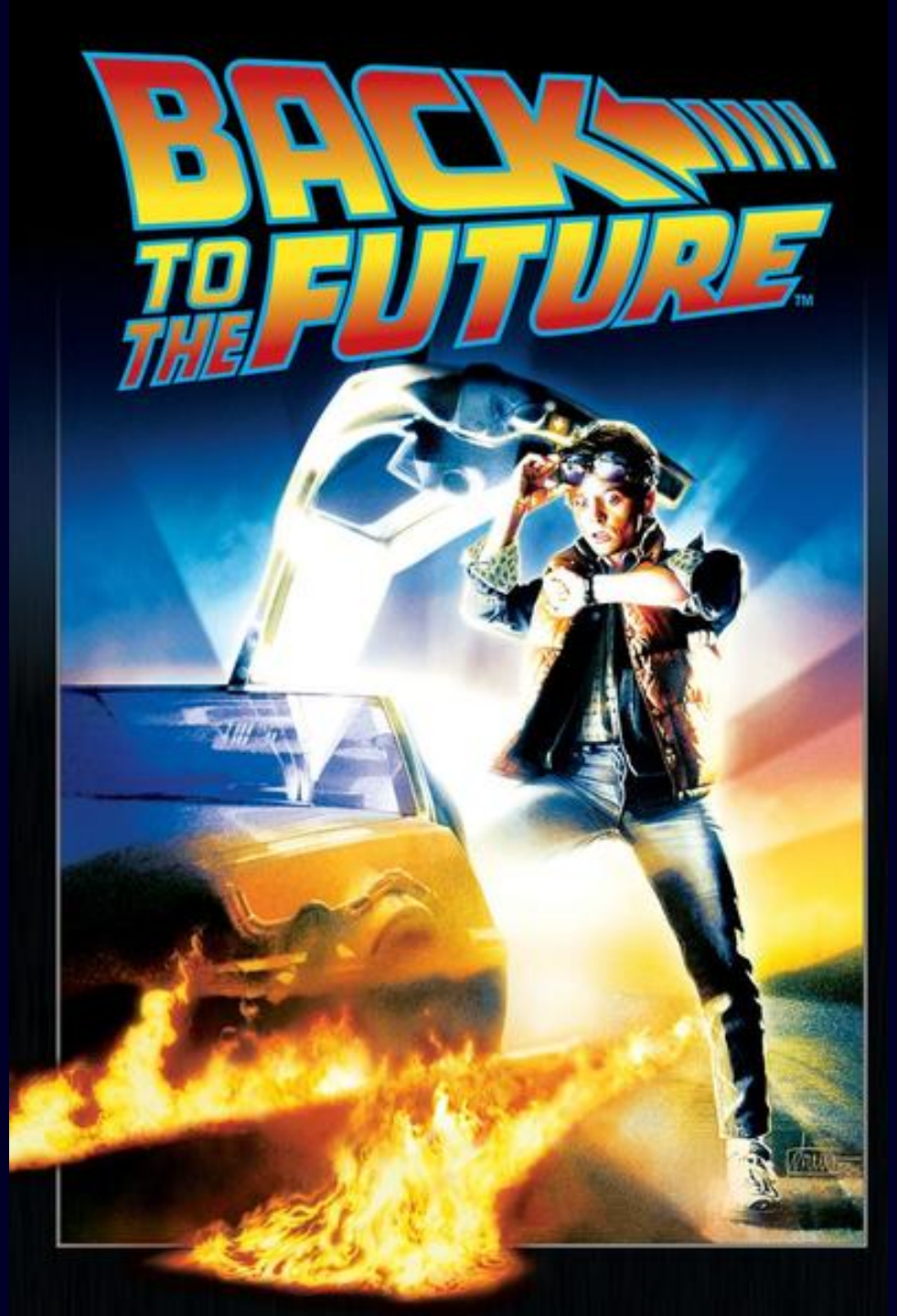
VIZBII

WebAssembly, Back to the Future?

Date : 04 / 06 / 2019



Sommaire

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1

WebAssembly,
What is it?
Where does it come from?

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50% Web

50% Assembly

Definition

WebAssembly or wasm is a new portable, size- and load-time-efficient format suitable for compilation to the web.

webassembly.org

1 Definition

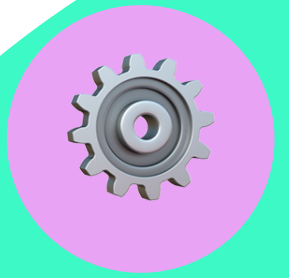
Key elements from this definition

FAST

At least better than javascript

PORTABLE

Should run on all (modern) browsers



COMPILED

Benefits from all the good things compiled languages can do

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JS is truly a thing of wonder

```
> [] == ![]
< true
> NaN == NaN
< false
> Number.MIN_VALUE > 0
< true
> parseInt('fibii')
< NaN
> parseInt('fibii', 16)
< 15
> Math.min() > Math.max()
< true
```

1 Definition

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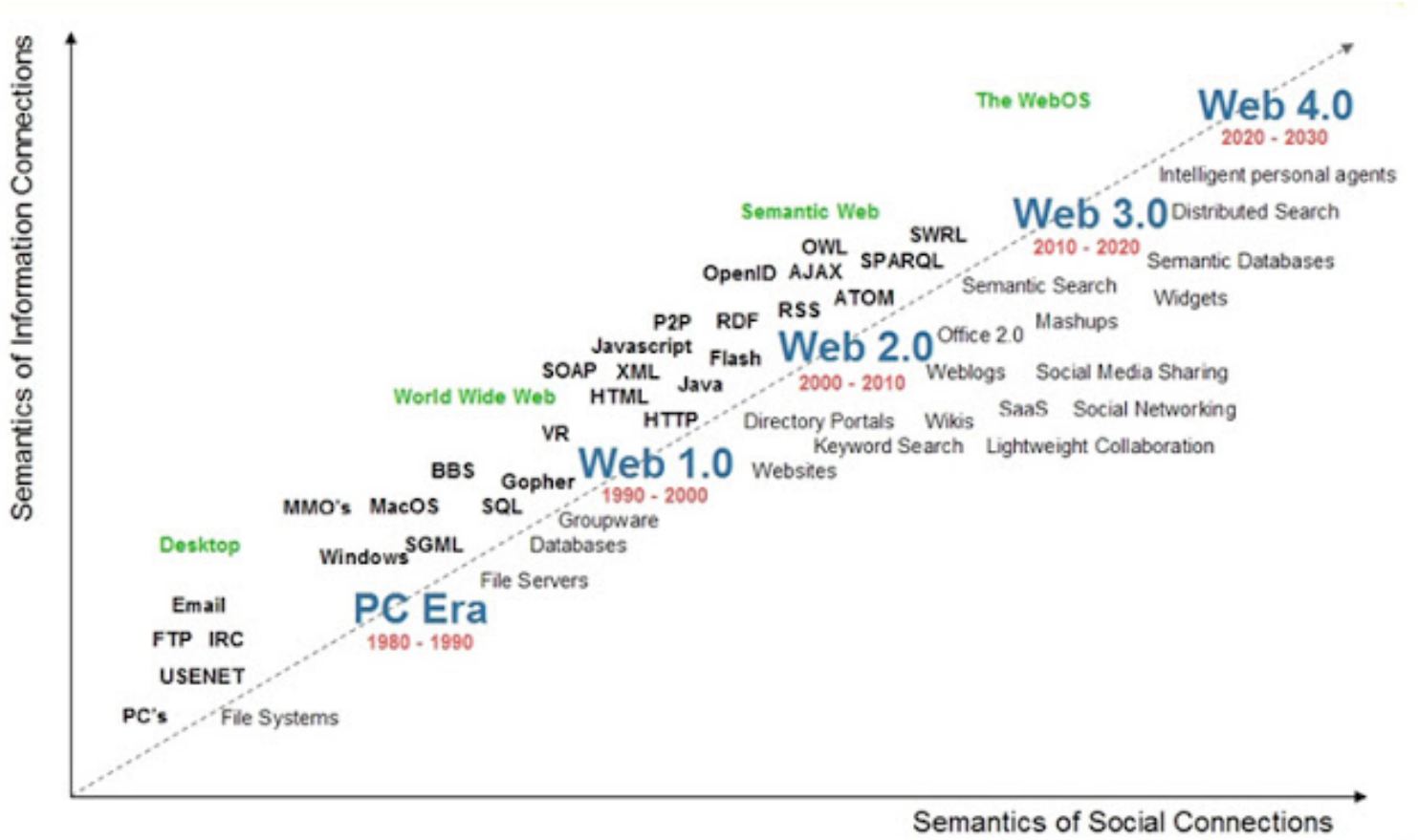
The evolution of the web (2008)



