

## Bringing Wave Engine to the Web through WebGL & WebAssembly



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Thank you!



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*Thanks guys!*



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# Agenda

1. Why Wave Engine for the Web?
2. WebAssembly
3. WebGL.NET
  1. The triangle
  2. The rotating cube
  3. The texture
  4. Head to full covering WebGL
4. And now, what?
5. Questions & Answers

# Why Wave Engine for the Web?





waveengine

<https://waveengine.net>

# 2015...

```
// Generated by JSIL v0.8.2 build 13182. [...]
[...]

(function Program$Members () {
    var $, $thisType;
    var $T00 = function () {
        return ($T00 = JSIL.Memoize($asm01.System.Console)) ();
    };
    function Program_Main () {
        $T00().WriteLine("Hello JSIL World!");
    };
    JSIL.MakeStaticClass("Program", true, [],
        function ($interfaceBuilder) {
            $ = $interfaceBuilder;
            $.Method({Static:true , Public:true }, "Main",
                JSIL.MethodSignature.Void,
                Program_Main
            );
            return function (newThisType) { $thisType = newThisType; };
        });
})();

using System;
using JSIL;
using JSIL.Meta;

public static class Program {
    public static void Main () {
        Console.WriteLine("Hello JSIL World!");
    }
}
```

- ☺ We multiplied 1 matrix
- ☹ We drew nothing

# WebAssembly



[A] X = X + 1

Y = Y + 1

IF X != 0 GOTO A

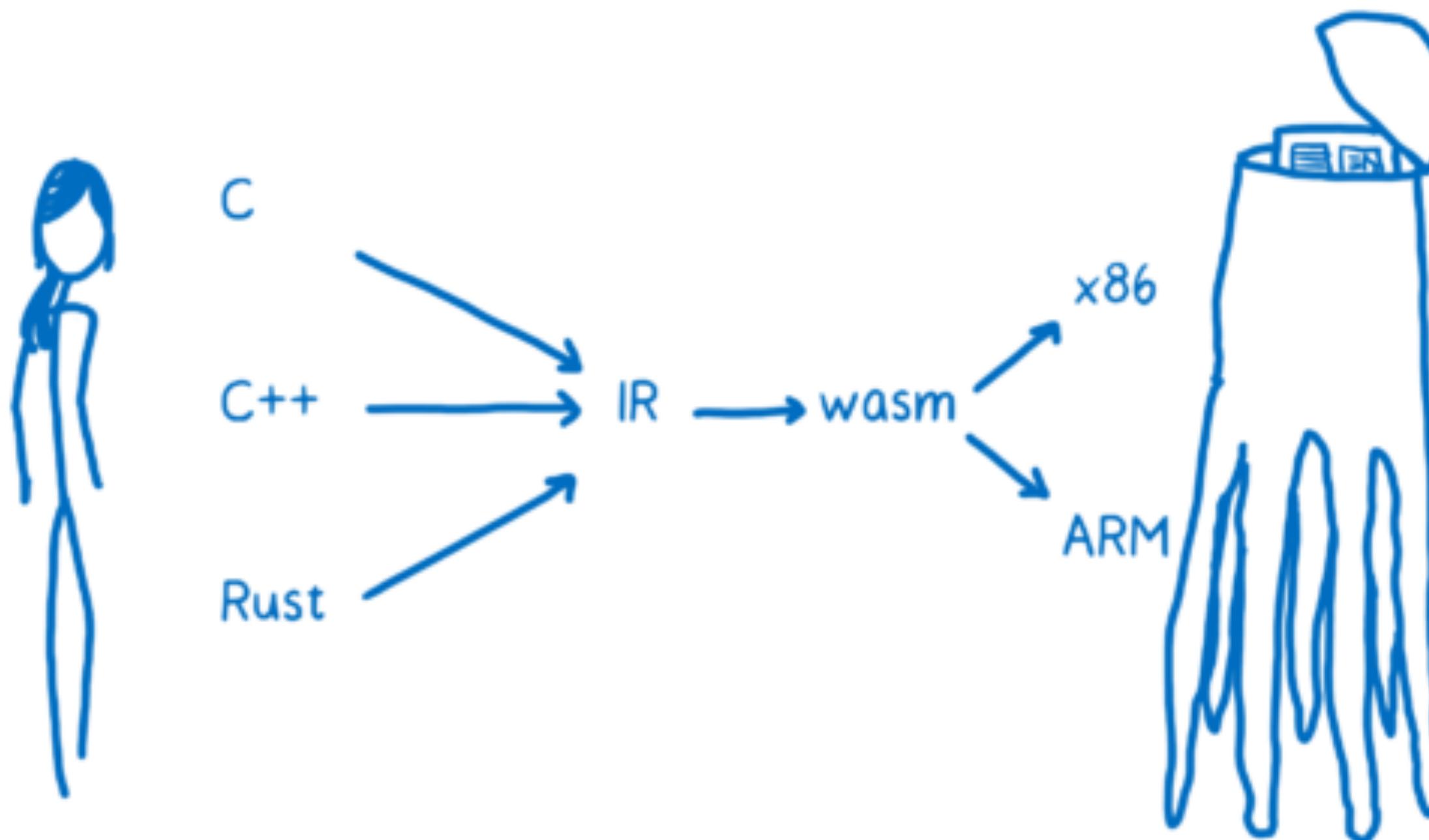
```
$ mono gotool.exe build ../../../../Samples/CopyX.goto  
GOTO-ol
```

