

the  
Deno



handbook

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The Deno Handbook

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# Preface

The Deno Handbook follows the 80/20 rule: learn in 20% of the time the 80% of a topic.

In particular, the goal is to get you up to speed quickly with Deno.

This book is written by Flavio. I **publish programming tutorials** every day on my website [flaviocopes.com](http://flaviocopes.com).

You can reach me on Twitter [@flaviocopes](https://twitter.com/flaviocopes).

Enjoy!

# The Deno Handbook

I explore new projects every week, and it's rare that one hits my attention so much as [Deno](#) did.



## What is Deno?

If you are familiar with Node.js, the popular server-side JavaScript ecosystem, then Deno is just like Node. Except deeply improved in many ways.

Let's start from a quick list of the features I like the most about Deno:

- It is based on modern features of the JavaScript language

- It has an extensive standard library
- It has TypeScript at its core, which brings a huge advantage in many different ways, including a first-class TypeScript support (you don't have to separately compile TypeScript, it's automatically done by Deno)
- It embraces [ES modules](#)
- It has no package manager
- It has a first-class `await`
- It has a built-in testing facility
- It aims to be browser-compatible as much as it can, for example by providing a built-in `fetch` and the global `window` object

We'll explore all of those features in this guide.

After you use Deno and learn to appreciate its features, Node.js will look like something *old*.

Especially because the Node.js API is callback based, as it was written way before promises and `async/await`. There's no change in place for that in Node, as such a change would be monumental, so we're stuck to callbacks or to promisifying API calls.

Node.js is **awesome** and will continue to be the de facto standard in the JavaScript world. But I think we'll gradually see Deno more adopted because of its first-class TypeScript support and modern standard library.

Deno can afford to have everything written with modern technologies, since there's no backward compatibility to maintain. Of course there's no

guarantee that in a decade the same will happen to Deno and a new technology will emerge, but this is the reality at the moment.

## Why Deno? Why now?

Deno was announced almost 2 years ago by the Node.js original creator Ryan Dahl at JSConf EU. Watch [the YouTube video of the talk](#), it's very interesting and it's a mandatory watch if you are involved in Node.js and JavaScript in general.

Every project manager must take decisions. Ryan regretted some early decisions in Node. Also, technology evolves, and today JavaScript is a totally different language than what it was back in 2009 when Node started. Think about the modern ES6/2016/2017 features, and so on.

So he started a new project to create some sort of second wave of JavaScript-powered server side apps.

The reason I am writing this guide now and not back then is because technologies need a lot of time to mature. And we have finally reached **Deno 1.0** (1.0 should be released on May 13, 2020), the first release of Deno officially declared stable.

That's might seem just a number, but 1.0 means there will not be major breaking changes until Deno 2.0, which is a big deal when you dive into a new technology - you don't want to learn something and then have it change too fast.

# Should you learn Deno?

That's a big question.

Learning something new such as Deno is a big effort. My suggestion is that if you are starting out now with server-side JS and you don't know Node yet, and never wrote any TypeScript, I'd start with Node.

No one was ever fired for choosing Node.js (paraphrasing a common quote).

But if you love TypeScript, don't depend on a gazillion npm packages in your projects and you want to use `await` anywhere, hey Deno might be what you're looking for.

## Will it replace Node.js?

No. Node.js is a giant, well established, incredibly well supported technology that is going to stay for decades.

## First-class TypeScript support

Deno is written in Rust and TypeScript, two of the languages that today are really growing fast.

In particular being written in TypeScript means we get a lot of the benefits of TypeScript even if we might choose to write our code in plain JavaScript.

And running TypeScript code with Deno does not require a compilation step - Deno does that automatically for you.

You are not forced to write in TypeScript, but the fact the core of Deno is written in TypeScript is huge.

First, an increasingly big percentage of JavaScript programmers love TypeScript.

Second, the tools you use can infer many information about software written in TypeScript, like Deno.

This means that while we code in VS Code for example, which obviously has a tight integration with TypeScript since both are developed at MicroSoft, we can get benefits like type checking as we write our code, and advanced [IntelliSense](#) features. In other words the editor can help us in a deeply useful way.

## Similarities and differences with Node.js

Since Deno is basically a Node.js replacement, it's useful to compare the two directly.

Similarities:

- Both are developed upon the [V8 Chromium Engine](#)
- Both are great for developing server-side with JavaScript

Differences:

- Node is written in C++ and JavaScript. Deno is written in Rust and TypeScript.
- Node has an official package manager called `npm`. Deno does not, and instead lets you import any ES Module from URLs.
- Node uses the CommonJS syntax for importing packages. Deno uses ES Modules, the official way.
- Deno uses modern ECMAScript features in all its API and standard library, while Node.js uses a callbacks-based standard library and has no plans to upgrade it.
- Deno offers a sandbox security layer through permissions. A program can only access the permissions set to the executable as flags by the user. A Node.js program can access anything the user can access
- Deno has for a long time envisioned the possibility of compiling a program into an executable that you can run without external dependencies, like Go, but [it's still not a thing yet](#). That'd be a game changer.

## No package manager

Having no package manager and having to rely on URLs to host and import packages has pros and cons. I really like the pros: it's very flexible, we can create packages without publishing them on a repository like npm.

I think that some sort of package manager will emerge, but nothing official is out yet.

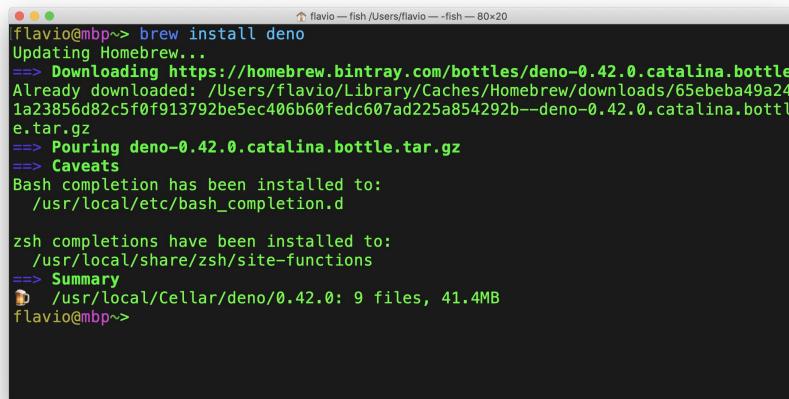
The Deno website provides code hosting (and thus distribution through URLs) to 3rd party packages: <https://deno.land/x/>

## Install Deno

Enough talk! Let's install Deno.

The easiest way is to use [Homebrew](#):

```
brew install deno
```



```
flavio@mbp~> brew install deno
Updating Homebrew...
==> Downloading https://homebrew.bintray.com/bottles/deno-0.42.0.catalina.bottle
Already downloaded: /Users/flavio/Library/Caches/Homebrew/downloads/65ebeba49a241a23856d82c5f0f913792be5ec406b60fedc607ad225a854292b--deno-0.42.0.catalina.bottle.tar.gz
==> Pouring deno-0.42.0.catalina.bottle.tar.gz
==> Caveats
Bash completion has been installed to:
  /usr/local/etc/bash_completion.d

zsh completions have been installed to:
  /usr/local/share/zsh/site-functions
==> Summary
🍺 /usr/local/Cellar/deno/0.42.0: 9 files, 41.4MB
flavio@mbp~>
```

Once this is done, you will have access to the `deno` command. Here's the help that you can get using

```
deno --help :
```

```
flavio@mbp~> deno --help
deno 0.42.0
A secure JavaScript and TypeScript runtime

Docs: https://deno.land/std/manual.md
Modules: https://deno.land/std/
https://deno.land/x/
Bugs: https://github.com/denoland/deno/issues

To start the REPL, supply no arguments:
deno

To execute a script:
deno run https://deno.land/std/examples/
  welcome.ts
deno https://deno.land/std/examples/welcome.ts

To evaluate code in the shell:
deno eval "console.log(30933 + 404)"

Run 'deno help run' for 'run'-specific flags.

USAGE:
deno [OPTIONS] [SUBCOMMAND]

OPTIONS:
-h, --help
    Prints help information

-L, --log-level <log-level>
    Set log level [possible values: debug,
    info]

-q, --quiet
    Suppress diagnostic output
    By default, subcommands print human-
    readable diagnostic messages to stderr.
    If the flag is set, restrict these
    messages to errors.

-V, --version
    Prints version information
```

