



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



Long live Rust!

@kiffin

https://github.com/kgish



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

Pinned

Customize your pins

📄 [assembla-to-jira-migration](#)

A comprehensive toolset for migrating data from Assembla to Jira.

● Ruby ★ 3 🍴 7

📄 [angular-unit-testing-workshop](#)

Angular unit testing workshop

● TypeScript

📄 [rust-webgl-template](#)

Rust and WebGL sample template

● Rust

📄 [angular-challenge](#)

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

● TypeScript

📄 [rust-amethyst-pong](#)

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

● Rust

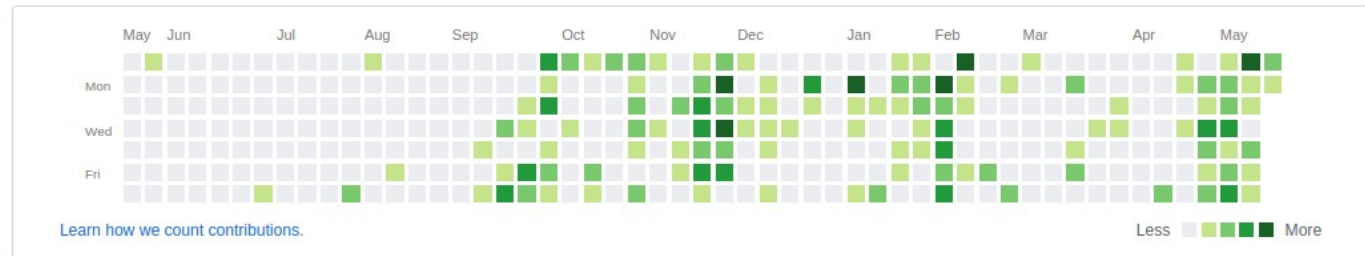
📄 [rust-node-addon-template](#)

Rust Node Addon example template using N-API

● Rust

521 contributions in the last year

Contribution settings ▾



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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
- Low-level access to hardware (device drivers)



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More specifically, using Rust means:

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Foreign
Function
Interface

“Start by rewriting specific performance critical modules in Rust ...”



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Foreign Function Interface (FFI)

```
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)

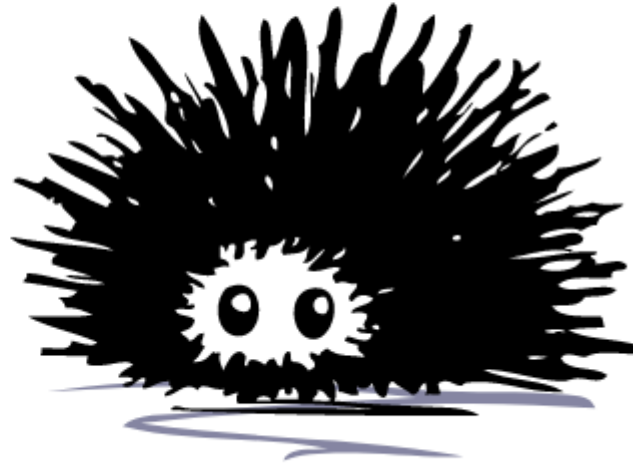
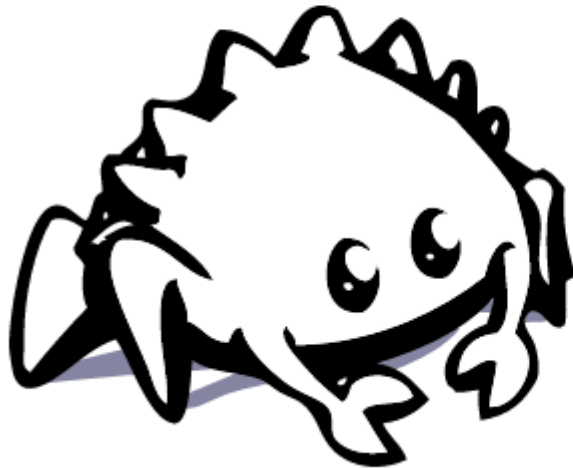
```
extern "C" {  
    fn sqrt(x: f64) -> f64;  
}  
  
