OVHcloud

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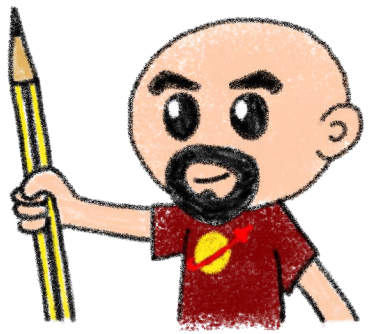
100% OPEN SOURCE - Conférences et Workshops

Server-side WebAssembly

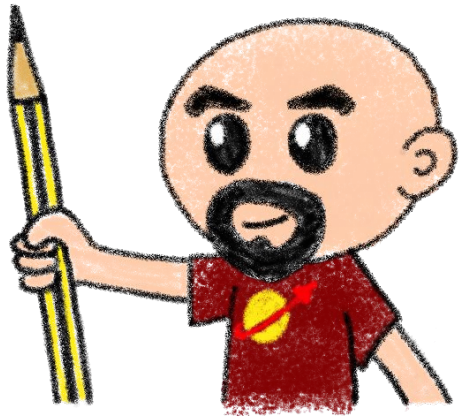
Horacio Gonzalez

2021-06-24



Who are we?

Introducing myself and introducing ~~OVH~~ OVHcloud



Horacio Gonzalez

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@LostInBrittany

Spaniard lost in Brittany, developer, dreamer and all-around geek

OVHcloud

Head of DevRel

LES BRIQUES DU WEB

Finist Devs

DevFest du Bout du Monde

Google Developers Experts 2019

Web Technologies GDE

Flutter

OVHcloud: A global leader

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- **Web Cloud & Telcom**
- **Private Cloud**
- **Public Cloud**
- **Storage**
- **Network & Security**

- **30 Data Centers** in 12 locations
- **34 Points of Presence** on a 20 TBPS Bandwidth Network
- **2200 Employees** worldwide
- **115K Private Cloud** VMS running
- **300K Public Cloud** instances running
- **380K Physical Servers** running in our data centers
- **1 Million+ Servers** produced since 1999
- **1.5 Million Customers** across 132 countries
- **3.8 Million Websites** hosting
- **1.5 Billion Euros Invested** since 2016
- **P.U.E. 1.09** Energy efficiency indicator
- **20+ Years in Business** Disrupting since 1999

Did I say WebAssembly?

Wasm for friends...

WebAssembly, what's that?

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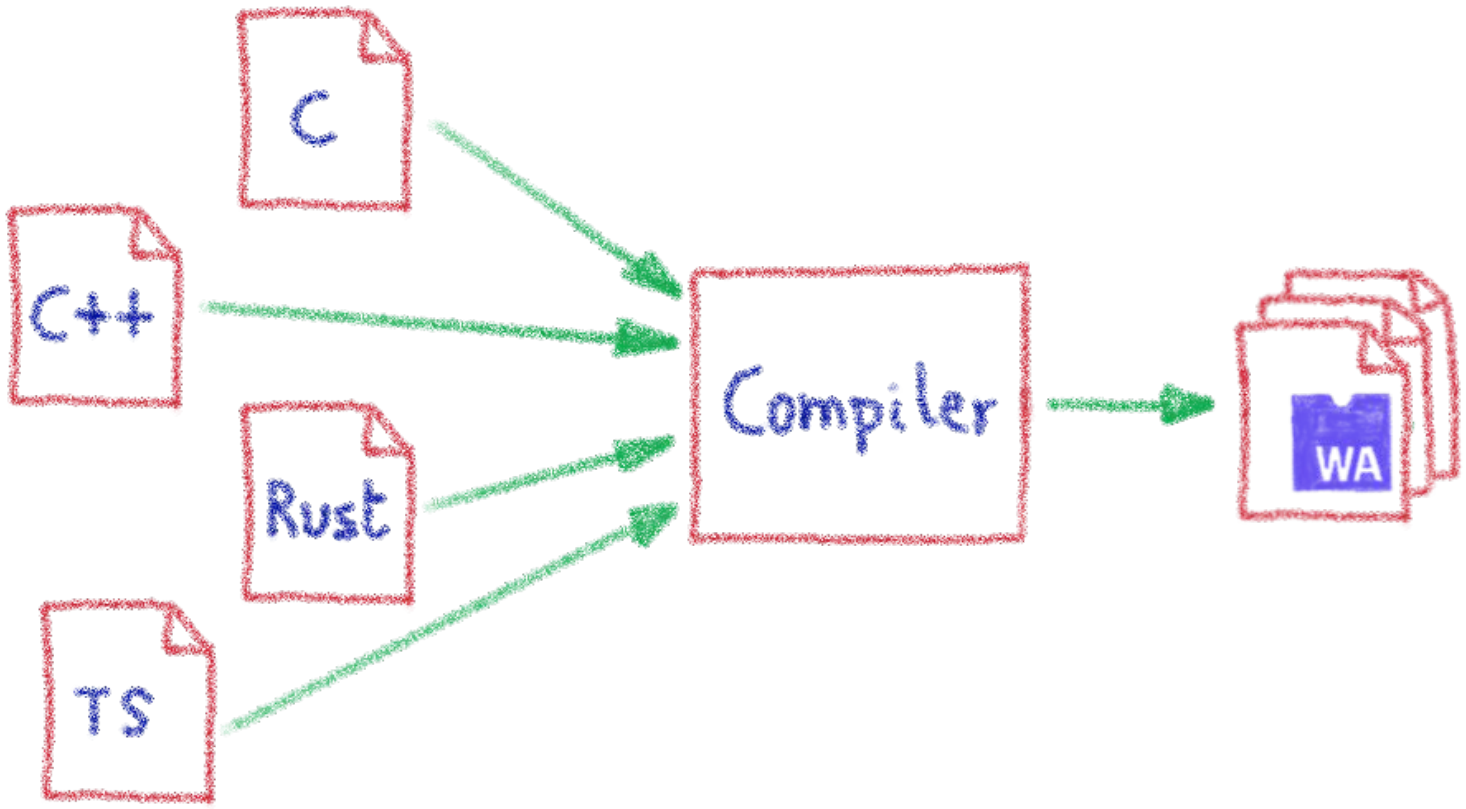
What's WASM ?

Does it replace JS ?

Can I code webapps in Rust?

Is HTML/CSS/JS stack obsolete?

A low-level binary format



Not a programming language, a compilation target

That runs on a stack-based virtual machine

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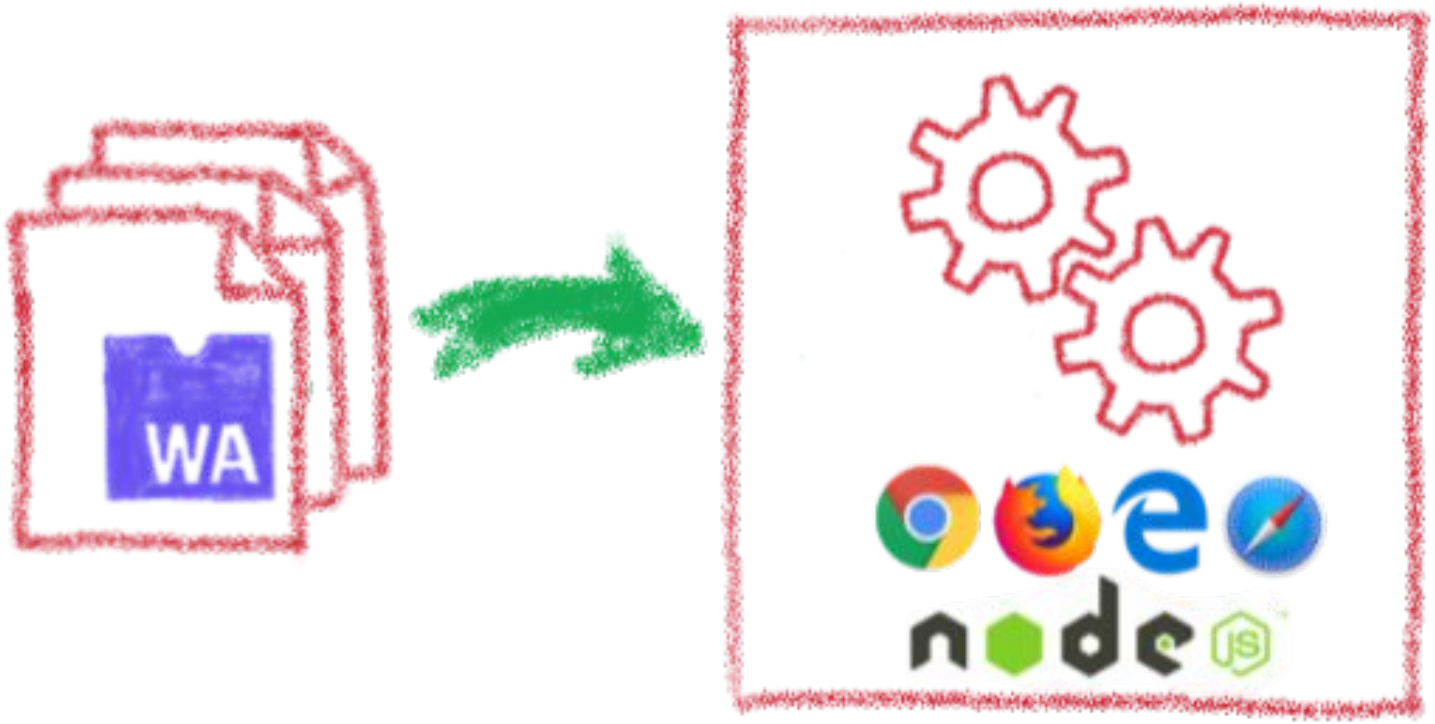

A portable binary format that runs on all modern browsers… but also on NodeJS and elsewhere!!

With several key advantages

Fast & Efficient

Memory-safe & Sandboxed

Open & Deboggable

WWW Part of the Web Platform

But above all...

Wasm is not meant to replace JavaScript

Who is using WebAssembly today?

And many more others...