**SUBCOMMANDS:**

bundle	Bundle module and dependencies into single file
cache	Cache the dependencies
completions	Generate shell completions
doc	Show documentation for a module
eval	Eval script
fmt	Format source files
help	Prints this message or the help of the given subcommand(s)
info	Show info about cache or info related to source file
install	Install script as an executable
repl	Read Eval Print Loop
run	Run a program given a filename or url to the module
test	Run tests
types	Print runtime TypeScript declarations
upgrade	Upgrade deno executable to newest version

**ENVIRONMENT VARIABLES:**

DENO_DIR	Set deno's base directory (defaults to \$HOME/.deno)
DENO_INSTALL_ROOT	Set deno install's output directory (defaults to \$HOME/.deno /bin)
NO_COLOR	Set to disable color
HTTP_PROXY	Proxy address for HTTP requests (module downloads, fetch)
HTTPS_PROXY	Same but for HTTPS

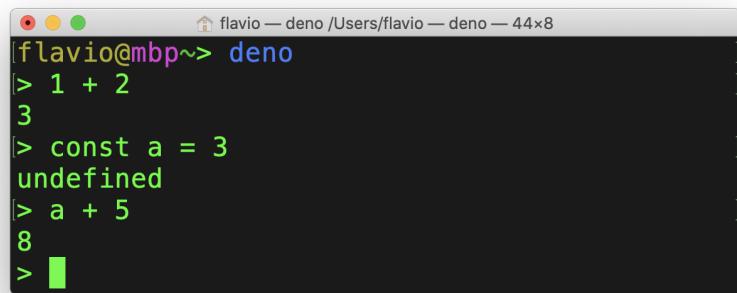
# The Deno commands

Note the `SUBCOMMANDS` section in the help, that lists all the commands we can run. What subcommands do we have?

- `bundle` bundle module and dependencies of a project into single file
- `cache` cache the dependencies
- `completions` generate shell completions
- `doc` show documentation for a module
- `eval` to evaluate a piece of code, e.g. `deno eval "console.log(1 + 2)"`
- `fmt` a built-in code formatter (similar to `gofmt` in Go)
- `help` prints this message or the help of the given subcommand(s)
- `info` show info about cache or info related to source file
- `install` install script as an executable
- `repl` Read-Eval-Print-Loop (the default)
- `run` run a program given a filename or url to the module
- `test` run tests
- `types` print runtime TypeScript declarations
- `upgrade` upgrade `deno` to the newest version

You can run `deno <subcommand> help` to get specific additional documentation for the command, for example `deno run --help`.

As the help says, we can use this command to start a REPL (Read-Execute-Print-Loop) using `deno` without any other option.



A screenshot of a macOS terminal window titled "flavio — deno /Users/flavio — deno — 44x8". The window shows the Deno REPL in action:

```
flavio@mbp ~> deno
> 1 + 2
3
> const a = 3
undefined
> a + 5
8
>
```

This is the same as running `deno repl`.

A more common way you'll use this command is to execute a Deno app contained in a TypeScript file.

You can run both TypeScript (`.ts`) files, or JavaScript (`.js`) files.

If you are unfamiliar with TypeScript, don't worry: Deno is written in TypeScript, but you can write your "client" applications in JavaScript.

My [TypeScript tutorial](#) will help you get up and running quickly with TypeScript if you want.

## Your first Deno app

Let's run a Deno app for the first time.

What I find pretty amazing is that you don't even have to write a single line - you can run a command from any URL.

Deno downloads the program, compiles it and then runs it:



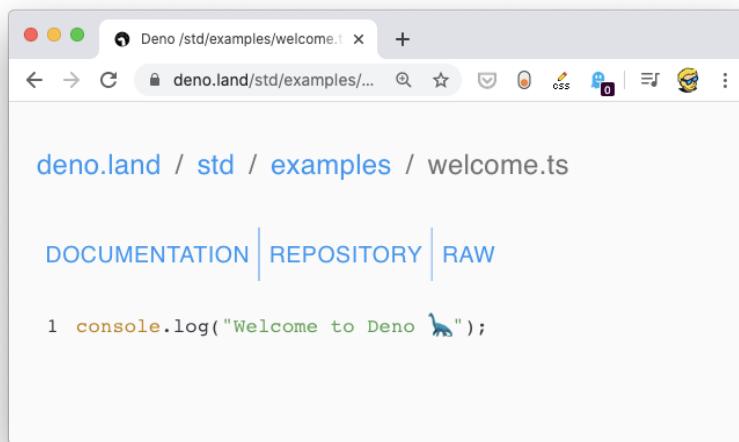
```
flavio@mbp ~> deno run https://deno.land/std/examples/welcome.ts
Download https://deno.land/std/examples/welcome.ts
Compile https://deno.land/std/examples/welcome.ts
Welcome to Deno 🦸
flavio@mbp ~>
```

Of course running arbitrary code from the Internet is not a practice generally recommendable. In this case we are running it from the Deno official site, plus Deno has a sandbox that prevents programs to do anything you don't want to allow. More on this later.

This program is very simple, just a `console.log()` call:

```
console.log('Welcome to Deno 🦸')
```

If you open the <https://deno.land/std/examples/welcome.ts> URL with the browser, you'll see this page:



Weird, right? You'd probably expect a TypeScript file, instead we have a web page. The reason is the Web server of the Deno website knows you're using a browser and serves you a more user friendly page.

Download the same UR using `wget` for example, which requests the `text/plain` version of it instead of `text/html`:



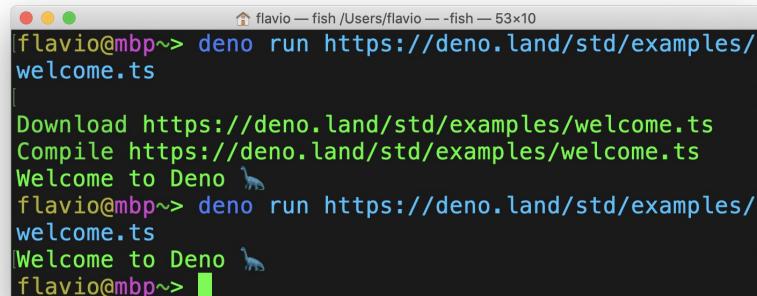
```
flavio@mbp~> wget https://deno.land/std/examples/welcome.ts
--2020-05-09 13:52:18-- https://deno.land/std/examples/welcome.ts
Resolving deno.land (deno.land)... 104.24.106.237, 104.24.107.237
Connecting to deno.land (deno.land)|104.24.106.237|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: unspecified [text/plain]
Saving to: 'welcome.ts'

welcome.ts          [ =>                      ]      37  --.-KB/s   in 0s

2020-05-09 13:52:18 (574 KB/s) - 'welcome.ts' saved [37]

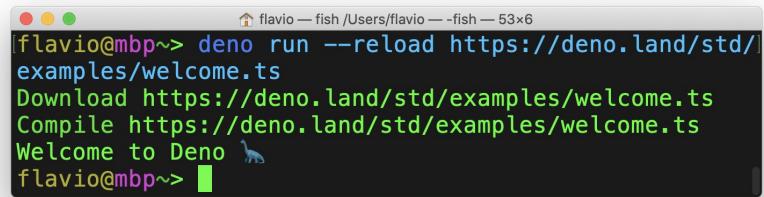
[flavio@mbp~> cat welcome.ts
console.log("Welcome to Deno 🦎");
flavio@mbp~>
```