Trying to get into the web

Here lies those who tried

non-exhaustive list

- Java
- Flash
- Silverlight
- ActiveX
- NaCl
- Dart

Why did they fail?

non-exhaustive list

- Compatibility issues
- Proprietary
- Safety

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2

Conception

What do we want?

Human writable

- C/C++
- Rust
- Go
- ~~Brainfuck~~

+

Browser readable

- Easy to load
- Pre-optimized
- Bytecode

+

Machine executable

- Machine instructions
- System calls
- Safe

Compiling C to JS then?

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ASM.js,
our yellow savior

```c
size_t strlen(char *ptr) {
  char *curr = ptr;
  while (*curr != 0) {
    curr++;
  }
  return (curr - ptr);
}
```

```asm
function strlen(ptr) {
  ptr = ptr|0;
  var curr = 0;
  curr = ptr;
  while (MEM8[curr]|0 != 0) {
    curr = (curr + 1)|0;
  }
  return (curr - ptr)|0;
}
```

2 Conception

—

ASM.js, the messiah

Project at Mozilla in 2013

Porting C code to a (performant) subset of javascript

Project was a success

Porting of Unreal Engine 3 took only 4 days

Emscripten’s LLVM backend new output : ASM.js

Laying out solid foundations for a portable, safe and fast language

How does this work?

0 Definition

—

From ASM.js to WebAssembly

Organization

- All major browsers representatives were invited
- W3C : WebAssembly Working Group

Goals

- Creating a stack-based VM
- Standardized
- Safe code
- Portable code
- Fast code

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Inner workings

How does this work?

3 Inner workings

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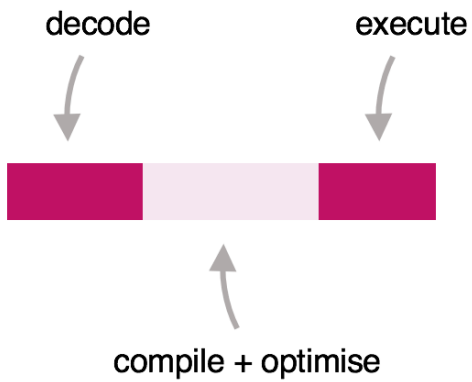
In the browser

JIT vs AOT

- JS is interpreted
- WebAssembly is compiled



3 Inner Workings

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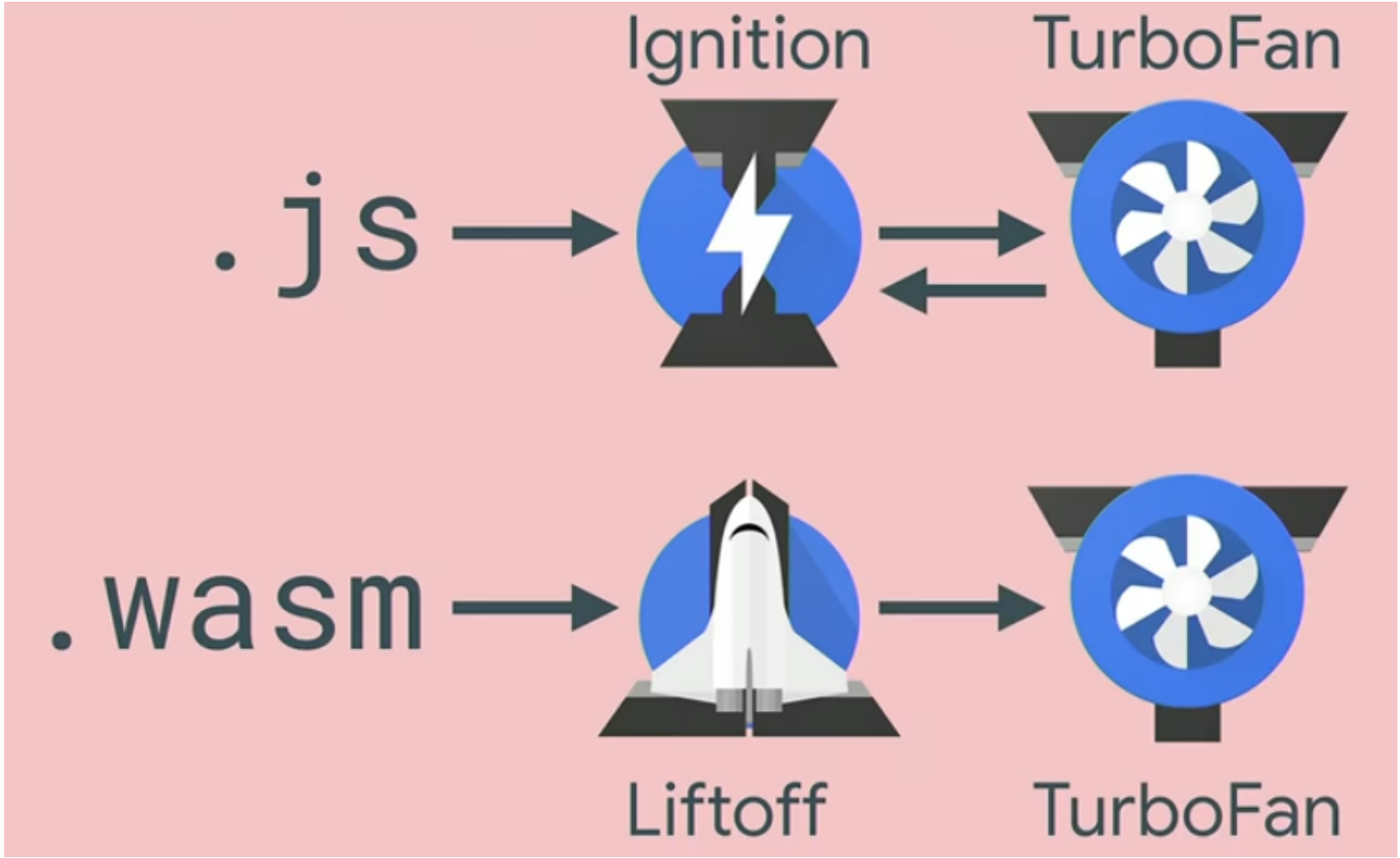
Chrome’s V8



