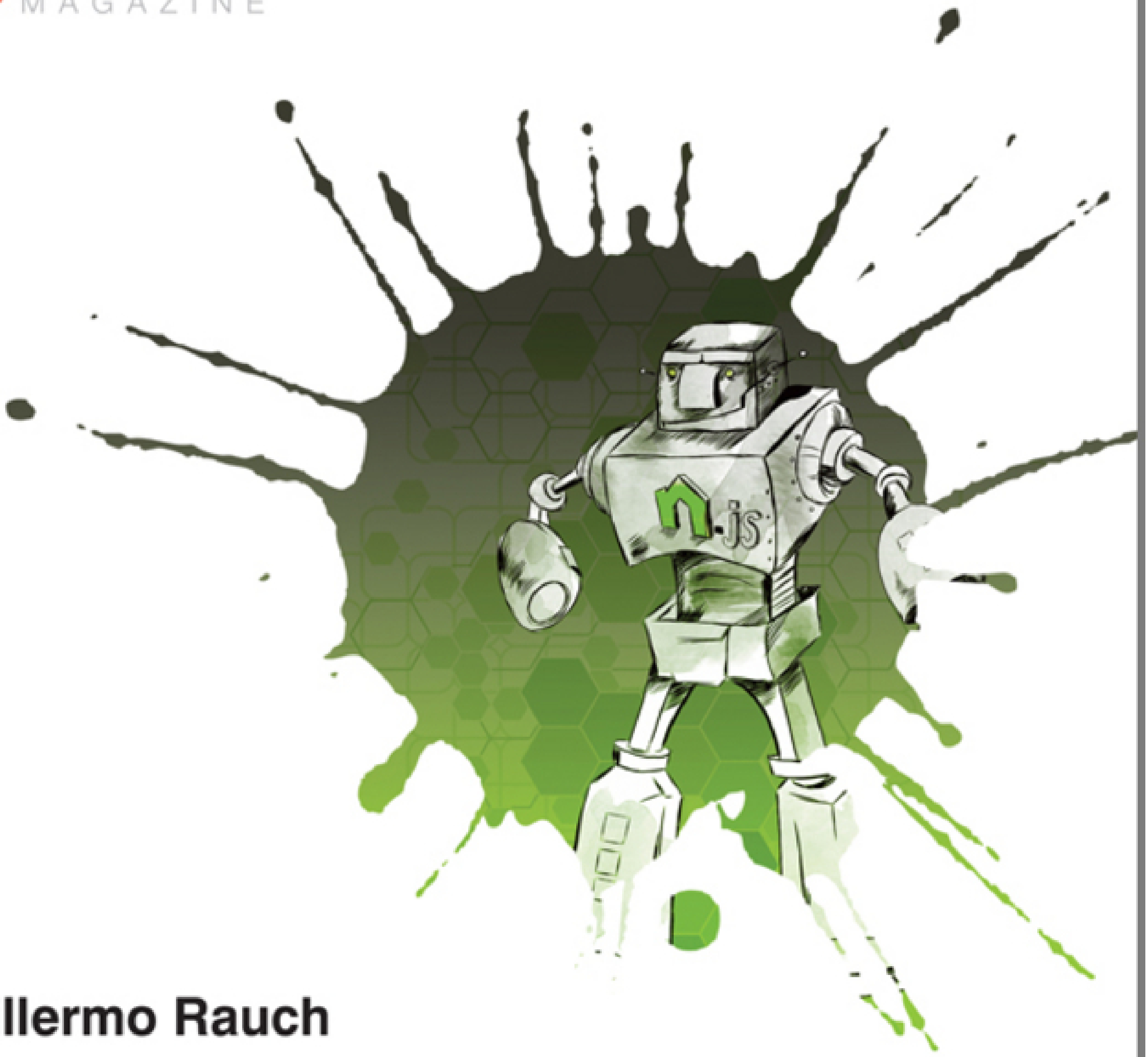
SMASHING
MAGAZINE



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SMASHING Node.js

JavaScript Everywhere

CHAPTER

1

THE SETUP

INSTALLING NODE.JS IS a painless process. Since its conception, one of its goals has been maintaining a small number of dependencies that would make the compilation or installation of the project very seamless.

This chapter describes the installation process for Windows, OS X, and Linux systems. For the latter, you're going to ensure that you have the correct dependencies and compile it from the source.