If you want to run the program again, it's now cached by Deno and it does not need to download it again:



```
flavio — fish /Users/flavio — -fish — 53x10
[flavio@mbp~> deno run https://deno.land/std/examples/
welcome.ts
[
  Download https://deno.land/std/examples/welcome.ts
  Compile https://deno.land/std/examples/welcome.ts
  Welcome to Deno 🦎
  flavio@mbp~> deno run https://deno.land/std/examples/
welcome.ts
  Welcome to Deno 🦎
  flavio@mbp~>
```

You can force a reload of the original source with the `--reload` flag:



```
flavio@mbp ~> deno run --reload https://deno.land/std/examples/welcome.ts
Download https://deno.land/std/examples/welcome.ts
Compile https://deno.land/std/examples/welcome.ts
Welcome to Deno 🦕
flavio@mbp ~>
```

`deno run` has lots of different options that were not listed in the `deno --help`. Instead, you need to run `deno run --help` to reveal them:

```
flavio@mbp~> deno run --help
deno-run
Run a program given a filename or url to the
module.

By default all programs are run in sandbox without
access to disk, network or
ability to spawn subprocesses.
deno run https://deno.land/std/examples/
welcome.ts

Grant all permissions:
deno run -A https://deno.land/std/http/
file_server.ts

Grant permission to read from disk and listen to
network:
deno run --allow-read --allow-net
https://deno.land/std/http/file_server.ts

Grant permission to read whitelisted files from
disk:
deno run --allow-read=/etc
https://deno.land/std/http/file_server.ts

USAGE:
deno run [OPTIONS] <SCRIPT_ARG>...

OPTIONS:
-A, --allow-all
    Allow all permissions

--allow-env
    Allow environment access

--allow-hrtime
    Allow high resolution time measurement

--allow-net=<allow-net>
    Allow network access

--allow-plugin
    Allow loading plugins
```

```
--allow-read=<allow-read>
    Allow file system read access

--allow-run
    Allow running subprocesses

--allow-write=<allow-write>
    Allow file system write access

--cached-only
    Require that remote dependencies are
    already cached

--cert <FILE>
    Load certificate authority from PEM
    encoded file

-c, --config <FILE>
    Load tsconfig.json configuration file

-h, --help
    Prints help information

--importmap <FILE>
    UNSTABLE:
    Load import map file
    Docs: https://deno.land/std/manual.md#import-maps
    Specification: https://wicg.github.io/import-maps/
    Examples: https://github.com/WICG/import-maps#the-import-map

--inspect=<HOST:PORT>
    activate inspector on host:port
    (default: 127.0.0.1:9229)

--inspect-brk=<HOST:PORT>
    activate inspector on host:port and
    break at start of user script

--lock <FILE>
    Check the specified lock file
```

```
--lock-write
    Write lock file. Use with --lock.

-L, --log-level <log-level>
    Set log level [possible values: debug,
    info]

--no-remote
    Do not resolve remote modules

-q, --quiet
    Suppress diagnostic output
    By default, subcommands print human-
    readable diagnostic messages to stderr.
    If the flag is set, restrict these
    messages to errors.

-r, --reload=<CACHE_BLACKLIST>
    Reload source code cache (recompile
    TypeScript)
    --reload
        Reload everything
    --reload=https://deno.land/std
        Reload only standard modules
    --reload=https://deno.land/std/fs/
        utils.ts,https://deno.land/std/fmt/
        colors.ts
        Reloads specific modules
    --seed <NUMBER>
        Seed Math.random()

    --unstable
        Enable unstable APIs

    --v8-flags=<v8-flags>
        Set V8 command line options.
        For help: --v8-flags=--help
```

#### ARGS:

```
<SCRIPT_ARG>...
    script args
```

# Deno code examples

In addition to the one we ran above, the Deno website provides some other examples you can check out: <https://deno.land/std/examples/>.

At the time of writing we can find:

- `cat.ts` prints the content a list of files provided as arguments
- `catj.ts` prints the content a list of files provided as arguments
- `chat/` an implementation of a chat
- `colors.ts` an example of
- `curl.ts` a simple implementation of `curl` that prints the content of the URL specified as argument
- `echo_server.ts` a TCP echo server
- `gist.ts` a program to post files to `gist.github.com`
- `test.ts` a sample test suite
- `welcome.ts` a simple `console.log` statement (the first program we ran above)
- `xeval.ts` allows you to run any TypeScript code for any line of standard input received. [Once known as `deno xeval`](#) but since removed from the official command.

## Your first Deno app (for real)

Let's write some code.

Your first Deno app you ran using `deno run https://deno.land/std/examples/welcome.ts` was an app that someone else wrote, so you didn't see anything in regards to how Deno code looks like.

We'll start from the default example app listed on the Deno official website:

```
import { serve } from
  'https://deno.land/std/http/server.ts'
const s = serve({ port: 8000 })
console.log('http://localhost:8000/')
for await (const req of s) {
  req.respond({ body: 'Hello World\n' })
}
```

This code imports the `serve` function from the `http/server` module. See? We don't have to install it first, and it's also not stored on your local machine like it happens with Node modules. This is one reason why the Deno installation was so fast.

Importing from `https://deno.land/std/http/server.ts` imports the latest version of the module. You can import a specific version using `@VERSION`, like this:

```
import { serve } from
  'https://deno.land/std@v0.42.0/http/server.ts'
```

The `serve` function is defined like this in this file:

```

/**
 * Create a HTTP server
 *
 * import { serve } from
 * "https://deno.land/std/http/server.ts";
 * const body = "Hello World\n";
 * const s = serve({ port: 8000 });
 * for await (const req of s) {
 *   req.respond({ body });
 * }
 */
export function serve(addr: string | HTTPOptions): Server {
  if (typeof addr === 'string') {
    const [hostname, port] = addr.split(':')
    addr = { hostname, port: Number(port) }
  }

  const listener = listen(addr)
  return new Server(listener)
}

```

We proceed to instantiate a server calling the `serve()` function passing an object with the `port` property.

Then we run this loop to respond to every request coming from the server.

```

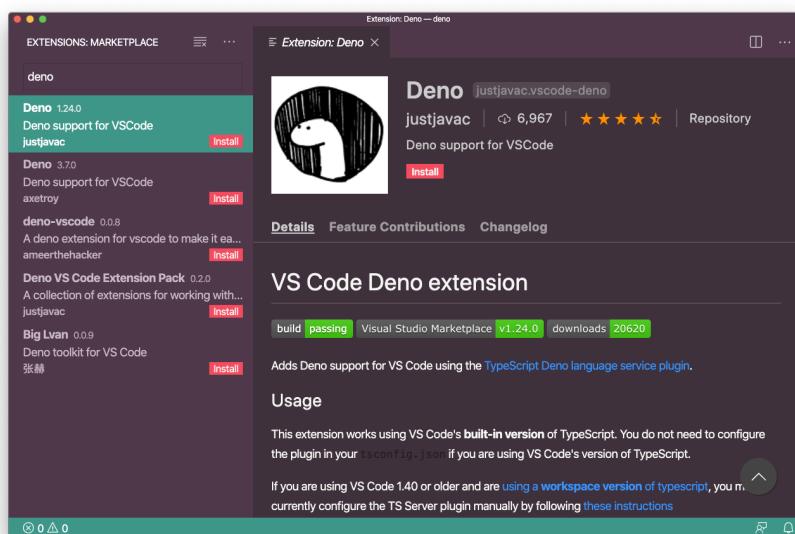
for await (const req of s) {
  req.respond({ body: 'Hello World\n' })
}

```

Note that we use the `await` keyword without having to wrap it into an `async` function because Deno implements [top-level await](#).

