block scope.



```
var v=10;
fun();

function fun() {
    console.log('v:', v);
    let l=20;
    console.log('l:', l);
}
console.log('v: ', v);
console.log('l:', l);    //error: l is not defined
```

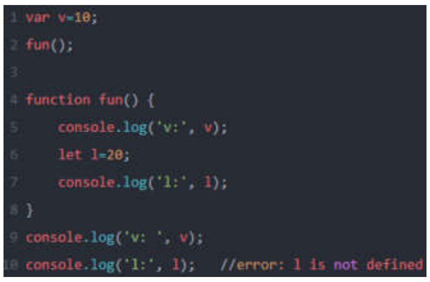
- **for .. Of**
  - for...of is an alternative for both for...in and forEach() and loops iterable data structures like Arrays, Maps, Sets, and strings



```
const arr = ['one', 'two', 'three'];
for (const a of arr) {
    console.log(a);
}
```

ECMAScript 6 new Features

- **Default parameter values:**
  - Provides default values to function parameters if no value or undefined is passed.



```
var v=10;
fun();

function fun() {
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    let l=20;
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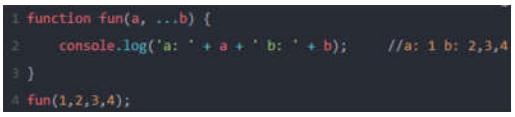
- **Rest operator:**
  - Rest Operator is used to handle



```
function fun(a, ...b) {
    console.log('a: ' + a + ' b: ' + b);     //a: 1 b: 2,3,4
}
fun(1,2,3,4);
```

ECMAScript 6 new Features

- **Default parameter values:**
  - Provides default values to function parameters if no value or undefined is passed.

```
var v=10;
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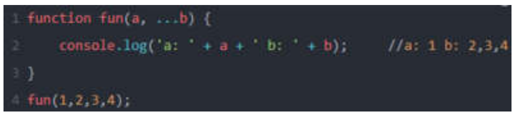

```
function fun(a, ...b) {
    console.log('a: ' + a + ' b: ' + b);     //a: 1 b: 2,3,4
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ECMAScript 6 new Features

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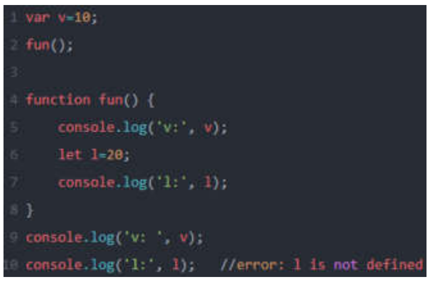

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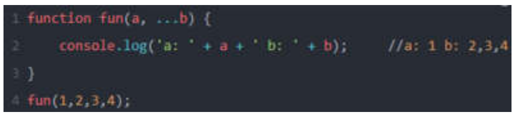
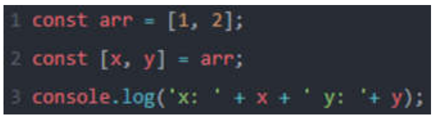


```
function fun(a, ...b) {
    console.log('a: ' + a + ' b: ' + b);    //a: 1 b: 2,3,4
}
fun(1,2,3,4);
```

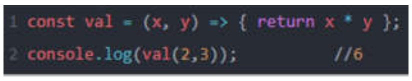
ECMAScript 6 new Features

- **Destructuring**
  - Destructuring helps in unpacking values from an array or an object.



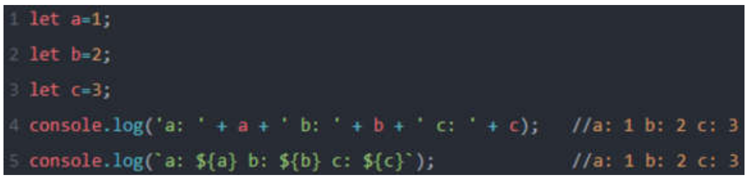
```
const arr = [1, 2];
const [x, y] = arr;
console.log('x: ' + x + ' y: '+ y);
```

- **ARROW FUNCTIONS:**
  - Arrow Functions use => as its token