Macromedia Flash

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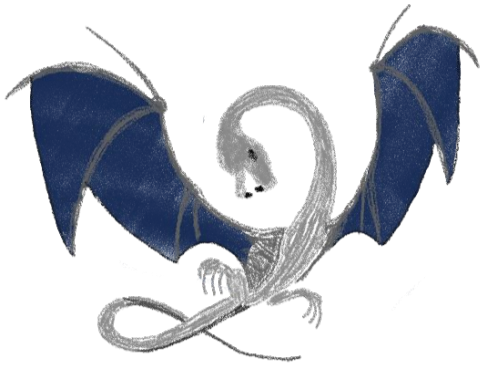
A bit of history

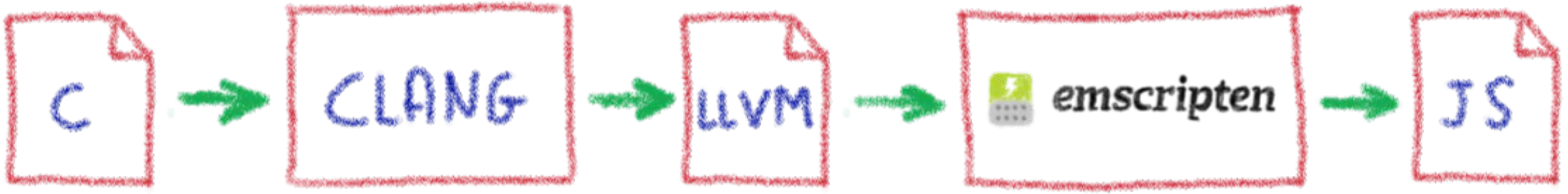
Remembering the past
to better understand the present



Executing other languages in the browser

A long story, with many failures...

2012 - From C to JS: enter emscripten



Passing by LLVM pivot

2013 - Generated JS is slow...

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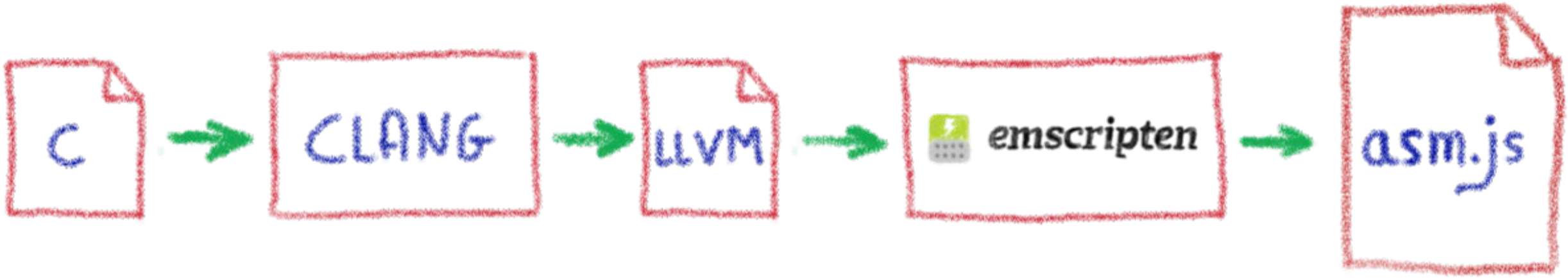


Let's use only a strict subset of JS: asm.js

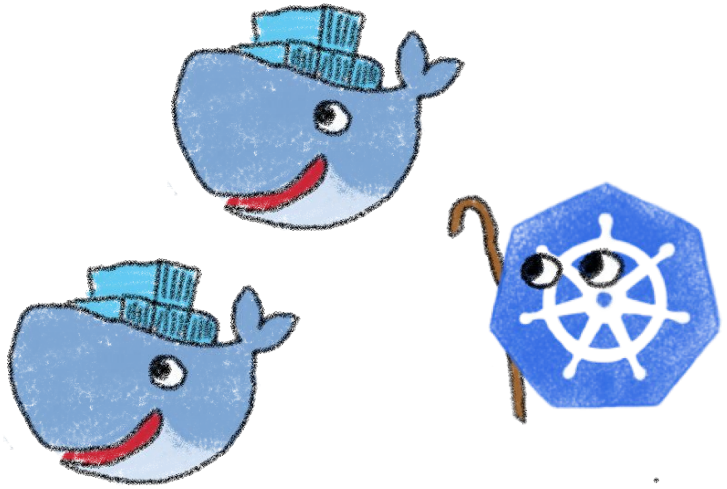
Only features adapted to AOT optimization

WebAssembly project

Joint effort

Server-side WebAssembly

Too good to not to use it



Solomon on Web Assembly

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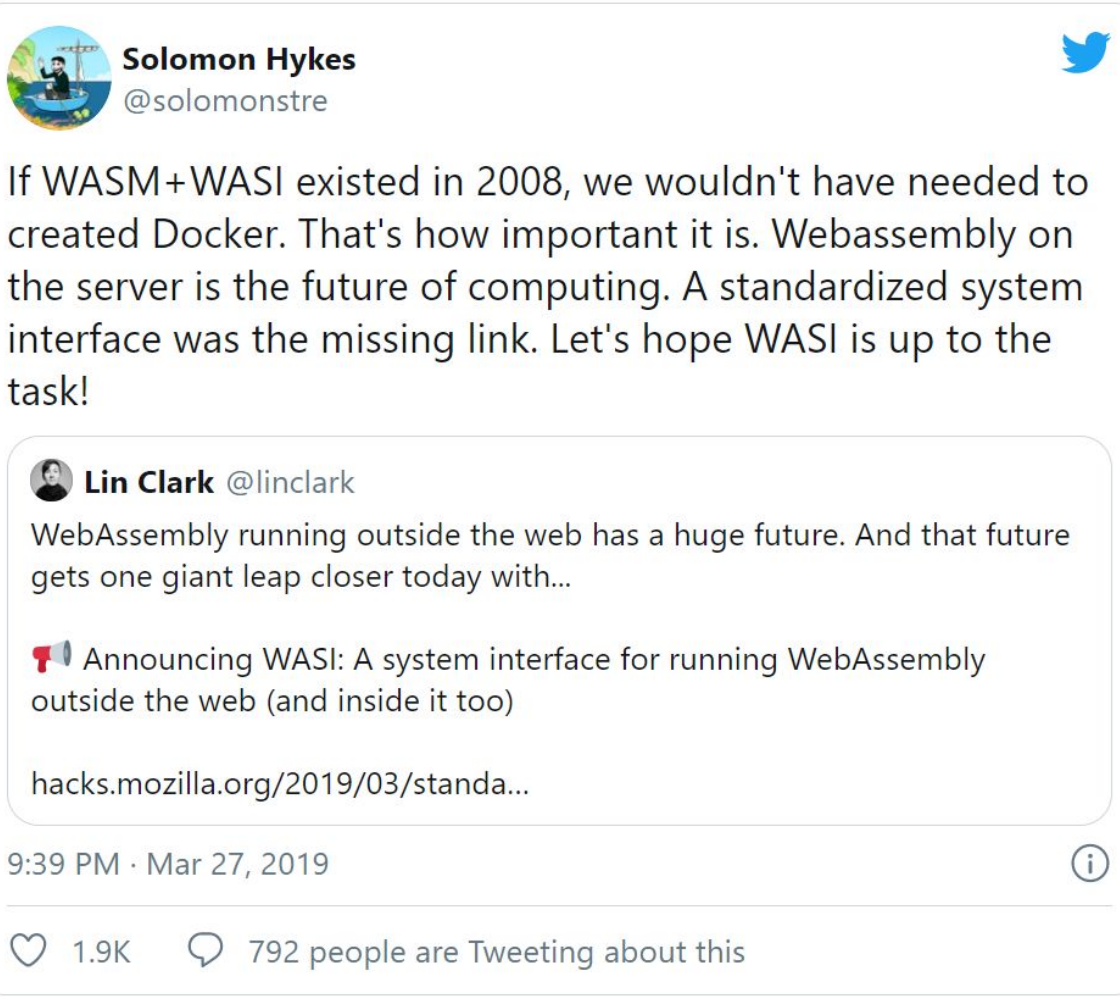
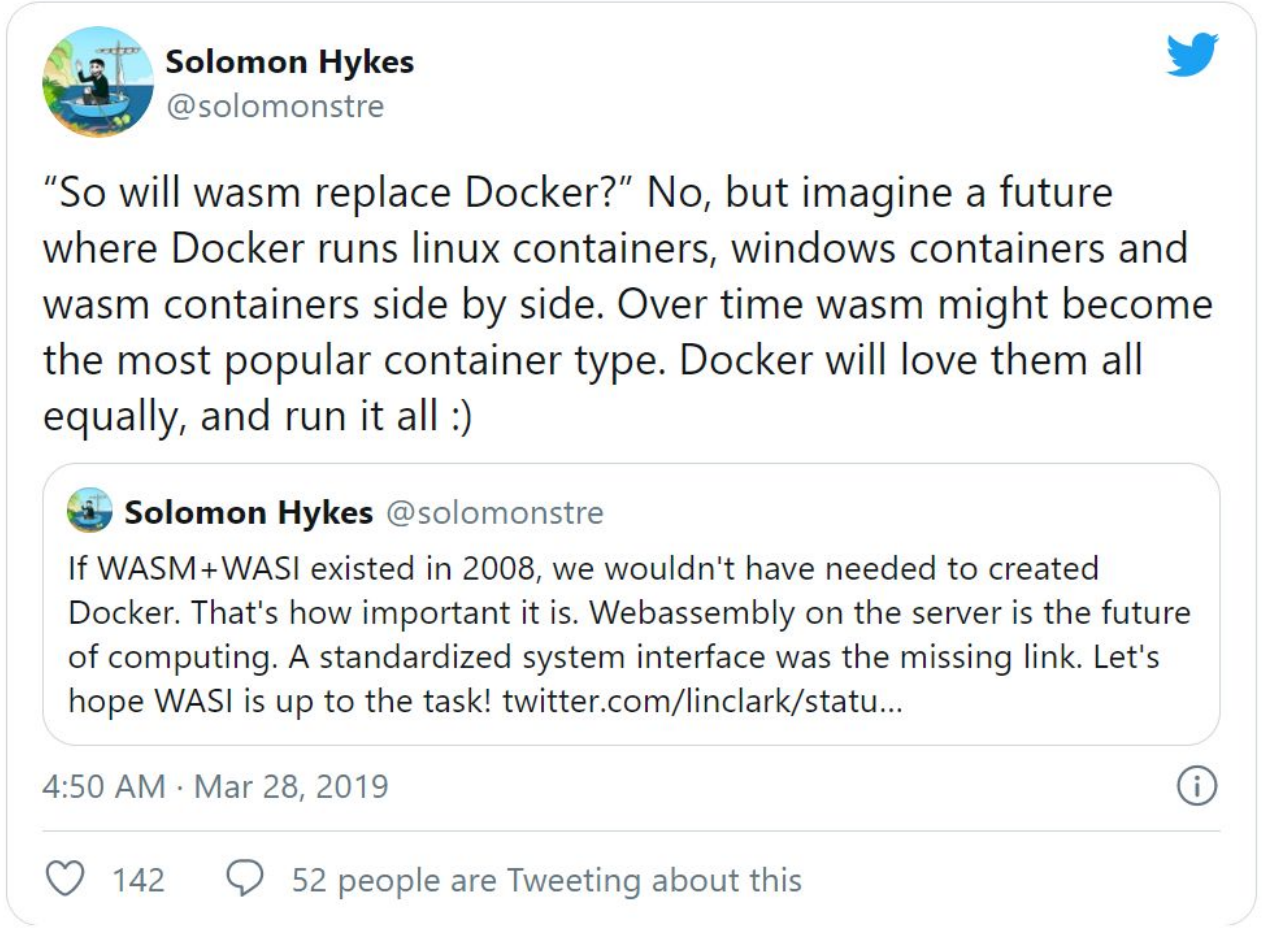