3 Inner Workings

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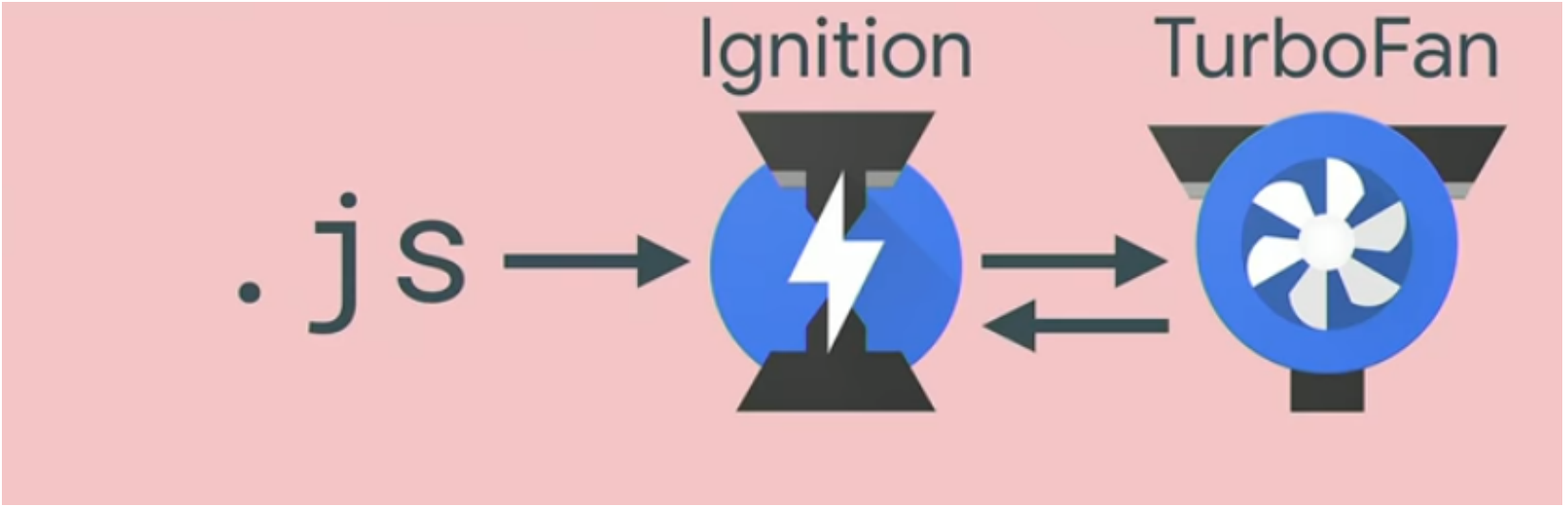
Chrome’s V8



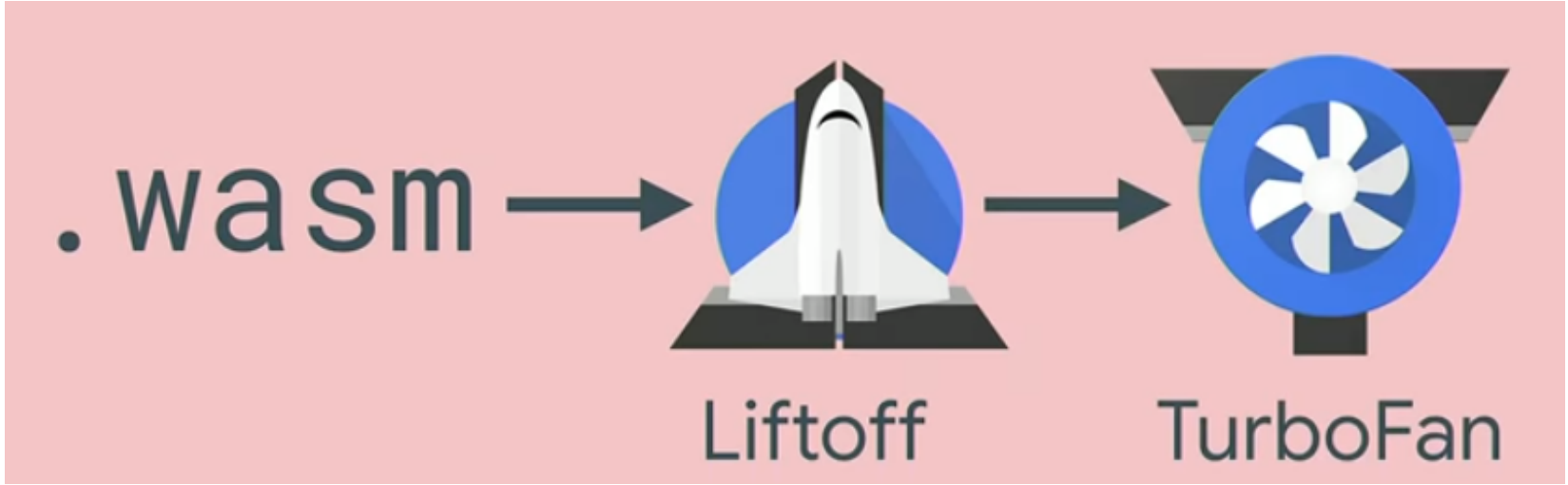
- Normal execution (JIT)
- A “hot-path” is found
- TF kicks in to run optimized JS
- TF might de-optimize
- Back to Igniter to interpret JS
- A “hot-path” is found
- …