```
const val = (x, y) => { return x * y };
console.log(val(2,3));          //6
```

- **Template strings:**
  - It allows embedded expressions, which makes print statements easy.

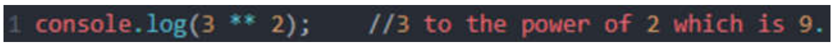


```
let a=1;
let b=2;
let c=3;
console.log('a: ' + a + ' b: ' + b + ' c: ' + c);    //a: 1 b: 2 c: 3
console.log(`a: ${a} b: ${b} c: ${c}`);              //a: 1 b: 2 c: 3
```

- **Other features : Classes, Promises, Modules, Proxies, …**

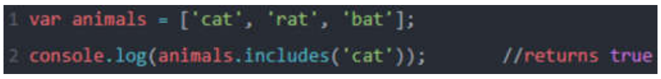
ECMAScript 7 new Features

- **Exponentiation operator**
  - ES7 added an exponentiation operator (**) to already JavaScript supported arithmetic operations like +,-,*. This operator raises the first operand to the power second operand.



```
console.log(3 ** 2);    //3 to the power of 2 which is 9.
```

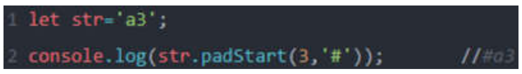
- **Includes**
  - Returns true if an array includes a value, if not returns false.Template strings:



```
var animals = ['cat', 'rat', 'bat'];
console.log(animals.includes('cat'));      //returns true
```

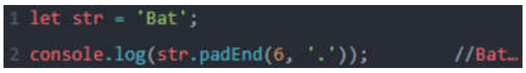
ECMAScript 8 new Features

- **padStart():**
  - This method pads a string with another string at the beginning.



```
let str='a3';
console.log(str.padStart(3,'#'));      //#a3
```

- **padEnd():**
  - This method pads a string with another string and makes the resulting string reach a given length. It adds spaces at the end of the string.



```
let str = 'Bat';
console.log(str.padEnd(6, '.'));      //Bat…
```

- **async/await**
  - Await operator, applied only inside an async function, waits to be rejected or resolved by a promise.

What is TypeScript?

- **Superset of JavaScript**
  - It was designed by Anders Hejlsberg (designer of C#) at Microsoft. The first version (0.8) was released in 2012. TypeScript is both a language and a set of tools
- **Compiles to plain JavaScript**
- **Strongly typed**
- **Class-based object-orientation**

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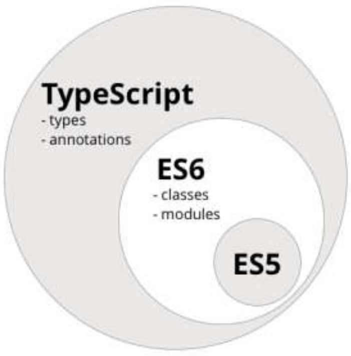


Strong Typing

JavaScript

```
let x;

x = 42;

let y = ‘Hello’;