Solomon on Web Assembly



Solomon Hykes
@solomonstre

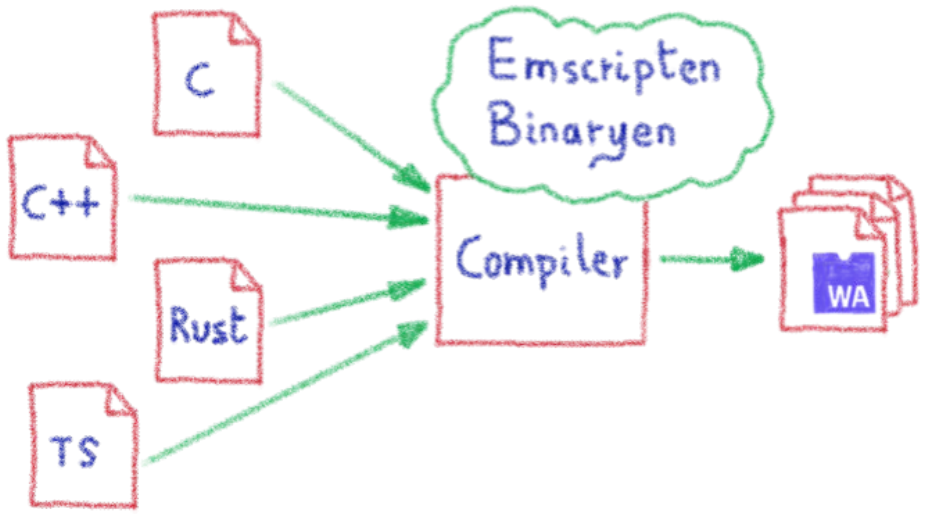
"So will wasm replace Docker?" No, but imagine a future where Docker runs linux containers, windows containers and wasm containers side by side. Over time wasm might become the most popular container type. Docker will love them all equally, and run it all :)

> **Solomon Hykes** @solomonstre
> If WASM+WASI existed in 2008, we wouldn't have needed to created Docker. That's how important it is. Webassembly on the server is the future of computing. A standardized system interface was the missing link. Let's hope WASI is up to the task! twitter.com/linclark/statu...

4:50 AM · Mar 28, 2019

142 52 people are Tweeting about this

A very interesting feature set



Fast & Efficient

Memory-safe & Sandboxed

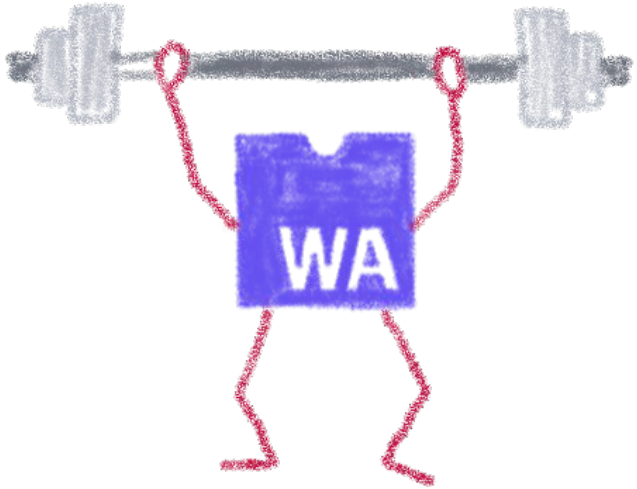
Open & Deboggable

~~www Part of the Web Platform~~

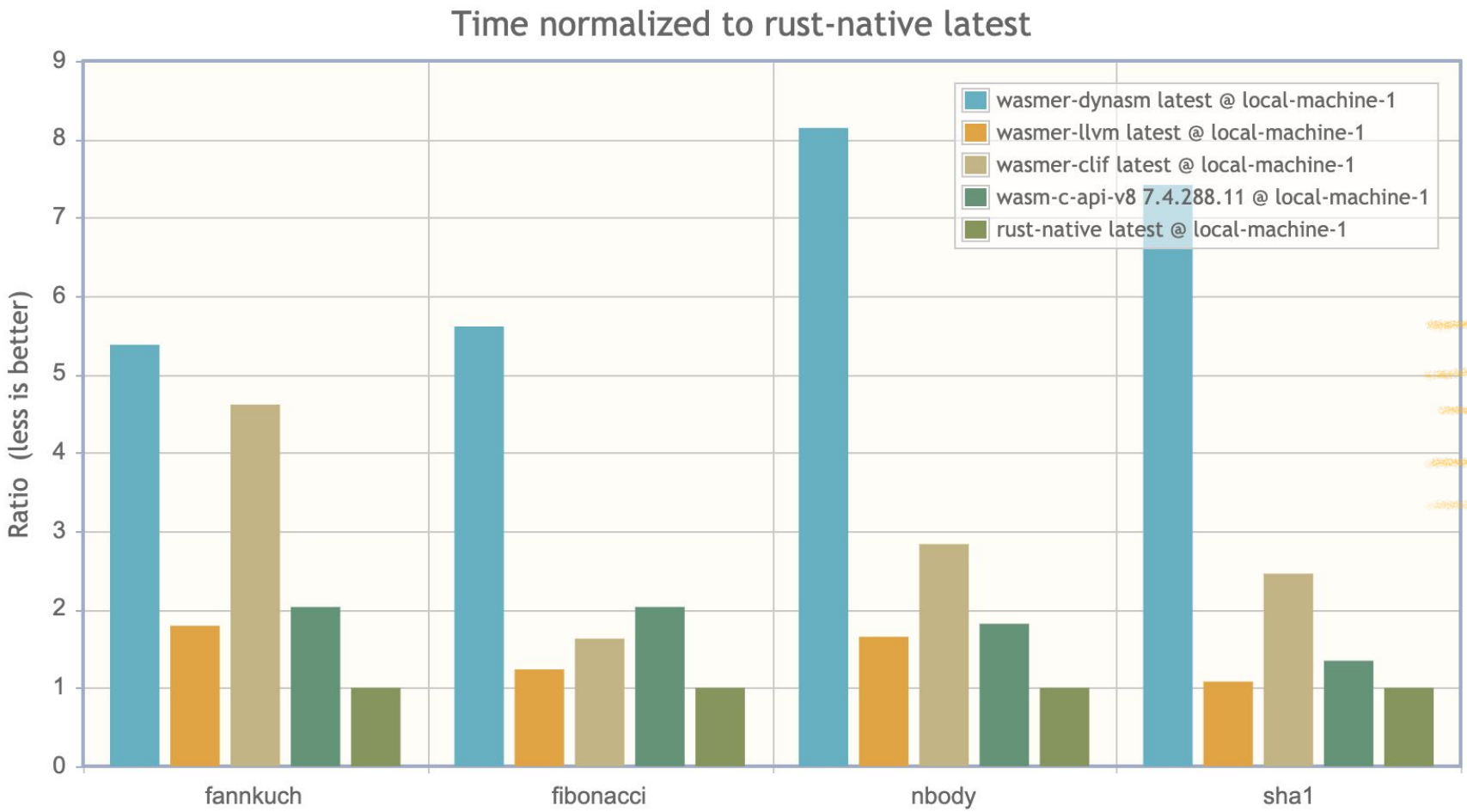
WHY ONLY FOR THE WEB ??

Features of Wasm

Why is everybody looking at it?

