You Don't Know Node

Guide to Node's Core Features

Slides 

https://github.com/azat-co/you-dont-know-node

or

PDF: http://bit.ly/1VJWpQK

or

```
$ mkdir node_modules && npm install you-dont-know-node
```

Better Apps—Better Life

Disclaimer

How to drink from a firehose: If we skip some slides (and we'll do)—that's by design to encourage further exploration on your own.

Key Takeaways

1. Event loop: Brush-up on the core concept which enables non-blocking I/O
2. Streams and buffers: Effective way to work with data
3. Global and process: How to access more info

More Key Takeaways

1. Event emitters: Crash course in the event-based pattern
2. Clusters: Fork processes like a pro
3. Handling async errors: AsyncWrap, Domain and uncaughtException
4. C++ addons: Contributing to the core and writing your own C++ addons

About Presenter

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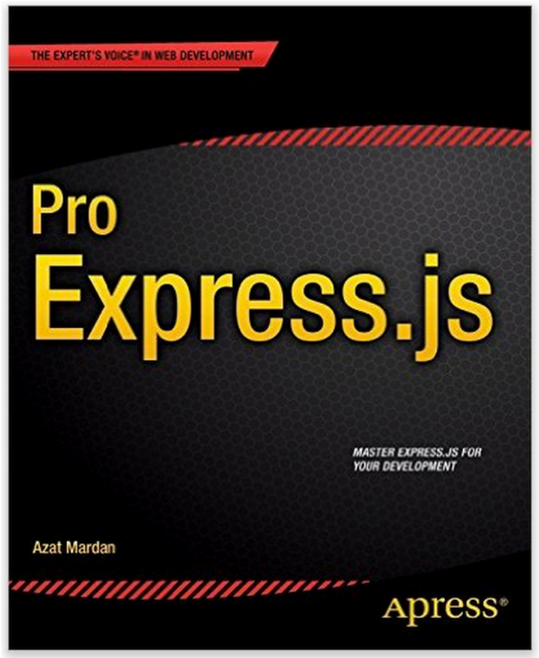
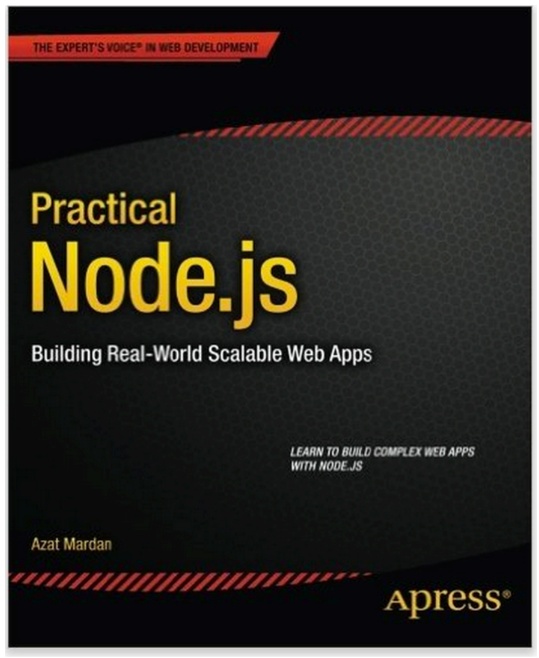
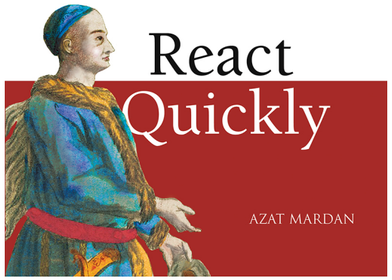
About Presenter

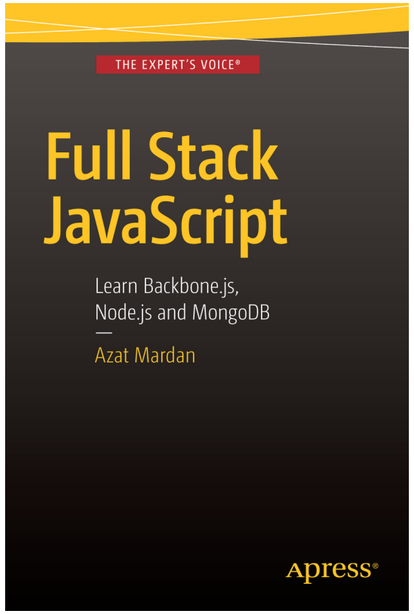
- Work: Technology Fellow at Capital One
- Experience: FDIC, NIH, DocuSign, HackReactor and Storify
- Books: React Quickly, Practical Node.js, Pro Express.js, Express.js API and 8 others
- Teach: NodeProgram.com