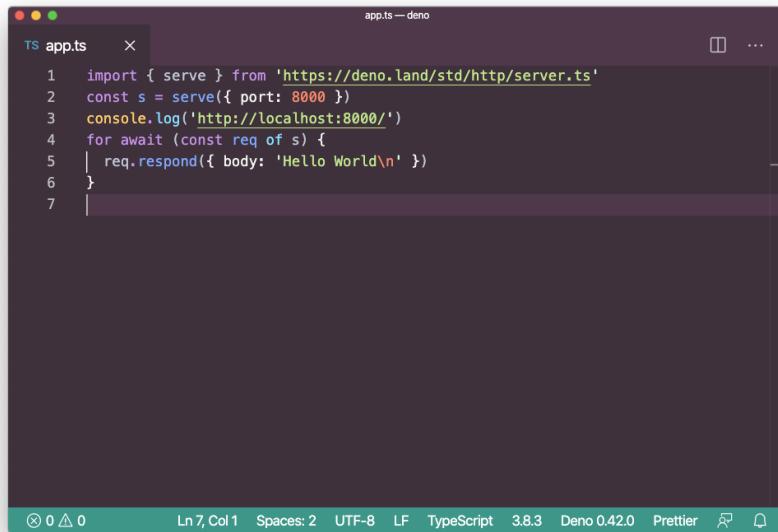
Let's run this program locally. I assume you use [VS Code](#), but you can use any editor you like.

I recommend installing the Deno extension from [justjavac](#) (there was another one with the same name when I tried, but deprecated - might disappear in the future)



The extension will provide several utilities and nice thing to VS Code to help you write your apps.

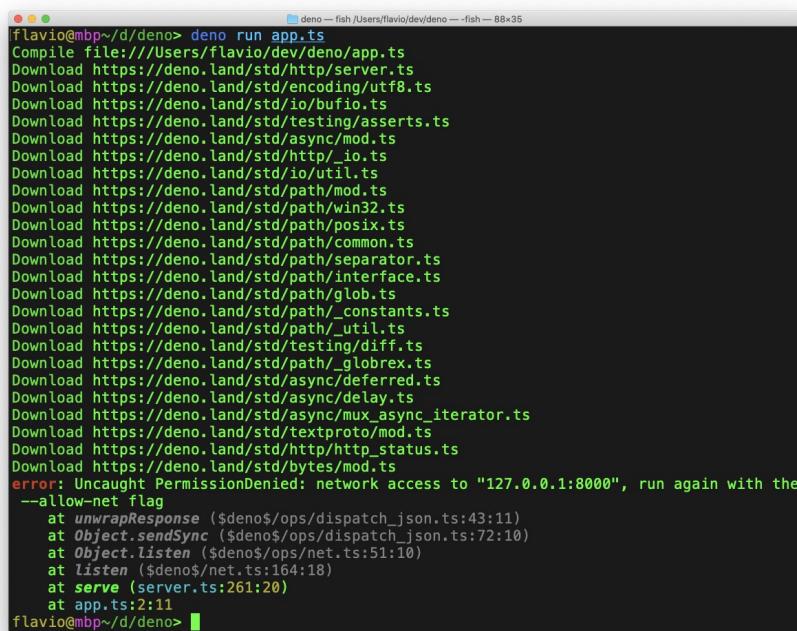
Now create an `app.ts` file in a folder and paste the above code:



```
TS app.ts
1 import { serve } from 'https://deno.land/std/http/server.ts'
2 const s = serve({ port: 8000 })
3 console.log('http://localhost:8000/')
4 for await (const req of s) {
5 | req.respond({ body: 'Hello World\n' })
6 }
7 
```

Ln 7, Col 1 Spaces: 2 UTF-8 LF TypeScript 3.8.3 Deno 0.42.0 Prettier ⚡ ⚡

Now run it using `deno run app.ts`:



```
flavio@mbp~/d/deno> deno run app.ts
Compile file:///Users/flavio/dev/deno/app.ts
Download https://deno.land/std/http/server.ts
Download https://deno.land/std/encoding/utf8.ts
Download https://deno.land/std/io/bufio.ts
Download https://deno.land/std/testing/asserts.ts
Download https://deno.land/std/async/mod.ts
Download https://deno.land/std/http/_io.ts
Download https://deno.land/std/io/util.ts
Download https://deno.land/std/path/mod.ts
Download https://deno.land/std/path/win32.ts
Download https://deno.land/std/path posix.ts
Download https://deno.land/std/path/common.ts
Download https://deno.land/std/path/separator.ts
Download https://deno.land/std/path/interface.ts
Download https://deno.land/std/path/glob.ts
Download https://deno.land/std/path/_constants.ts
Download https://deno.land/std/path/_util.ts
Download https://deno.land/std/testing/diff.ts
Download https://deno.land/std/path/_globrex.ts
Download https://deno.land/std/async/deferred.ts
Download https://deno.land/std/async/delay.ts
Download https://deno.land/std/async/mux_async_iterator.ts
Download https://deno.land/std/textproto/mod.ts
Download https://deno.land/std/http/http_status.ts
Download https://deno.land/std/bytes/mod.ts
error: Uncaught PermissionDenied: network access to "127.0.0.1:8000", run again with the
--allow-net flag
  at unwrapResponse ($deno$ops/dispatch_json.ts:43:11)
  at Object.sendSync ($deno$ops/dispatch_json.ts:72:10)
  at Object.listen ($deno$ops/net.ts:51:10)
  at listen ($deno$net.ts:164:18)
  at serve (server.ts:261:20)
  at app.ts:2:11
flavio@mbp~/d/deno>
```

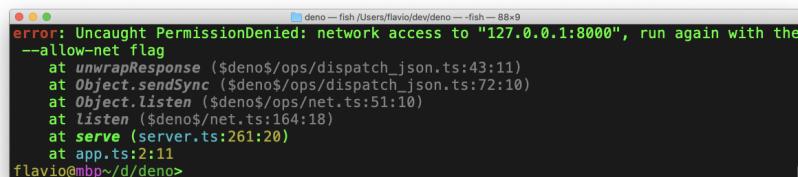
Deno downloads all the dependencies it needs, by first downloading the one we imported.

The <https://deno.land/std/http/server.ts> file has several dependencies on its own:

```
import { encode } from '../encoding(utf8.ts'
import { BufReader, BufWriter }
from '../io/bufio.ts'
import { assert } from '../testing/asserts.ts'
import { deferred, Deferred, MuxAsyncIterator }
from '../async/mod.ts'
import {
bodyReader,
chunkedBodyReader,
emptyReader,
writeResponse,
readRequest,
} from './io.ts'
import Listener = Deno.Listener
import Conn = Deno.Conn
import Reader = Deno.Reader
```

and those are imported automatically.

At the end though we have a problem:

A screenshot of a terminal window titled "deno — fish /Users/flavio/dev/deno — -fish — 88x9". The window shows a stack trace for an Uncaught PermissionDenied error. The error message is: "error: Uncaught PermissionDenied: network access to \"127.0.0.1:8000\", run again with the --allow-net flag". The stack trace includes frames like "at unwrapResponse (\$deno\$/ops/dispatch\_json.ts:43:11)", "at Object.sendSync (\$deno\$/ops/dispatch\_json.ts:72:10)", "at Object.listen (\$deno\$/ops/net.ts:51:10)", "at listen (\$deno\$/net.ts:164:18)", "at serve (server.ts:261:20)", and "at app.ts:2:11". The prompt at the bottom right is "flavio@mbp~/.deno>".

What is happening? We have a permission denied problem.

Let's talk about the sandbox.

## The Deno sandbox

I mentioned previously that Deno has a sandbox that prevents programs to do anything you don't want to allow.

What does this mean?

One of the things that Ryan mentions in the Deno introduction talk is that sometimes you want to run a JavaScript program outside of the Web Browser, and yet do not allow it to access anything it wants on your system. Or talk to the external world using a network.

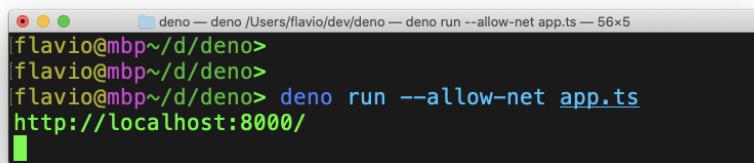
There's nothing stopping a Node.js app to get your SSH keys or any other thing on your system and send it to a server. This is why we usually only install Node packages from trusted sources, but how can we know if one of the projects we use gets hacked and in turn everyone else does?