let user =
    { id: 1111, name: ‘guest’ };
```

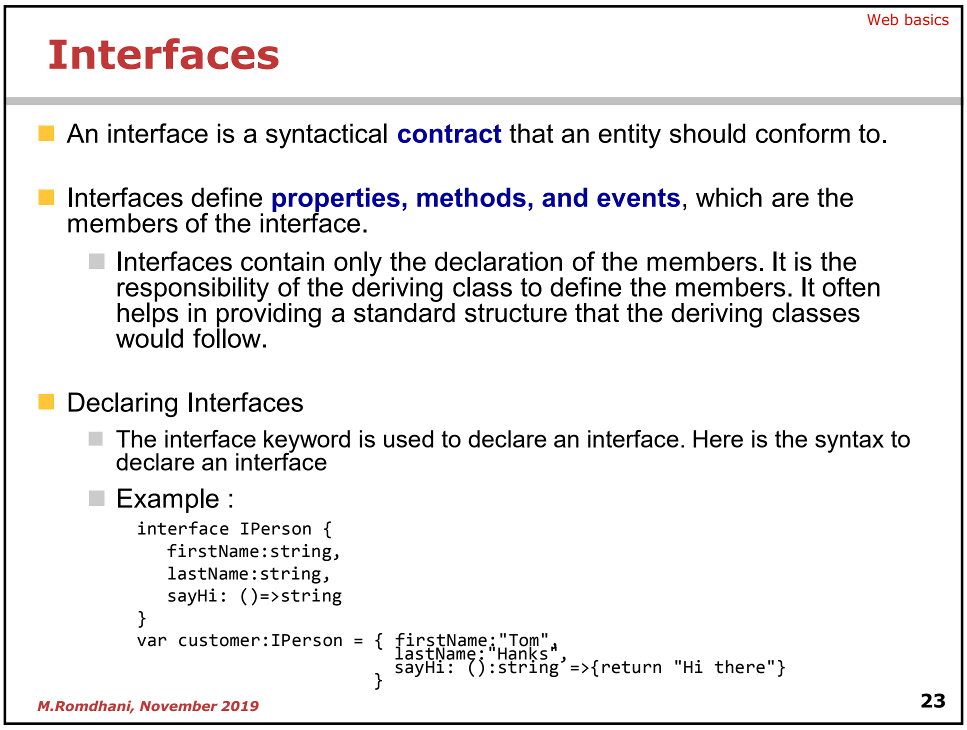
TypeScript

```
let x : number;
x = 42;

let y : string = ‘Hello’;

interface User {
   id: number;
   name: string
};

let user: User =
    { id: 1111, name: ‘guest’ };
```



Interfaces

- An interface is a syntactical **contract** that an entity should conform to.
- Interfaces define **properties, methods, and events**, which are the members of the interface.
  - Interfaces contain only the declaration of the members. It is the responsibility of the deriving class to define the members. It often helps in providing a standard structure that the deriving classes would follow.
- Declaring Interfaces
  - The interface keyword is used to declare an interface. Here is the syntax to declare an interface
  - Example :