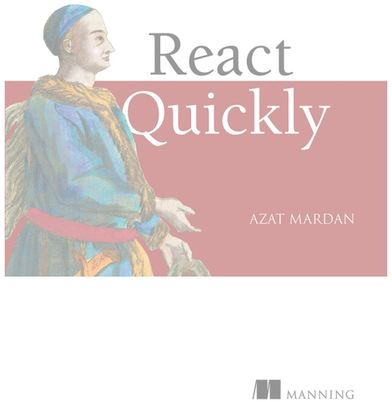


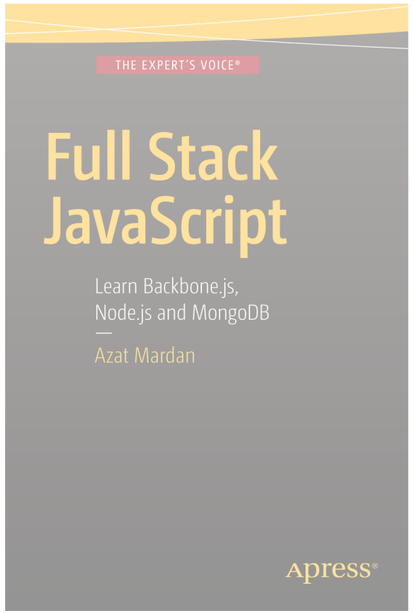


MANNING



FREE: 7+ hours of videos: http://reactquickly.co and http://bit.ly/1Umn0pC

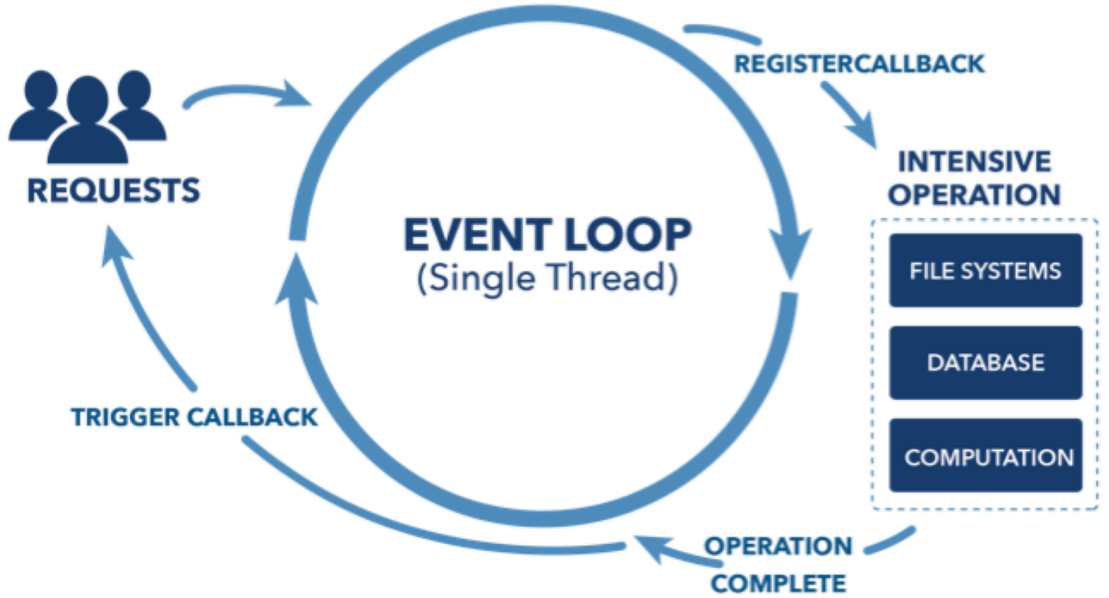




Don't Buy the Books

Event Loop

TECH | NON-BLOCKING I/O



Basic Event Loop Example

```
System.out.println("Step: 1");
System.out.println("Step: 2");
Thread.sleep(1000);
System.out.println("Step: 3");
```