Note: When you see lines prefixed with `$` in the code snippets in the book, you should type these expressions into your OS shell.

INSTALLING ON WINDOWS

On Windows, go to http://nodejs.org and download the MSI installer. Every release of node has a corresponding MSI installer that you need to download and execute.

The filename follows the format `node-v?.?.?.msi`. Upon executing it, simply follow the instructions in the setup wizard shown in Figure 1-1.

To ensure that the installation worked, open the shell or command prompt by running `cmd.exe` and typing `$ node -version`.

The version name of the package you just installed should display.

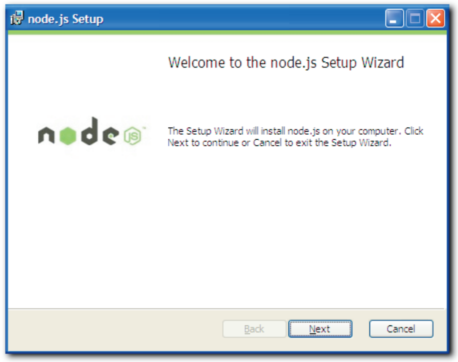

Figure 1-1: The Node.JS setup wizard.

INSTALLING ON OS X

On the Mac, similarly to Windows, you can leverage an installer package. From the Node.JS website, download the PKG file that follows the format `node-v?.?.?.pkg`. If you want to compile it instead, ensure you have XCode installed and follow the Compilation instructions for Linux.

Run the downloaded package and follow the simple steps (see Figure 1-2).

To ensure installation was successful, open the shell or terminal by running `Terminal.app` (you can type in "Terminal" in Spotlight to locate it) and type in `$ node -version`.

The version of Node you just installed should be outputted.

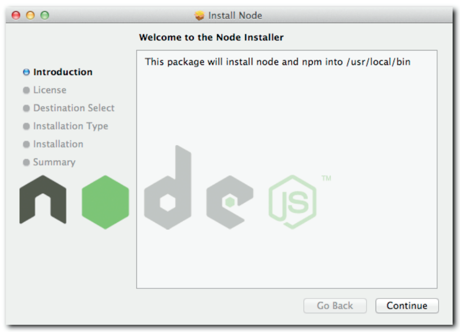

Figure 1-2: The Node.JS package installer.

INSTALLING ON LINUX

Compiling Node.JS is almost just as easy as installing binaries. To compile it in most *nix systems, simply make sure a C/C++ compiler and the OpenSSL libraries are available.

Most Linux distributions come with a package manager that allows for the easy installation of these.

For example, for Amazon Linux, you use

```
> sudo yum install gcc gcc-c++ openssl-devel curl
```

On Ubuntu, the installation is slightly different; you use

```
> sudo apt-get install g++ libssl-dev apache2-utils curl
```

COMPILING

From your OS terminal, execute the following commands:

> *Note: Replace ? with the latest available version of node in the following example.*

```
$ curl -O http://nodejs.org/dist/node-v?.?.?.tar.gz
$ tar -xzvf node-v?.?.?.tar.gz
$ cd node-v?.?.?
$ ./configure
$ make
$ make test
$ make install
```

If the `make test` command aborts with errors, I recommend you stop the installation and post a log of the `./configure`, `make`, and `make test` commands to the Node.JS mailing list.

ENSURING THAT IT WORKS

Launch a terminal or equivalent, such as XTerm, and type in `$ node –version`.

The version of Node you just installed should be outputted.

THE NODE REPL

To run the Node REPL, simply type `node`.

Try running some JavaScript expressions. For example:

```
> Object.keys(global)
```

> *Note: When you see lines prefixed with > in the code snippets in the book, you should run these expressions in the REPL.*

The REPL is one of my favorite tools for quickly verifying that different Node or vanilla JavaScript APIs work as expected. While developing larger modules, it's often useful to check a certain API works exactly the way you remember it when unsure. To that end, opening a separate terminal tab and quickly evaluating some JavaScript primitives in a REPL helps immensely.

EXECUTING A FILE

Like most scripted programming languages, Node can interpret the contents of a file by appending a path to the `node` command.

With your favorite text editor, create a file called `my-web-server.js`, with the following contents:

```
var http = require('http');
var serv = http.createServer(function (req, res) {
  res.writeHead(200, { 'Content-Type': 'text/html' });
  res.end('<marquee>Smashing Node!</marquee>');
});
serv.listen(3000);
```

Run the file:

```
$ node my-web-server.js
```

Then, as shown in Figure 1-3, point your web browser to http://localhost:3000.