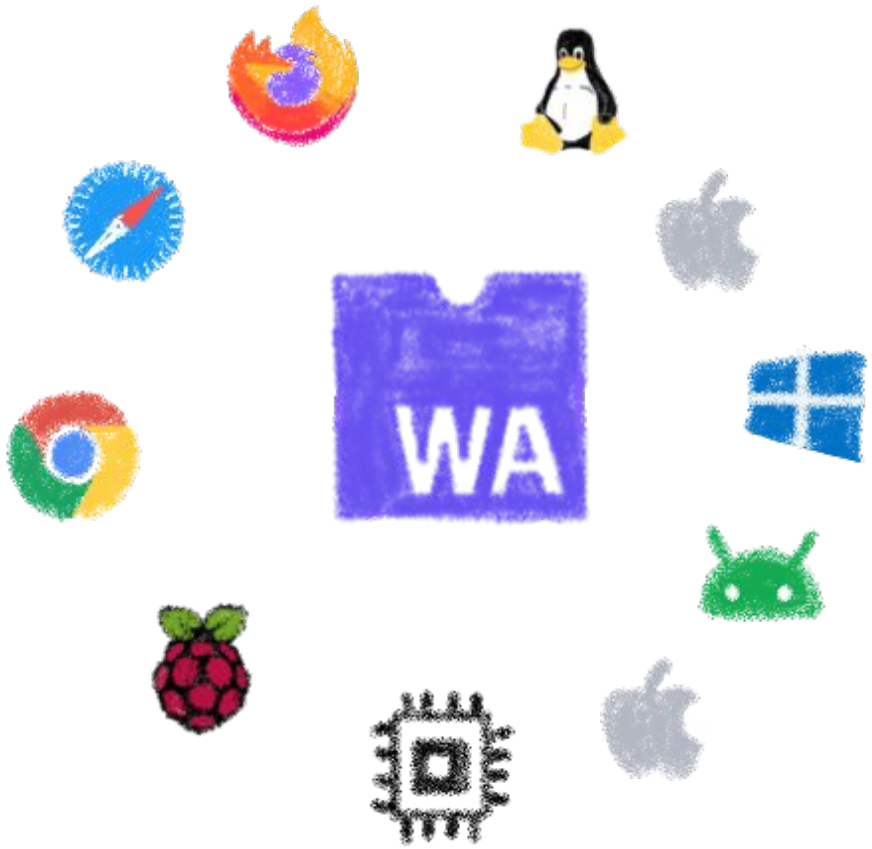


Near native speed



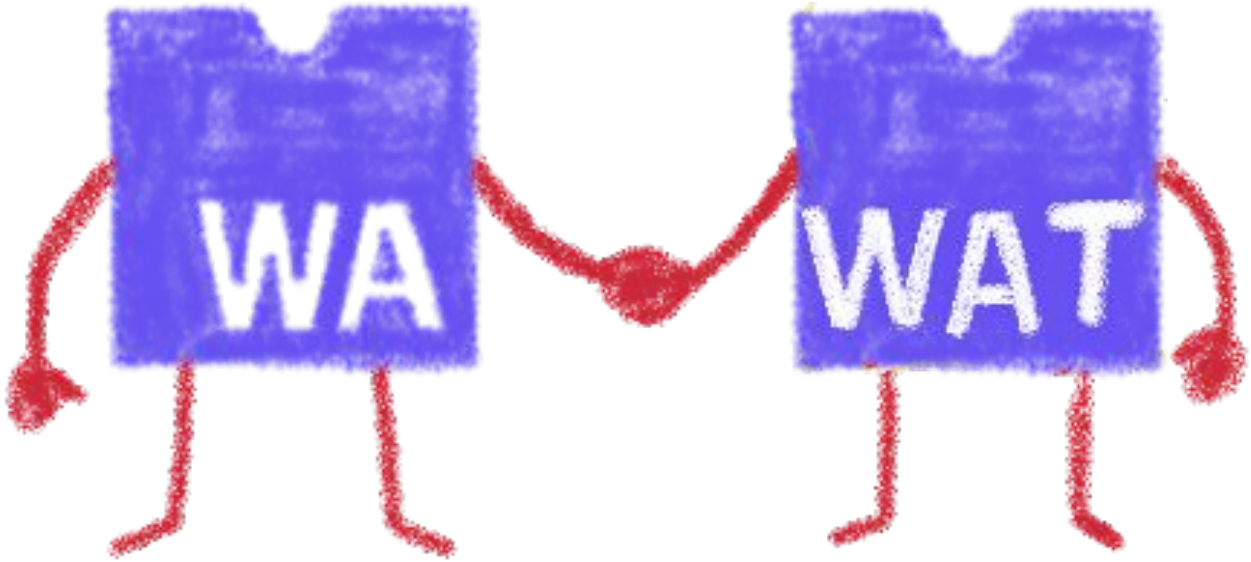
https://medium.com/wasmer/benchmarking-webassembly-runtimes-18497ce0d76e

Highly portable



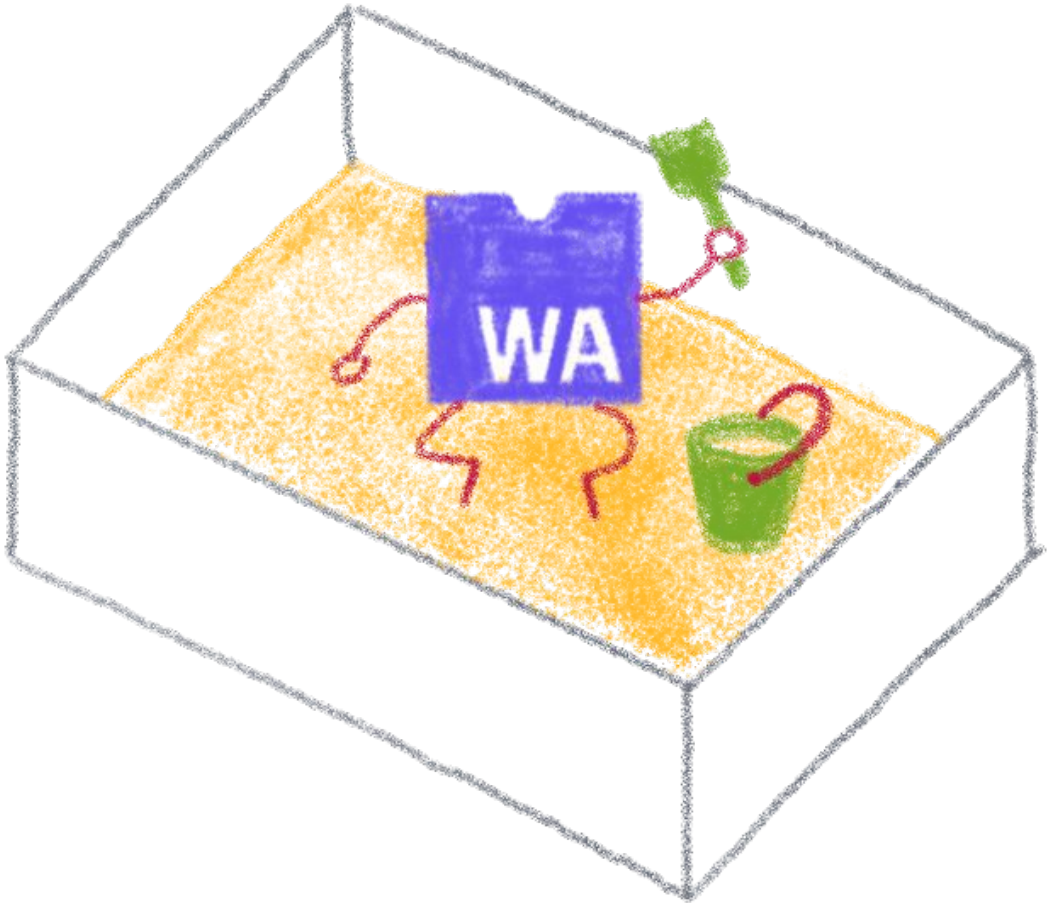
It can be run almost everywhere...

Readable and debuggable



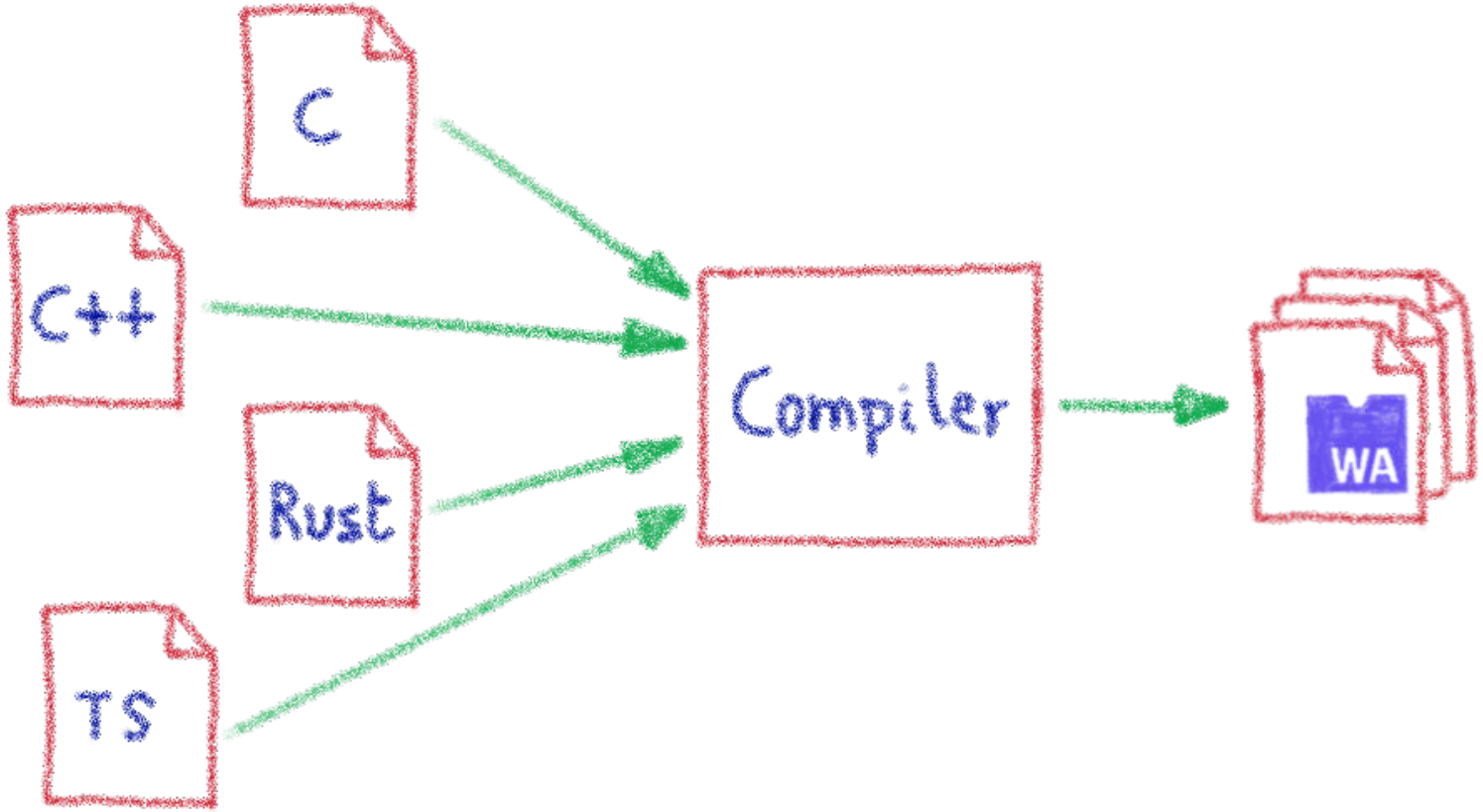
Each `.wasm` file with it `.wat` companion file

Memory safe & secure



Running in a fully sandboxed environment

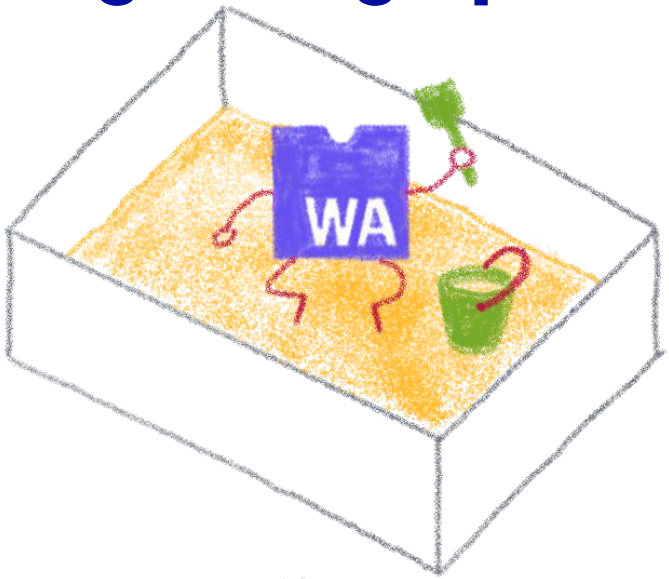
Accepting many source languages



And more and more...