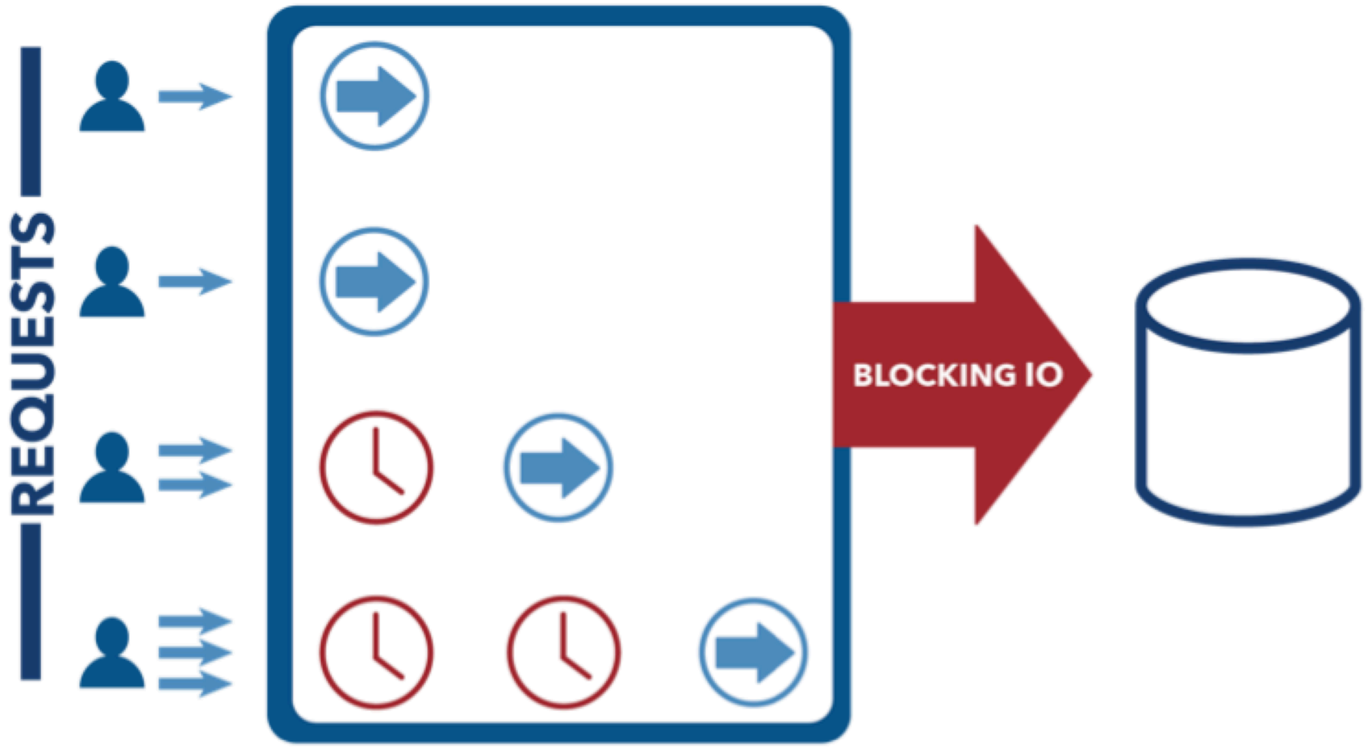
vs.

```
console.log('Step: 1')
setTimeout(function () {
  console.log('Step: 3')
}, 1000)
console.log('Step: 2')
```