3 Inner Workings

—

Chrome’s V8

- WASM is loaded
- WASM is already optimized
- Wasm is executed
- Done



3 Inner Workings

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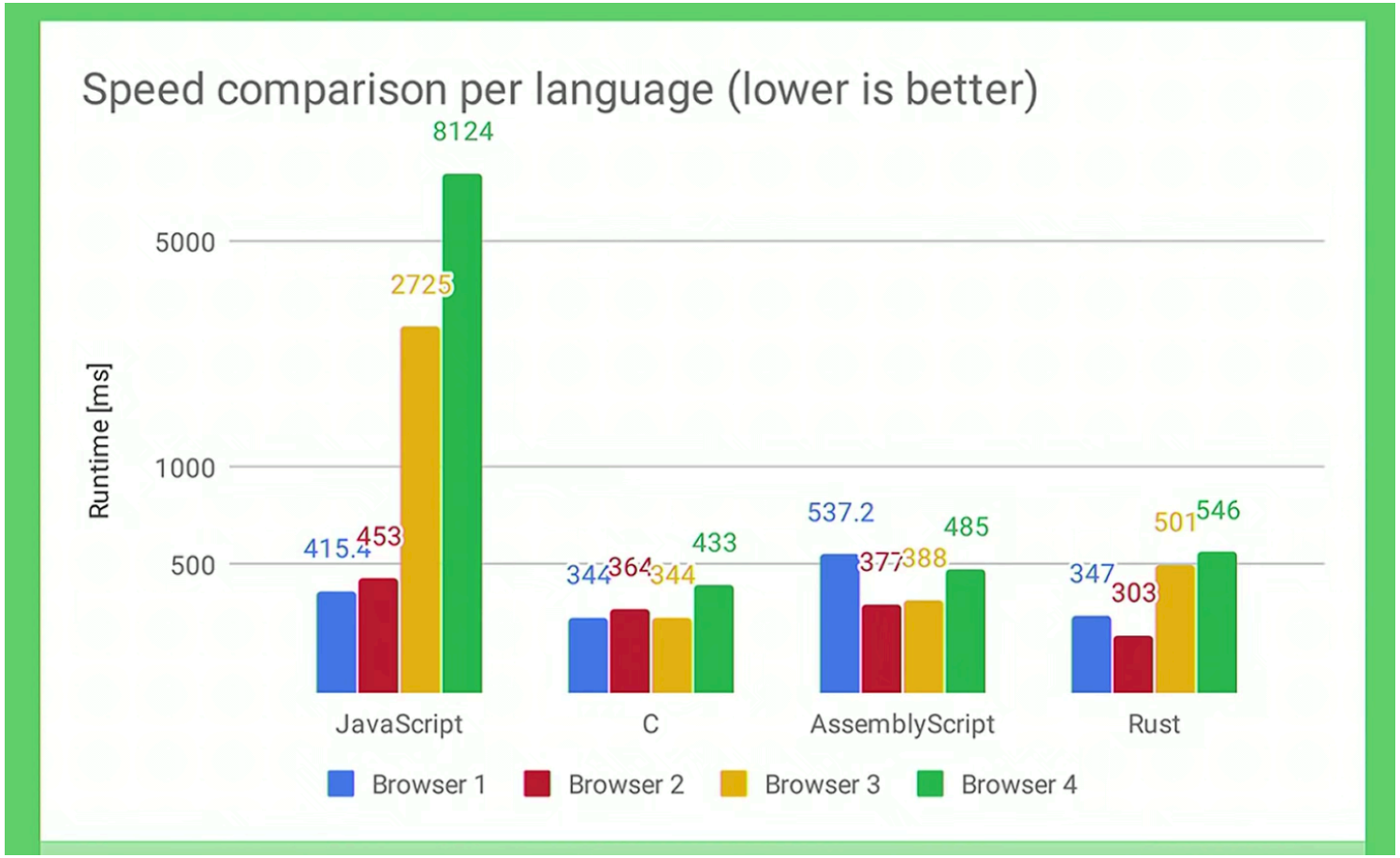
Wasm Performance

- 10% slower than native C/C++
- Around 30% faster than JS
- Even closure compiled JS
- Low-end devices benefit from WASM even more!



What does it look like?

C WAT ASM

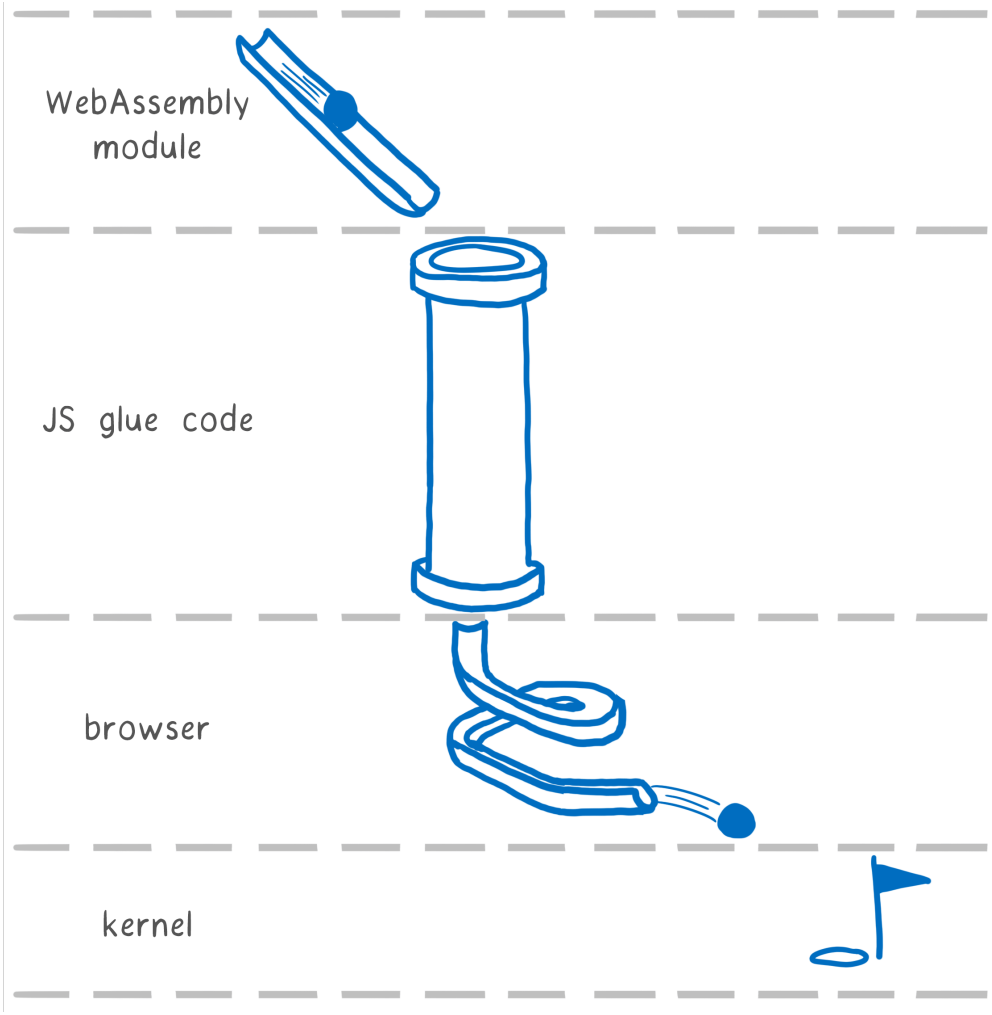
3 Inner workings

—

How do I call my WASM code?

Javascript I choose you!

- Only JS is able to interact with the DOM
- JS will load WASM modules
- Some “glue” code might be required
- Safe way to interact with the system