Deno tries to replicate the same permission model that the browser implements. No JavaScript running in the browser can do shady things on your system unless you explicitly allow it.

Going back to Deno, if a program want to access the network like in the previous case, then we need to give it permission.

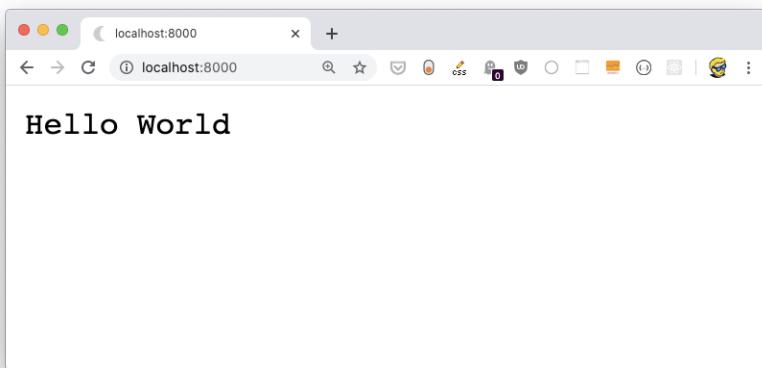
We can do so by passing a flag when we run the command, in this case `--allow-net` :

```
deno run --allow-net app.ts
```

A screenshot of a macOS terminal window titled "deno". The window shows the command "deno run --allow-net app.ts" being run, followed by the output "http://localhost:8000/".

```
deno — deno /Users/flavio/dev/deno — deno run --allow-net app.ts — 56x5
flavio@mbp~/d/deno>
flavio@mbp~/d/deno>
flavio@mbp~/d/deno> deno run --allow-net app.ts
http://localhost:8000/
```

The app is now running an HTTP server on port 8000:



Other flags allow Deno to unlock other functionality:

- `--allow-env` allow environment access
- `--allow-hrtime` allow high resolution time measurement
- `--allow-net=<allow-net>` allow network access
- `--allow-plugin` allow loading plugins
- `--allow-read=<allow-read>` allow file system read access
- `--allow-run` allow running subprocesses
- `--allow-write=<allow-write>` allow file system write access
- `--allow-all` allow all permissions (same as `-A`)

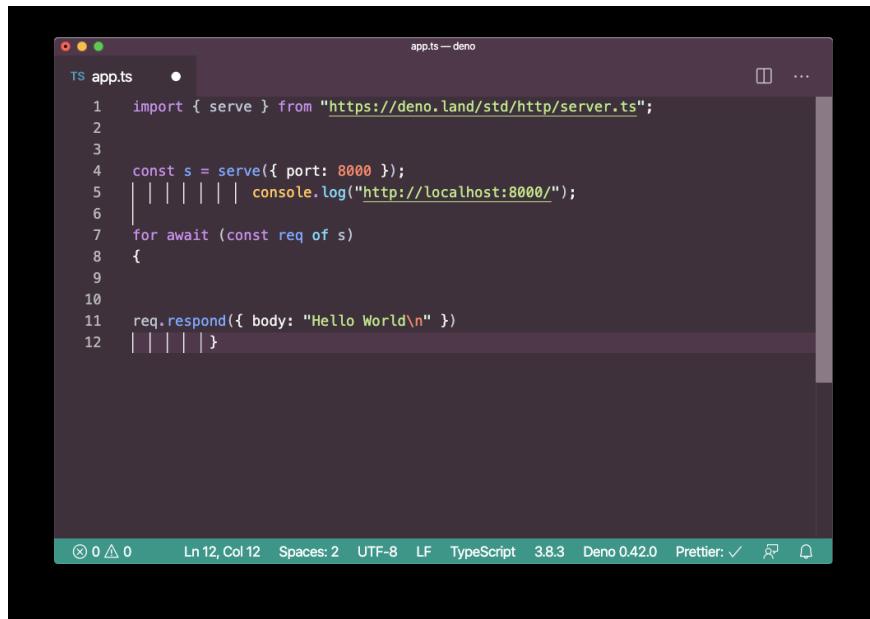
Permissions for `net`, `read` and `write` can be granular. For example, you can allow reading from a specific folder using `--allow-read=/dev`

## Formatting code

One of the things I really liked from Go was the `gofmt` command that came with the Go compiler. All Go code looks the same. Everyone uses `gofmt`.

JavaScript programmers are used to running [Prettier](#), and `deno fmt` actually runs that under the hood.

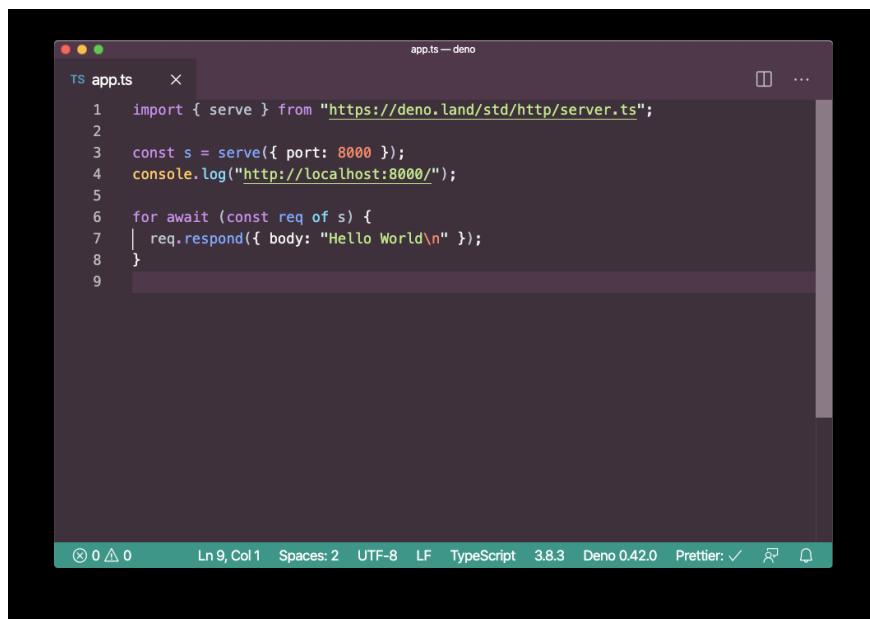
Say you have a file formatted badly like this:



```
TS app.ts
1 import { serve } from "https://deno.land/std/http/server.ts";
2
3
4 const s = serve({ port: 8000 });
5 | | | | | console.log("http://localhost:8000/");
6 |
7 for await (const req of s)
8 {
9
10 req.respond({ body: "Hello World\n" })
11 | | | | }
```

The terminal status bar at the bottom shows: ⌘ 0 △ 0 Ln 12, Col 12 Spaces: 2 UTF-8 LF TypeScript 3.8.3 Deno 0.42.0 Prettier: ✓ 🔍 🔍

You run `deno fmt app.ts` and it's automatically formatted properly, also adding semicolons where missing:



```
TS app.ts
1 import { serve } from "https://deno.land/std/http/server.ts";
2
3 const s = serve({ port: 8000 });
4 console.log("http://localhost:8000/");
5
6 for await (const req of s) {
7   req.respond({ body: "Hello World\n" });
8 }
```

The terminal status bar at the bottom shows: ⌘ 0 △ 0 Ln 9, Col 1 Spaces: 2 UTF-8 LF TypeScript 3.8.3 Deno 0.42.0 Prettier: ✓ 🔍 🔍

## The standard library

The Deno standard library is extensive despite the project being very young.