```
interface IPerson {
   firstName:string,
   lastName:string,
   sayHi: ()=>string
}
var customer:IPerson = { firstName:"Tom",
                         lastName:"Hanks",
                         sayHi: ():string =>{return "Hi there"}
                       }
```

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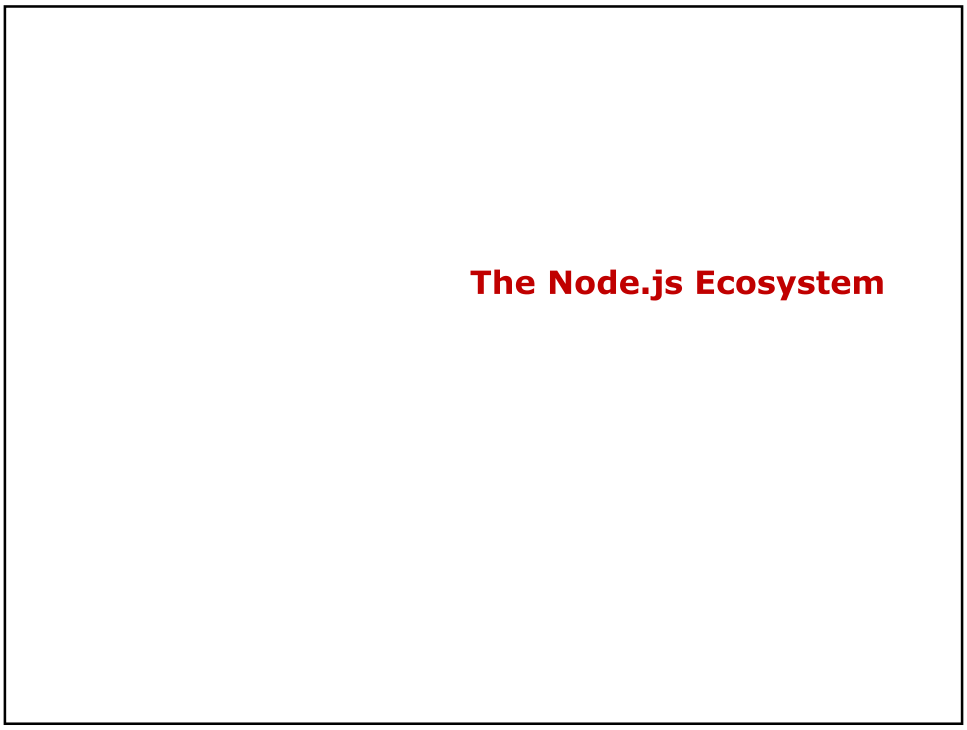
The Node.js Ecosystem

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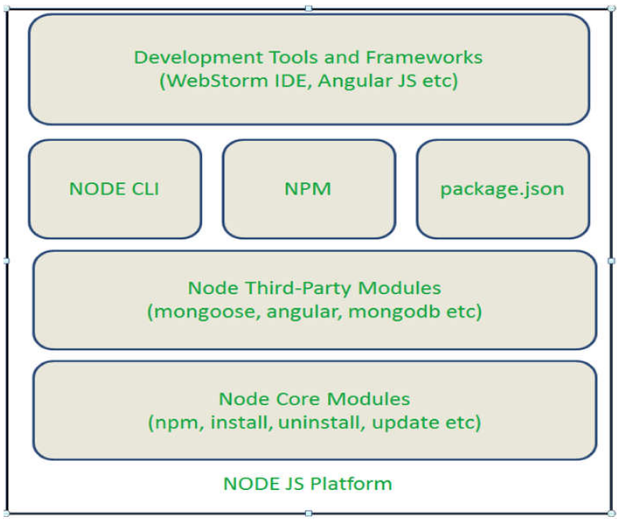
NodeJS Platform


Development Tools and Frameworks
(WebStorm IDE, Angular JS etc)
NODE CLI
NPM
package.json
Node Third-Party Modules
(mongoose, angular, mongodb etc)
Node Core Modules
(npm, install, uninstall, update etc)
NODE JS Platform

Node.js Modules

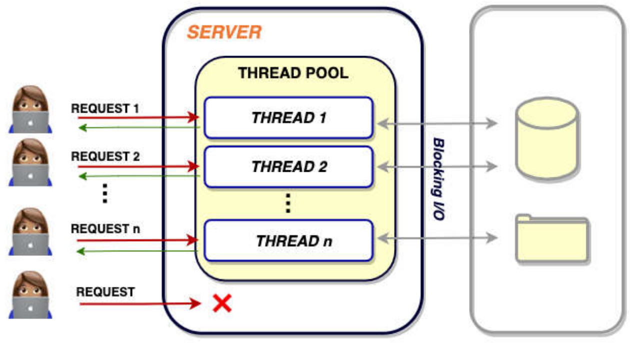
- **The node.js Modules**
  - Module in Node.js is a simple or complex functionality organized in single or multiple JavaScript files which can be reused throughout the Node.js application.
- **Types of modules**
  - Core modules
    - The core modules include bare minimum functionalities of Node.js. These core modules are compiled into its binary distribution and load automatically when Node.js process starts.
  - Third-party modules
    - Additional Libraries and frameworks for web development, data access, etc.

Node.js NPM

- **NPM is a package manager for Node.js packages, or modules if you like.**
  - The NPM program is installed on your computer when you install Node.js
- **www.npmjs.com hosts thousands of free packages to download and use.**
- **NPM is two things:**
  1. is an online repository for the publishing of open-source Node.js projects
  2. It is a command-line utility for interacting with said repository that aids in package installation, version management, and dependency management.