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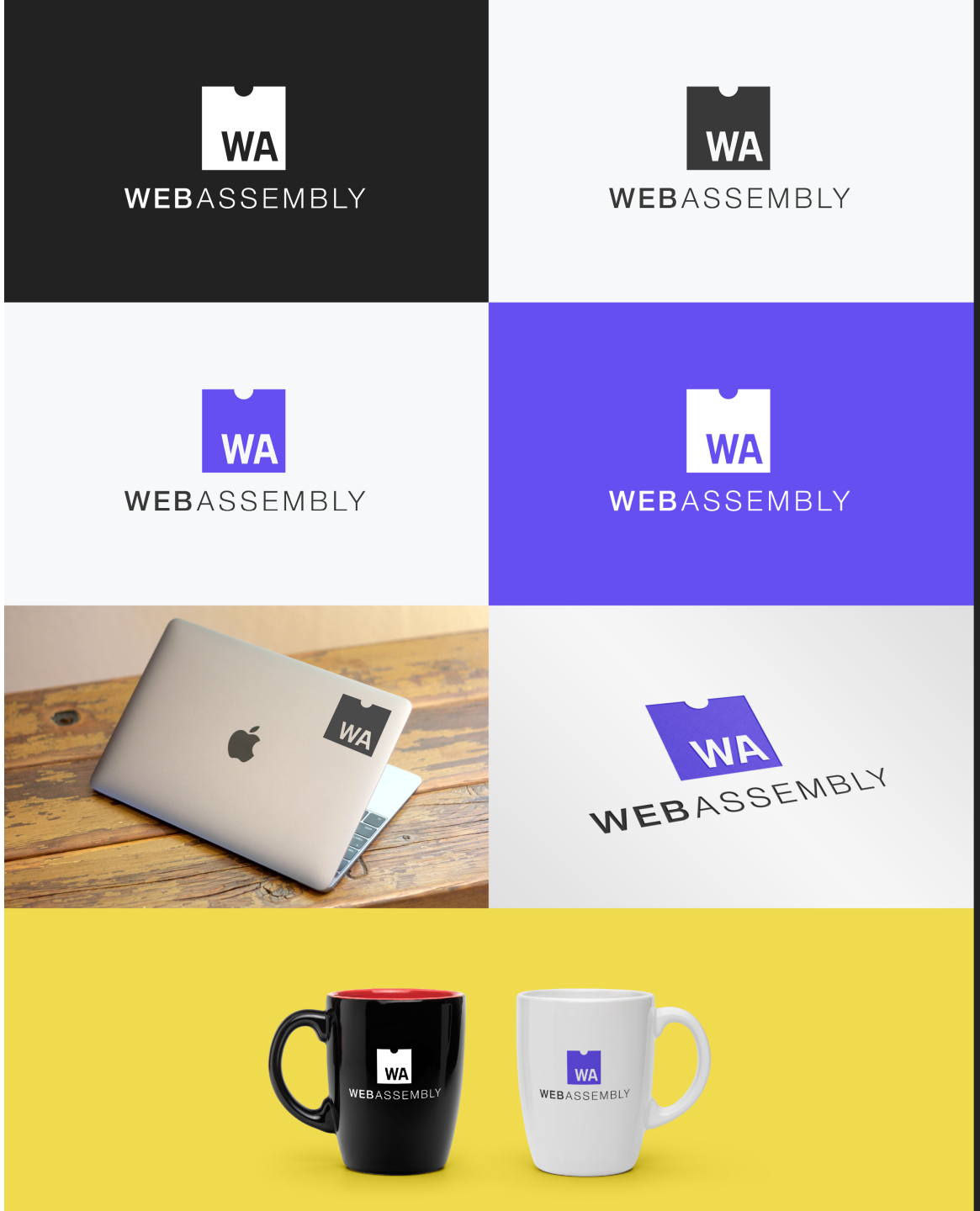
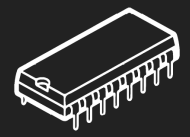
A strong dependency with JS

They’re best buddies



WASM LOGO INSPIRATION

1. **Integrated Circuit** *(IC)*



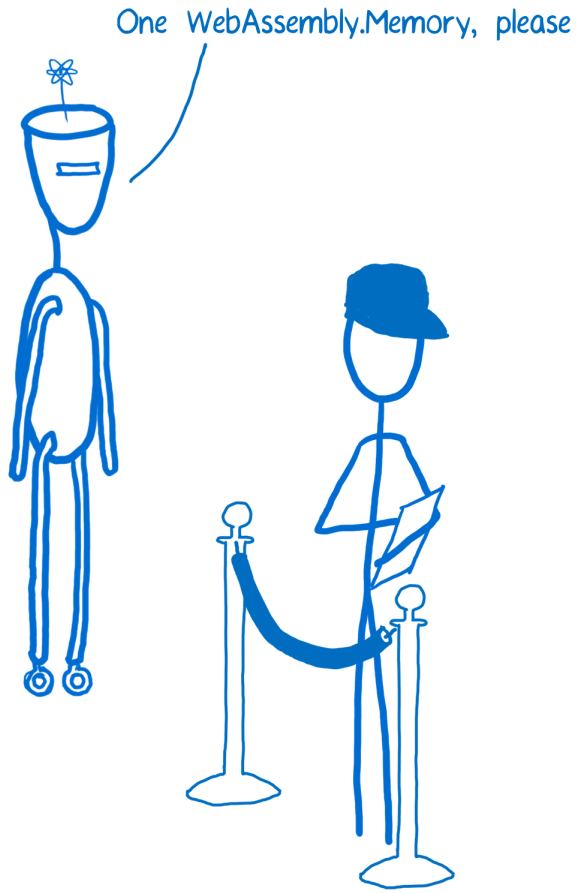
Top **notch** like the orientation notch of an IC

Low level: data structures, memory and CPU efficiency, etc

2. **WASM complements JS**

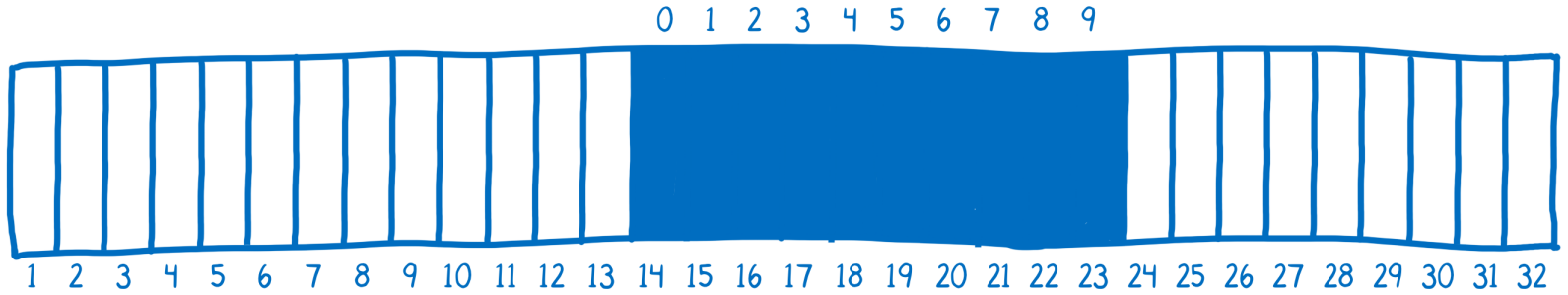
Similar **boxed logo** emphatises the relation between JS and WASM

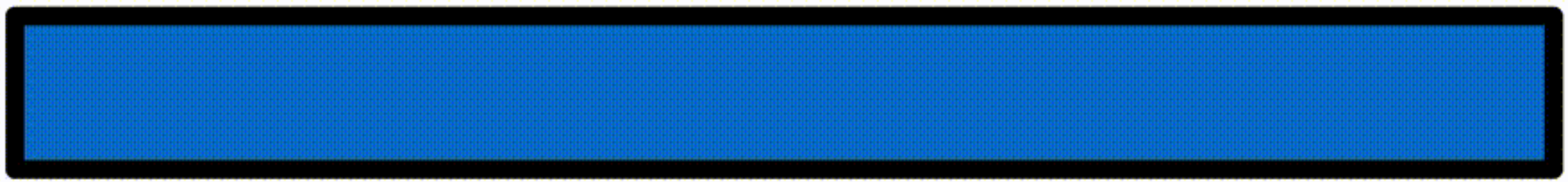
Primary color is JS complementary color



You shall only pass numbers between functions

- But there is a memory array
- Write JS object in
- Pass pointers to the data as numbers
- Read data from the buffer in WASM





WebAssembly.Memory

3 Inner workings

—

Passing pointers to data...

...nobody wants that

This is what the “glue” code might looks like.

