WebAssembly

Or: How I tried to write a web app without using Javascript

Michael Kreuzer

July 3, 2019
Overview

What is WebAssembly?

History

How it works

Rust Ecosystem
Disclaimers

Disclaimer

I'm not an expert in web development. Things I say in this talk could be wrong.
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This talk might contain rants about Javascript and other web technologies.
What is WebAssembly?

From the Website

WebAssembly (abbreviated Wasm) is a binary instruction format for a stack-based virtual machine. Wasm is designed as a portable target for compilation of high-level languages like C/C++/Rust, enabling deployment on the web for client and server applications.
What is WebAssembly?
Benefits

According to the Website:

- Efficient and fast
- Safe
- Part of the open web platform
- Open and debuggable
What is WebAssembly?

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Intermezzo: Rust

Rust Ecosystem

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```
get_local 0
i64.const 0
i64.eq
if i64
    i64.const 1
else
    get_local 0
get_local 0
i64.const 1
i64.sub
call 0
i64.mul
end
```
Benefits

My Opinion:

- Write your web code in a usable language
- Use Code from non web libraries
- Avoid the use of Javascript.
Benefits

My Opinion:

- Write your web code in a usable language
- Use Code from non web libraries
- Avoid the use of Javascript. Almost.
History

- 2015 - WebAssembly Community Group started and first public announcement
- 2016 - Definition of core features and Browser Preview with different implementations
2015 - WebAssembly Community Group started and first public announcement

2016 - Definition of core features and Browser Preview with different implementations

March 2017 - Cross-browser consensus and end of Browser Preview

Current Status

Minimum Viable Product (MVP)

WebAssembly is currently in the status of a MVP. Version 1.0 *works* in all major browsers
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Future Work

▶ Stabilize LLVM backend
▶ Multi-threading
▶ Garbage collection
▶ Everything else…
How it works

Machine Model

WebAssembly uses a stack-based virtual machine with linear memory to evaluate instructions
How it works

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Data Format

Normally stored in a compact binary format, but can be converted to an equivalent text format that is human readable. Code is compiled to this format via LLVM.
How it works

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Execution

WebAssembly can currently only be executed through a specific Javascript API. It is planned to add the possibility to use Wasm as a script module directly in the future.
A Small Function

(module
  (func $f (param f64) (result f64)
    get_local 0
    f64.const 1
    f64.lt
    if (result f64)
      f64.const 1
    else
      get_local 0
      get_local 0
      f64.const 1
      f64.sub
      call $f
      f64.mul
    end)
  (export "f" (func $f)))
A Small Example

```javascript
fetch('demo.wasm').then(response =>
    response.arrayBuffer()
).then(buffer =>
    WebAssembly.instantiate(buffer)
).then(({module, instance}) =>
    console.log(instance.exports.f(5))
);
```
The Rust Programming Language

- Modern system programming language funded by Mozilla
- Innovative memory management system
- Zero cost abstractions for safer code
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Factorial in Rust

```rust
fn fac(n : u32) {
    if n == 0 {
        1
    } else {
        n * fac(n-1)
    }
}
```
The Ecosystem for Rust

Compile target

Rust natively supports Wasm with the \texttt{wasm32-unknown-unknown} compile target.
The Ecosystem for Rust

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Rust natively supports Wasm with the `wasm32-unknown-unknown` compile target. Unfortunately this is not very useful on its own.
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What do we need to make it useful?

- Some way of making the file run in our browser
- Accessing common WebAPI functions (DOM manipulation, events, ...)
- Interop with other Javascript code
Two Choices

Wasm-Bindgen

Cargo-Web / Stdweb
Two Choices

Wasm-Bindgen

- Official Wasm toolkit of the Rust foundation

Cargo-Web / Stdweb

- Unofficial Wasm toolkit, but has been around a bit longer
Two Choices

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- Only supports Rust’s native Wasm toolchain

**Cargo-Web / Stdweb**
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- Supports Rust’s native but also the emscripten build
## Two Choices

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<td>▶ Aims at providing a tight integration between Javascript and Rust</td>
<td>▶ Aims at providing a tool to write a full-Rust web app.</td>
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## Wasm-Bindgen

### Deployment Options

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### Wasm-Pack

Can magically pack your whole code and publish it to the npm repositories...
Wasm-Bindgen Hello World

src/main.rs

use wasm_bindgen::prelude::*;

#[wasm_bindgen]
extern "C" {
    fn alert(s: &str);
}

#[wasm_bindgen]
pub fn greet(name: &str) {
    alert(&format!("Hello, {}!", name));
}
index.html

```html
<html>
<body>

<script type="module">
    import init, { greet } from './pkg/hello.js';

    async function run() {
        await init();
        greet("Michael");
    }
    run();
</script>

</body>
</html>
```
# What is WebAssembly?

## History

## How it works

## Intermezzo: Rust

## Rust Ecosystem

## Accessing the DOM

```rust
#[wasm_bindgen(start)]
pub fn main() -> Result<(), JsValue> {
    let window = web_sys::window().unwrap();
    let document = window.document().unwrap();
    let body = document.body().unwrap();

    let val = document.create_element("p")?
        val.set_inner_html("Hello from Rust!");
    body.append_child(&val)?;

    Ok(())
}
```
State of the Art

- Low level access to nearly all browser and Javascript APIs via the web-sys and js-sys crates.
- Replacing some functions in your Javascript code with Rust is easy.
- Writing a complete web app in Rust is a bit more difficult especially when using javascript libraries, but still doable.
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The Future

The WebAssembly Working Group is currently working on glue which is intended to provide increasingly higher level abstractions for all use cases.
Where to go from here

- WebAssembly Main Site: https://webassembly.org/
- Rust and WebAssembly: https://rustwasm.github.io/