In this code snippet, you're leveraging the power of Node to script a fully compliant HTTP server that serves a basic HTML document. This is the traditional example used whenever Node.JS is being discussed, because it demonstrates the power of creating a web server just like Apache or IIS with only a few lines of JavaScript.

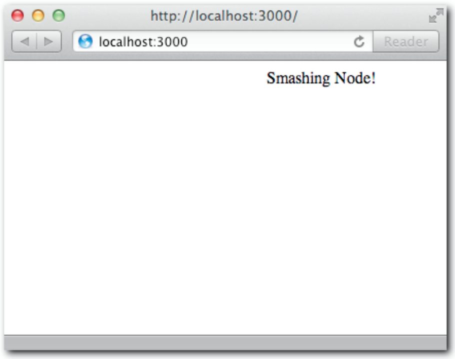

Figure 1-3: Serving a basic HTML document in Node.

NPM

The Node Package Manager (NPM) allows you to easily manage modules in projects by downloading packages, resolving dependencies, running tests, and installing command-line utilities.

Even though doing so is not essential to the core functionality of the project, you truly need to work efficiently on projects that rely on other pre-existing modules released by third parties.

NPM is a program written in Node.JS and shipped with the binary packages (the MSI Windows installer, and the PKG for the Mac). If you compiled node from the source files, you want to install NPM as follows:

```
$ curl http://npmjs.org/install.sh | sh
```

To ensure successful installation, issue the following command:

```
$ npm --version
```

The NPM version should be displayed.

INSTALLING MODULES

To illustrate the installation of a module with NPM, install the `colors` library in the directory `my-project` and then create an `index.js` file:

```
$ mkdir my-project/
$ cd my-project/
$ npm install colors
```

Verify that the project was installed by ensuring the path `node_modules/colors` was created.

Then edit `index.js` with your favorite editor:

```
$ vim index.js
```

And add the following contents:

```
require('colors');
console.log('smashing node'.rainbow);
```

The result should look like Figure 1-4.

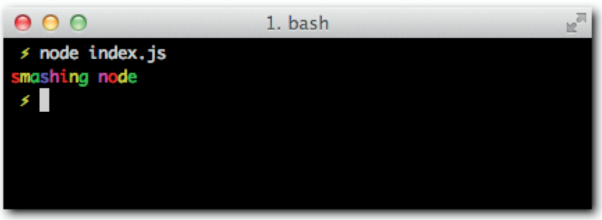

Figure 1-4: The result of installing a module

DEFINING YOUR OWN MODULE

To define your own module, you need to create a `package.json` file. Defining your own module has three fundamental benefits:

- Allows you to easily share the dependencies of your application with others, without sending along the `node_modules` directory. Because `npm install` takes care of fetching everything, distributing this directory wouldn't make sense. This is especially important in SCM systems like Git.
- Allows you to easily track the versions of the modules you depend on that you know work. For example, when you wrote a particular project, you ran `npm install colors` and that installed colors 0.5.0. A year later, due to API changes, perhaps the latest colors are no longer compatible with your project, and if you were to run `npm install` without specifying the version, your project would break.
- Makes redistribution possible. Did your project turn out fine and you want to share it with others? Because you have a `package.json`, the command `npm publish.` publishes it to the NPM registry for everyone to install.

In the directory created earlier (`my-project`), remove the `node_modules` directory and create a `package.json` file:

```
$ rm -r node_modules
$ vim package.json
```

Then add the following contents:

```
{
    "name": "my-colors-project"
  , "version": "0.0.1"
  , "dependencies": {
      "colors": "0.5.0"
    }
}
```

Note: The contents of this file must be valid JSON. Valid JavaScript is not enough. This means that you must make sure, for example, to use double quotes for all strings, including property names.

The `package.json` file is the file that describes your project to both Node.JS and NPM. The only required fields are name and version. Normally, modules have dependencies, which is an object that references other projects by the name and version they defined in their `package.json` files.