It includes:

- `archive` tar archive utilities
- `async` async utils
- `bytes` helpers to manipulate bytes slices
- `datetime` date/time parsing
- `encoding` encoding/decoding for various formats
- `flags` parse command-line flags
- `fmt` formatting and printing
- `fs` file system API
- `hash` crypto lib
- `http` HTTP server
- `io` I/O lib
- `log` logging utilities
- `mime` support for multipart data
- `node` Node.js compatibility layer
- `path` path manipulation
- `ws` websockets

## Another Deno example

Let's see another example of a Deno app, from the Deno examples: `cat` :

```
const filenames = Deno.args
for (const filename of filenames) {
    const file = await Deno.open(filename)
    await Deno.copy(file, Deno.stdout)
    file.close()
}
```

This assigns to the `filenames` variable the content of `Deno.args`, which is a variable containing all the arguments sent to the command.

We iterate through them, and for each we use `Deno.open()` to open the file and we use `Deno.copy()` to print the content of the file to `Deno.stdout`. Finally we close the file.

If you run this using

```
deno run https://deno.land/std/examples/cat.ts
```

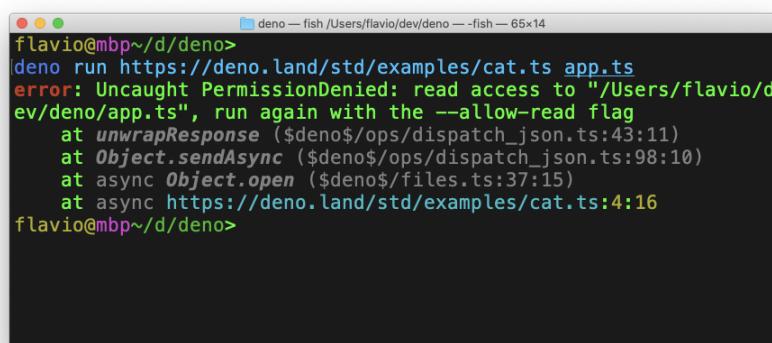
The program is downloaded and compiled, and nothing happens because we didn't specify any argument.

Try now

```
deno run https://deno.land/std/examples/cat.ts  
app.ts
```

assuming you have `app.ts` from the previous project in the same folder.

You'll get a permission error:

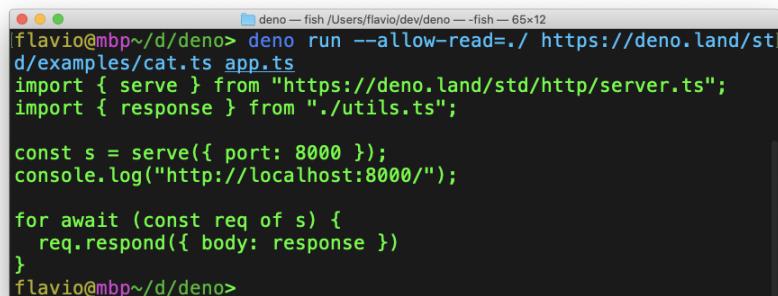


A screenshot of a macOS terminal window titled "deno — fish /Users/flavio/dev/deno — -fish — 65x14". The command entered is "deno run https://deno.land/std/examples/cat.ts app.ts". The output shows an "error: Uncaught PermissionDenied: read access to '/Users/flavio/dev/deno/app.ts'" message, followed by a stack trace of Deno's internal code. The terminal window has a dark theme with light-colored text.

```
flavio@mbp~/d/deno>  
deno run https://deno.land/std/examples/cat.ts app.ts  
error: Uncaught PermissionDenied: read access to "/Users/flavio/dev/deno/app.ts", run again with the --allow-read flag  
  at unwrapResponse ($deno$/ops/dispatch_json.ts:43:11)  
  at Object.sendAsync ($deno$/ops/dispatch_json.ts:98:10)  
  at async Object.open ($deno$/files.ts:37:15)  
  at async https://deno.land/std/examples/cat.ts:4:16  
flavio@mbp~/d/deno>
```

Because Deno disallows access to the filesystem by default. Grant access to the current folder using `--allow-read=.` :

```
deno run --allow-read=.  
https://deno.land/std/examples/cat.ts app.ts
```



```
deno — fish /Users/flavio/dev/deno — -fish — 65x12  
flavio@mbp~/d/deno> deno run --allow-read=.  
https://deno.land/std/examples/cat.ts app.ts  
import { serve } from "https://deno.land/std/http/server.ts";  
import { response } from "./utils.ts";  
  
const s = serve({ port: 8000 });  
console.log("http://localhost:8000/");  
  
for await (const req of s) {  
    req.respond({ body: response })  
}  
flavio@mbp~/d/deno>
```

## Is there an Express/Hapi/Koa/\* for Deno?

Yes, definitely. Check out projects like

- [deno-drash](#)
- [deno-express](#)
- [oak](#)
- [pogo](#)
- [servest](#)

## Example: use Oak to build a REST API

I want to make a simple example of how to build a REST API using Oak. Oak is interesting because it's inspired by [Koa](#), the popular Node.js middleware, and due to this it's very familiar if you've used that before.

The API we're going to build is very simple.

Our server will store, in memory, a list of dogs with name and age.

We want to:

- add new dogs
- list dogs
- get details about a specific dog
- remove a dog from the list
- update a dog age

We'll do this in TypeScript, but nothing stops you from writing the API in JavaScript - you simply remove the types.

Create a `app.ts` file.

Let's start by importing the `Application` and `Router` objects from Oak:

```
import { Application, Router }  
from 'https://deno.land/x/oak/mod.ts'
```

then we get the environment variables `PORT` and `HOST`:

```
const env = Deno.env.toObject()  
const PORT = env.PORT || 4000  
const HOST = env.HOST || '127.0.0.1'
```

By default our app will run on localhost:4000.

Now we create the Oak application and we start it:

```
const router = new Router()

const app = new Application()

app.use(router.routes())
app.use(router.allowedMethods())

console.log(`Listening on port ${PORT}...`)

await app.listen(`${HOST}:${PORT}`)
```

Now the app should be compiling fine.

Run

```
deno run --allow-env --allow-net app.ts
```

and Deno will download the dependencies:

```

Compile file:///Users/flavio/dev/deno/apiserver/server.ts
Download https://deno.land/x/oak/mod.ts
Download https://deno.land/x/oak/application.ts
Download https://deno.land/x/oak/context.ts
Download https://deno.land/x/oak/cookies.ts
Download https://deno.land/x/oak/httpError.ts
Download https://deno.land/x/oak/middleware.ts
Download https://deno.land/x/oak/request.ts
Download https://deno.land/x/oak/response.ts
Download https://deno.land/x/oak/router.ts
Download https://deno.land/x/oak/send.ts
Download https://deno.land/x/oak/types.ts
Download https://deno.land/x/oak/deps.ts
Download https://deno.land/x/oak/keyStack.ts
Download https://deno.land/x/oak/tssCompare.ts
Download https://deno.land/std@0.50.0/hash/sha256.ts
Download https://deno.land/std@0.50.0/http/server.ts
Download https://deno.land/std@0.50.0/http/http_status.ts
Download https://deno.land/std@0.50.0/http/cookie.ts
Download https://deno.land/std@0.50.0/path/mod.ts
Download https://deno.land/std@0.50.0/testing/asserts.ts
Download https://deno.land/x/media_types@v2.2.0/mod.ts
Download https://deno.land/std@0.50.0/encoding/utf8.ts
Download https://deno.land/std@0.50.0/io/bufio.ts
Download https://deno.land/std@0.50.0/async/mod.ts
Download https://deno.land/std@0.50.0/http/_io.ts
Download https://deno.land/std@0.50.0/io/util.ts
Download https://deno.land/std@0.50.0/path/win32.ts
Download https://deno.land/std@0.50.0/path posix.ts
Download https://deno.land/std@0.50.0/path/common.ts
Download https://deno.land/std@0.50.0/path/separator.ts
Download https://deno.land/std@0.50.0/path/interface.ts
Download https://deno.land/std@0.50.0/path/glob.ts
Download https://deno.land/std@0.50.0/path/_constants.ts
Download https://deno.land/std@0.50.0/path/_util.ts
Download https://deno.land/std@0.50.0/fmt/colors.ts
Download https://deno.land/std@0.50.0/testing/diff.ts
Download https://deno.land/std@0.50.0/path/_globrex.ts
Download https://deno.land/std@0.50.0/async/deferred.ts
Download https://deno.land/std@0.50.0/async/delay.ts
Download https://deno.land/std@0.50.0/async/mux_async_iterator.ts
Download https://deno.land/std@0.50.0/textproto/mod.ts
Download https://deno.land/std@0.50.0/bytes/mod.ts
Download https://deno.land/std@0.50.0/datetime/mod.ts
Download https://deno.land/x/media_types@v2.2.0/db.ts
Download https://deno.land/x/media_types@v2.2.0/deps.ts
Download https://deno.land/x/oak/encoding.ts
Download https://deno.land/x/oak/isMediaType.ts
Download https://deno.land/x/oak/mediaType.ts
Download https://deno.land/x/oak/mediaTyper.ts
Download https://deno.land/x/oak/util.ts
Download https://deno.land/x/oak/pathToRegExp.ts

```

and then listen on port 4000.

