JavaScript & Node.js

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COMEM Web Services 2016

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Quick Poll

Quick Poll

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- **What is your current perception of JavaScript?**
- **Scope**
  - It's a **"toy" language for creating animations** on web pages, but I would not use it for anything "serious".
  - It's **a very powerful language**. It is essential on the client side, but it is also really interesting on the server side.

Quick Poll

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- **What is your current perception of JavaScript?**
- **Personal taste**
    - I **hate** it.
    - I am not a big fan.
    - It's kind of interesting.
    - I **love** it.
    - I don't care.

Quick Poll

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- **What is your current perception of JavaScript?**
- **Relationship to Java**
  - **It's Java**, with a few syntactic differences.
  - **It has nothing to do with Java**, except for some common syntax.

Quick Poll

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- **What is your current perception of JavaScript?**
- **Current knowledge**
  - **Novice**: I may have hacked a few scripts on web pages, but mostly by copy-pasting examples and without fully understanding the language (what is a prototype?).
  - **Intermediate**: I have used JavaScript quite a bit. I can describe the object-oriented model, I understand what a constructor is and how it works. I have quite a bit of experience with JQuery and other libraries. I am always working with a debugger.
  - **Expert**: closures and modules have no secret for me, I have read "JavaScript: the good parts". I have designed my development workflow with yeoman, grunt, bower and a few other tools. I know who Paul Irish is.

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Douglas Crockford: JavaScript: The Good Parts

https://www.youtube.com/watch?v=_DKkVvOt6dk

JavaScript is built on some very good ideas and a few very bad ones.

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JavaScript is an important language because it is the language of the web browser. Its association with the browser makes it one of the most popular programming languages in the world. **At the same time, it is one of the most despised programming languages in the world**. […]

Most people in that situation **don't even bother to learn JavaScript first**, and then they are surprised when JavaScript turns out to have significant differences from the some other language they would rather be using, and that those differences matter.

The amazing thing about JavaScript is that it is possible to get work done with it without knowing much about the language, or even knowing much about programming. It is a language with enormous expressive power. It is even better when you know what you're doing. **Programming is difficult business. It should never be undertaken in ignorance.**

JavaScript is important. That wasn't always so, but it's true now.

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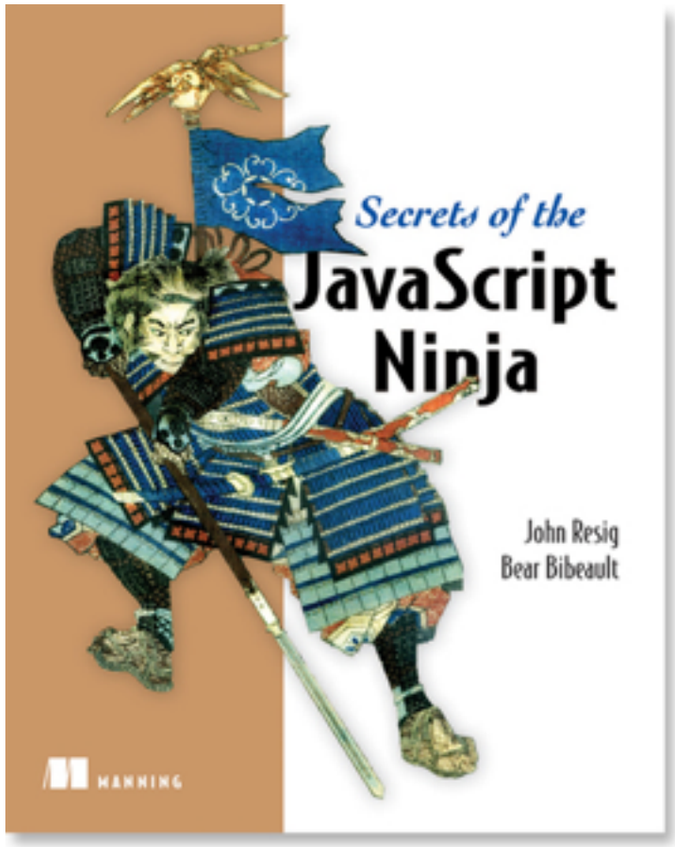
Web applications are expected to give users a rich user interface experience, and without JavaScript, you might as well just be showing pictures of kittens. More than ever, web developers need to have a sound grasp of the language that brings life to web applications.

And like orange juice and breakfast, **JavaScript isn't just for browsers anymore**. The language has knocked down the walls of the browser and is being **used on the server** in engines such as Rhino and V8, and in frameworks like Node.js.

Although this book is primarily focused on JavaScript for web applications, the fundamentals of the language presented in part 2 of this book are applicable across the board.

With more and more developers using JavaScript, it's now more important than ever that they **grasp its fundamentals**, so that they can become true ninjas of the language.



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JavaScript 101

Rule #1
JavaScript defines 6 types

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```
var aNumber = 3.12;
var aBoolean = true;
var aString = "HEIG-VD";
var anObject = {
  aProperty: null
};

// t is true for all of these:
var t;
t = typeof aNumber === "number";
t = typeof aBoolean === "boolean";
t = typeof aString === "string";
t = typeof anObject === "object";
t = typeof anObject.aProperty === "object";
t = typeof anObject.foo === "undefined";
```

- The 6 types are:
  - number
  - boolean
  - string
  - object
  - undefined
  - null
- **null** is a type, but **typeof null === object**.

Rule #2
JavaScript is a dynamic language

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```
var myVariable = "aString";
typeof myVariable; // "string"

myVariable = 3.12;
typeof myVariable; // "number"

myVariable = true;
typeof myVariable; // "boolean"

myVariable = {
  aProperty: "aValue"
};
typeof myVariable; // "object"
```

- When you declare a **variable**, you don't specify a type.
- The type can **change** over time.