Node.js architecture

Traditional Multi-Threaded Processing Model in Web Frameworks



- If the threadpool is exhausted , the server is forced to wait for at least one of the busy threads to be freed for the new request(s) to be catered to.
- The synchronous nature of processing inside each thread means that even though we can spin up multiple threads for concurrent requests, each thread, individually, will be slowed down

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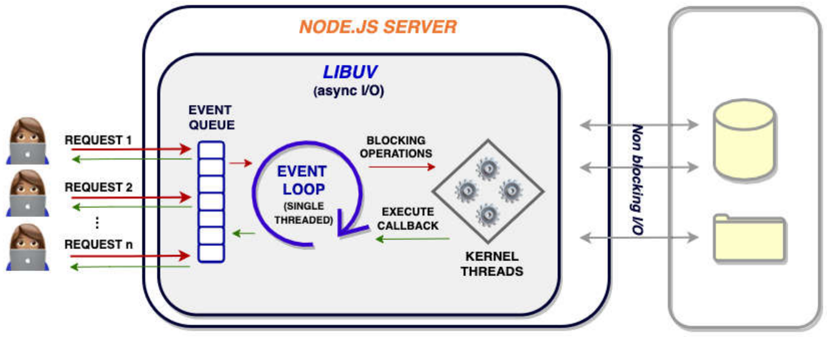
Single-Threaded Event Loop Architecture in Node.js



- The event loop can take care of basic processing itself, but for async I/O operations, involving modules such as fs (I/O-heavy) and crypto (CPU-heavy), it can offload the processing to the worker pool in the system kernel.
- While these threads work on their assigned operations, the event loop can continue operating as usual, concurrently catering to other requests.

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Installing Nodejs

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Installing Node.js

- **Installation on Windows**
  - Nodejs Installer to install Node.js and npm
    - Installer available on https://nodejs.org/en/download/
  - Install using Chocolatey
    - choco install nodejs
  - Install using nvm
    - nvm install 14.16.0
- **Installation on MacOS**
  - Nodejs Installer to install Node.js and npm
    - Installer available on https://nodejs.org/en/download/
  - Install using nvm
- **Installation on Linux/Unix**
  - Use the Platform Package manager to install Node.js and npm
    - Apt-get, rpm, yum, …
  - Install using nvm

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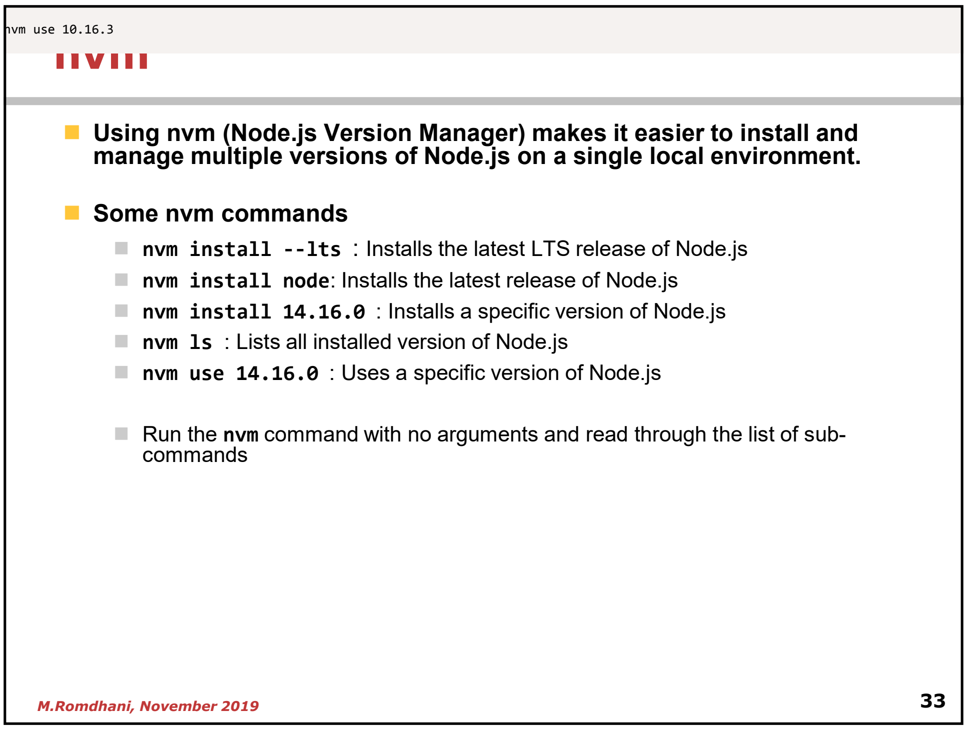