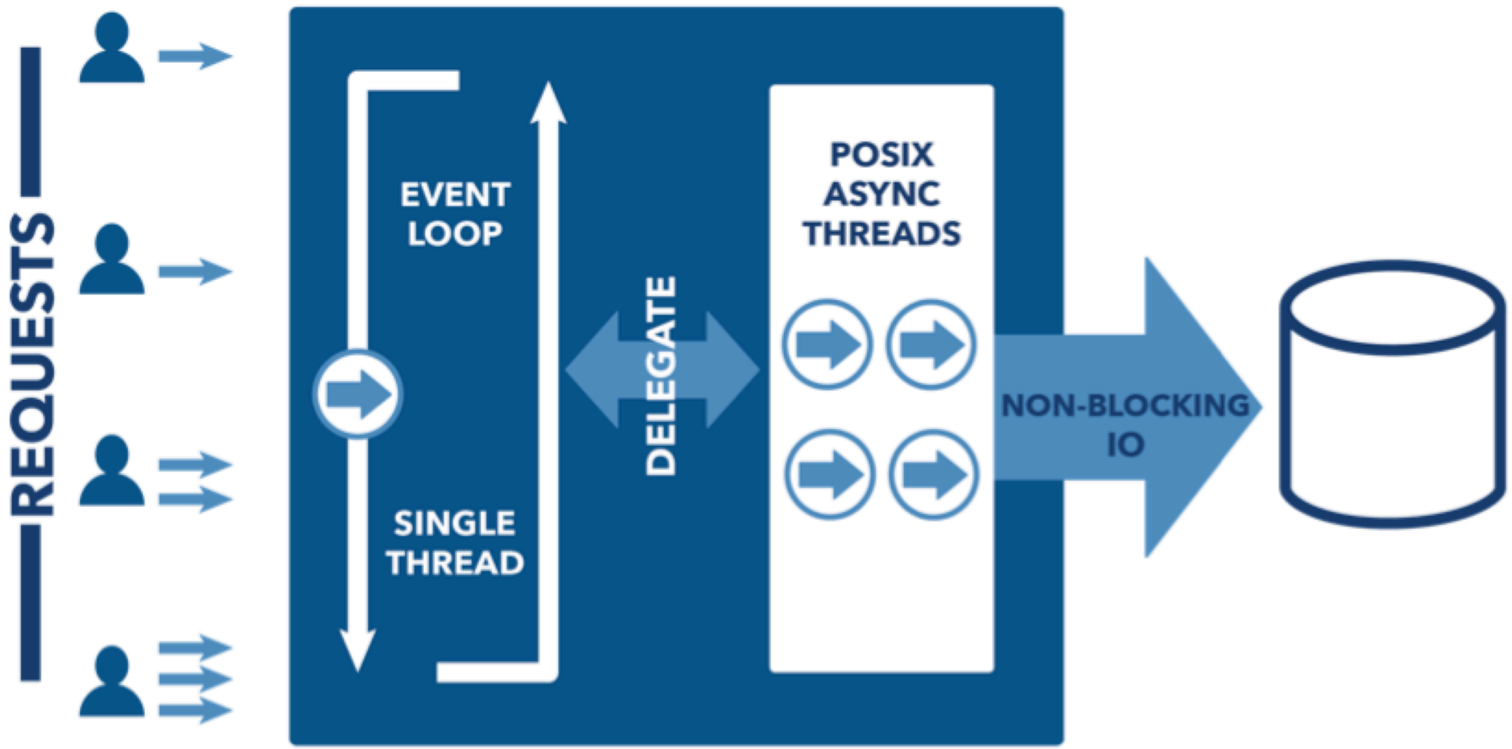
Thinking in Async Code

```
console.log('Step: 1')
setTimeout(function () {
  console.log('Step: 3')
  // console.log('Step 5')
}, 1000);
console.log('Step: 2')
// console.log('Step 4')
```

TECH | BLOCKING I/O



TECH | NON-BLOCKING I/O



It's still possible to write blocking code in Node.js. 😳

Blocking Node.js Code

```
console.log('Step: 1')
for (var i = 1; i<10000000000; i++) {
  // This will take 100-1000ms
}
console.log('Step: 2')
```

Blocking Node.js Code

```
var fs = require('fs')

var contents = fs.readFileSync('accounts.txt','utf8')
console.log(contents)
console.log('Hello Ruby\n')

var contents = fs.readFileSync('ips.txt','utf8')
console.log(contents)
console.log('Hello Node!')
```

Non-Blocking Node.js Code

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

var contents = fs.readFile('accounts.txt','utf8', function(err,contents){
   console.log(contents);
});
console.log('Hello Python\n');


var contents = fs.readFile('ips.txt','utf8', function(err,contents){
   console.log(contents);
});
console.log("Hello Node!");
```

Global and Process

- Where to store passwords?
- How to create global variables (no `window` in Node)?
- How to access CLI input, OS, platform, memory usage, versions, etc.?

Global

- `global.process`
- `global.__filename`
- `global.__dirname`
- `global.module`
- `global.require`
- `global.console`

Process

- `process.pid`
- `process.versions`
- `process.arch`
- `process.argv`
- `process.env`

More Process

- `process.uptime()`
- `process.memoryUsage()`
- `process.cwd()`
- `process.exit`
- `process.on()`

Who likes and understands callbacks? 

http://callbackhell.com