Save the file, install the local project, and run `index.js` again:

```
$ npm install
$ node index   # notice that you don't need to include ".js"!
```

In this case, the intention is to create a module for internal use. If you wanted, NPM makes it really easy to publish a module by running:

```
$ npm publish
```

To tell Node which file to look for when someone calls `require('my-colors-project')` we can specify the `main` property in the `package.json`:

```
{
    "name": "my-colors-project"
  , "version": "0.0.1"
  , "main": "./index"
  , "dependencies": {
      "colors": "0.5.0"
    }
}
```

When you learn how to make modules export APIs, the `main` property will become a lot more important, because you will need it to define the entry point of your modules (which sometimes are comprised of multiple files).

To learn about all the possible properties for the `package.json` file, run:

```
$ npm help json
```

> *Tip: If you never intend to publish a certain project, add* `"private": "true"` *to your* `package.json`*. This prevents accidental publication.*

INSTALLING BINARY UTILITIES

Some projects distribute command-line tools that were written in Node. When that's the case, you need to install them with the `-g` flag.

For example, the web framework you're going to learn in this book called express contains an executable utility to create projects.

```
$ npm install -g express
```

Then try it out by creating a directory and running "express" inside:

```
$ mkdir my-site
$ cd mysite
$ express
```

> *Tip: If you want to distribute a script like this, include a flag `"bin": "./path/to/script"` pointing to your executable script or binary when publishing.*

EXPLORING THE NPM REGISTRY

Once you get comfortable with the Node.JS module system in Chapter 4, you should be able to write programs that leverage any module in the ecosystem.

NPM has a rich registry that contains thousands of modules. Two commands are instrumental in your exploration of the registry: `search` and `view`.

If you want to search for plugins related to `realtime`, for example, you would execute the following:

```
$ npm search realtime
```

This will search all the published modules that contain MySQL in their name, tags, and description fields.

Once you find a package that interests you, you can see its `package.json` and other properties related to the NPM registry by running `npm view` followed by the module name. For example:

```
$ npm view socket.io
```

> *Tip: If you want to learn more about a certain NPM command, type "npm help <command>." For example, "npm help publish" will teach you more about how to publish modules.*

SUMMARY

After this chapter, you should now have a working Node.JS + NPM environment.

In addition to being able to run the `node` and `npm` commands, you should now have a basic understanding of how to execute simple scripts, but also how to put together modules with dependencies.

You now know that an important keyword in Node.JS is `require`, which allows for module and API interoperability, and which will be an important subject in Chapter 4, after quickly reviewing the language basics.

You also are now aware of the NPM registry, which is the gateway to the Node.JS module ecosystem. Node.JS is an open source project, and as a result many of the programs that are written with it are also open source and available for you to reuse, a few keystrokes away.

CHAPTER

2 JAVASCRIPT: AN OVERVIEW

INTRODUCTION

JAVASCRIPT IS A prototype-based, object-oriented, loosely-typed dynamic scripting language. It has powerful features from the functional world, such as *closures* and *higher-order functions,* that are of special interest here.

JavaScript is technically an implementation of the ECMAScript language standard. It's important to know that with Node, because of v8, you'll be primarily dealing with an implementation that gets close to the standard, with the exception of a few extra features. This means that the JavaScript you're going to be dealing with has some important differences with the one that earned the language its bad reputation in the browser world.

In addition, most of the code you'll write is in compliance with the "good parts" of JavaScript that Douglas Crockford enounced in his famous book, *JavaScript: The Good Parts*.

This chapter is divided into two parts:

- **Basic JavaScript.** The fundamentals of the language. They apply everywhere: node, browser, and standards committee.
- **v8 JavaScript.** Some features used in v8 are not available in all browsers, especially Internet Explorer, because they've recently been standardized. Others are nonstandard, but you still use them because they solve fundamental problems.

In addition, the next chapter covers the language extensions and features exclusively available in Node.

BASIC JAVASCRIPT

This chapter assumes that you're somewhat familiar with JavaScript and its syntax. It goes over some fundamental concepts you must understand if you want to work with Node.js.

TYPES

You can divide JavaScript types into two groups: *primitive* and *complex*. When one of the primitive types is accessed, you work directly on its value. When a complex type is accessed, you work on a reference to the value.

- The primitive types are `number`, `boolean`, `string`, `null`, and `undefined`.
- The complex types are `array`, `function`, and `object`.

To illustrate:

```
// primitives
var a = 5;
var b = a;
b = 6;
a; // will be 5
b; // will be 6

// complex
var a = ['hello', 'world'];
var b = a;
b[0] = 'bye';
a[0]; // will be 'bye'
b[0]; // will be 'bye'
```

In the second example, `b` contains the *same reference* to the value as `a` does. Hence, when you access the first member of the array, you alter the original, so `a[0] === b[0]`.