```
nvm use 10.16.3
```

nvm

- **Using nvm (Node.js Version Manager) makes it easier to install and manage multiple versions of Node.js on a single local environment.**
- **Some nvm commands**
  - **`nvm install --lts`** : Installs the latest LTS release of Node.js
  - **`nvm install node`**: Installs the latest release of Node.js
  - **`nvm install 14.16.0`** : Installs a specific version of Node.js
  - **`nvm ls`** : Lists all installed version of Node.js
  - **`nvm use 14.16.0`** : Uses a specific version of Node.js

  - Run the **`nvm`** command with no arguments and read through the list of sub-commands

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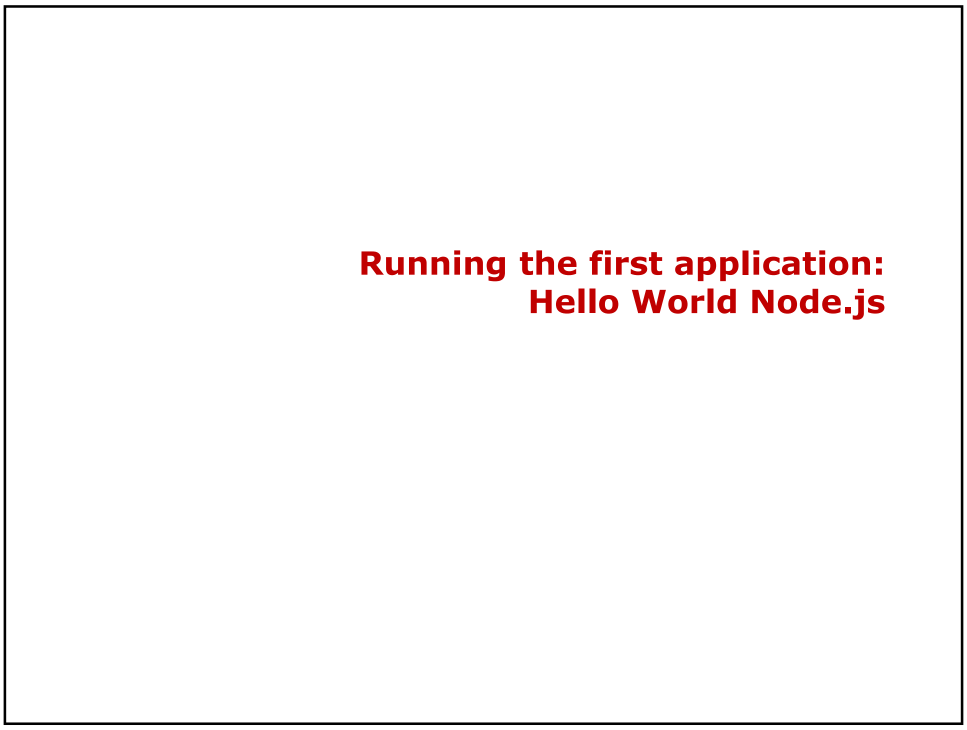

Running the first application: Hello World Node.js

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Using the Node.js REPL

- **REPL also known as Read Evaluate Print Loop is a programming language environment(Basically a console window) that takes single expression as user input and returns the result back to the console after execution**
- **The REPL mode is activated just by calling the `node` command.**
  - REPL will wait for JavaScript expressions and Javascript code
  - REPL provides autocomplete (with TAB key)
- **To exit REPL :**
  - .exit command or CTRL-C twice

Hello World, Node.js

- **Display simple message**

