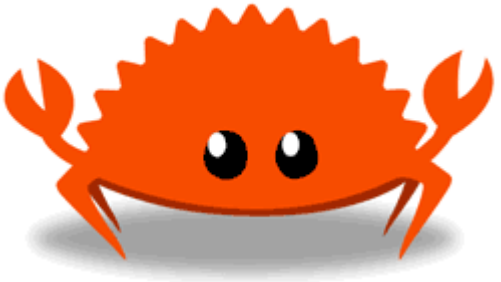

Rust Berlin Meetup

Embedding Rust in NodeJS Applications

Rust and Tell

Kiffin Gish
26 May, 2020

Who am I?

Please allow me to introduce myself:

- Born and raised in sunny California
- Survived 35+ years hacking thru life
- Started with Assembler, Unix and C
- Ended up a “full stack” developer
- Got the Rust itch and can’t get enough

https://github/kgish

Learning new stuff ...

Kiffin Gish

kgish

Edit profile

Never too old to learn new stuff ...

Gishtech

Gouda, The Netherlands

kiffin.gish@planet.nl

http://gishtech.com

PRO

Overview | Repositories 87 | Projects 0 | Packages 0 | Stars 41 | Followers 21 | Following 31

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assembla-to-jira-migration

A comprehensive toolset for migrating data from Assembla to Jira.

Ruby ★ 3 7

angular-challenge

Challenge to build a web app using the Angular and NestJS frameworks

TypeScript

angular-unit-testing-workshop

Angular unit testing workshop

TypeScript

rust-amethyst-pong

Game of pong written in Rust and using the Amethyst game engine.

Rust

rust-webgl-template

Rust and WebGL sample template

Rust

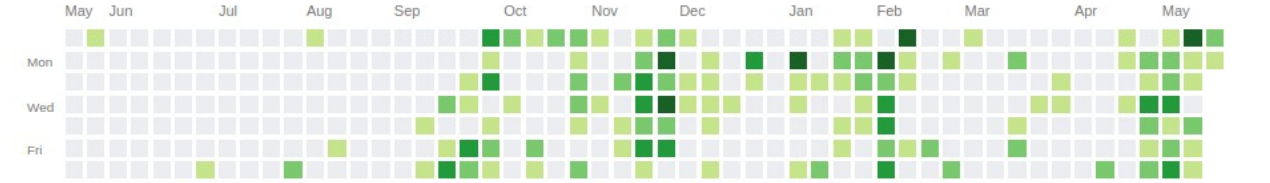
rust-node-addon-template

Rust Node Addon example template using N-API

Rust

521 contributions in the last year

Contribution settings



Long live Rust!

@kiffin

Why use Rust?

We already know why Rust is such a fantastic and fun programming language:

- Safe
- Fast
- Concurrent
- No garbage collection (GC)

Why use Rust with Node.js?

More specifically, using Rust means:

- High computational speed
- Interoperability with external libraries (FFI)
- No runtime overhead
- Predictable performance

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Foreign Function Interface

"Start by rewriting specific performance critical modules in Rust ..."

Foreign Function Interface (FFI)

```rust
extern "C" {
    fn sqrt(x: f64) -> f64;
}

#[link(name = "m")]
fn main() {

    let x: f64 = 2.;
    let result: f64 = unsafe { sqrt(x) };

    println!("The square root of {} is {}", x, result);
}
```

Foreign Function Interface (FFI)

```rust
extern "C" {
    fn sqrt(x: f64) -> f64;
}

#[link(name = "m")]
fn main() {

    let x: f64 = 2.;
    let result: f64 = unsafe { sqrt(x) };

    println!("The square root of {} is {}", x, result);
}
```

All FFI functions are unsafe to call because the other language can do operations the the Rust compiler cannot check.