```
fs.readdir(source, function (err, files) {
  if (err) {
    console.log('Error finding files: ' + err)
  } else {
    files.forEach(function (filename, fileIndex) {
      console.log(filename)
      gm(source + filename).size(function (err, values) {
        if (err) {
          console.log('Error identifying file size: ' + err)
        } else {
          console.log(filename + ' : ' + values)
          aspect = (values.width / values.height)
          widths.forEach(function (width, widthIndex) {
            height = Math.round(width / aspect)
            console.log('resizing ' + filename + 'to ' + height + 'x' + height)
            this.resize(width, height).write(dest + 'w' + width + '_' + filename, function(err) {
              if (err) console.log('Error writing file: ' + err)
            })
          }.bind(this))
        }
      })
    })
  }
})
```

Event Emitters

How to modularize and organize asynchronous code besides callbacks which are not very developmental scalable?

Event Emitters

Event emitter is something that triggers an event to which anyone can listen.

https://nodejs.org/api/events.html

In node.js an event can be described simply as a string with a corresponding callback.

Event Emitters

- Event handling in Node uses the observer pattern
- An event, or subject, keeps track of all functions that are associated with it
- These associated functions, known as observers, are executed when the given event is triggered

Using Event Emitters

```
var events  = require('events')
var emitter = new events.EventEmitter()

emitter.on('knock', function() {
  console.log('Who\'s there?')
})

emitter.on('knock', function() {
  console.log('Go away!')
})

emitter.emit('knock')
```

Inheriting from EventEmitter

```
// job.js
var util = require('util')
var Job = function Job() {
  // ...
  this.process = function() {
    // ...
    job.emit('done', { completedOn: new Date() })
  }
}

util.inherits(Job, require('events').EventEmitter)
module.exports = Job
```

Inheriting from EventEmitter

```
// weekly.js
var Job = require('./job.js')
var job = new Job()

job.on('done', function(details){
  console.log('Job was completed at', details.completedOn)
  job.removeAllListeners()
})

job.process()
```

Listeners

```
emitter.listeners(eventName)
emitter.on(eventName, listener)
emitter.once(eventName, listener)
emitter.removeListener(eventName, listener)
```

Streams and Buffers

Problems with large data

- Speed: Too slow
- Buffer limit: ~1Gb

Streams

Abstactions for continuos chunking of data

No need to wait for the entire resource to load

Types of Streams

- Readable
- Writable
- Duplex
- Transform

Streams inherit from Event Emitter

`process.stdin`

Standard input streams contain data going into applications.

This is achieved via a read operation.

Input typically comes from the keyboard used to start the process.

To listen in on data from stdin, use the `data` and `end` events:

```
process.stdin.resume()
process.stdin.setEncoding('utf8')

process.stdin.on('data', function (chunk) {
  console.log('chunk: ', chunk)
})

process.stdin.on('end', function () {
  console.log('--- END ---')
})
```

Notes:

- `data` - input fed into the program. Depending on the size of the input, this event can trigger multiple times
- an `end` event is necessary to signal the conclusion of the input
  stream
- `stdin` is paused by default, and must be resumed before data can
  be read from it

stdout

The standard output streams contain data going out of an application.

This is done via a write operation.

Data written to standard output is visible on the command line.

To write to `stdout`, use the `write` function:

```
process.stdout.write('A simple message\n')
```

What about HTTP?

```
const http = require('http')
var server = http.createServer( (req, res) => {
  var body = ''
  req.setEncoding('utf8')
  req.on('data', (chunk) => {
    body += chunk
  })
  req.on('end', () => {
    var data = JSON.parse(body)
    res.write(typeof data)
    res.end()
  })
})

server.listen(1337)
```

Pipe

```
var r = fs.createReadStream('file.txt')
var z = zlib.createGzip()
var w = fs.createWriteStream('file.txt.gz')
r.pipe(z).pipe(w)
```

What data type to use for binary data?

Buffers

Binary data type, to create:

- `new Buffer(size)`
- `new Buffer(array)`
- `new Buffer(buffer)`
- `new Buffer(str[, encoding])`

Docs: http://bit.ly/1IeAcZ1

```
buf = new Buffer(26)
for (var i = 0 ; i < 26 ; i++) {
  buf[i] = i + 97 // 97 is ASCII a
}
buf // <Buffer 61 62 63 64 65 66 67 68 69 6a 6b 6c 6d 6e 6f 70 71 72 73 74 75 76 77 78 79 7a>
```

Buffer Convertion:

```
buf.toString('ascii') // outputs: abcdefghijklmnopqrstuvwxyz
buf.toString('ascii', 0, 5) // outputs: abcde
buf.toString('utf8', 0, 5) // outputs: abcde
buf.toString(undefined, 0, 5) // encoding defaults to 'utf8', outputs abcde
```

Remember fs?