The following times you'll run the command, Deno will skip the installation part because those packages are already cached:

```

flavio@mbp~/d/d/apiserver> deno run --allow-env --allow-net app.ts
Listening on port 4000...

```

At the top of the file, let's define an interface for a dog, then we declare an initial `dogs` array of Dog objects:

```
interface Dog {  
    name: string  
    age: number  
}  
  
let dogs: Array<Dog> = [  
    {  
        name: 'Roger',  
        age: 8,  
    },  
    {  
        name: 'Syd',  
        age: 7,  
    },  
]
```

Now let's actually implement the API.

We have everything in place. After you create the router, let's add some functions that will be invoked any time one of those endpoints is hit:

```
const router = new Router()  
  
router  
.get('/dogs', getDogs)  
.get('/dogs/:name', getDog)  
.post('/dogs', addDog)  
.put('/dogs/:name', updateDog)  
.delete('/dogs/:name', removeDog)
```

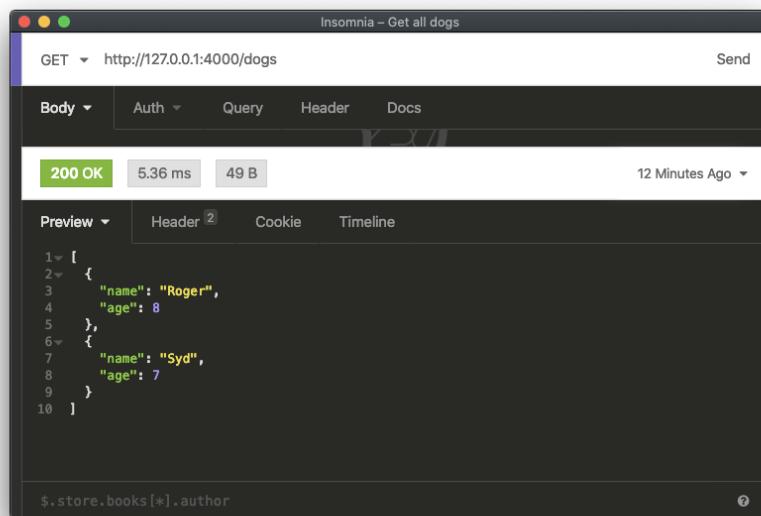
See? We define

- GET /dogs
- GET /dogs/:name
- POST /dogs
- PUT /dogs/:name
- DELETE /dogs/:name

Let's implement those one-by-one.

Starting from `GET /dogs`, which returns the list of all the dogs:

```
export const getDogs =
  ({ response }: { response: any }) => {
  response.body = dogs
}
```



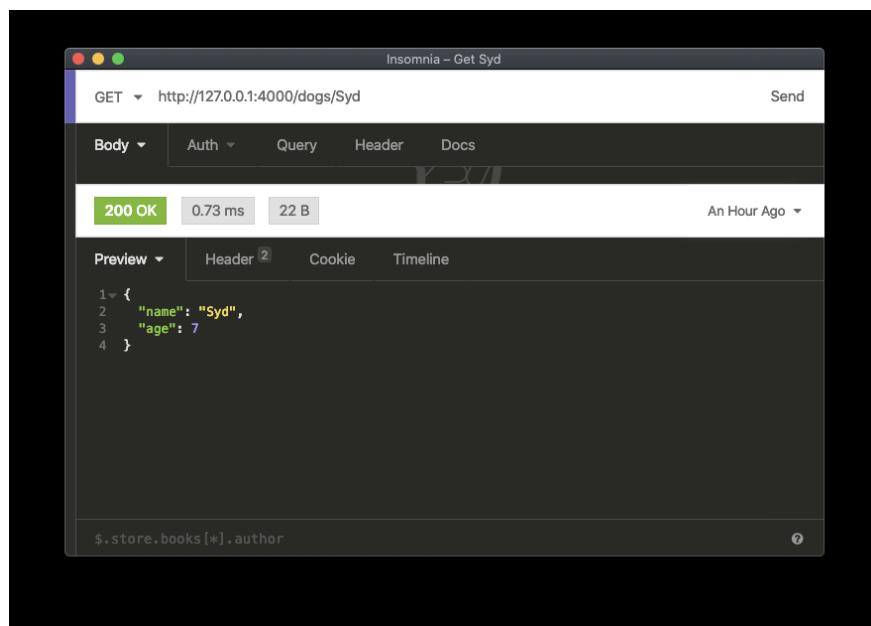
Next, here's how we can retrieve a single dog by name:

```

export const getDog = ({
  params,
  response,
}: {
  params: {
    name: string
  }
  response: any
}) => {
  const dog = dogs.filter((dog) =>
    dog.name === params.name)
  if (dog.length) {
    response.status = 200
    response.body = dog[0]
    return
  }

  response.status = 400
  response.body = { msg: `Cannot
    find dog ${params.name}` }
}

```



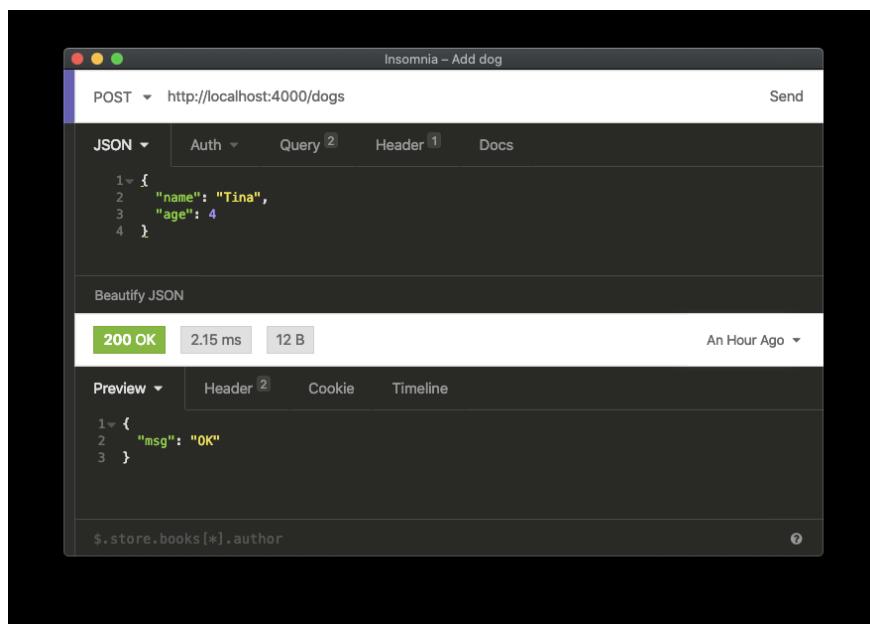
Here is how we add a new dog:

```

export const addDog = async ({
  request,
  response,
}: {
  request: any
  response: any
}) => {
  const body = await request.body()
  const dog: Dog = body.value
  dogs.push(dog)

  response.body = { msg: 'OK' }
  response.status = 200
}

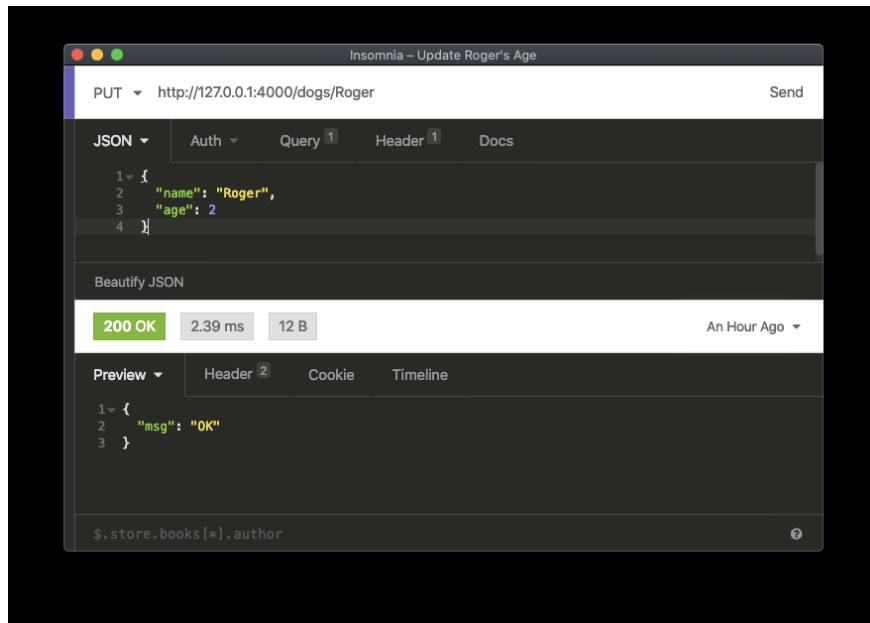
```