Crate libm

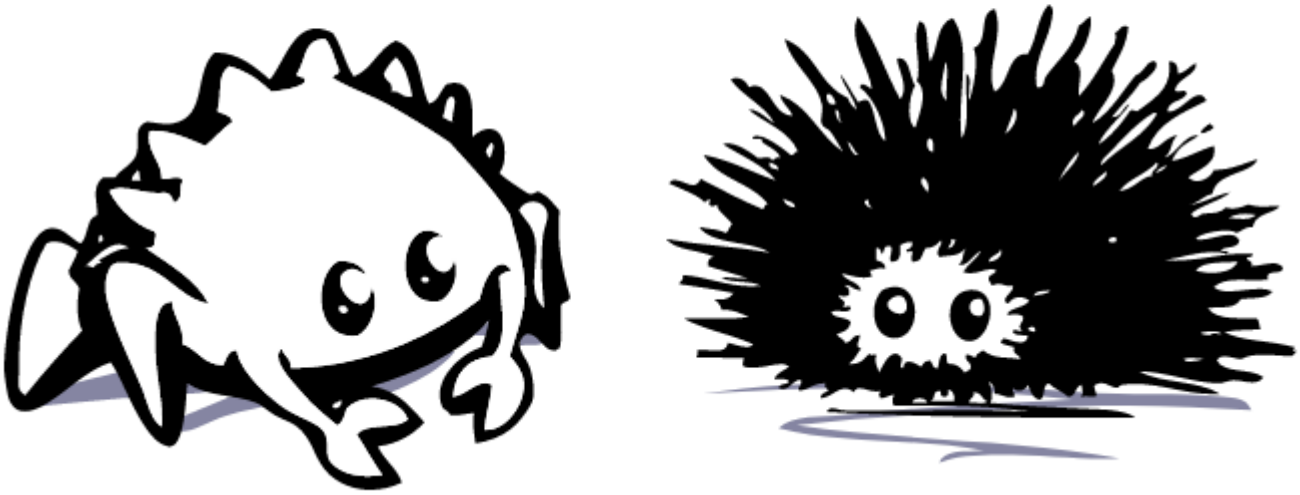
```rust
use libm::sqrt;

fn main() {

    let x: f64 = 2.;
    let result: f64 = sqrt(x);

    println!("The square root of {} is {}", x, result);
}
```

Primitive Type f64

```rust
fn main() {

    let x: f64 = 2.;
    let result: f64 = x.sqrt();

    println!("The square root of {} is {}", x, result);
}
```

Rustonomicon

Meet Safe and Unsafe



https://doc.rust-lang.org/nomicon/meet-safe-and-unsafe.html

https://doc.rust-lang.org/book/ch19-01-unsafe-rust.html

Node.js API (N-API)

N-API (pronounced N as in the letter, followed by API) is an API for building native Addons. It is independent from the underlying JavaScript runtime (for example, V8) and is maintained as part of Node.js itself. This API will be Application Binary Interface (ABI) stable across versions of Node.js. It is intended to insulate Addons from changes in the underlying JavaScript engine and allow modules compiled for one major version to run on later major versions of Node.js without recompilation. The ABI Stability guide provides a more in-depth explanation.

Addons are built/packaged with the same approach/tools outlined in the section titled C++ Addons . The only difference is the set of APIs that are used by the native code. Instead of using the V8 or Native Abstractions for Node.js APIs, the functions available in the N-API are used.

APIs exposed by N-API are generally used to create and manipulate JavaScript values. Concepts and operations generally map to ideas specified in the ECMA-262 Language Specification. The APIs have the following properties:

https://nodejs.org/api/n-api.html#n_api_n_api

Crate | nodejs-sys

https://crates.io/crates/nodejs-sys

Cargo.toml

Create a Rust package with a library target `src/lib.rs` by executing.

```
$ cargo init --lib --crate-type=cdylib
```

The `--crate-type=cdylib` flag produces a dynamic system library which is used when compiling a dynamic library to be loaded from another language. This output type will create the relevant file type for other operating systems, the *.so file for Linux.

The project directory should look like this:

```
├── Cargo.toml
├── package.json
└── src
    └── lib.rs
```

Cargo.toml

```
[package]
name = "rust-node-addon-template"
version = "0.1.0"
authors = ["Kiffin Gish <kiffin.gish@planet.nl>"]
edition = "2018"

[lib]
crate-type=["cdylib"]

[dependencies]
nodejs-sys = "0.3.0"
```

A dynamic system library will be produced. This is used when compiling a dynamic library to be loaded from another language. This output type will create *.so files on Linux, *.dylib files on macOS, and *.dll files on Windows.