```
fs.readFile('/etc/passwd', function (err, data) {
  if (err) return console.error(err)
  console.log(data)
});
```

data is buffer!

Buffer methods and properties

- `buf.length`
- `buf.write(string[, offset][, length][, encoding])`
- `buf.toString([encoding][, start][, end])`
- `buf.toJSON()`

Buffer methods and properties

- `buf.equals(otherBuffer)`
- `buf.compare(otherBuffer)`
- `buf.copy(targetBuffer[, targetStart][, sourceStart][, sourceEnd])`
- `buf.slice([start][, end])`
- `buf.fill(value[, offset][, end])`

Encodings

```
ascii utf8 utf16le
ucs2 base64 binary
char hex
```

Streams and Buffer Demo

server-stream.js:

```
app.get('/stream', function(req, res) {
  var stream = fs.createReadStream(largeImagePath)
  stream.pipe(res)
})
```

```
$ node server-stream
```

http://localhost:3000/stream

http://localhost:3000/non-stream

DevTools

X-Response-Time
~300ms vs. 3-5s

Stream Resources

https://github.com/substack/stream-adventure

```
$ sudo npm install -g stream-adventure
$ stream-adventure
```

https://github.com/substack/stream-handbook

Clusters

Clusters

```
var cluster = require('cluster')
if (cluster.isMaster) {
  for (var i = 0; i < numCPUs; i++) {
    cluster.fork()
  }
} else if (cluster.isWorker) {
  // your server code
})
```

Cluster Demo

1. Run `code/cluster.js` with `node` (`node cluster.js`).
2. Install `loadtest` with `npm`: `$ npm install -g loadtest`
3. Run load testing with: `$ loadtest http://localhost:3000 -t 20 -c 10`

Press control+c on the server terminal

Cluster Libraries

- Core cluster: lean and mean
- strong-cluster-control (https://github.com/strongloop/strong-cluster-control), or `$ slc run`: good choice
- pm2 (https://github.com/Unitech/pm2): good choice

pm2

https://github.com/Unitech/pm2

http://pm2.keymetrics.io

Advantages:

- Load-balancer and other features
- 0s reload down-time, i.e., forever alive
- Good test coverage

pm2 Demo: Typical Express Server

```
var express = require('express')
var port = 3000
global.stats = {}
console.log('worker (%s) is now listening to http://localhost:%s',
 process.pid, port)
var app = express()
app.get('*', function(req, res) {
  if (!global.stats[process.pid]) global.stats[process.pid] = 1
  else global.stats[process.pid] += 1;
  var l ='cluser '
    + process.pid
    + ' responded \n';
  console.log(l, global.stats)
  res.status(200).send(l)
})
app.listen(port)
```

pm2 Demo

Using `server.js`:

```
$ pm2 start server.js -i 0
```

In a new window:

```
$ loadtest  http://localhost:3000 -t 20 -c 10
$ pm2 list
```

Spawn vs fork vs exec

- `require('child_process').spawn()` - large data, stream, no new V8 instance
- `require('child_process').fork()` - new V8 instance, multiple workers
- `require('child_process').exec()` - buffer, async, all the data at once

Spawn Example

```
fs = require('fs')
process = require('child_process')
var p = process.spawn('node', 'program.js')
p.stdout.on('data', function(data)) {
  console.log('stdout: ' + data)
})
```

Fork Example

```
fs = require('fs')
process = require('child_process')
var p = process.fork('program.js')
p.stdout.on('data', function(data)) {
  console.log('stdout: ' + data)
})
```

Exec Example

```
fs = require('fs')
process = require('child_process')
var p = process.exec('node program.js', function (error, stdout, stderr) {
  if (error) console.log(error.code)
})
```

Handling Async Errors

Event Loop: Async errors are harder to handle/debug, because system loses context of the error. Then, application crashes.

Try/catch is not good enough.

Synchronous Error in Node