TYPE HICCUPS

Correctly identifying the type of value a certain variable holds remains a challenge in JavaScript.

Because JavaScript has constructors for most primitives like in other languages with object-oriented features, you can create a string in these two ways:

```
var a = 'woot';
var b = new String('woot');
a + b; // 'woot woot'
```

If you use the `typeof` and `instanceof` operators on these two variables, however, things get interesting:

```
typeof a; // 'string'
typeof b; // 'object'
a instanceof String; // false
b instanceof String; // true
```

However, both are definitely strings that have the same prototypical methods:

```
a.substr == b.substr; // true
```

And they evaluate in the same way with the `==` operator but not with `===`:

```
a == b; // true
a === b; // false
```

Considering these discrepancies, I encourage you to always define your types in the literal way, avoiding `new`.

It's important to remember that certain values will be evaluate to `false` in conditional expressions: `null`, `undefined`, `''`, `0`:

```
var a = 0;
if (a) {
  // this will never execute
}
a == false; // true
a === false; // false
```

Also noteworthy is the fact that `typeof` doesn't recognize `null` as its own type:

```
typeof null == 'object'; // true, unfortunately
```

And the same goes for arrays, even if defined with `[]`, as shown here:

```
typeof [] == 'object'; // true
```

You can be thankful that v8 provides a way of identifying an array without resorting to hacks. In browsers, you typically inspect the internal `[[Class]]` value of an object: `Object.prototype.toString.call([]) == '[object Array]'`. This is an immutable property of objects that has the benefit of working across different contexts (for example, browser frames), whereas `instanceof Array` is true only for arrays initialized within that particular context.

FUNCTIONS

Functions are of utmost importance in JavaScript.

They're *first class*: they can be stored in variables as references, and then you can pass them around as if they were any other object:

```
var a = function () {}
console.log(a); // passing the function as a parameter
```

All functions in JavaScript can be named. It's important to distinguish between the function name and the variable name:

```
var a = function a () {
  'function' == typeof a; // true
};
```

THIS, FUNCTION#CALL, AND FUNCTION#APPLY

When the following function is called, the value of `this` is the global object. In the browser, that's `window`:

```
function a () {
  window == this; // true;
};

a();
```

By using the `.call` and `.apply` methods, you can change the reference of `this` to a different object when calling the function:

```
function a () {
  this.a == 'b'; // true
}

a.call({ a: 'b' });
```

The difference between `call` and `apply` is that `call` takes a list of parameters to pass to the function following, whereas `apply` takes an array:

```
function a (b, c) {
  b == 'first'; // true
  c == 'second'; // true
}

a.call({ a: 'b' }, 'first', 'second')
a.apply({ a: 'b' }, ['first', 'second']);
```

FUNCTION ARITY

An interesting property of a function is its *arity*, which refers to the number of arguments that the function was declared with. In JavaScript, this equates to the `length` property of a function:

```
var a = function (a, b, c);
a.length == 3; // true
```

Even though less common in the browser, this feature is important to us because it's leveraged by some popular Node.JS frameworks to offer different functionality depending on the number of parameters the functions you pass around take.

CLOSURES

In JavaScript, every time a function is called, a new scope is defined.

Variables defined within a scope are accessible only to that scope and inner scopes (that is, scopes defined within that scope):

```
var a = 5;

function woot () {
  a == 5; // true

  var a = 6;

  function test () {
    a == 6; // true
  }

  test();
};

woot();
```

Self-invoked functions are a mechanism by which you declare and call an anonymous function where your only goal is defining a new scope:

```
var a = 3;

(function () {
  var a = 5;
})();

a == 3 // true;
```

These functions are very useful when you want to declare *private variables* that shouldn't be exposed to another piece of code.

CLASSES

In JavaScript, there's no `class` keyword. A class is defined like a function instead:

```
function Animal () { }
```

To define a method on all the instances of `Animal` that you create, you set it on the prototype:

```
Animal.prototype.eat = function (food) {
  // eat method
}
```

It's worth mentioning that within functions in the prototype, `this` doesn't refer to the global object like regular functions, but to the class instance instead:

```
function Animal (name) {
  this.name = name;
}

Animal.prototype.getName () {
  return this.name;
};

var animal = new Animal('tobi');
a.getName() == 'tobi'; // true
```

INHERITANCE

JavaScript has *prototypical inheritance*. Traditionally, you simulate classical inheritance as follows.