Cargo.toml

```
[package]
name = "rust-node-addon-template"
version = "0.1.0"
authors = ["Kiffin Gish <kiffin.gish@planet.nl>"]
edition = "2018"

[lib]
crate-type=["cdylib"]

[dependencies]
nodejs-sys = "0.3.0"
```

Module registration 1/2

Module registration

N-API modules are registered in a manner similar to other modules except that instead of using the `NODE_MODULE` macro the following is used:

```
NAPI_MODULE(NODE_GYP_MODULE_NAME, Init)
```

The next difference is the signature for the `Init` method. For a N-API module it is as follows:

```
napi_value Init(napi_env env, napi_value exports);
```

The return value from `Init` is treated as the `exports` object for the module. The `Init` method is passed an empty object via the `exports` parameter as a convenience. If `Init` returns `NULL`, the parameter passed as `exports` is exported by the module. N-API modules cannot modify the `module` object but can specify anything as the `exports` property of the module.

https://nodejs.org/api/n-api.html#n_api_module_registration

Module registration 2/2

```rust
use nodejs_sys::{napi_env, napi_value};

#[no_mangle]
pub unsafe extern "C" fn napi_register_module_v1(
    env: napi_env,
    exports: napi_value,
) -> nodejs_sys::napi_value {

    register_functions(env, exports);

    exports
}
```

Create function

```rust
unsafe fn create_function(env: napi_env, exports: napi_value, name: &str, func: CallbackFn) {

    let cname : CString  = CString::new( t: name).expect( msg: "CString::new failed");
    let mut result: napi_value = std::mem::zeroed();

    napi_create_function(
        env,
        cname.as_ptr(),
        cname.as_bytes().len(),
        Some(func),
        std::ptr::null_mut(),
        &mut result,
    );

    napi_set_named_property(env, exports, cname.as_ptr(), result);
}
```

Create function

```
create_function(env, exports, name: "sayHello", func: say_hello);
```

```
unsafe fn create_function(env: napi_env, exports: napi_value, name: &str, func: CallbackFn) {
    let cname : CString = CString::new( t: name).expect( msg: "CString::new failed");
    let mut result: napi_value = std::mem::zeroed();

    napi_create_function(
        env,
        cname.as_ptr(),
        cname.as_bytes().len(),
        Some(func),
        std::ptr::null_mut(),
        &mut result,
    );

    napi_set_named_property(env, exports, cname.as_ptr(), result);
}
```

say_hello() → sayHello()

```
    create_function(env, exports,  name: "sayHello",  func: say_hello);
```

```
use nodejs_sys::{napi_callback_info, napi_create_string_utf8, napi_env, napi_value};
use std::ffi::CString;

// --- say_hello() => string --- //
pub unsafe extern "C" fn say_hello(env: napi_env, _info: napi_callback_info) -> napi_value {

    let mut result: napi_value = std::mem::zeroed();
    let s :CString  = CString::new( t: "Hello from the mighty kingdom of Rust!").unwrap();

    napi_create_string_utf8(env, s.as_ptr(), s.as_bytes().len(), &mut result);

    result
}
```

Build and run

```
$ cargo build --release
$ cp ./target/release/librust_node_addon_template.so index.node
```