Rule #3
There are 2 scopes for variables: the (evil) global scope and the function scope

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```
var aVariableInGlobalScope;

function myFunction() {
  var aVariableInFunctionScope;
  anotherVariableInGlobalScope;
}

function myFunction2() {
  for (i = 0; i < 10; i++) {
    // i is in global scope!
  }
  for (var j = 0; j < 10; j++) {
    // j is in function scope!
  }
}
```

- A variable declared within a function is **not accessible** outside this function.
- Unless using **strict mode**, it is not mandatory to declare variables (beware of typos…)
- Two scripts loaded from the same HTML page share the same global scope (beware of **conflicts**…).
- There is **no block scope**.

Rule #4
JavaScript supports first-class functions

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```
function multiplyByTwo(n) {
  return n * 2;
}

multiplyByTwo(3); // 6



var hello = function(name) {
  console.log("Hello " + name + "!");
};

hello("World"); // "Hello World!"



function applyToArray(array, func) {
  for (int i = 0; i < array.length; i++) {
    array[i] = func(array[i]);
  }
}

var a = [ 1, 2, 3 ];
applyToArray(a, multiplyByTwo);
console.log(a); // [ 2, 4, 6 ]
```

- New functions can be defined at **runtime**.
- Functions can be **stored** in data structures.
- Functions can be passed as **arguments** to other functions.

Rule #5
Objects are dynamic bags of properties

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```
// let's create an object
var person = {
  firstName: 'olivier',
  lastName: 'liechti'
};

// we can dynamically add properties
person.gender = 'male';
person['zip'] = 1446;

// and delete them
delete person.zip;

for (var key in person) {
  console.log(key + " : " + person[key]);
};
```

- There are different ways to **access properties** of an object.
- JavaScript is **dynamic**: it is possible to **add** and **remove** properties to an object at any time.
- Every object has a different list of properties (**no class**).

Rule #6
Arrays are objects

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```
var fruits = ["apple", "pear"];

fruits.push("banana");
typeof fruits; // "object"

for (var i = 0; i < fruits.length; i++) {
  console.log("fruits[" + i + "] = " + fruits[i]);
}

var transformedFruits = fruits.map( function(fruit) {
  return fruit.toUpperCase();
});

transformedFruits.forEach( function(fruit) {
  console.log(fruit);
});
```

Rule #7
The language has no support for classes
There are 3 ways to create objects

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```
// create an object with a literal
var person = {
  firstName: "olivier",
  lastName: "liechti"
};

// create an object with a prototype
var child = Object.create(person);

// create an object with a constructor
var child = new Person("olivier", "liechti");
```

- **class** is a reserved word in JavaScript, but it is not used in the current version of the language (reserved for the future).
- A **constructor** is function like any other (uppercase is a coding convention).
- It is the use of the **new** keyword that triggers the object creation process.

Rule #8
Every object inherits from a prototype object

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```
var person = {
  firstName: "olivier",
  lastName: "liechti"
};
// person's prototype is Object.prototype

var father = {};
var child = Object.create(father);
// child's prototype is father

function Person(fn, ln) {
  this.firstName = fn;
  this.lastName = ln;
}
var john = new Person("John", "Doe");
// john's prototype is Person.prototype
```

Rule #5
Every object inherits from a prototype object

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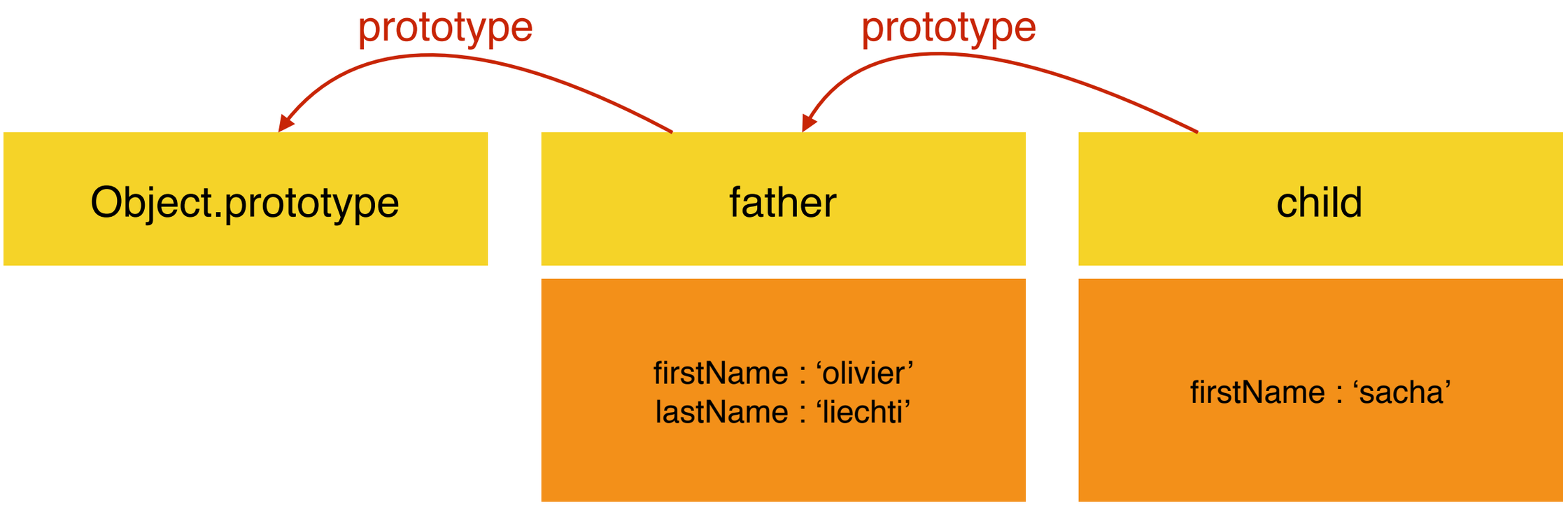


```
console.log(child.lastName);
// prints ‘liechti’ on the console
```

