Diplomat

Polyglot tool to use rust from other languages

Jan Cristina

2025 May 27

About me

Day Job: Head of AI at Starmind. Mostly work in Scala and Python. Some Typescript. Have been able toinject some rust code. More to come.

Rust experience: Started learning in 2020, been programming on the side since then.

What I like about rust: Speed is nice, but correctness is better, e.g. resources are cleaned up when they go out of scope. No accidental mutation. Other things are things I like in Scala too: ADTs, exhaustive matches, functional patterns for collections/iterators.

github: `@jcrist1`

mastodon: `@gigapixel@mathstodon.xyz`

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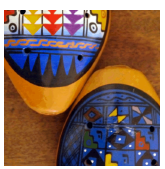
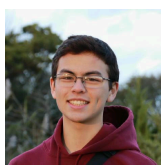


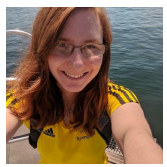
`@manishearth` and `@sffc` project and `C++` backend

`@robertbastian` Dart backend

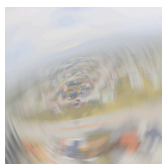


`@qnnokabayashi` and `@shadaj` initial setup

`@ambiguousname` javascript backend



`@emarteca` and `@jcrist1` (me) Kotlin backend



`@walter-reactor` Python-nanobind backend

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Language specific tools: PyO3, Napi-rs

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```
#[no_mangle]
extern "C" fn some_function() -> const * CVoid {
    ...
}
```

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Let’s work through a simple example:

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```rust
#![feature(prelude_import)]
#[prelude_import]
use std::prelude::rust_2024::*;
#[macro_use]
extern crate std;
pub mod ffi {
    use diplomat_runtime::DiplomatStr;
    pub struct Wrapper(String);
    impl Wrapper {
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    use diplomat_runtime::*;
    use core::ffi::c_void;
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    extern "C" fn Wrapper_new() -> Box<Wrapper> {
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    #[no_mangle]
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Then we run our command in the shell

```
diplomat-tool -e rust/src/lib.rs -c rust/config.toml kotlin kotlin/
```

where our `config.toml` contains some basic config for the project.

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The HIR is what allows for the diplomat to by polyglot. It is a “least common denominator” of functionality that can then be shared between language backends.

What do we get on the other side?

For an opaque type we generate a class. This generated class will wrap the `<Wrapper>` returned from the native code, i.e. it holds onto a pointer:

```
internal interface WrapperLib: Library {
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    internal val handle: Pointer,
    // These ensure that anything that is borrowed is kept alive and not cleaned
    // up by the garbage collector.
    internal val selfEdges: List<Any>,
)  {

    internal class WrapperCleaner(val handle: Pointer, val lib: WrapperLib) : Runnable {
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    fun new_(): Opaque {

        val returnVal = lib.Opaque_new();
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```

Now let's add the kind of function we might actually want to use

```
#[allow(clippy::needless_lifetimes)]
pub fn return_inner<'a>(&'a self) -> &'a DiplomatStr {
    self.0.as_bytes()
}
```

```
...
fun Wrapper_return_inner(handle: Pointer): Slice
...

fun returnInner(): String {

    val returnVal = lib.Wrapper_return_inner(handle);
        return PrimitiveArrayTools.getUtf8(returnVal)
}
```

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Where the `getUtf8` method is a standard function which is packaged in the library

```
fun getUtf8(slice: Slice): String {
    val byteArray = slice.data.getByteArray(0, slice.len.toInt())

    return byteArray.decodeToString()
}
```

How does this work with GC

- support several GC'd backends: Kotlin, JS, Dart
- Rust side handles allocation and deallocation
- GC needs to call the destroy function
- In JVM, the data is stored on the native heap and not JVM heap (important to keep in mind when allocating memory in say K8S)

Why should you use diplomat?

- Write once and share code between backends. Same API across backends.
- Want to benefit from native performance (especially things like vectorisation)
- Want to expose useful and performant Rust libraries

What is it really for 😐 ?