Notice that I now used `const body = await request.body()` to get the content of the body, since the `name` and `age` values are passed as JSON.

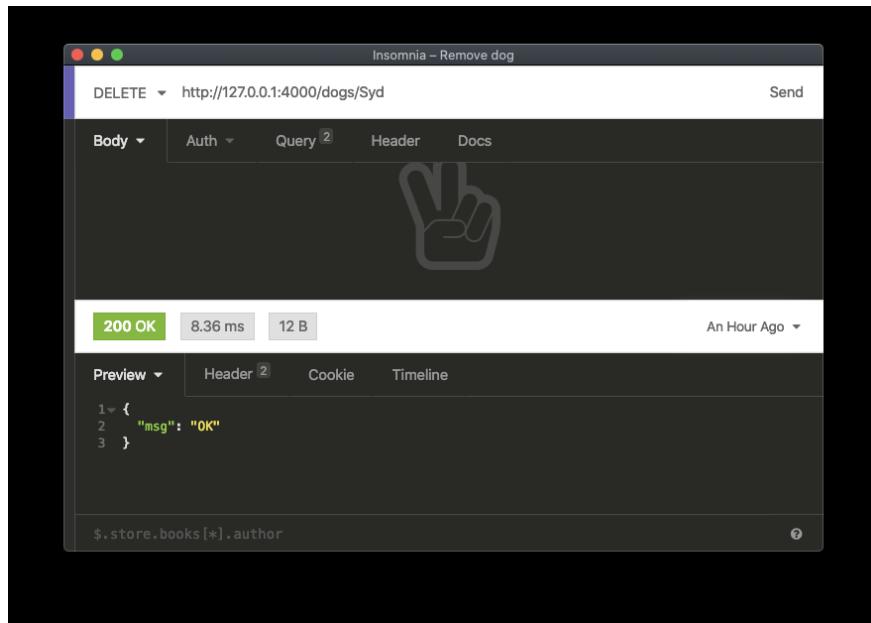
Here's how we update a dog's age:

```
export const updateDog = async ({  
  params,  
  request,  
  response,  
}: {  
  params: {  
    name: string  
  }  
  request: any  
  response: any  
) => {  
  const temp = dogs.filter((existingDog) =>  
    existingDog.name === params.name)  
  const body = await request.body()  
  const { age }: { age: number } = body.value  
  
  if (temp.length) {  
    temp[0].age = age  
    response.status = 200  
    response.body = { msg: 'OK' }  
    return  
  }  
  
  response.status = 400  
  response.body = { msg: `Cannot find dog  
  ${params.name}` }  
}
```



and here is how we can remove a dog from our list:

```
export const removeDog = ({  
  params,  
  response,  
}: {  
  params: {  
    name: string  
  }  
  response: any  
) => {  
  const lengthBefore = dogs.length  
  dogs = dogs.filter((dog) =>  
    dog.name !== params.name)  
  
  if (dogs.length === lengthBefore) {  
    response.status = 400  
    response.body = { msg: `Cannot find  
      dog ${params.name}` }  
    return  
  }  
  
  response.body = { msg: 'OK' }  
  response.status = 200  
}
```



Here's the complete example code:

```

import { Application, Router }
from 'https://deno.land/x/oak/mod.ts'

const env = Deno.env.toObject()
const PORT = env.PORT || 4000
const HOST = env.HOST || '127.0.0.1'

interface Dog {
    name: string
    age: number
}

let dogs: Array<Dog> = [
    {
        name: 'Roger',
        age: 8,
    },
    {
        name: 'Syd',
        age: 7,
    },
]

export const getDogs =
({ response }: { response: any }) => {
    response.body = dogs
}

export const getDog = ({
    params,
    response,
}: {
    params: {
        name: string
    }
    response: any
}) => {
    const dog = dogs.filter((dog) =>
        dog.name === params.name)
    if (dog.length) {
        response.status = 200
        response.body = dog[0]
        return
    }
}

```

```

}

response.status = 400
response.body = { msg: `Cannot find
  dog ${params.name}` }
}

export const addDog = async ({
  request,
  response,
}: {
  request: any
  response: any
}) => {
  const body = await request.body()
  const { name, age }: {
    name: string; age: number } = body.value
  dogs.push({
    name: name,
    age: age,
  })

  response.body = { msg: 'OK' }
  response.status = 200
}

export const updateDog = async ({
  params,
  request,
  response,
}: {
  params: {
    name: string
  }
  request: any
  response: any
}) => {
  const temp = dogs.filter((existingDog) =>
    existingDog.name === params.name)
  const body = await request.body()
  const { age }: { age: number } = body.value

  if (temp.length) {
    temp[0].age = age
  }
}

```

```

        response.status = 200
        response.body = { msg: 'OK' }
        return
    }

    response.status = 400
    response.body = { msg: `Cannot find
        dog ${params.name}` }
}

export const removeDog = ({
    params,
    response,
}: {
    params: {
        name: string
    }
    response: any
}) => {
    const lengthBefore = dogs.length
    dogs = dogs.filter((dog) =>
        dog.name !== params.name)

    if (dogs.length === lengthBefore) {
        response.status = 400
        response.body = { msg: `Cannot find
            dog ${params.name}` }
        return
    }

    response.body = { msg: 'OK' }
    response.status = 200
}

const router = new Router()
router
    .get('/dogs', getDogs)
    .get('/dogs/:name', getDog)
    .post('/dogs', addDog)
    .put('/dogs/:name', updateDog)
    .delete('/dogs/:name', removeDog)

const app = new Application()

```

```
app.use(router.routes())
app.use(router.allowedMethods())

console.log(`Listening on port ${PORT}...`)

await app.listen(`:${HOST}:${PORT}`)
```

## Find out more

The Deno official website is <https://deno.land>

The API documentation is available at  
<https://doc.deno.land> and  
<https://deno.land/typedoc/index.html>

awesome-deno <https://github.com/denolib/awesome-deno>

## A few more random tidbits

- Deno provides a built-in `fetch` implementation that matches the one available in the browser
- Deno has a compatibility layer with the Node.js `stdlib` [in progress](#)