- Every object inherits from a prototype object. **It inherits and can override its properties**, including its methods.
- Objects created with object literals inherit from **Object.prototype**.
- When you access the property of an object, JavaScript **looks up the prototype chain** until it finds an ancestor that has a value for this property.

Rule #6
With patterns, it is possible to implement class-like data structures

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```
function Person(fn, ln) {
  var privateVar;
  this.firstName = fn;
  this.lastName = ln;
  this.badGreet = function() {
    console.log("Hi " + this.firstName);
  };
};

Person.prototype.greet = function() {
  console.log("Hey " + this.firstName);
};

var p1 = new Person("olivier", "liechti");

p1.badGreet(); // "Hi olivier"
p1.greet();    // "Hey olivier"
```

- **badGreet** is a property that will be replicated for every object created with the Person constructor:
  - poor memory management
  - not possible to alter behavior of all instances at once
- **greet** is a property that will be shared by all instances (because it will be looked up along the object inheritance chain).
- **privateVar** is not accessible outside of the constructor.
- **fistName** is publicly accessible (no encapsulation).

JavaScript resources

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- **A re-introduction to JavaScript**
  - https://developer.mozilla.org/en-US/docs/Web/JavaScript/A_re-introduction_to_JavaScript
- **Inheritance and the prototype chain**
  - https://developer.mozilla.org/en-US/docs/Web/JavaScript/Guide/Inheritance_and_the_prototype_chain
- **Introduction to Object-Oriented JavaScript**
  - https://developer.mozilla.org/en-US/docs/Web/JavaScript/Introduction_to_Object-Oriented_JavaScript

JavaScript Objects in Detail

January 27 Last Year

JavaScript's core—most often used and most fundamental—data type is the Object data type. JavaScript has one complex data type, the Object data type, and it has five simple data types: Number, String, Boolean, Undefined, and Null. Note that these simple (primitive) data types are immutable, they cannot be changed, while objects are mutable.

What is an Object

An object is an unordered list of primitive data (and sometimes reference data types) types that are stored as name-value pairs. Each item in the list is called a property (functions are called methods) and each property name has to be unique and can be a string or a number.

Here is a simple object:

```
var myFirstObject = {firstName: "Richard", favoriteAuthor:
"Conrad"};
```

To reiterate: Think of an object as a list that contains items and each item (a property) in the list is stored by a name-value pair. The property names in the example above are firstName and favoriteAuthor. And the values for each are "Richard" and "Conrad."

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Node.js

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“Node.js is a **platform** built on Chrome's JavaScript runtime for easily building **fast**, **scalable network applications**.

not only!

Node.js uses an **event-driven**, **non-blocking I/O model** that makes it lightweight and efficient, perfect for **data-intensive real-time applications that run across distributed devices**.”

Google

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Trends

Topics

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Software

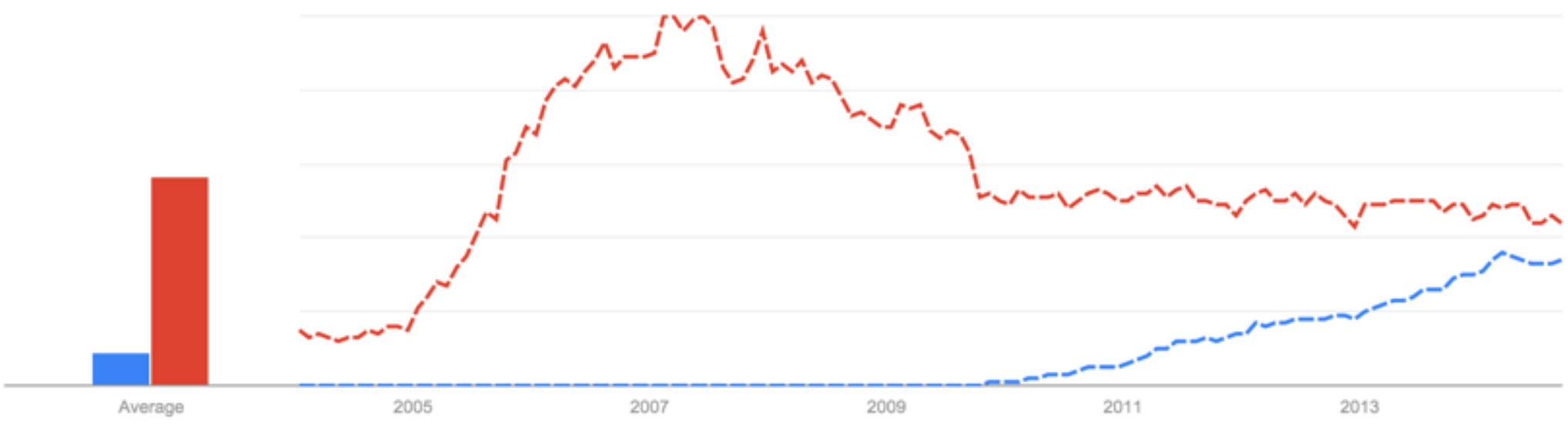
Ruby on Rails
Web Framework

+ Add term

Beta: Measuring search interest in *topics* is a beta feature which quickly provides accurate measurements of overall search interest. To measure search interest for a specific *query*, select the "search term" option.

Interest over time

News headlines Forecast



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Single-threaded Asynchronous

"I am not leaving until you are done..."
vs
"Wake me up when you have result"

Let's look at a **synchronous example**