Does anyone want to write this ?

```
import * as wasm from './foo_bg'; // imports from wasm file

const heap = new Array(32);
heap.push(undefined, null, true, false);
let heap_next = 36;

function addHeapObject(obj) {
  if (heap_next === heap.length)
    heap.push(heap.length + 1);
  const idx = heap_next;
  heap_next = heap[idx];
  heap[idx] = obj;
  return idx;
}

export function foo(arg0) {
  const idx0 = addHeapObject(arg0);
  wasm.foo(idx0);
}

export function __wbindgen_object_drop_ref(idx) {
  heap[idx ] = heap_next;
  heap_next = idx;
}
```

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A little dependency with the ecosystem

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

#[wasm_bindgen]
pub fn read_filename(filename: &str) {
    alert(&format!("Hello, {}!", filename));
}
```

Going full circle?

1 — Write in assembly

2 — Compile to assembly

3 — Static typing

4 — Interpreted language

5 — Javascript

6 — Typescript

7 — WebAssembly

8 — Write in assembly ?

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4

Use cases

4 Use cases

—

Autodesk

Autocad

-35 years old codebase

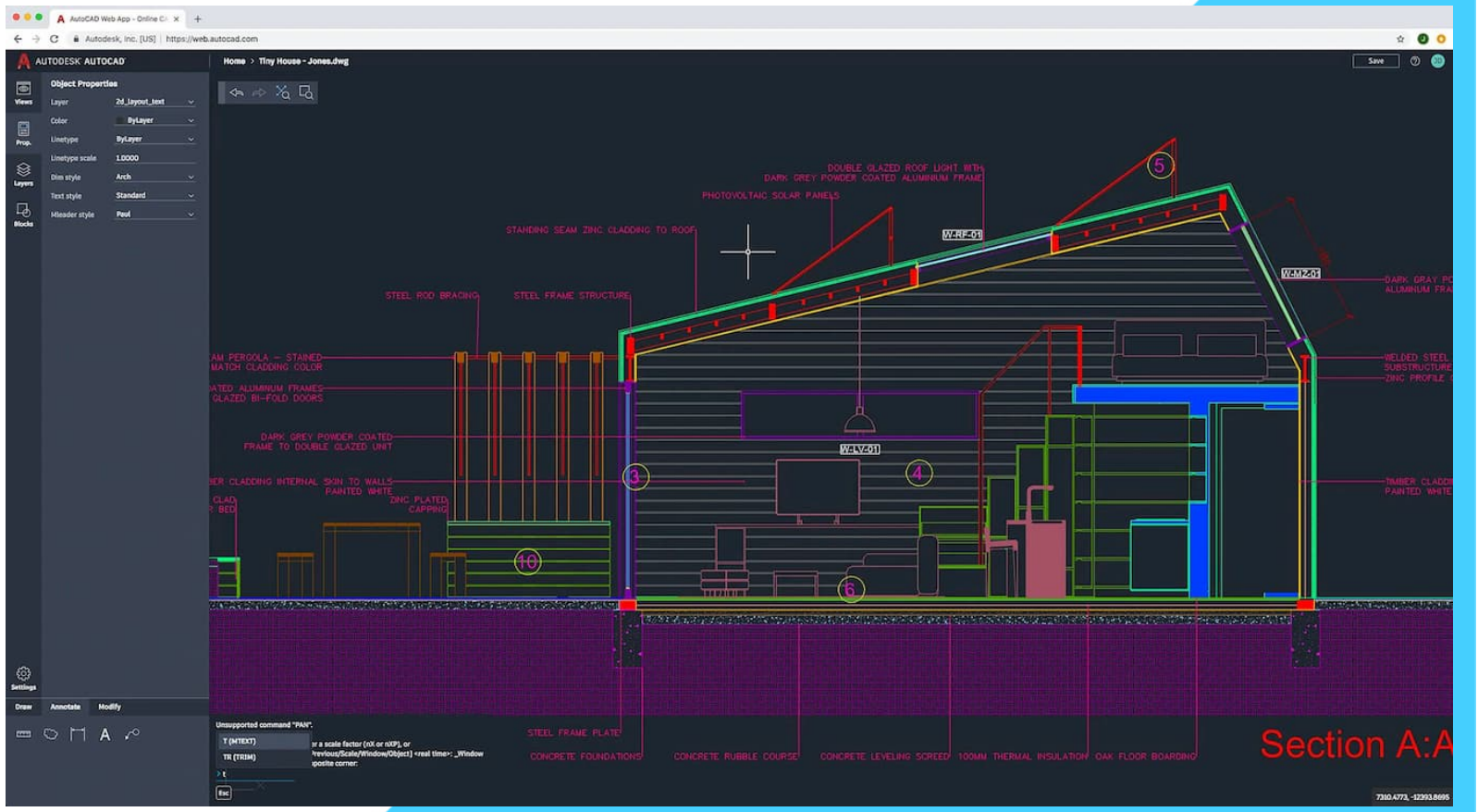
-Compile to WebAssembly

-JS bindings

-Read-only first

-Progressively porting existing c++ code

-Now run 100% in the browser



4 Use cases

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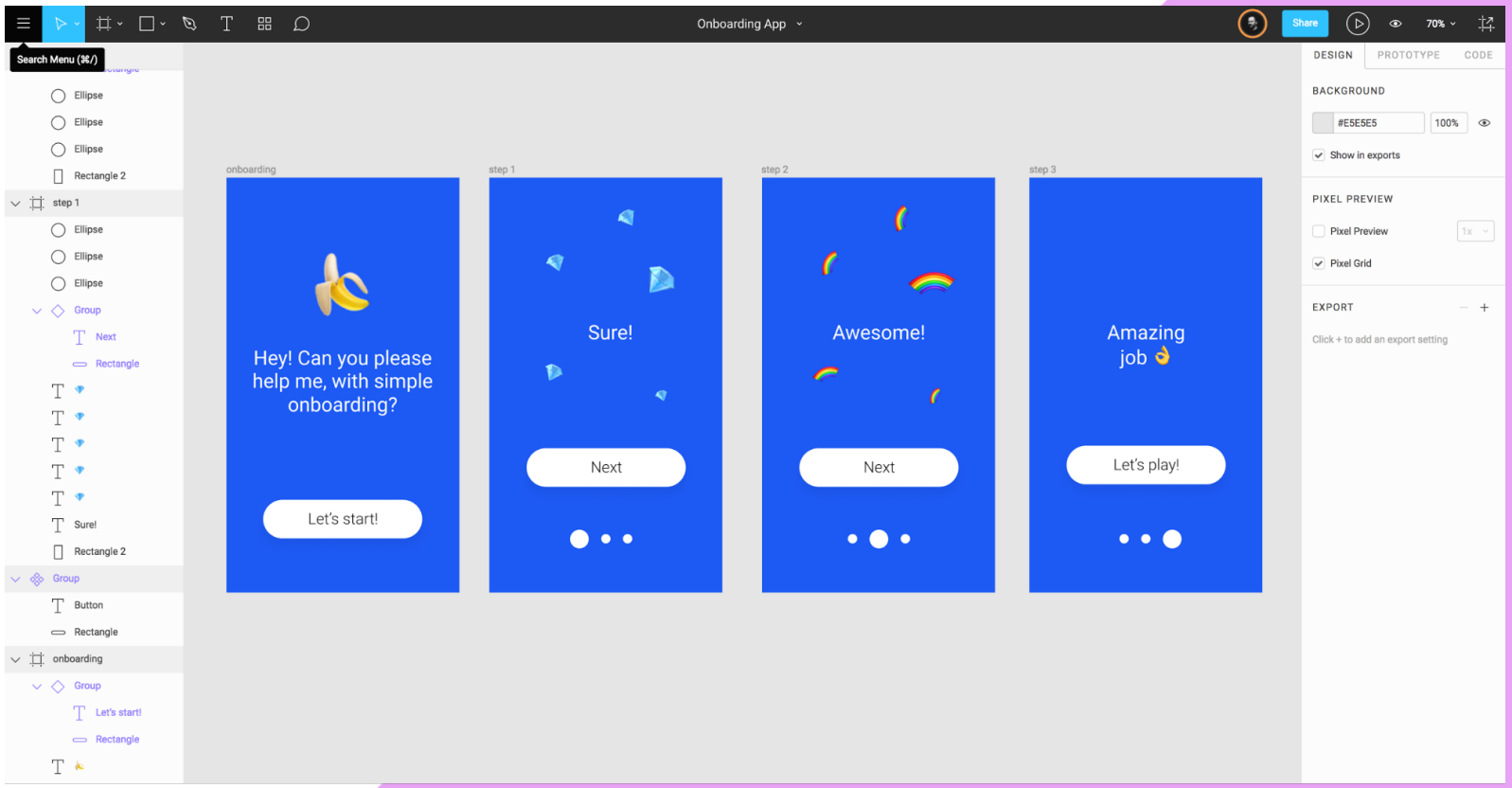
Figma

Design tool