```
try {
  throw new Error('Fail!')
} catch (e) {
  console.log('Custom Error: ' + e.message)
}
```

For sync errors try/catch works fine.

Async Error Example

```
try {
  setTimeout(function () {
    throw new Error('Fail!')
  }, Math.round(Math.random()*100))
} catch (e) {
  console.log('Custom Error: ' + e.message)
}
```

Async Errors

The app crashes! How to deal with it?

Best Practices for Async Errors?

- Listen to all “on error” events
- Listen to `uncaughtException`
- Use `domain` (soft deprecated) or AsyncWrap
- Log, log, log & Trace
- Notify (optional)
- Exit & Restart the process

on('error')

Anything that inherits from or creates an instance of the above: Express, LoopBack, Sails, Hapi, etc.

```
server.on('error', function (err) {
  console.error(err)
})
```

on('error') Chained Method Example

```
var http = require(‘http’)
var server = http.createServer(app)
  .on('error', function(e) {
    console.log(‘Failed to create server’)
    console.error(e)
    process.exit(1)
  })
```

on(‘error’) Named Variable Example

```
var req = http.request(options, function(res) {
  // … processing the response
})

req.on('error', function(e) {
  console.log('problem with request: ' + e.message)
})
```

uncaughtException

`uncaughtException` is a very crude mechanism for exception handling. An unhandled exception means your application - and by extension Node.js itself - is in an undefined state. Blindly resuming means anything could happen.

uncaughtException

Always listen to uncaughtException!

```
process.on(‘uncaughtException’, handle)
```

or

```
process.addListener('uncaughtException', handle)
```

uncaughtException Expanded Examples

```
process.on('uncaughtException', function (err) {
  console.error('uncaughtException: ', err.message)
  console.error(err.stack)
  process.exit(1)
})
```

or

```
process.addListener('uncaughtException', function (err) {
  console.error('uncaughtException: ', err.message)
  console.error(err.stack)
  process.exit(1)
```

Domain

This module is softly deprecated in 4.0 (most likey will be separate from core module), but there's no alternatives in core as of now.

Domain Example

```
var domain = require('domain').create()
domain.on('error', function(error){
  console.log(error)
})
domain.run(function(){
  throw new Error('Failed!')
})
```

Domain with Async Error Demo

domain-async.js:

```
var d = require('domain').create()
d.on('error', function(e) {
    console.log('Custom Error: ' + e)
})
d.run(function() {
  setTimeout(function () {
    throw new Error('Failed!')
  }, Math.round(Math.random()*100))
});
```

C++ Addons

How to Write C/C++ binding for your IoT, hardware, drone, smartdevice, etc.?

Node and C++

Create the `hello.cc` file:

```
#include <node.h>

namespace demo {

using v8::FunctionCallbackInfo;
using v8::HandleScope;
using v8::Isolate;
using v8::Local;
using v8::Object;
using v8::String;
using v8::Value;
```

Node and C++

Create the `hello.cc` file:

```
void Method(const FunctionCallbackInfo<Value>& args) {
  Isolate* isolate = args.GetIsolate();
  args.GetReturnValue().Set(String::NewFromUtf8(isolate, "capital one"));
}

void init(Local<Object> exports) {
  NODE_SET_METHOD(exports, "hello", Method);
}

NODE_MODULE(addon, init)

}  // namespace demo
```

Creating `binding.gyp`

Create `binding.gyp`:

```
{
  "targets": [
    {
      "target_name": "addon",
      "sources": [ "hello.cc" ]
    }
  ]
}
```

node-gyp

```
$ npm install -g node-gyp
```

https://github.com/nodejs/node-gyp

Configuring and Building

```
$ node-gyp configure
$ node-gyp build
```

Check for compiled `.node` files in build/Release/

C++ Addons Examples

https://github.com/nodejs/node-addon-examples

Including Addon

Create `hello.js` and include your C++ addon:

```
var addon = require('./build/Release/addon')
console.log(addon.hello()) // 'capital one'
```

Run

```
$ node hello.js
```

Capital One

We use Node a lot!

https://www.youtube.com/watch?v=BJPeLJhv1Ic

30-second Summary

1. Event Emitters
2. Streams
3. Buffers
4. Clusters
5. C++ Addons
6. Domain

Q&A ❓🙋➡️😄

Send bugs 🐛 to

https://github.com/azat-co/you-dont-know-node/issues

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