```
var fs = require("fs");

/**
 * Simple function to test the synchronous readFileSync function of Node.js
 * @param {string} filename – the file to read
 */
function testSyncRead(filename) {
  console.log("I am about to read a file: " + filename);
  var data = fs.readFileSync(filename);
  console.log("I have read " + data.length + " bytes (synchronously).");
  console.log("I am done.");
}

// We get the file name from the argument passed on the command line
var filename = process.argv[2];

console.log("\nTesting the synchronous call");
testSyncRead(filename);
```

We use a standard **Node module** for accessing the file system

fs.readFileSync is synchronous: it blocks the main thread until the data is available.

```
$ node sample2.js medium.txt

Testing the synchronous call
I am about to read a file: medium.txt
I have read 1024 bytes (synchronously).
I am done.
```

*Synchronous functions are easier to use, but they have **severe** performance implications!!*

Let's look at an **asynchronous example**

```
var fs = require("fs");

/**
 * Simple function to test the asynchronous readFile function of Node.js
 * @param {string} filename - the file to read
 */
function testAsyncRead(filename) {
  console.log("I am about to read a file: " + filename);

  fs.readFile(filename, function (err, data) {
    console.log("Nodes just told me that I have read the file.");
  });

  console.log("I am done. Am I?");
}
// We get the file name from the argument passed on the command line
var filename = process.argv[2];

console.log("\nTesting the asynchronous call");
testAsyncRead(filename);
```

```
$ node sample2.js medium.txt

Testing the asynchronous call
I am about to read a file: medium.txt
I am done. Am I?
Nodes just told me that I have read the file.
```

fs.readFile is asynchronous: it does not block the main thread until the data is available.

We must provide a **callback function**, which Node.js will invoke when the data is available.

Problems can happen when an (asynchronous) function is called.

*Node.js developers **have to** learn the asynchronous programming style.*

Node.js **callback** convention

When calling an asynchronous operation, the convention in Node.js is to use a **callback function** that will be called with **2 arguments**. If an error occurs, **the first argument** will be an error describing the problem. If the operation succeeds, **the second argument** will be the result. You will only receive one or the other, not both.

```
var fs = require("fs");

fs.readFile(filename, function (err, data) {

  if (err) {
    // handle the error
    console.warn("An error occurred: " + err.message);
    return;
  }

  // do something with the data
  process(data)
});
```

The callback function with its two arguments.

Before doing anything with the data, **check** if there is an error.

If there was an error, handle it and **stop there**. There is no data available.

Otherwise, if there was no error, you may use the **data**.

Node.js v0.10.32 Manual & Documentation

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- Assertion Testing
- Buffer
- C/C++ Addons
- Child Processes
- Cluster
- Console
- Crypto
- Debugger
- DNS
- Domain
- Events
- File System
- Globals
- HTTP
- HTTPS
- Modules
- Net
- OS
- Path
- Process
- Punycode
- Query Strings
- Readline
- REPL
- Stream
- String Decoder
- Timers
- TLS/SSL
- TTY
- UDP/Datagram
- URL
- Utilities
- VM
- ZLIB

Let's look at a **another example**

```
/*global require */

var http = require("http");

/**
 * This function starts a http daemon on port 9000. It also
 * registers a callback handler, to handle incoming HTTP
 * requests (a simple message is sent back to clients).
 */
function runHttpServer() {
  var server = http.createServer();

  server.on("request", function (req, res) {
    console.log("A request has arrived: URL=" + req.url);
    res.writeHead(200, {
      'Content-Type': 'text/plain'
    });
    res.end('Hello World\n');
  });