- Product initially written in C++
- Build with ASM.js
- WebAssembly = drop-in replacement
- Parsing is 20x faster than ASM.js
- Already optimized by the compiler
- 3x load time improvement



4 Use cases

—

Ebay

Barcode scanner

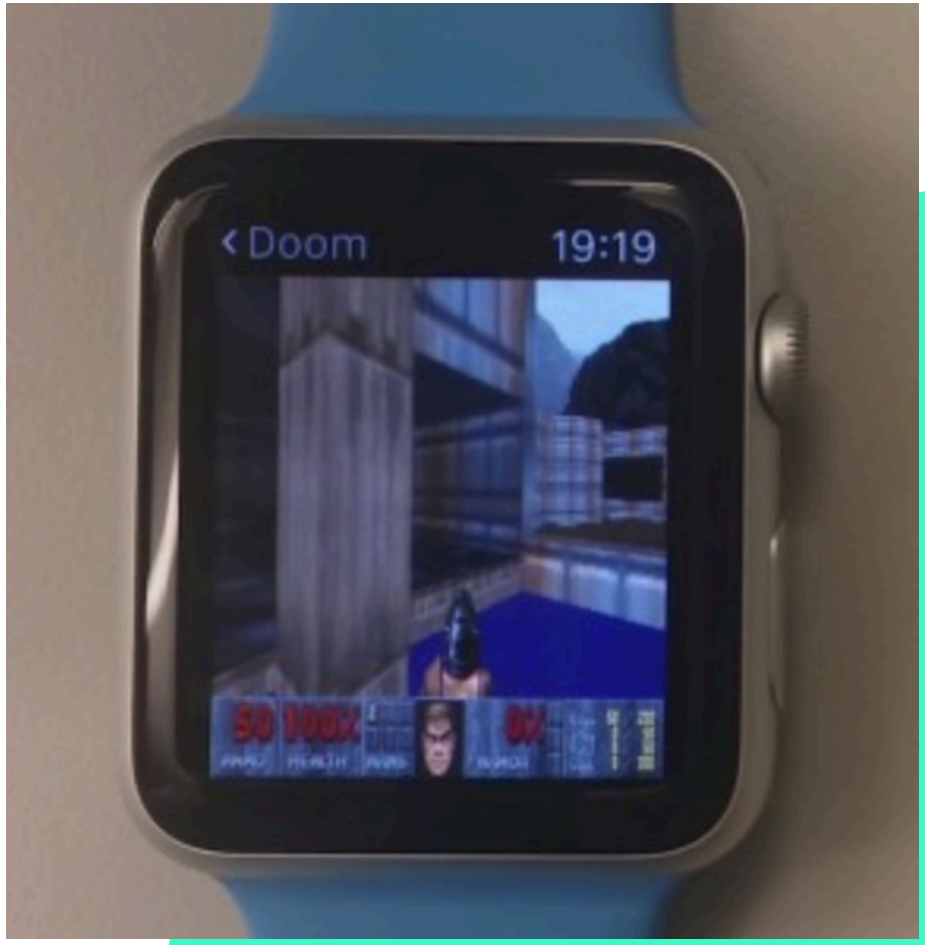
- C++ scanner code for native app
- JS version had poor performance
- WebAssembly to the rescue !

4 Use cases

—

And so much more...

- Game engines
- Video
- Image
- Sound
- ...



Some more examples

Game engine:
DOOM 3

- 7 weeks
- 40-60% slower than native
- 850MB in RAM

Image manipulation:
Squoosh.app

- Convertion
- Crop
- Resize
- Rotate

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5

DEMO

1

Write in assembly

2

Compile to assembly

3

Static typing

4

Interpreted language

5

Javascript

6

Typescript

7

WebAssembly

8

Write in assembly ?

1

—

Write in assembly

2

—

Compile to assembly

3

—

Static typing

4

—

Interpreted language

5

—

Javascript

6

—

Typescript

7

—

WebAssembly

8

—

Write in assembly ?

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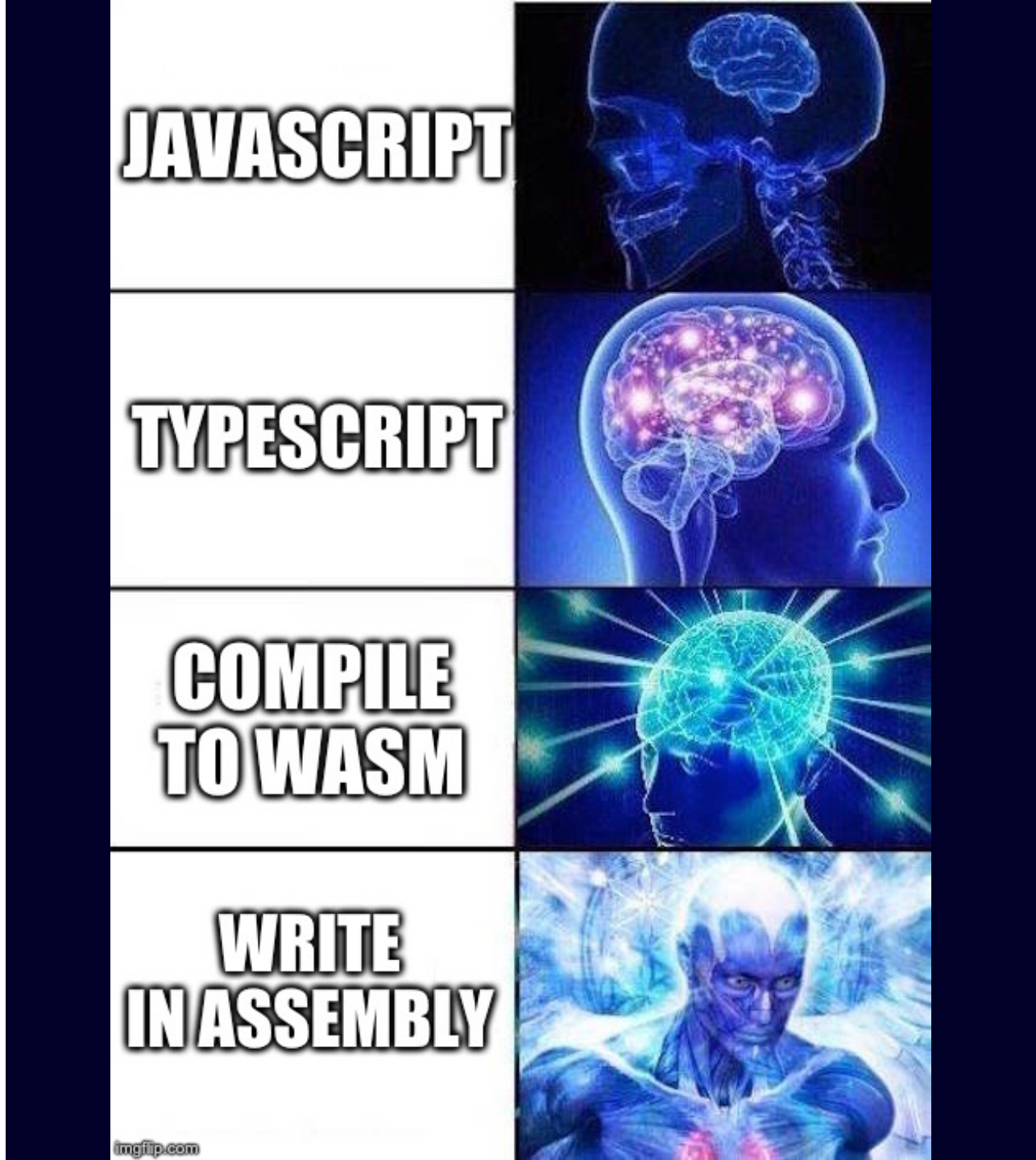
Let’s start with the easy one

Writing in assembly for the browser

Yes we’re really gonna do that, I’m so sorry



4 Demo

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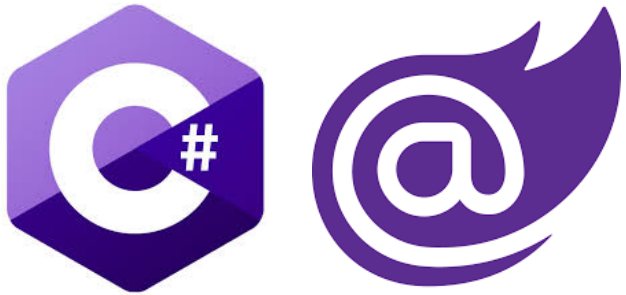
What if I need to convince my CTO?

Hello World

C++ / emscripten

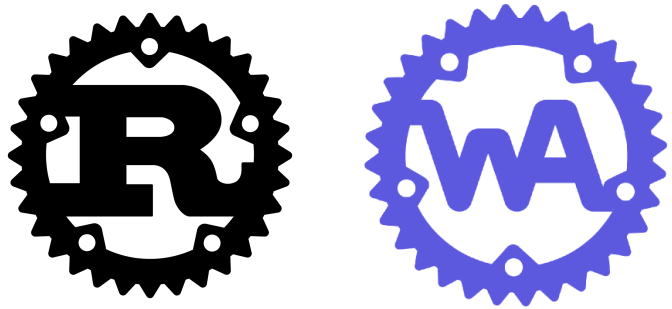