Still a young platform...

But growing up fast!



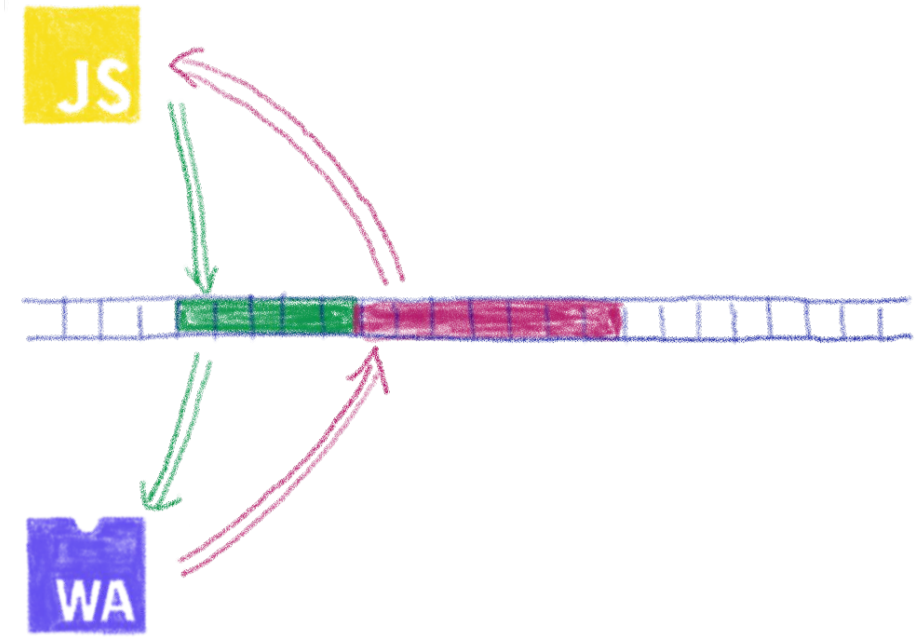
Native WASM types are limited

WASM currently has four available types:

- `i32`: 32-bit integer
- `i64`: 64-bit integer
- `f32`: 32-bit float
- `f64`: 64-bit float

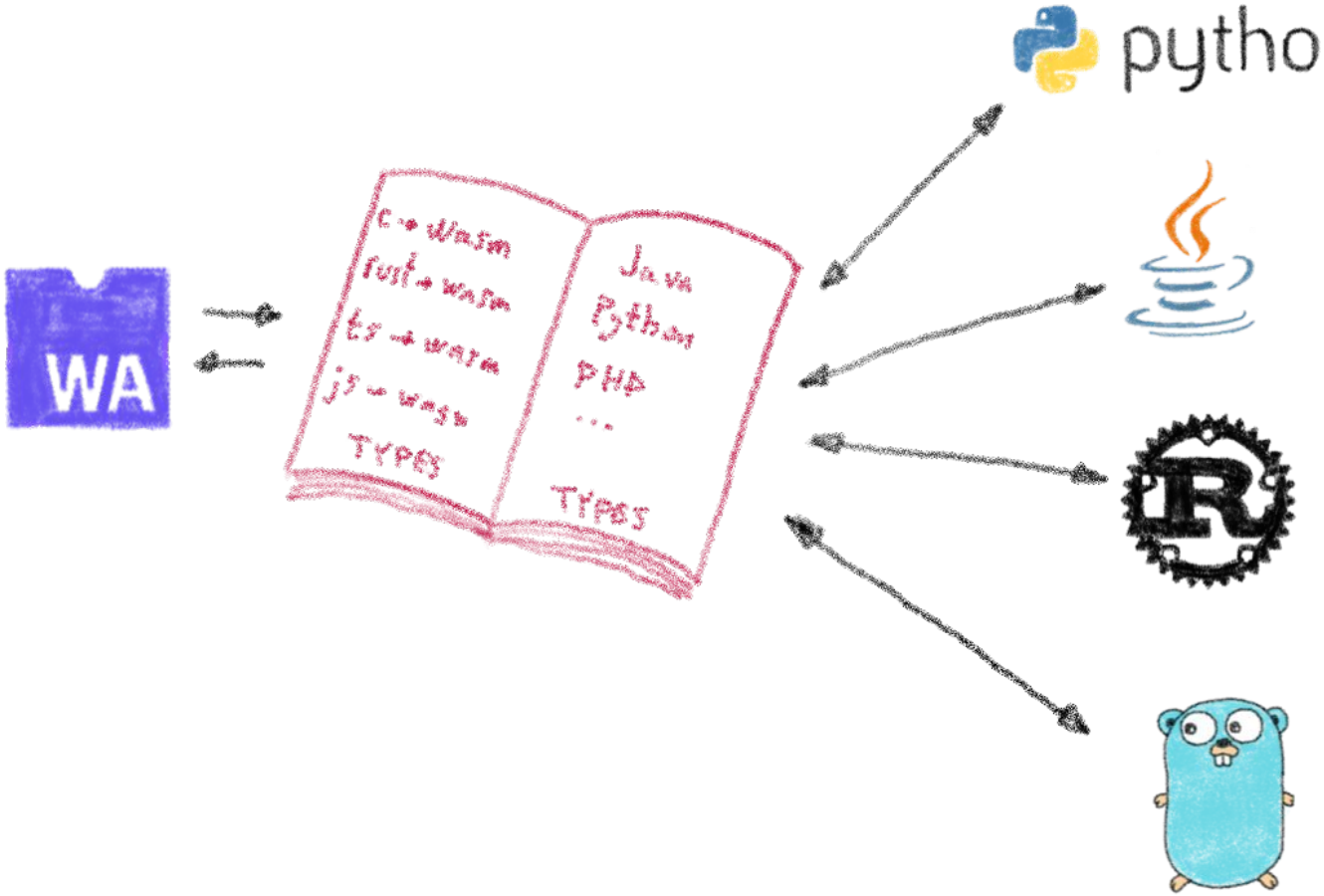
Types from languages compiled to WASM are mapped to these types

How can we share data?



Using the same data in WASM and JS?
Shared linear memory between them,
and serializing the data to one Wasm types

Solution is coming: Interface types



Beautiful description at:

https://hacks.mozilla.org/2019/08/webassembly-interface-types

No outside access

By design, communication is done
using the shared linear memory only

Solution exists: WASI

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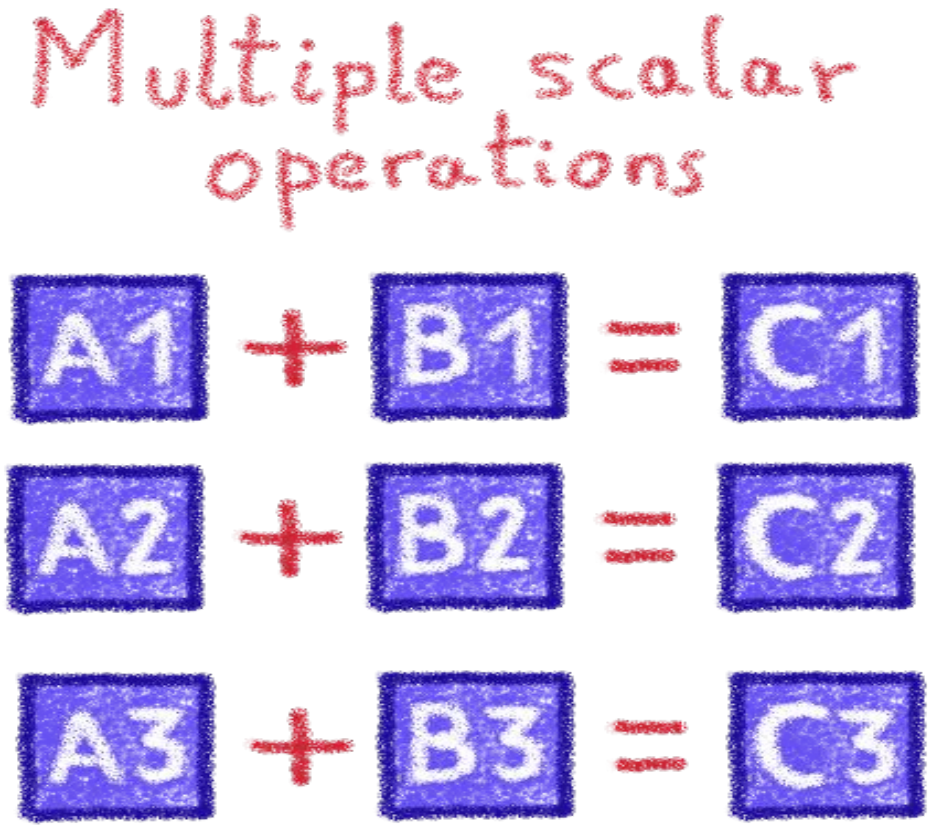
Already available in Wasmer

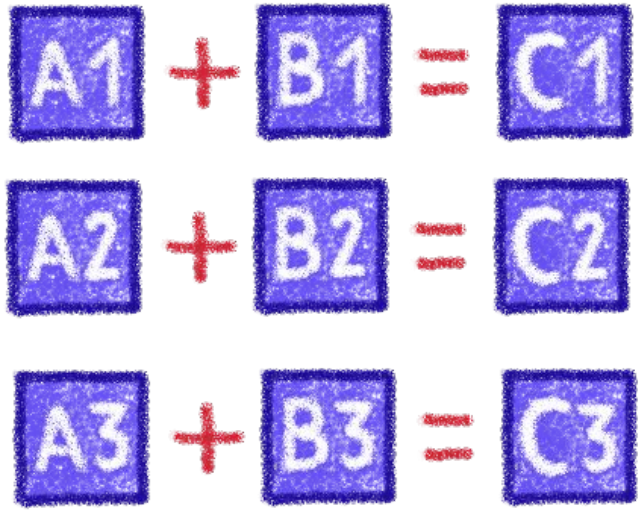
Mono-thread and scalar operations only



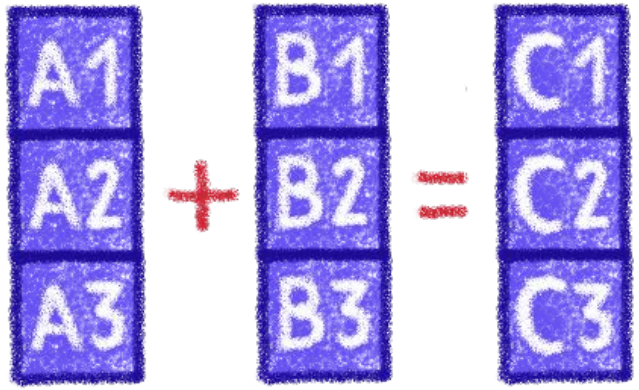
Not the most efficient way...