#[link(name = "m")]  
fn main() {  
  
    let x: f64 = 2.;  
    let result: f64 = unsafe { sqrt(x) };  
  
    println!("The square root of {} is {}", x, result);  
}
```

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



Rustonomicon

Meet Safe and Unsafe



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



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Node.js API (N-API)

“... for building native Addons. It is independent from the underlying JavaScript runtime 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...”

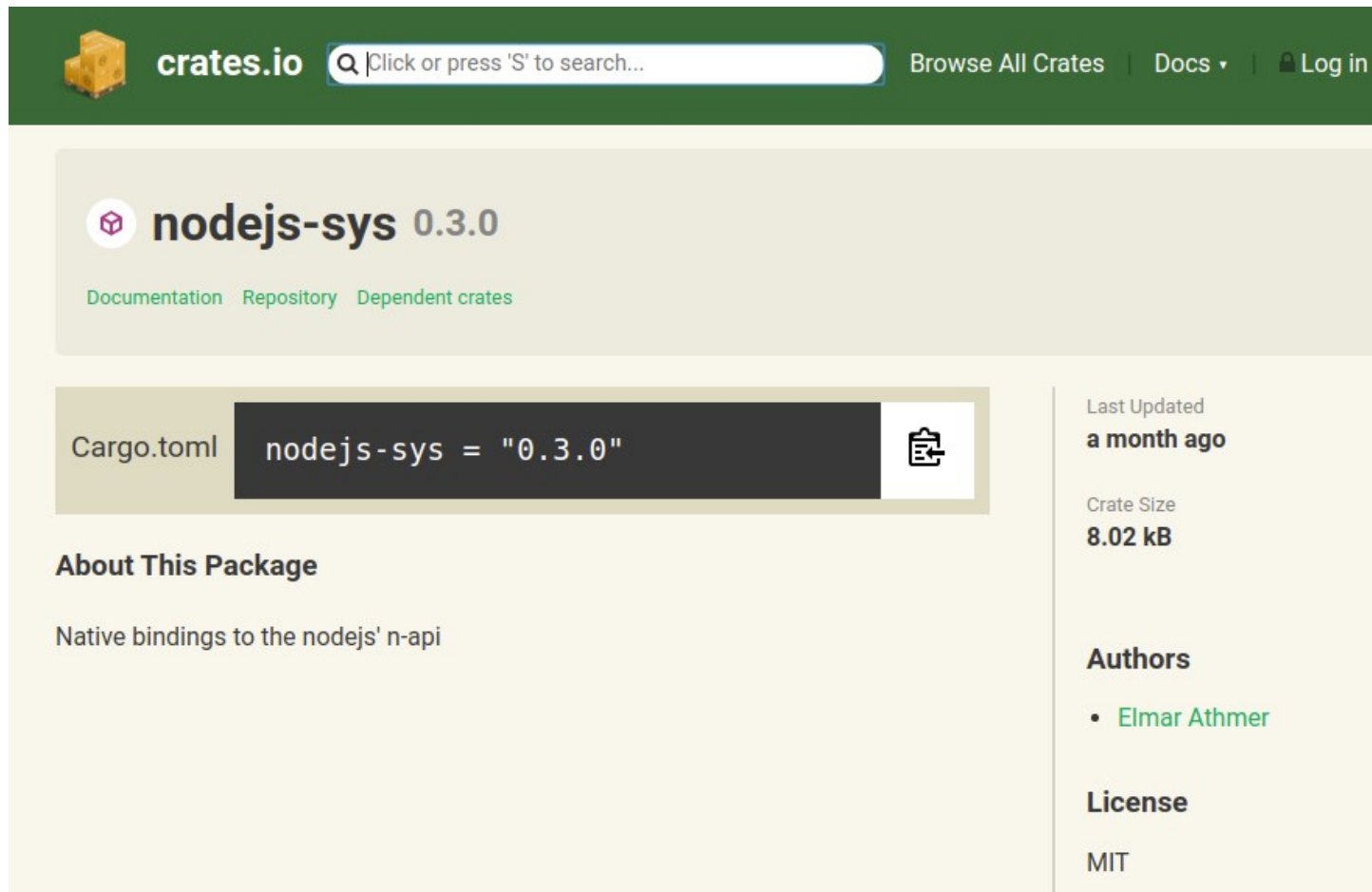
<https://nodejs.org/api/n-api.html>



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Nodejs-sys




The screenshot shows the crates.io interface for the `nodejs-sys` crate. At the top, there's a green header with the crates.io logo, a search bar, and links for "Browse All Crates", "Docs", and "Log in". Below the header, the crate name `nodejs-sys` and version `0.3.0` are displayed. Underneath, there are links for "Documentation", "Repository", and "Dependent crates". A code snippet shows the Cargo.toml entry: `nodejs-sys = "0.3.0"`. To the right of the code, it says "Last Updated a month ago". Below the code, there's a section "About This Package" with the description "Native bindings to the nodejs' n-api". On the right side, there's a sidebar with "Crate Size 8.02 kB", "Authors" (Elmar Athmer), and "License" (MIT).

crates.io Browse All Crates | Docs | Log in

 **nodejs-sys** 0.3.0

[Documentation](#) [Repository](#) [Dependent crates](#)

Cargo.toml `nodejs-sys = "0.3.0"` 

About This Package

Native bindings to the nodejs' n-api

Last Updated
a month ago

Crate Size
8.02 kB

Authors

- [Elmar Athmer](#)

License

MIT

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



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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"
```