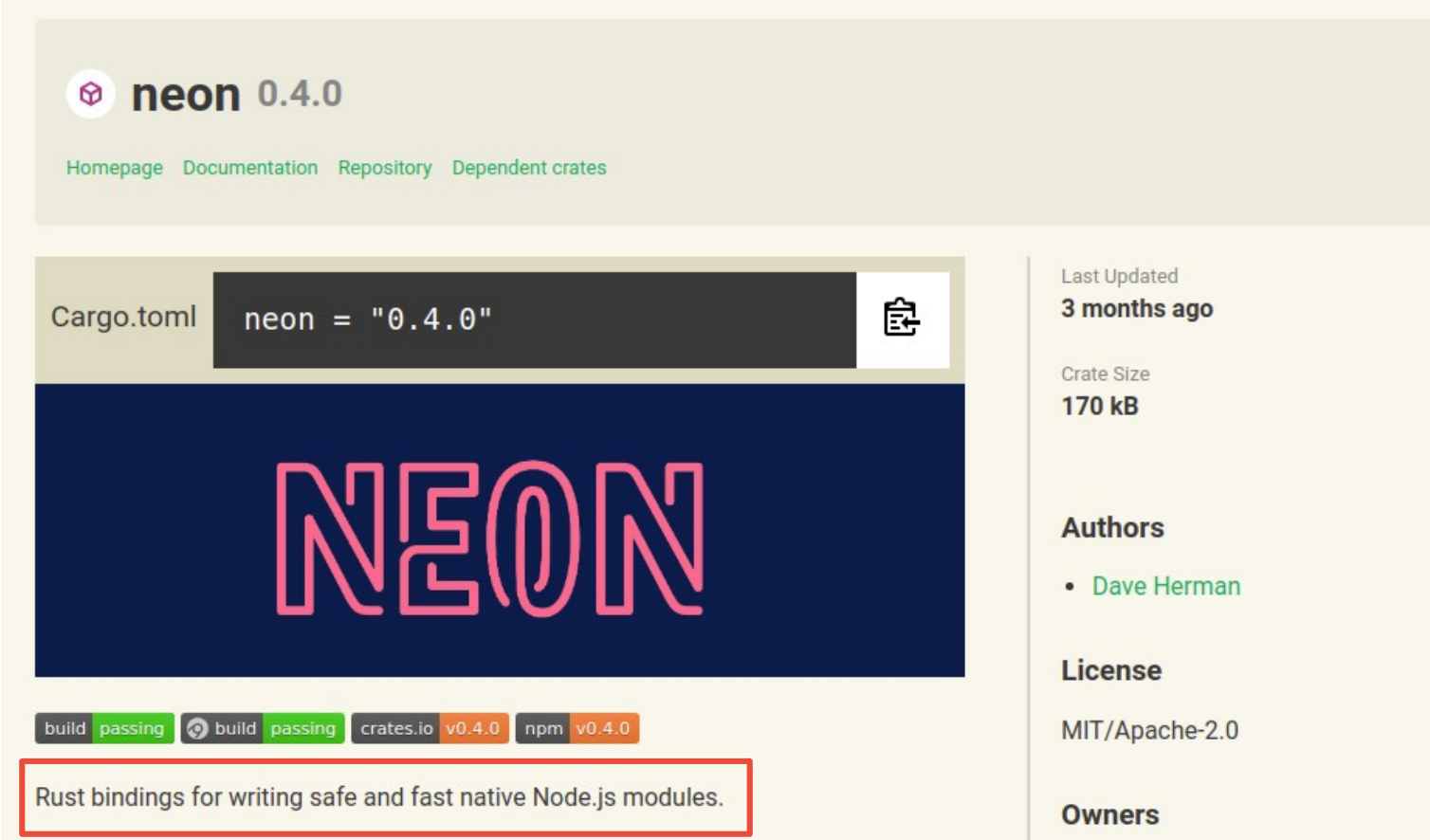
```
// index.js
const addon = require('./index.node');

console.log(`sayHello() => '${addon.sayHello()}'`);
```

```
$ node ./index.js
```

Demo

```rust
// --- add_numbers(x,y) => number --- //
pub unsafe extern "C" fn add_numbers(env: napi_env, info: napi_callback_info) -> napi_value {
    let mut buffer: [napi_value; 2] = std::mem::MaybeUninit::zeroed().assume_init();
    let mut argc :usize  = 2 as usize;
    let mut result: napi_value = std::mem::zeroed();

    napi_get_cb_info( env, info, &mut argc, buffer.as_mut_ptr(), std::ptr::null_mut(),
        std::ptr::null_mut(),
    );

    let mut x :f64  = 0 as f64;
    let mut y :f64  = 0 as f64;

    napi_get_value_double(env, buffer[0], &mut x);
    napi_get_value_double(env, buffer[1], &mut y);
    let value :f64  = x + y;

    napi_create_double(env, value, &mut result);
    result
}
```

Crate | neon



https://neon-bindings.com

Installation

Neon

Rust bindings for writing safe and fast native Node.js modules.