  console.log("Starting http server...");
  server.listen(9000);
}

runHttpServer();
```

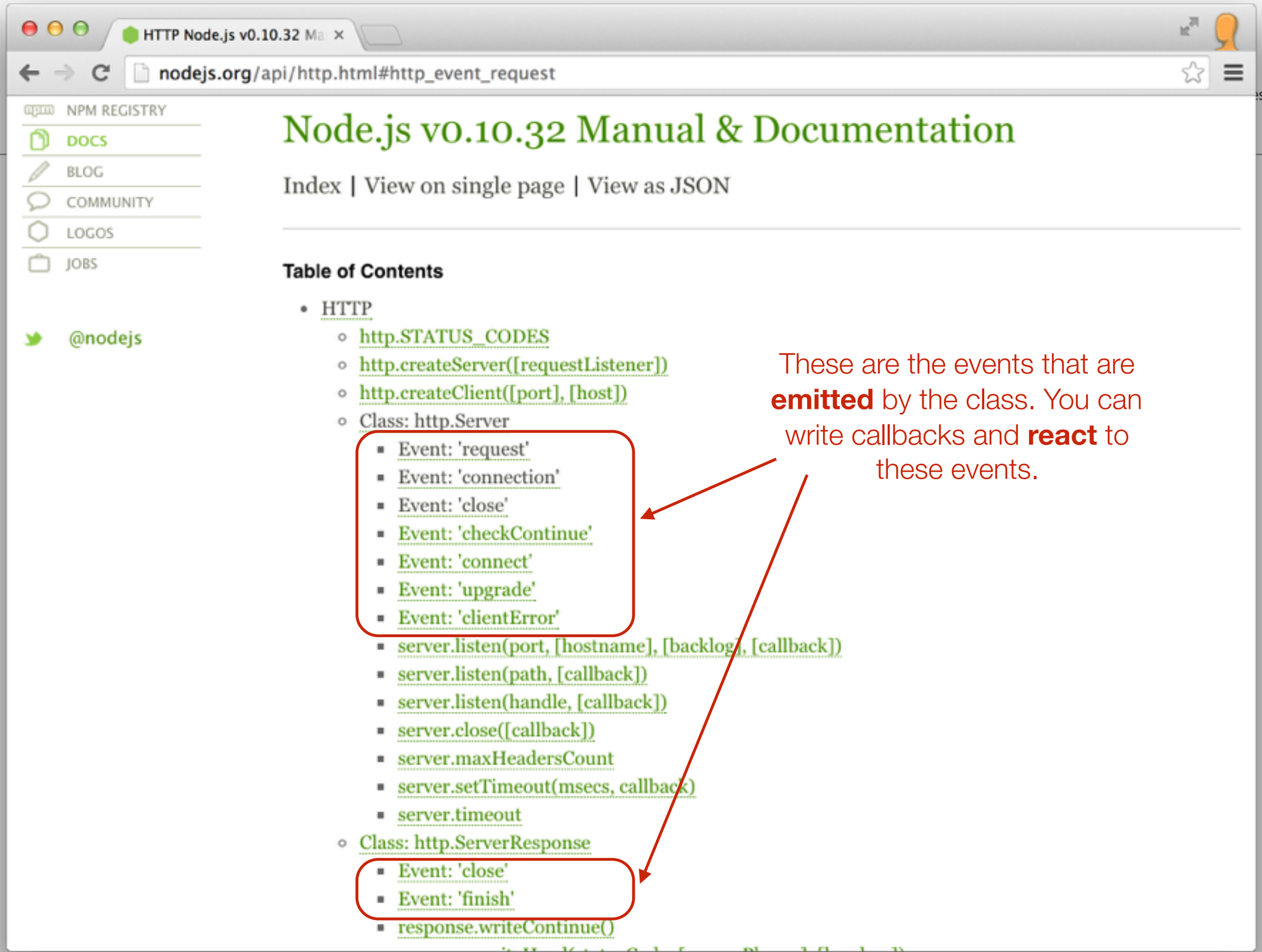
We use a standard **Node module** that takes care of the HTTP protocol.

Node can provide us with a **ready-to-use** server.

We can attach **event handlers** to the server. Node will notify us asynchronously, and give us access to the request and response.

We can **send back** data to the client.

We have wired everything, let's **welcome** clients!


HTTP Node.js v0.10.32 Ma
nodejs.org/api/http.html#http_event_request
NPM REGISTRY
DOCS
BLOG
COMMUNITY
LOGOS
JOBS
@nodejs
Node.js v0.10.32 Manual & Documentation
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HTTP
http.STATUS_CODES
http.createServer([requestListener])
http.createClient([port], [host])
Class: http.Server
Event: 'request'
Event: 'connection'
Event: 'close'
Event: 'checkContinue'
Event: 'connect'
Event: 'upgrade'
Event: 'clientError'
server.listen(port, [hostname], [backlog], [callback])
server.listen(path, [callback])
server.listen(handle, [callback])
server.close([callback])
server.maxHeadersCount
server.setTimeout(msecs, callback)
server.timeout
Class: http.ServerResponse
Event: 'close'
Event: 'finish'
response.writeContinue()