Register module

```
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

```
type CallbackFn = unsafe extern "C" fn(napi_env, napi_callback_info) -> napi_value;

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(b"Hello from the mighty kingdom of Rust!").unwrap();

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

    result
}
```



Nodejs-sys | 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
```



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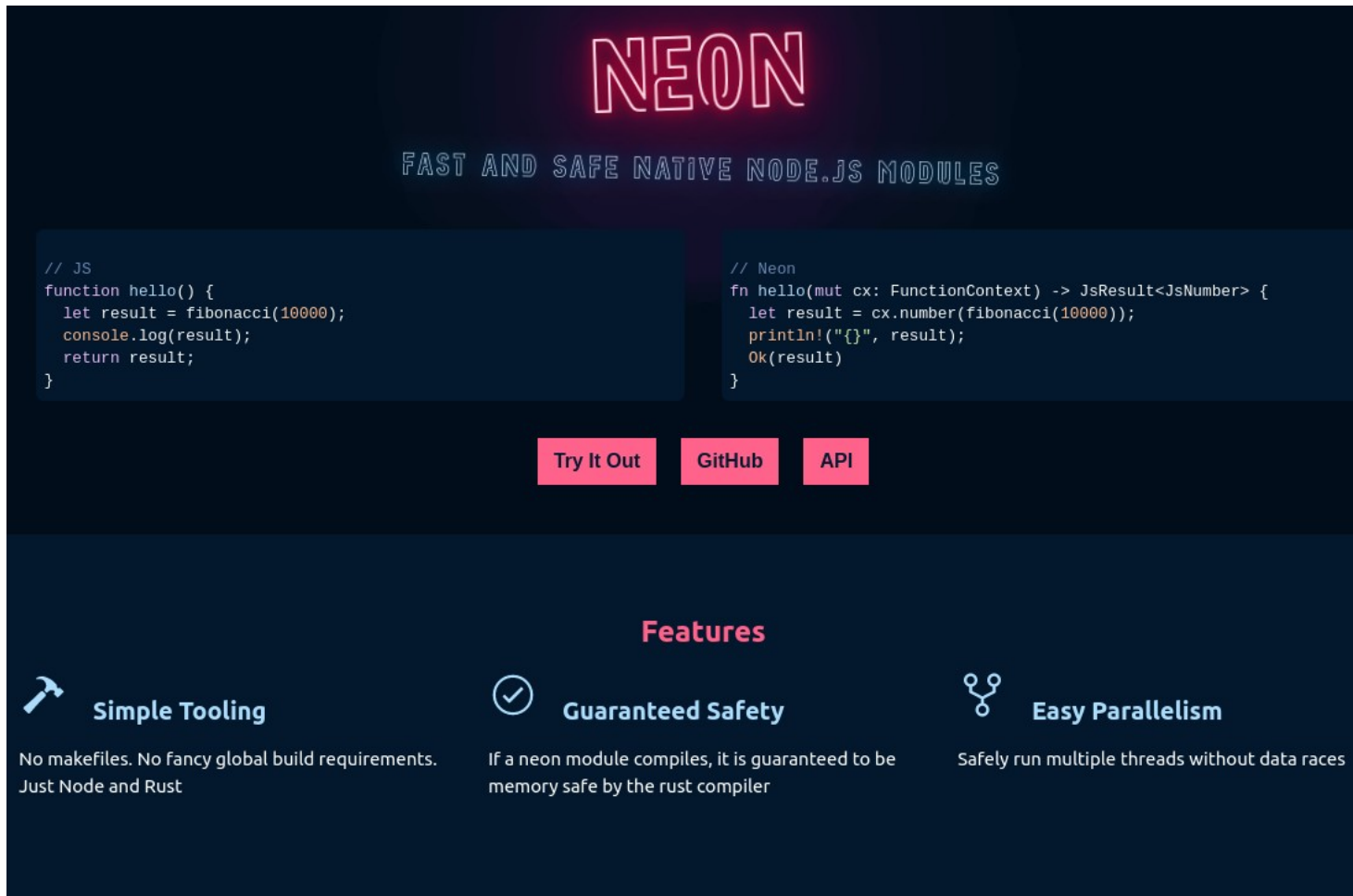
Demo

```
// --- 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  
}
```



Neon






The screenshot shows the Neon website with a dark theme. At the top, the word "NEON" is displayed in a glowing pink font, followed by the tagline "FAST AND SAFE NATIVE NODE.JS MODULES" in a light blue monospace font. Below this, two code snippets are shown side-by-side. The left snippet is JavaScript code for a Fibonacci function, and the right snippet is Rust code for the same function using Neon's API. Underneath the code, there are three pink buttons labeled "Try It Out", "GitHub", and "API". Further down, a section titled "Features" in pink lists three key benefits: "Simple Tooling" (with a hammer icon), "Guaranteed Safety" (with a checkmark icon), and "Easy Parallelism" (with a fork icon). Each feature is accompanied by a brief description of its advantages.

```
// JS
function hello() {
  let result = fibonacci(10000);
  console.log(result);
  return result;
}
```

```
// Neon
fn hello(mut cx: FunctionContext) -> JsResult<JsNumber> {
  let result = cx.number(fibonacci(10000));
  println!("{}", result);
  Ok(result)
}
```

Try It Out **GitHub** **API**

Features

-  **Simple Tooling**
No makefiles. No fancy global build requirements. Just Node and Rust
-  **Guaranteed Safety**
If a neon module compiles, it is guaranteed to be memory safe by the rust compiler
-  **Easy Parallelism**
Safely run multiple threads without data races

<https://neon-bindings.com>



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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
```



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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"
```



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Register module and export function

```
// 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()

```
// 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

```
// 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



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)



Some conclusions 2/2

There are also some disadvantages:

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



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>



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