```
let message = 'Hello World';
console.log(message);

for (let index = 0; index < 10; index++) {
    console.log(`${index} : message`);
}
```

- **Simple Web Server**

```
const http = require('http');

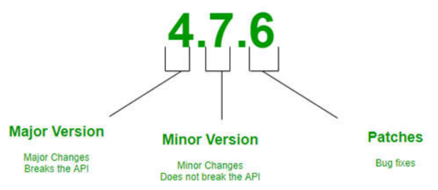
http.createServer(function (req, res) {
      res.writeHead(200, {'Content-Type': 'text/html'});
      res.end('Hello World!');
 }).listen(3000,
       ()=> console.log('The server is listening on port 3000'));
```

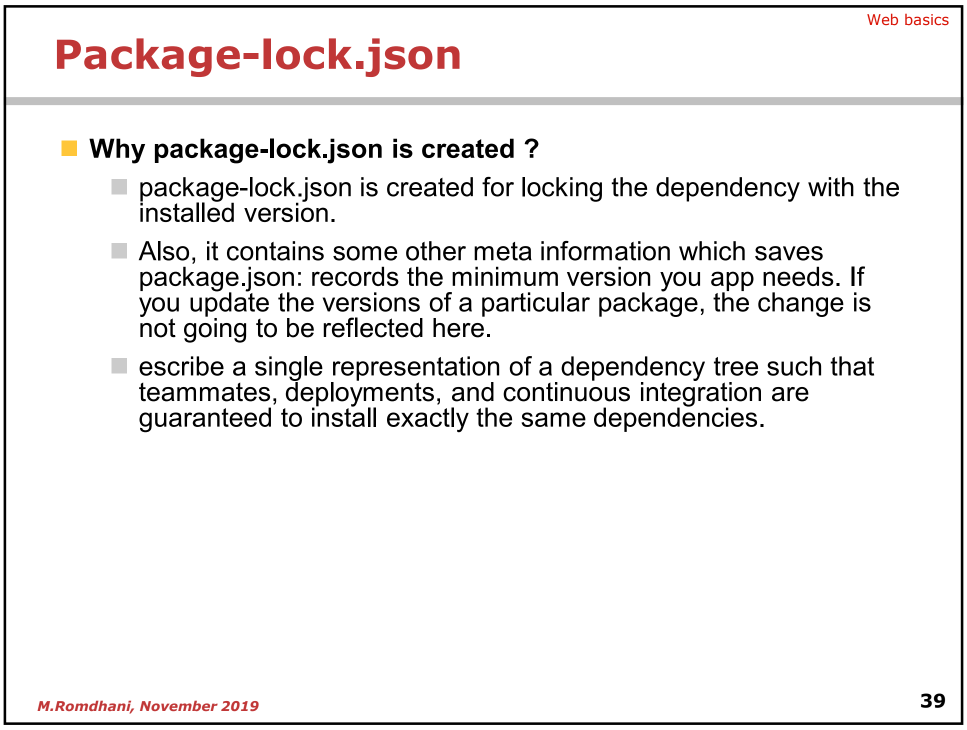
npm

- **npm (originally short for Node Package Manager) is the package manager for the JavaScript programming language.**
- **It consists of:**
  - a command line client, also called npm, and
  - an online database of public and paid-for private packages, called the npm registry.
- **Some npm commands :**
  - `npm init` : Creates a package.json in the project folder
  - `npm install --global @typescript` : Installs globally the typescript compiler
  - `npm install --save bootstrap` : Installs Bootstrap locally in the project
  - `npm install -save-dev mocha` : Installs the latest stable version of Bootstrap
  - `npm update axios` : updates the axios package
  - `npm unistall axios` : uninstalls the axios package

package.json

- **`package.json` file can be described as a manifest of your project that includes the packages and applications it depends on, information about its unique source control, and specific metadata like the project's name, description, and author.**
  - There are two kinds of dependencies :
    - **`dev-dependencies`** : which are needed for quality control and production
    - **`dependencies`** that are needed for development
- **Semantic versioning**
  - Semantic versioning is a formal convention for specifying compatibility using a three-part version number: major version; minor version; and patch.
  - ~version “Approximately equivalent to version”,
    - ~1.2.3 will use releases 1.2.*
  - ^version “Compatible with version”,
    - ^2.3.4 will use releases from 2.*.*


4.7.6
Major Version
Major Changes Breaks the API
Minor Version
Minor Changes Does not break the API
Patches
Bug fixes



Package-lock.json

- **Why package-lock.json is created ?**
  - package-lock.json is created for locking the dependency with the installed version.
  - Also, it contains some other meta information which saves package.json: records the minimum version you app needs. If you update the versions of a particular package, the change is not going to be reflected here.
  - escribe a single representation of a dependency tree such that teammates, deployments, and continuous integration are guaranteed to install exactly the same dependencies.