These are the events that are emitted by the class. You can write callbacks and react to these events.

How does Node.js use an **event loop** to offer an asynchronous programming model?

on('request', function(req, res) { // my code});

on('data', function(data) { // my code});

Callback functions that **you** have written and registered

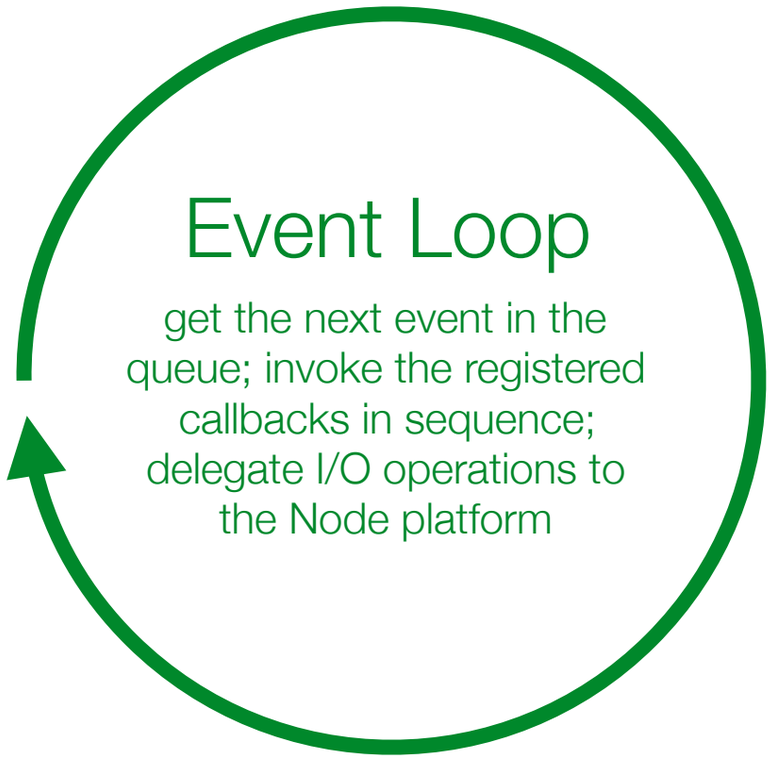
'request' **event**

'request' **event**

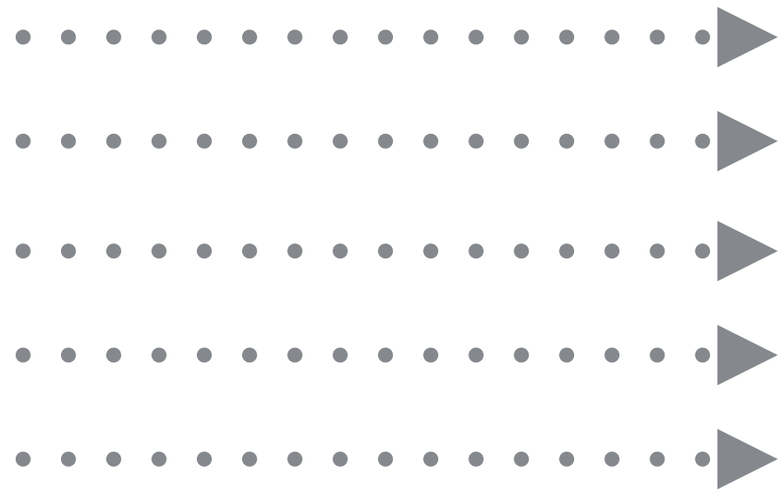
'data' **event**

'request' **event**

Queue of events that have been **emitted**



All the code that **you** write runs on a **single thread**



The **long-running tasks** (I/Os) are executed by Node in parallel; Node emits events to report progress (which triggers your callbacks).

Another pattern is to provide a callback to node when invoking an asynchronous function.

Node.js resources

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- **Understanding the Node.js Event Loop**
  - http://strongloop.com/strongblog/node-js-event-loop/
- **Mixu's Node book: What is Node.js? (chapter 2)**
  - http://book.mixu.net/node/ch2.html
- **Node.js Explained, video**
  - http://kunkle.org/talks/

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Node.js package manager