You define another constructor that's going to inherit from `Animal`:

```
function Ferret () { };
```

To define the inheritance chain, you initialize an `Animal` object and assign it to the `Ferret.prototype`.

```
// you inherit
Ferret.prototype = new Animal();
```

You can then define methods and properties exclusive to your subclass:

```
// you specialize the type property for all ferrets
Ferret.prototype.type = 'domestic';
```

To override methods and call the parent, you reference the prototype:

```
Ferret.prototype.eat = function (food) {
  Animal.prototype.eat.call(this, food);
  // ferret-specific logic here
}
```

This technique is almost perfect. It's the best performing across the board (compared to the alternative functional technique) and doesn't break the `instanceof` operator:

```
var animal = new Animal();
animal instanceof Animal // true
animal instanceof Ferret // false

var ferret = new Ferret();
ferret instanceof Animal // true
ferret instanceof Ferret // true
```

Its major drawback is that an object is initialized when the inheritance is declared (`Ferret.prototype = new Animal`), which might be undesirable. A way around this problem is to include a conditional statement in the constructor:

```
function Animal (a) {
  if (false !== a) return;
  // do constructor stuff
}

Ferret.prototype = new Animal(false)
```

Another workaround is to define a new, empty constructor and override its prototype:

```
function Animal () {
  // constructor stuff
}

function f () {};
f.prototype = Animal.prototype;
Ferret.prototype = new f;
```

Fortunately, v8 has a cleaner solution for this, which is described later in this chapter.

TRY {} CATCH {}

`try/catch` allows you to capture an exception. The following code throws one:

```
> var a = 5;
> a()
TypeError: Property 'a' of object #<Object> is not a function
```

When a function throws an error, execution stops:

```
function () {
  throw new Error('hi');
  console.log('hi'); // this will never execute
}
```

If you use `try/catch`, you can handle the error and execution continues:

```
function () {
  var a = 5;
  try {
    a();
  } catch (e) {
    e instanceof Error; // true
  }

  console.log('you got here!');
}
```

V8 JAVASCRIPT

So far you've looked at the JavaScript features that are most relevant to dealing with the language in most environments, including ancient browsers.

With the introduction of the Chrome web browser came a new JavaScript engine, v8, which has been quickly pushing the boundaries by providing us with an extremely fast execution environment that stays up-to-date and supports the latest ECMAScript features.

Some of these features address deficiencies in the language. Others were introduced thanks to the advent of client-side frameworks like jQuery and PrototypeJS, because they provided extensions or utilities that are so frequently used it's now unimaginable to consider the JavaScript language without them.

In this section you'll learn about the most useful features that you can take advantage of from v8 to write more concise and faster code that fits right it with the style of code that the most popular Node.JS frameworks and libraries adopt.

OBJECT#KEYS

If you wanted to obtain the keys for the following object (`a` and `c`)

```
var a = { a: 'b', c: 'd' };
```

Then normally iterate as follows:

```
for (var i in a) { }
```

By iterating over the keys, you can collect them in an array. However, if you were to extend the `Object.prototype` as follows:

```
Object.prototype.c = 'd';
```

To avoid getting `c` in the list of keys you would need to run a `hasOwnProperty` check:

```
for (var i in a) {
  if (a.hasOwnProperty(i)) {}
}
```

To get around that complication, to get all the own keys in an object, in v8 you can safely use

```
var a = { a: 'b', c: 'd' };
Object.keys(a); // ['a', 'c']
```

ARRAY#ISARRAY

Like you saw before, the `typeof` operator will return `"object"` for arrays. Most of the time, however, you want to check that an array is actually an array.

`Array.isArray` returns `true` for arrays and `false` for any other value:

```
Array.isArray(new Array) // true
Array.isArray([]) // true
Array.isArray(null) // false
Array.isArray(arguments) // false
```

ARRAY METHODS

To loop over an array, you can use `forEach` (similar to jQuery `$.each`):

```
// will print 1 2 and 3
[1, 2, 3].forEach(function (v) {
  console.log(v);
});
```

To *filter elements out* of an array, you can use `filter` (similar to jQuery `$.grep`)

```
[1, 2, 3].forEach(function (v) {
  return v < 3;
}); // will return [1, 2]
```

To change the value of each item, you can use `map` (similar to jQuery `$.map`)

```
[5, 10, 15].map(function (v) {
  return v * 2;
}); // will return [10, 20, 30]
```

Also available but less commonly used are the methods `reduce`, `reduceRight`, and `lastIndexOf`.