Web App

C# / blazor



Leveraging libs

Rust / wasm-bindgen



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Rust ecosytem is reeeeeealy good 🦀

WASM is on the ~~(M)~~Loose

Definition

WebAssembly or wasm is a new portable, size- and load-time-efficient format suitable for compilation to the web.

webassembly.org

Definition

WebAssembly is a binary instruction format for a stack-based virtual machine. Wasm is designed as a portable target [...] for client and server applications.

webassembly.org

5 Epilogue

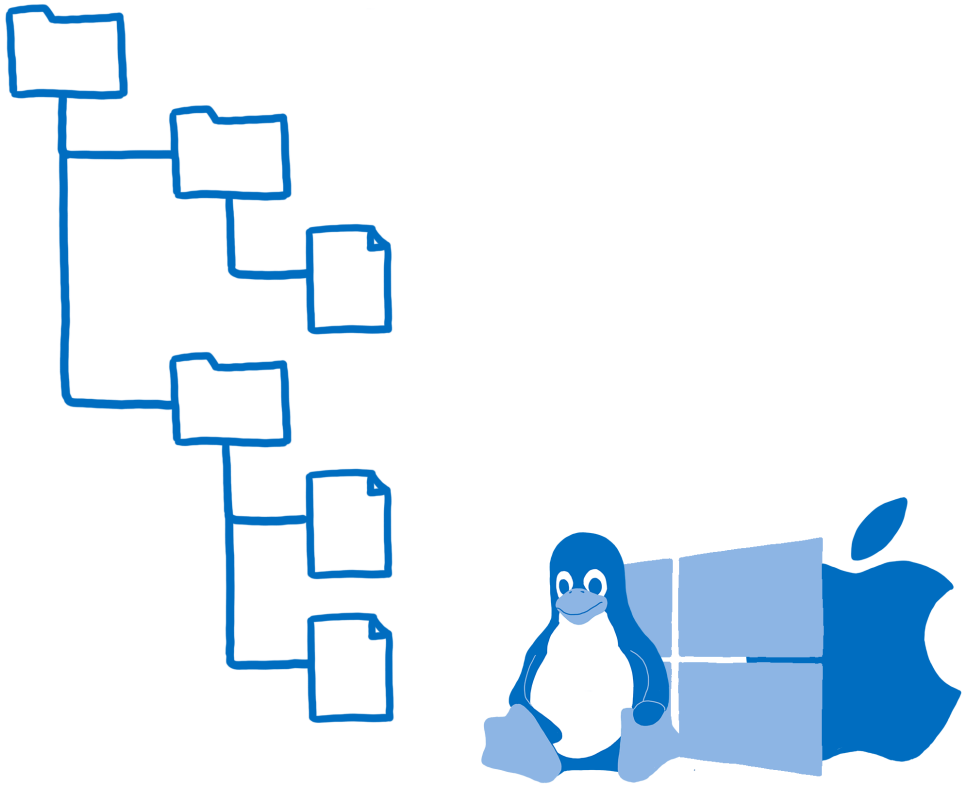
—

WASI, WebAssembly system interface

Running WebAssembly outside the web

- WASM runtimes
- Standardized system calls
- Safe execution everywhere
- WASM can now run outside a browser
- Already multiple runtimes available

5 Epilogue


Here you go. Here are some safe toys to interact with the OS.
Aw, man... Where is my network access!?
> risky-app
WA
safe_write
afe_read

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One more thing...

1 — Threads

2 — Exceptions

3 — Garbage collection

Code: https://github.com/thuchede/wasm-intro

—

Look what we've built today!

WAT

Add function in a simple module

C++

Hello world built with emscripten

Rust

Simple App leveraging existing libs with wasm-bindgen

C#

Demo app : https://dotnet.microsoft.com/apps/aspnet/web-apps/client

References

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Question(s)?

👋