What about **package management**?

Not reinventing
the wheel...

... building on the
shoulders of
giants.

What is **npm**?

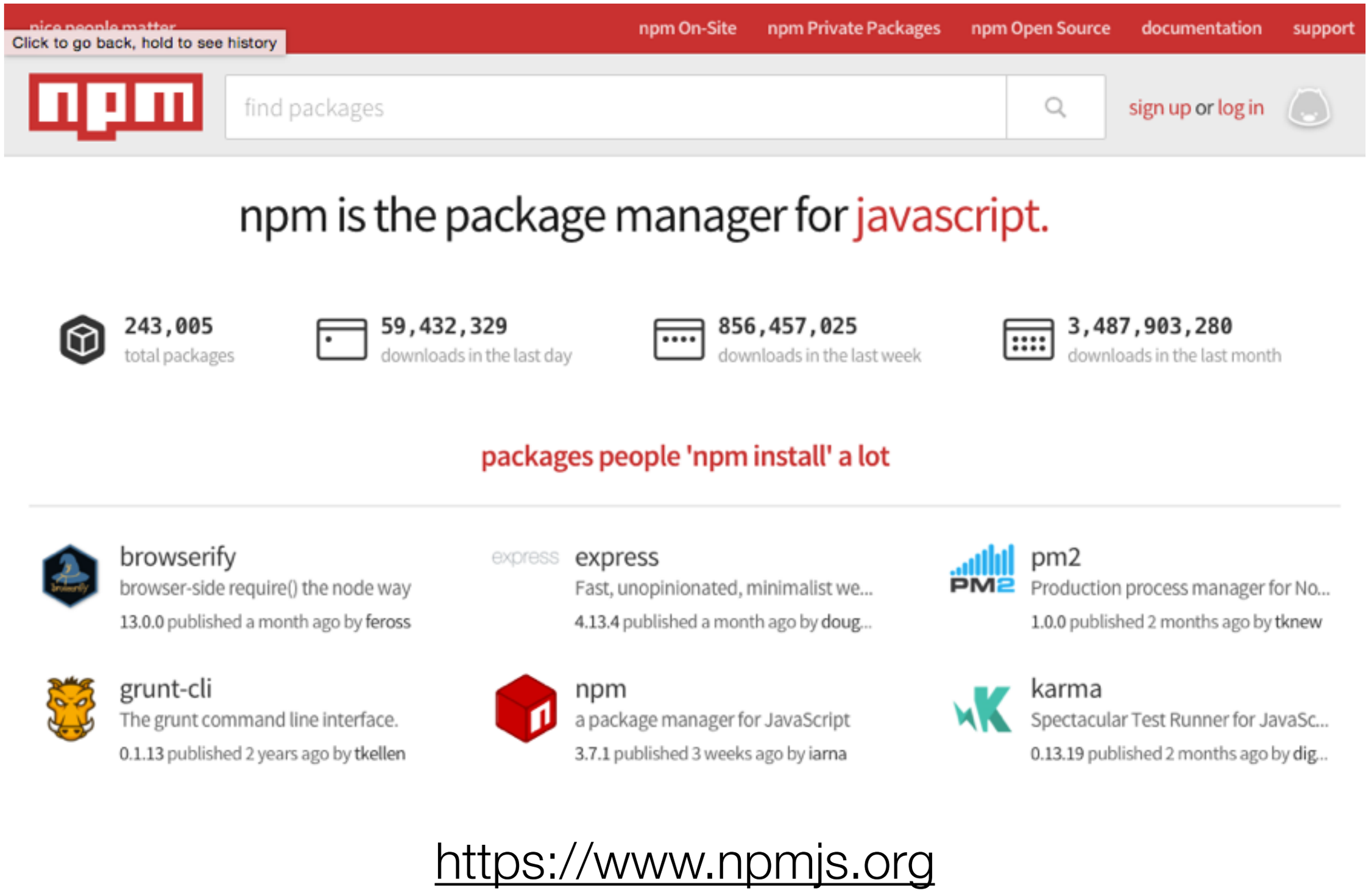
---

*”**npm** is the **package manager** for the Node JavaScript platform. It puts **modules** in place so that node can find them, and manages **dependency** conflicts intelligently.*

*It is extremely configurable to support a wide variety of use cases. Most commonly, it is used to **publish**, **discover**, **install**, and **develop** node programs.”*

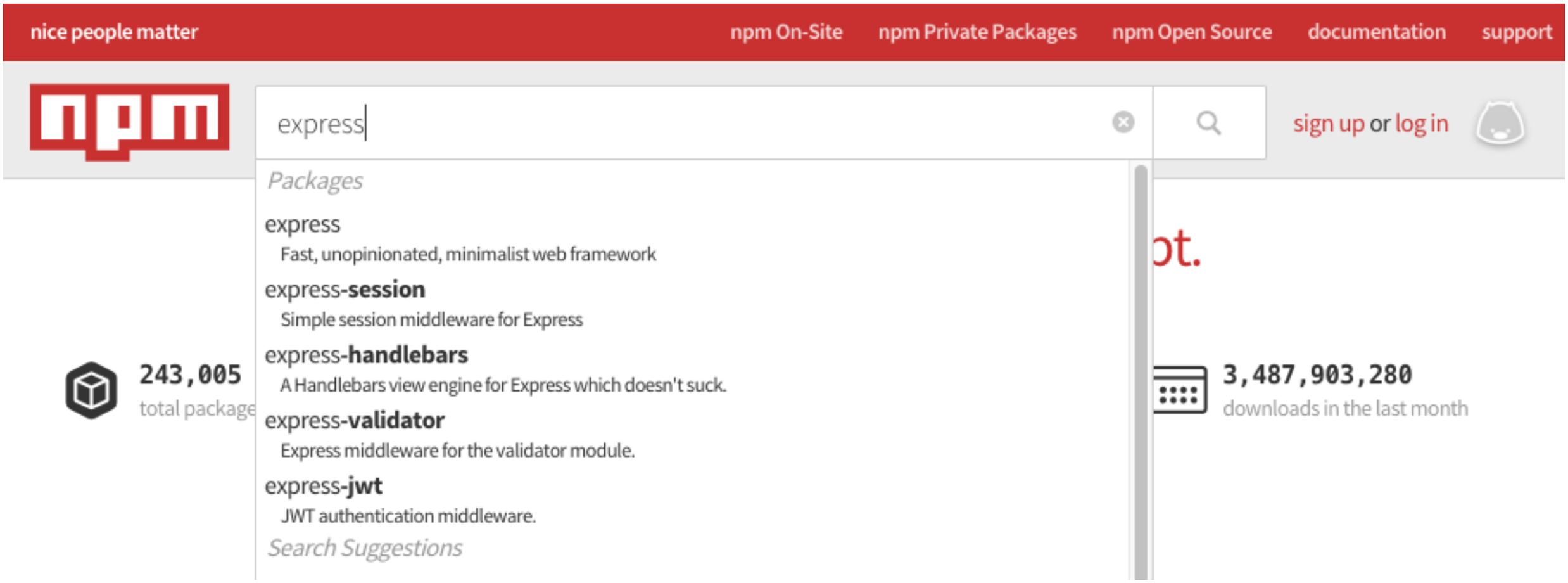
https://docs.npmjs.com/getting-started/what-is-npm

npm is a set of command line tools that work together with the **node registry**



https://www.npmjs.org

npm is a set of command line tools that work together with the **node registry**



https://www.npmjs.org

npm is a set of command line tools that work together with the **node registry**

---

nightly panic munchies | npm On-Site | npm Private Packages | npm Open Source | documentation | support

npm | find packages | sign up or log in

express public

Fast, unopinionated, minimalist web framework

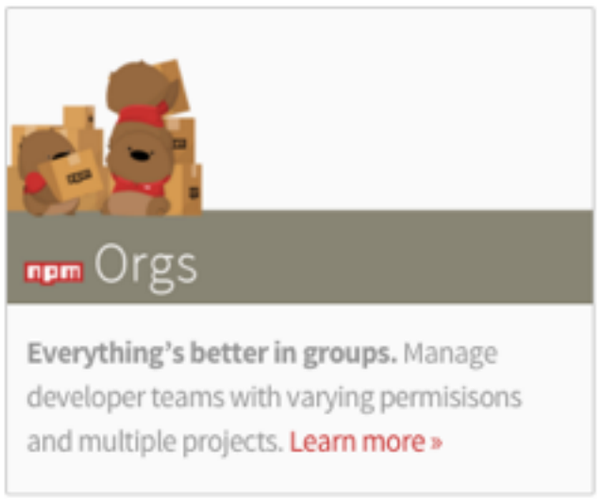
express

npm v4.13.4 | downloads 5M/month | linux passing | windows passing | coverage 100%