Let’s see what it looks like in javascript. First lets look at the typescript definitions

```
// generated by diplomat-tool
import type { pointer, codepoint } from "./diplomat-runtime.d.ts";



export class Wrapper {
    get ffiValue(): pointer;


    static new_(): Wrapper;

    returnInner(): string;

}
```

And the actual code looks like:

```
// generated by diplomat-tool
import wasm from "./diplomat-wasm.mjs";
import * as diplomatRuntime from "./diplomat-runtime.mjs";

const Wrapper_box_destroy_registry = new FinalizationRegistry((ptr) => {
    wasm.Wrapper_destroy(ptr);
});

export class Wrapper {
    // Internal ptr reference:
    #ptr = null;

    // Lifetimes are only to keep dependencies alive.
    // Since JS won't garbage collect until there are no incoming edges.
    #selfEdge = [];

    #internalConstructor(symbol, ptr, selfEdge) {
        if (symbol !== diplomatRuntime.internalConstructor) {
            console.error("Wrapper is an Opaque type. You cannot call its constructor.");
            return;
        }
        this.#ptr = ptr;
        this.#selfEdge = selfEdge;

        // Are we being borrowed? If not, we can register.
        if (this.#selfEdge.length === 0) {
            Wrapper_box_destroy_registry.register(this, this.#ptr);
        }

        return this;
    }
    get ffiValue() {
        return this.#ptr;
    }
```

```
    static new_() {
        const result = wasm.Wrapper_new();
        try {
            return new Wrapper(diplomatRuntime.internalConstructor, result, []);
        }
        finally {
        }
    }

    returnInner() {
        const diplomatReceive = new diplomatRuntime.DiplomatReceiveBuf(wasm, 8, 4, false);
        // This lifetime edge depends on lifetimes 'a
        let aEdges = [this];
        const result = wasm.Wrapper_return_inner(diplomatReceive.buffer, this.ffiValue);
        try {
            return new diplomatRuntime.DiplomatSliceStr(wasm, diplomatReceive.buffer,  "string8", aEdges).getValue();
        }
        finally {
            diplomatReceive.free();
        }
    }

    ownedBytes() {
        const write = new diplomatRuntime.DiplomatWriteBuf(wasm);
        const result = wasm.Wrapper_owned_bytes(this.ffiValue, write.buffer);
        try {
            return result === 0 ? null : write.readString8();
        }
        finally {
            write.free();
        }
    }

    constructor(symbol, ptr, selfEdge) {
        return this.#internalConstructor(...arguments)
    }
}
```

What should I be aware of?

- the FFI boundary is slow, especially string conversions.
  - If needed in a hot loop, try instead to send a bulk of data in a single flat array type and process it all at once.
- strings can operate differently (utf-16 vs utf-8), so indexes and offsets may have different meanings
  - Especially if you're trying to amortize that FFI cost as outlined above
- FFI is intrinsically unsafe. Diplomat tries to standardise the wrapper code which should help avoid mistakes.

Performance example

Let's look at a simple example, where we split a large text at all whitespace. This is a bad example because you are copying over a lot of data, especially in `benchSpliteratorFull` Which tries to create an ergonomic iterator

Kotlin

```
benchKt                avgt    4     96177,170 ±    5551,892  ns/op
```

Kotlin Diplomat

```
benchIdxs              avgt    4    279589,782 ±   22979,764  ns/op
benchSpliteratorFull   avgt    4  11236381,512 ± 4146516,540  ns/op
```

Rust

```
ws_split                time:   [80.557 µs 80.660 µs 80.794 µs]
```

Serious example – Markov Chains

A Markov chain is a probabilistic process that models transitions between states with the probability only dependent on the current state.

You can use them for simple autocomplete… or just to be silly

> Rust began sponsorship syntainring governal inteers at Rust package.
>
> Rust's expansion, Newsquestem, cit rarelegaokar substant fungin Rust pure as decade.
>
> Rust 0.1 was removing thership systepped focused feder 5,000 compiler the Rust published in Manished a people,: arough the the deceased, and a Reque aking good itself-hostly using initialized increas notation
>
> — My stochastic parrot trained on some of the rust wikipedia page

How do they compare

This is a task that involves “training” the model. It requires traversing the entire text and accumulating statistics into hashmaps. Once the statistics are calculated we can make the markov chain, which generates text for us.

Kotlin

```
benchTrainKt     avgt    4  4815836,004 ± 655981,779  ns/op
benchGenerateKt  avgt    4  3305800,670 ±  74799,994  ns/op
```

Kotlin Diplomat

```
benchTrainRs     avgt    4   969304,276 ± 101890,199  ns/op
benchGenerateRs  avgt    4    79349,769 ±   4450,638  ns/op
```

Rust

```
train_markov            time:   [861.30 µs 864.58 µs 868.76 µs]
markov_generate         time:   [65.937 µs 66.127 µs 66.346 µs]
```