Installation

```
$ npm install -g neon-cli
$ neon new my-project
$ cd my-project
$ npm install
```

The directory tree should look something like this.

```
.
├── lib
│   └── index.js
├── native
│   ├── build.rs
│   ├── Cargo.toml
│   └── src
│       └── lib.rs
├── package.json
└── README.md
```

Cargo.toml

```
[package]
name = "my-project"
version = "0.1.0"
authors = ["Kiffin Gish <kiffin.gish@planet.nl>"]
license = "MIT"
build = "build.rs"
edition = "2018"
exclude = ["artifacts.json", "index.node"]

[lib]
name = "my_project"
crate-type = ["cdylib"]

[build-dependencies]
neon-build = "0.4.0"

[dependencies]
neon = "0.4.0"
```

Module registration

```rust
// src/lib.rs
use neon::register_module;

// --- Register and export all functions --- //
register_module!(mut m, {

    m.export_function("sayHello", say_hello)?;

    Ok(())
});
```

say_hello()

```rust
// say_hello.rs
use neon::prelude::*;

// --- say_hello() => string --- //
pub fn say_hello(mut cx: FunctionContext) -> JsResult<JsString> {

    Ok(cx.string("Hello from the mighty kingdom of Rust!"))

}
```

Demo

```rust
// add_numbers.rs
use neon::prelude::*;

// --- add_numbers(x,y) => number --- //
pub fn add_numbers(mut cx: FunctionContext) -> JsResult<JsNumber> {
    let x = cx.argument::<JsNumber>(0)?.value();
    let y = cx.argument::<JsNumber>(1)?.value();

    Ok(cx.number(x + y))
}
```

Additional examples

Run

```
$ ./run.sh [n]
```

where:

```
optional n = 1 - 5 in order to run only given example:

1. Function sayHello() => void
2. Function sendMessage(str) => void
3. Function addNumbers(x,y) => number
4. Function getUser() => user
5. Async function fibonacci(n) => number
```

Async Fibonacci

```rust
// fibonacci_async.rs
use neon::prelude::*;

pub fn fibonacci_async(mut cx: FunctionContext) -> JsResult<JsUndefined> {
    let n : usize = cx.argument::<JsNumber>(0)?.value() as usize;
    let cb = cx.argument::<JsFunction>(1)?;

    let task = FibonacciTask { argument: n };
    task.schedule(cb);

    Ok(cx.undefined())
}
```

Some conclusions 1/2

Advantages of using Rust with Node.js:

- Computational demands
- Performance is predictable
- Low-level access to GPU and GPIO

Some conclusions 1/2

Advantages of using Rust with Node.js:

- Computational demands
- Performance is predictable
- Low-level access to GPU and GPIO
- Cheaper hardware (IoT)

2 CPU cores, 1 GB RAM

$$$

1 CPU core, 512 MB RAM

$

Some conclusions 2/2

There are also some disadvantages:

- Support another programming language
- Different tool chain and deploy pipeline
- Steep learning curve

Github

Rust Node Addon Template

A simple Rust Node addon example template using N-API

Introduction

This is part of the presentation that I gave at a recent Berlin Rust Meetup.

Requirements

For this project template, the following is required:

- Rust
- Node.js
- npm
- nvm

In order to build the `nodejs-sys` crate (below) you need `libclang` since bindings are being generated at build-time by `bindgen`. Therefore, you will require the `clang` and `llvm-dev` libraries:

```
$ sudo apt-get install llvm-dev clang
```

Ensure that you have the correct Node version installed:

```
$ nvm install 12.16.3
$ nvm use 12.16.3
```

https://github.com/kgish/rust-node-addon-template

End

Hope you liked it!

If you are looking for an eager and enthusiastic guy to help you out ... look me up!

kiffin.gish@planet.nl

https://github.com/kgish

https://www.linkedin.com/in/kiffin