```
var express = require('express')
var app = express()

app.get('/', function (req, res) {
  res.send('Hello World')
})

app.listen(3000)
```



npm install express

how? learn more

dougwilson published a month ago

4.13.4 is the latest of 273 releases

github.com/expressjs/express

MIT

https://www.npmjs.org

npm provides many **commands**

admin — bash — 120×30

```
Last login: Wed Sep 23 19:59:09 on console
$ npm help

Usage: npm <command>

where <command> is one of:
    access, add-user, adduser, apihelp, author, bin, bugs, c,
    cache, completion, config, ddp, dedupe, deprecate, dist-tag,
    dist-tags, docs, edit, explore, fa[illegible], find, find-dupes, get,
    help, help-search, home, i, info, init, install, issues, la,
    link, list, ll, ln, login, ls, outdated, owner, pack,
    prefix, prune, publish, r, rb, rebuild, remove, repo,
    restart, rm, root, run-script, s, se, search, set, show,
    shrinkwrap, star, stars, start, stop, t, tag, test, tst, un,
    uninstall, unlink, unpublish, unstar, up, update, v,
    verison, version, view, whoami

npm <cmd> -h     quick help on <cmd>
npm -l           display full usage info
npm faq          commonly asked questions
npm help <term>  search for help on <term>
npm help npm     involved overview

Specify configs in the ini-formatted file:
    /Users/admin/.npmrc
or on the command line via: npm <command> --key value
Config info can be viewed via: npm help config

npm@2.5.1 /usr/local/lib/node_modules/npm
$
```

init
install
publish
update

npm can **install packages**

- You can **install packages** with **npm install [options] <name>**:
  - **globally** (this is the case for tools and CLI utilities used across projects):
    - You need to use the **-g** flag if you want to do that (and often **sudo** on Unix systems).
  - **locally to a project** (this is the case for libs that your code depends on):
    - In this case, you first use **npm init** which will create a **package.json** file. This file lists the packages you use and at what versions.
    - Then you can use npm install with the **--save** flag, which will install the latest version of the package you want and save its version to the package file.
    - The modules are stored in a (often large) directory named **node_modules**, which you typically add to your **.gitignore** file.

How do I **reuse** code?

m1.js

```
module.exports.a = "b";

module.exports.hello = function() {
   console.log("Hello!");
};
```

m2.js

```
module.exports = function(name) {
  console.log("Hello " + name + "!");
};
```

myScript.js

```
var module1 = require("./m1");

console.log(module1.a);
module1.hello();

var module2 = require("./m2");

module2("World");
```

```
$> node myScript.js
b
Hello!
Hello World!
```

Run it!

How do I reuse code through **npm**?

KEEP
CALM
AND
SAY
HELLO

Someone wrote **myHello**.

I want to use it in **myScript**.

How?

How do I **publish** myHelloModule as an npm **package**?

myHello/hello.js

```
module.exports.hello = function() {
   console.log("Hello!");
};
```

myHello/package.json

```
{
  "name": "myHello",
  "version": "1.0.0",
  "description": "My awesome module.",
  "main": "./hello.js",
  "repository": {
    "type": "git",
    "url": "https://github.com/jdoe/hello"
  },
  "author": "John Doe <john.doe@example.com>",
  "license": "MIT"
}
```

Define the package:

Publish it!

```
$> cd
myHelloModule
$> npm publish
```

How do I **install** myHelloModule and **use** it?

Add the package as a **dependency** to your own package:

myScript/package.json

```
{
  "name": "myApp",
  "version": "1.0.0",
  "description": "My awesome app.",
  "main": "script.js",
  "dependencies": {
    "myHello": "1.0.0"
  }
}
```

Install dependencies:

```
$> npm install
```

myScript/script.js

Require and use the dependency:

```
var myHelloModule = require("myHelloModule");

myHelloModule.hello();
```

Enjoy:

```
$> node script.js
Hello!
```

How do I use npm if I'm lazy?

Install the latest version of a new module and automatically save it to your `package.json` file:

```
$> npm install --save myHelloModule
```

(Note: Your package.json file must already exist.)

npm resources

heig-vd
Haute Ecole d'Ingénierie et de Gestion
du Canton de Vaud

Command line usage

https://www.npmjs.org/doc/cli/npm.html

package.json format

https://docs.npmjs.com/files/package.json