Solution exists: SIMD

Multiple scalar operations



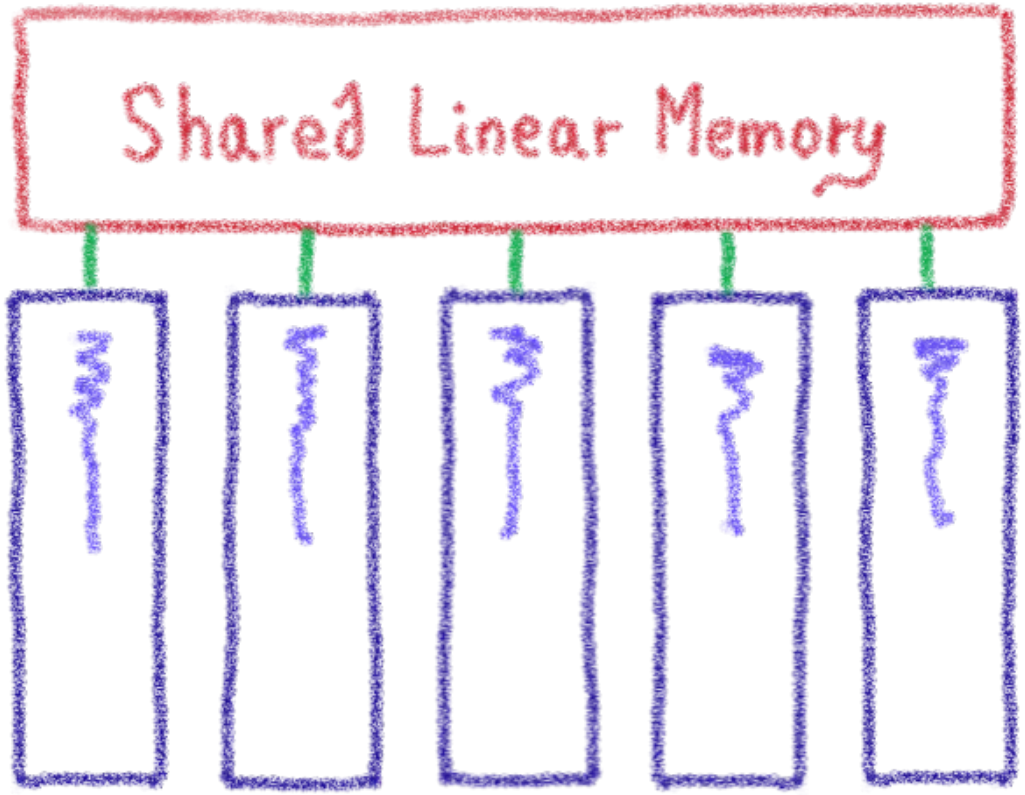
Single vectorial operation



Already available in Wasmer

Single Instruction, Multiple Data

Solutions are coming too: Wasm Threads



Threads on Web Workers
with shared linear memory

Incoming proposals: Garbage collector

And exception handling

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The Bytecode Alliance

Taking WASM out of the browser

BYTECODE ALLIANCE

The Bytecode Alliance

BYTECODE ALLIANCE

mozilla

fastly

Red Hat

intel

Bytecode Alliance projects

Wasmtime

Cranelift

WebAssembly Micro Runtime (WAMR)

Lucet

Enarx

Wasmtime

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wasmtime

A standalone runtime for WebAssembly

A Bytecode Alliance project

CI passing | zulip join chat | rustc 1.37+ | docs 0.19.0

Guide | Contributing | Website | Chat

Installation

The Wasmtime CLI can be installed on Linux and macOS with a small install script:

```
$ curl https://wasmtime.dev/install.sh -sSf | bash
```

Windows or otherwise interested users can download installers and binaries directly from the GitHub Releases page.

Example

If you've got the Rust compiler installed then you can take some Rust source code:

```
fn main() {
    println!("Hello, world!");
}
```

and compile/run it with:

```
$ rustup target add wasm32-wasi
$ rustc hello.rs --target wasm32-wasi
$ wasmtime hello.wasm
Hello, world!
```


Cranelift

Cranelift Code Generator

A Bytecode Alliance project

Cranelift is a low-level retargetable code generator. It translates a target-independent intermediate representation into executable machine code.

CI passing Fuzzit Status chat zulip rustc 1.37+ docs 0.66.0

For more information, see the documentation.

For an example of how to use the JIT, see the SimpleJIT Demo, which implements a toy language.

For an example of how to use Cranelift to run WebAssembly code, see Wasmtime, which implements a standalone, embeddable, VM using Cranelift.

Status

Cranelift currently supports enough functionality to run a wide variety of programs, including all the functionality needed to execute WebAssembly MVP functions, although it needs to be used within an external WebAssembly embedding to be part of a complete WebAssembly implementation.

The x86-64 backend is currently the most complete and stable; other architectures are in various stages of development. Cranelift currently supports both the System V AMD64 ABI calling convention used on many platforms and the Windows x64 calling convention. The performance of code produced by Cranelift is not yet impressive, though we have plans to fix that.

The core codegen crates have minimal dependencies, support no_std mode (see below), and do not require any host floating-point support, and do not use callstack recursion.

WebAssembly Micro Runtime (wamr)

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WebAssembly Micro Runtime

Build WAMR VM core | Embed WAMR | Export native function | Build WASM applications | Samples

A Bytecode Alliance project

WebAssembly Micro Runtime (WAMR) is a standalone WebAssembly (WASM) runtime with a small footprint. It includes a few parts as below:

- The "**iwasm" VM core**, supporting WebAssembly interpreter, ahead of time compilation (AoT) and Just-in-Time compilation (JIT)
- The **application framework** and the supporting API's for the WASM applications
- The **dynamic management** of the WASM applications

iwasm VM core

key features

- 100% compliant to the W3C WASM MVP
- Small runtime binary size (85K for interpreter and 50K for AoT) and low memory usage
- Near to native speed by AoT
- Self-implemented module loader enables AoT working cross Linux, SGX and MCU systems
- Choices of WASM application libc support: the built-in libc subset for the embedded environment or WASI for standard libc
- Embeddable with the supporting C API's
- The mechanism for exporting native API's to WASM applications
- Multiple modules as dependencies
- Thread management and pthread library

Lucet

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Lucet

CI passing

A Bytecode Alliance project

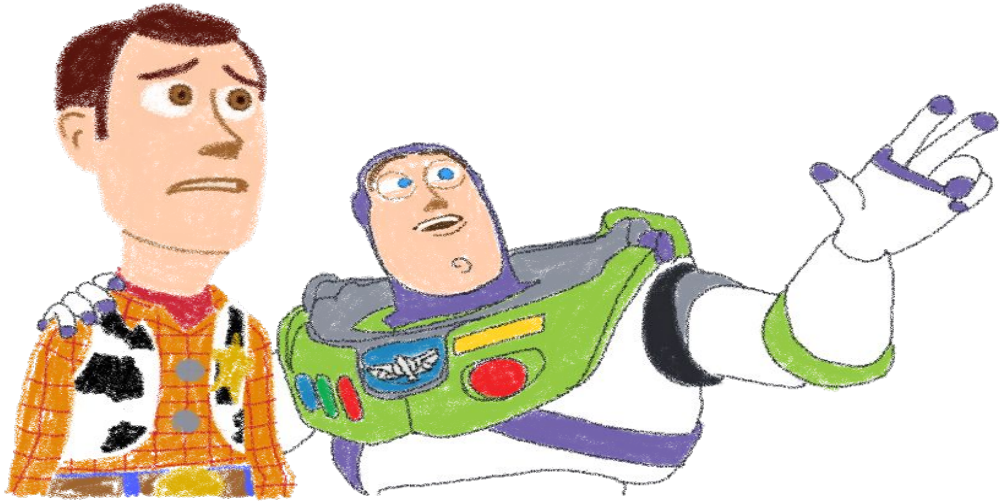
Lucet is a native WebAssembly compiler and runtime. It is designed to safely execute untrusted WebAssembly programs inside your application.

Check out our announcement post on the Fastly blog.