STRING METHODS

To remove space in the beginning and ending of a string, use

```
'  hello  '.trim(); // 'hello'
```

JSON

v8 exposes `JSON.stringify` and `JSON.parse` to decode and encode JSON, respectively.

JSON is an encoding specification that closely resembles the JavaScript object literal, utilized by many web services and APIs:

```
var obj = JSON.parse('{"a":"b"}')
obj.a == 'b'; // true
```

FUNCTION#BIND

`.bind` (equivalent to jQuery's `$.proxy`) allows you to change the reference of `this`:

```
function a () {
  this.hello == 'world'; // true
};

var b = a.bind({ hello: 'world' });
b();
```

FUNCTION#NAME

In v8, the nonstandard property `name` of a function is supported:

```
var a = function woot () {};
a.name == 'woot'; // true
```

This property is used internally by v8 in stack traces. When an error is thrown, v8 shows a *stack trace*, which is the succession of function calls it made to reach the point where the error occurred:

```
> var woot = function () { throw new Error(); };
> woot()
Error
    at [object Context]:1:32
```

In this case, v8 is not able to assign a name to the function reference. If you name it, however, v8 will be able to include it in the stack traces as shown here:

```
> var woot = function buggy () { throw new Error(); };
> woot()
Error
    at buggy ([object Context]:1:34)
```

Because naming significantly aids in debugging, I always recommend you name your functions.

PROTO (INHERITANCE)

`__proto__` makes it easy for you to define the inheritance chain:

```
function Animal () { }
function Ferret () { }
Ferret.prototype.__proto__ = Animal.prototype;
```

This is a very useful feature that removes the need to:

- Resort to intermediate constructors, as shown in the previous section.
- Leverage OOP toolkits or utilities. You don't need to require any third-party modules to expressively declare prototypical inheritance.

ACCESSORS

You are able to define properties that call functions when they're accessed (`__defineGetter__`) or set (`__defineSetter__`).

As an example, define a property called `ago` that returns the time ago in words for a `Date` object.

Many times, especially in the software you create, you want to express time in words relative to a certain point. For example, it's easier for people to understand that something happened three seconds ago than reading the complete date.

The following example adds an `ago` getter to all the `Date` instances that will output the distance of time in words to the present. Simply accessing the property will execute the function you define, without having to explicitly call it.

```
// Based on prettyDate by John Resig (MIT license)
Date.prototype.__defineGetter__('ago', function () {
  var diff = (((new Date()).getTime() - this.getTime()) / 1000)
    , day_diff = Math.floor(diff / 86400);
```

```
  return day_diff == 0 && (
      diff < 60 && "just now" ||
      diff < 120 && "1 minute ago" ||
      diff < 3600 && Math.floor( diff / 60 ) + " minutes ago" ||
      diff < 7200 && "1 hour ago" ||
      diff < 86400 && Math.floor( diff / 3600 ) + " hours ago") ||
      day_diff == 1 && "Yesterday" ||
      day_diff < 7 && day_diff + " days ago" ||
      Math.ceil( day_diff / 7 ) + " weeks ago";
});
```

Then you simply refer to the `ago` property. Notice that you're not executing a function, yet it's still being executed transparently for you:

```
var a = new Date('12/12/1990'); // my birth date
a.ago // 1071 weeks ago
```

SUMMARY

Understanding this chapter is essential to getting up to speed with the quirks of the language and handicaps of most environments the language has traditionally been run in, such as old browsers.

Due to JavaScript evolving really slowly and being somewhat overlooked for years, many developers have invested significant amounts of time in developing techniques to write the most efficient and maintainable code, and have characterized what aspects of the language don't work as expected.

v8 has done a fantastic job at keeping up to date with the recent editions of ECMA, and continues to do so. The Node.JS core team of developers always ensures that when you install the latest version of Node, you always get the most recent version of v8. This opens up a new panorama for server-side development, since we can leverage APIs that are easier to understand and faster to execute.

Hopefully during this chapter you've learned some of the features that Node developers commonly use, which are those that are defining the present and future of JavaScript.

CONTENTS