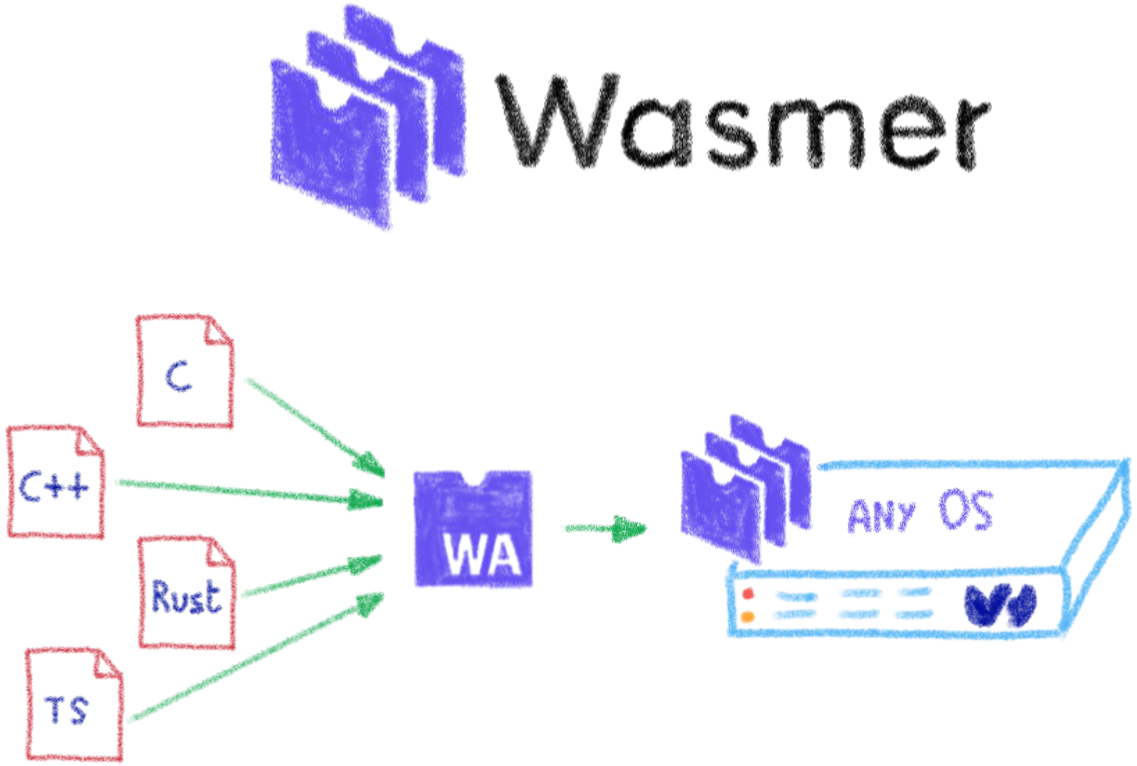
Lucet uses, and is developed in collaboration with, the Bytecode Alliance's Cranelift code generator. It powers Fastly's Terrarium platform.

Other runtimes

Runtimes, runtimes everywhere



Wasmer



Run any code* on any client… almost

* Languages compiling to WASM

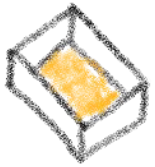
Wasmer

Wasmer

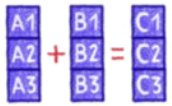
Run or embed anywhere super lightweight containers based on Wasm

FAST

WASI



Sandboxed



SIMD

Multi platform

Pluggable

LLVM Cranelift
Singlepass

@wasmerio

wasmerio/wasmer

Wasmer ecosystem

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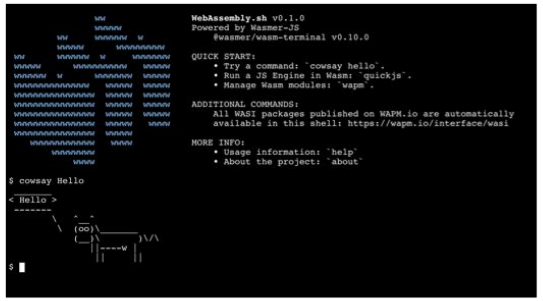
Wasmer ecosystem

WA PM

Web Assemby
Package Manager

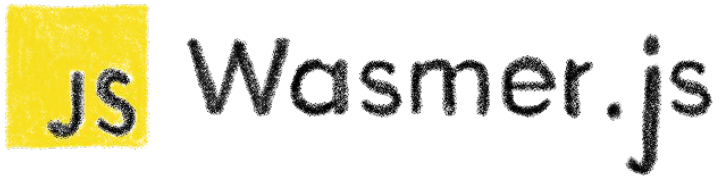
WebAssembly.sh



Install `wapm install cowsay`
or
Execute `wax cowsay Hello`

Online WebAssembly shell
Execution done in browser

Wasmer ecosystem



Bringing Languages to WASI

Wasm3

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Wasm3

wapm v0.4.7 | issues 30 | tests failing | license MIT

A high performance WebAssembly interpreter written in C.

~ **8x faster** than other known wasm interpreters
~ **4-5x slower** than state of the art wasm `JIT` engines
~ **12x slower** than native execution

* Based on CoreMark 1.0 benchmark. Your mileage may vary.

twitter 513 | discord 6 online | telegram chat

```
Wasm3
Wasm3 v0.4.6 on iOS (arm64-v8a)
Build Feb  7 2020 21:48:53
Device: iPhone10,4

Loading WebAssembly...
Running fib(40) on WebAssembly...
Result: 102334155
Elapsed: 4844 ms

Running fib(40) on Native C...
Result: 102334155
Elapsed: 611 ms
```

Status

`wasm3` passes the WebAssembly spec testsuite and is able to run many `WASI` apps.

Minimum useful system requirements: **~64Kb** for code and **~10Kb** RAM

`wasm3` runs on a wide range of architectures (`x86` , `x86_64` , `ARM` , `RISC-V` , `PowerPC` , `MIPS` , `Xtensa` , `ARC32` , ...) and platforms:

- Linux, Windows, OS X, FreeBSD
- Android, iOS
- **OpenWRT**-enabled routers
- Raspberry Pi, Orange Pi and other **SBC**s
- **MCU**s: Arduino, ESP8266, ESP32, Particle, ... see full list
- Browsers... yes, using WebAssembly itself!
- `wasm3` can execute `wasm3` (self-hosting)

Wasm3

The fastest WebAssembly interpreter

WASI

Multi platform

Wasm inception

WebAssembly & WASI self-hosting

@wasm3_engine

wasm3/wasm3

And even Wasm over GraalVM!

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GraalVM. ALL ARTICLES | LEARN MORE

Announcing GraalWasm — a WebAssembly engine in GraalVM

Aleksandar Prokopec Follow

Dec 2, 2019 · 10 min read

We're happy to announce the initial public work on GraalWasm — the WebAssembly engine implemented in GraalVM. GraalWasm currently implements the WebAssembly MVP (Minimum Viable Product) specification, and can run WebAssembly programs in the binary format, generated with compiler backends such as Emscripten.

Supporting WebAssembly expands the set of languages GraalVM can execute with a whole other set of languages to the ones supported by GraalVM and is further step towards making it a universal platform for programming language execution. This feature was also highly requested by the GraalVM community and we are happy to share our first results.

GraalVM™

Or in Kubernetes...

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Krustlet: Kubernetes Kubelet in Rust for running WASM

🚧 🚧 **This project is highly experimental.** 🚧 🚧 It should not be used in production workloads.

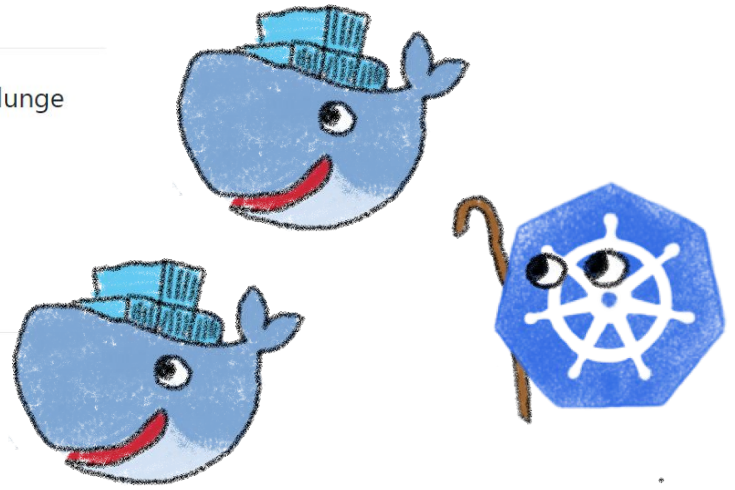
Krustlet acts as a Kubelet by listening on the event stream for new pods that the scheduler assigns to it based on specific Kubernetes tolerations.

The default implementation of Krustlet listens for the architecture `wasm32-wasi` and schedules those workloads to run in a `wasmtime`-based runtime instead of a container runtime.

Documentation

If you're new to the project, get started with the introduction. For more in-depth information about Krustlet, plunge right into the topic guides.

Looking for the developer guide? Start here.



Community, discussion, contribution, and support

You can reach the Krustlet community and developers via the following channels:

- Kubernetes Slack:
  - #krustlet
- Public Community Call on Mondays at 1:00 PM PT:
  - Zoom
  - Download the meeting calendar invite here

Some examples IRL?

Like companies using these things

clever cloud

fastly

Cloudflare Workers (FaaS)

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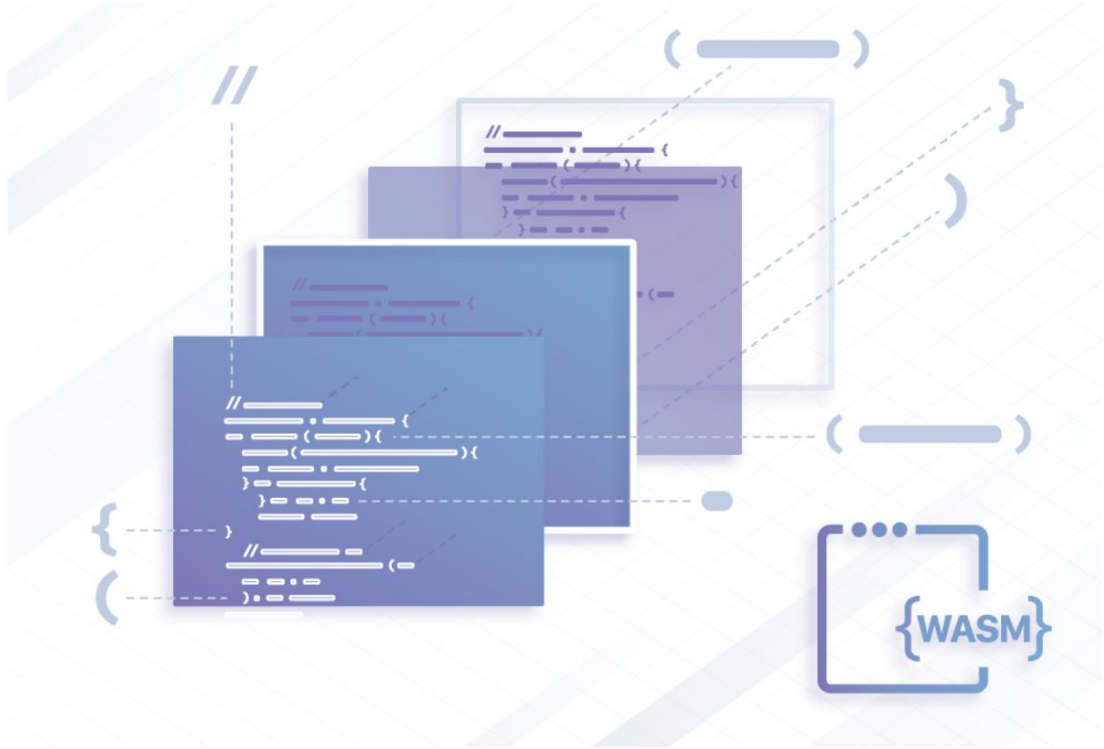
WebAssembly on Cloudflare Workers

10/01/2018



CLOUDFLARE

Cloudflare Workers (FaaS)

SophiaCon CLOUDFLARE Telecom

Exploring WebAssembly AI Services on Cloudflare Workers

10/09/2020

Guest Author

This is a guest post by Videet Parekh, Abelardo Lopez-Lagunas, Sek Chai at Latent AI.

Edge networks present a significant opportunity for Artificial Intelligence (AI) performance and applicability. AI technologies already make it possible to run compelling applications like object and voice recognition, navigation, and recommendations.

AI at the edge presents a host of benefits. One is scalability—it is simply impractical to send all data to a centralized cloud. In fact, one study has predicted a global scope of 90 zettabytes generated by billions of IoT devices by 2025. Another is privacy—many users are reluctant to move their personal data to the cloud, whereas data processed at the edge are more ephemeral.

When AI services are distributed away from centralized data centers and closer to the service edge, it becomes possible to enhance the overall application speed without moving data unnecessarily. However, there are still challenges to make AI from the deep-cloud run efficiently on edge hardware. Here, we use the term deep-cloud to

Let's build a Cloudflare Worker with WebAssembly and Haskell

10/06/2020

Cristhian Motoche

This is a guest post by Cristhian Motoche of Stack Builders.

At Stack Builders, we believe that Haskell's system of expressive static types offers many benefits to the software industry and the world-wide community that depends on our services. In order to fully realize these benefits, it is necessary to have proper training and access to an ecosystem that allows for reliable deployment of services. In exploring the tools that help us run our systems based on Haskell, our developer Cristhian Motoche has created a tutorial that shows how to compile Haskell to WebAssembly using Asterius for deployment on Cloudflare.

What is a Cloudflare Worker?

Cloudflare Workers is a serverless platform that allows us to run our code on the edge of the Cloudflare infrastructure. It's built on Google V8, so it's possible to write functionalities in JavaScript or any other language that targets WebAssembly.

WebAssembly is a portable binary instruction format that can be executed f[illegible] in a memory-safe sandboxed environment. For this reason, it's especially use[illegible] tasks

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Edge compute technology

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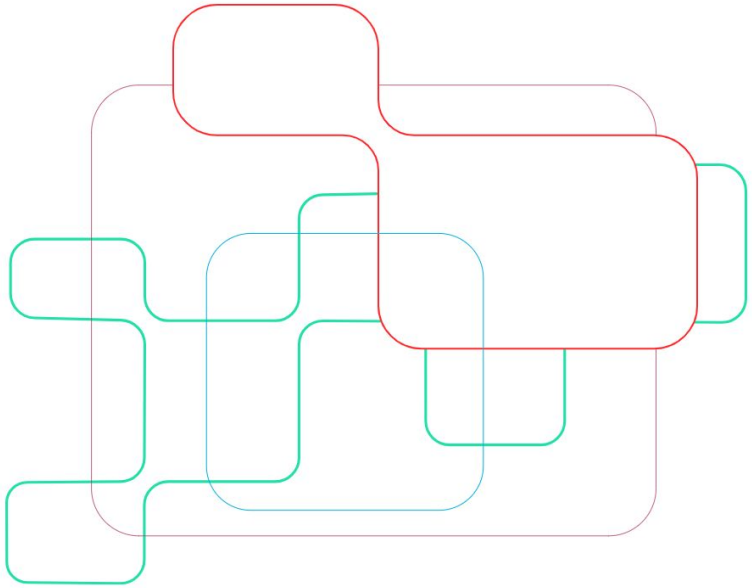

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Fastly works on the edge of the cloud

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COMPUTE@EDGE

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Compute@Edge is the next generation of serverless computing. It combines the best in emerging technology to give developers unmatched power, scalability, security, and speed at the edge.

WebAssembly

fastly

We built Compute@Edge on WebAssembly, a technology we've been collaborating on with the Bytecode Alliance. WebAssembly is uniquely suited to empower developers to write code in their preferred language, then run that code anywhere at near-native speeds.

Clever Cloud FaaS infrastructure

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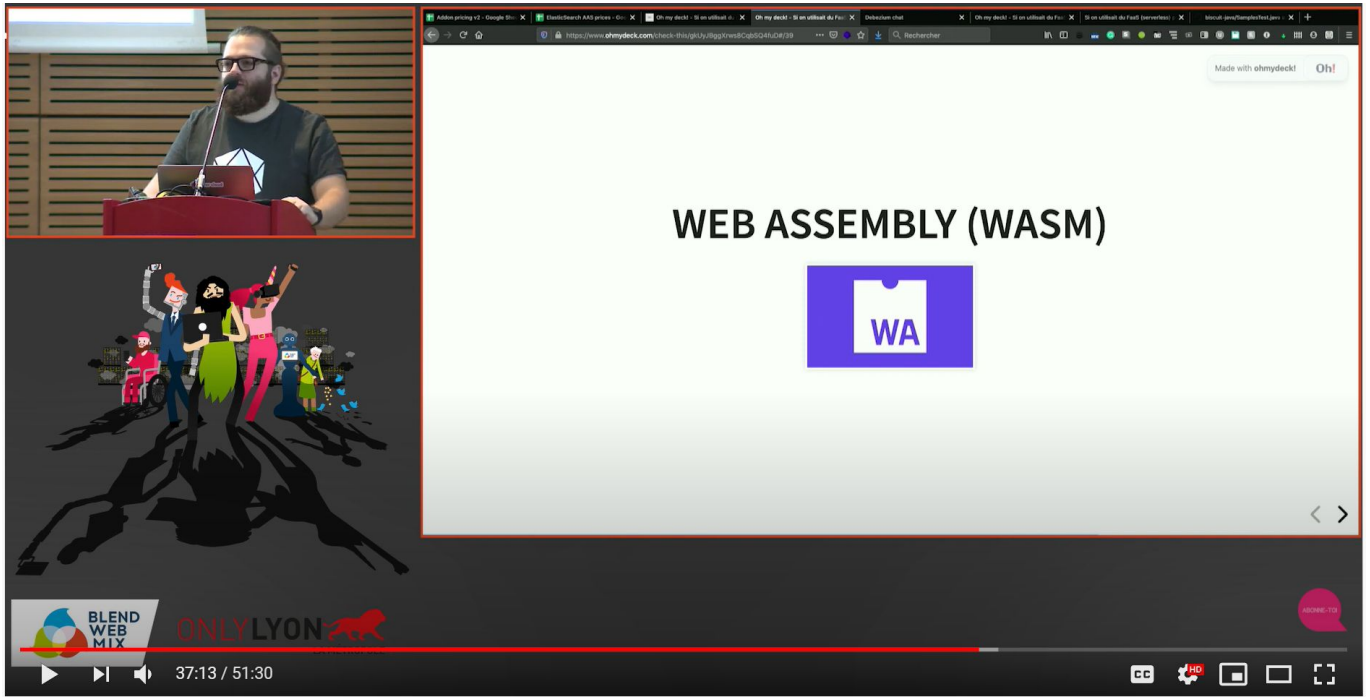

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https://www.youtube.com/watch?v=wchehMIsu80

Clever Cloud FaaS Infrastructure

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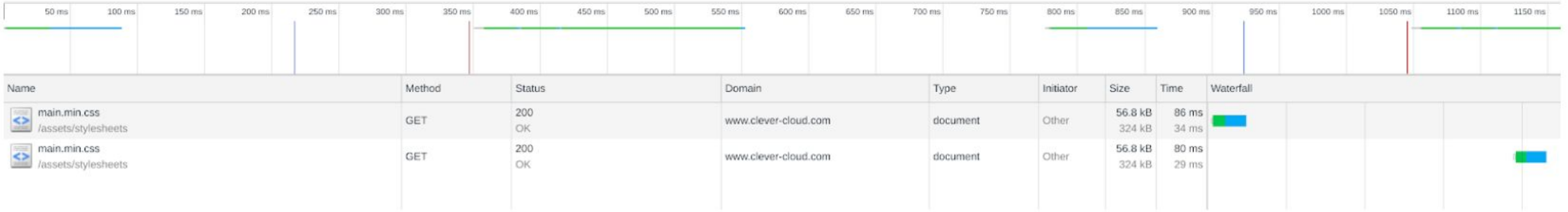
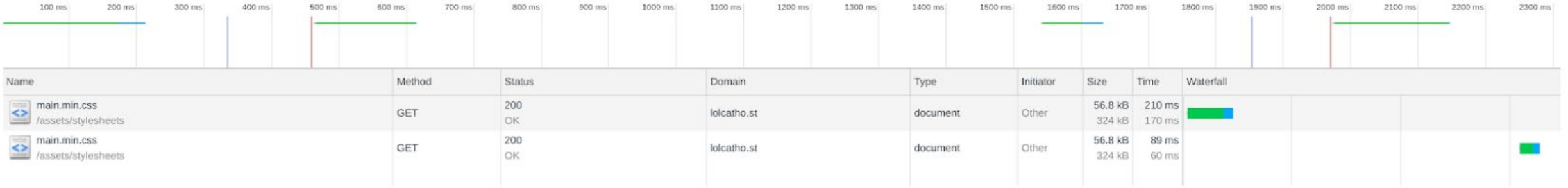
Already used in internal projects
Able to execute complex loads
(neural networks models)

Clever Cloud FaaS Infrastructure

le chargement directement depuis le site original



au travers du faas



on met 130ms à la première requête, parce qu'il faut boot la VM (9ms), la fork (1.5ms), puis établir la connexion TLS au backend

clever cloud

Blazing fast

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le site complet:

le site complet au travers du faas:

en gros, 260ms de plus sur le DomContentLoaded, 300ms de plus sur le load

sachant que mes VM s'exécutent sur un seul thread, j'ai pas parallélisé

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That's all, folks!

Thank you all!