Success! CopyX.dll

```
$ mono gotool.exe run CopyX.dll 28  
GOTO-ol
```

28

```
$ monodis CopyX.dll  
[...]  
IL_0000: ldc.i4 8  
IL_0005: newarr [mscorlib]System.Int32  
IL_000a: stloc.0  
IL_000b: ldloc.0  
IL_000c: ldc.i4 0  
IL_0011: ldarg 0  
[...]
```



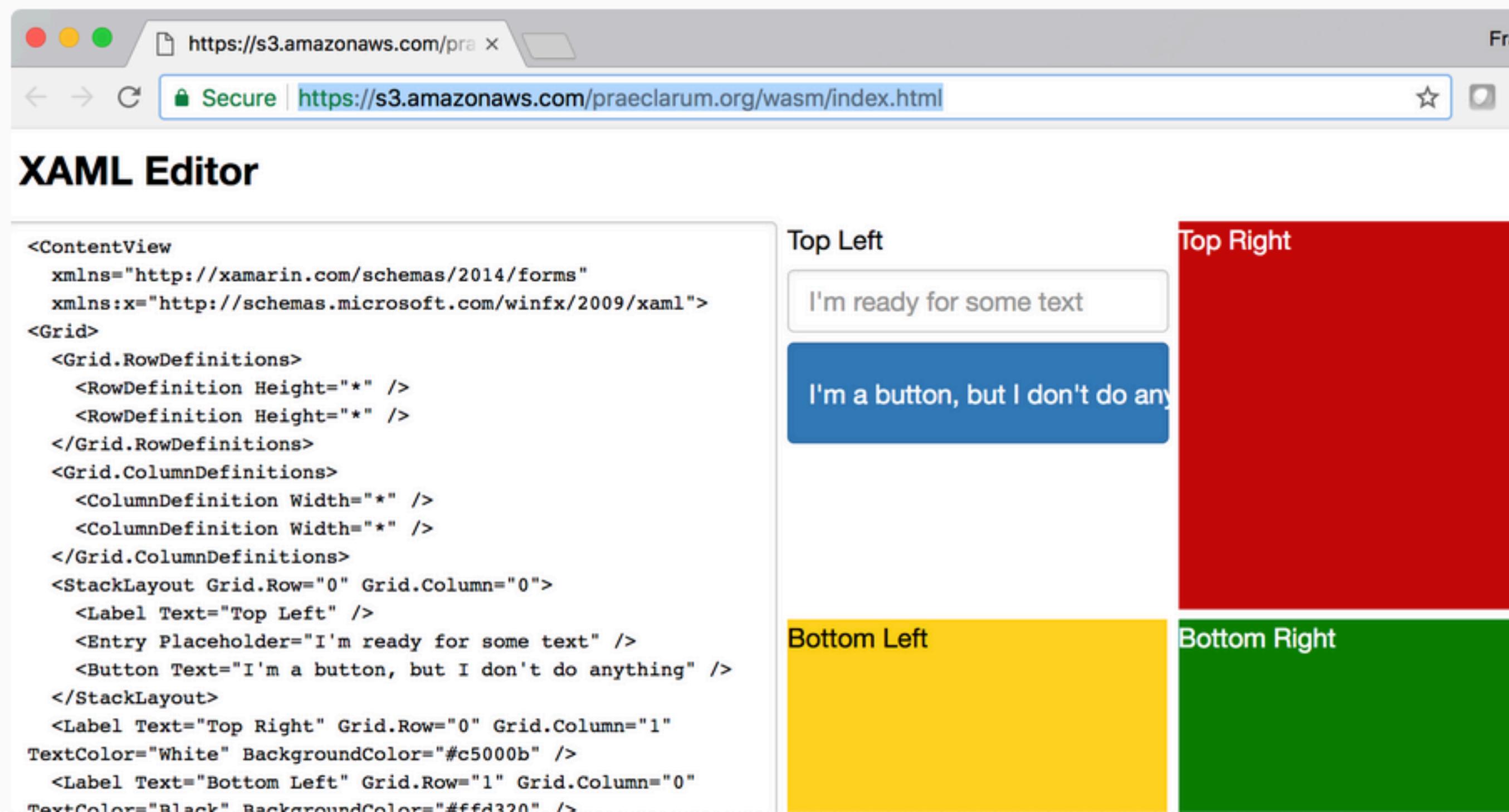
<https://hacks.mozilla.org/2017/02/creating-and-working-with-webassembly-modules/>

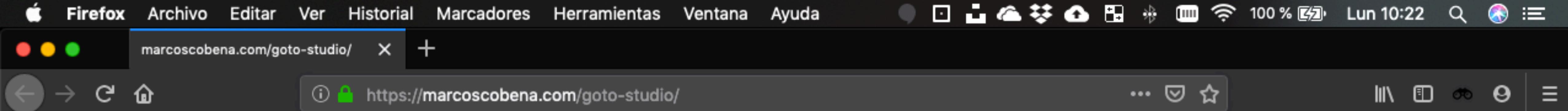
# Ooui.Wasm - .NET in the browser

Mar 15, 2018

I've been obsessing over my little .NET web framework Ooui and am excited to announce that it is now capable of running fully in the browser as a web assembly. This means that Xamarin.Forms apps can run completely in the browser - without a smart server - giving .NET developers even more reach and options for distributing their apps. Try the [Xamarin.Forms XAML editor demo](#) online or read the [getting started guide](#) if you want to try it yourself.

## Demo





# GoTo Studio

Debug

[Language](#) [Report issue](#)

```
; X must be > 0
[A] X = X - 1
Y = Y + 1
IF X != 0 GOTO A
```

28  
28  
X2  
X3  
X4  
X5  
X6  
X7  
X8

Program analyzed without errors (66 ms)  
Running...  
**Step #1:**  
- X1=27, X2=0, X3=0, X4=0, X5=0, X6=0, X7=0, X8=0  
- Y=0  
- Z1=0, Z2=0, Z3=0, Z4=0, Z5=0, Z6=0, Z7=0, Z8=0  
**Step #2:**  
- X1=27, X2=0, X3=0, X4=0, X5=0, X6=0, X7=0, X8=0  
- Y=1  
- Z1=0, Z2=0, Z3=0, Z4=0, Z5=0, Z6=0, Z7=0, Z8=0  
**Step #3:**  
- X1=27, X2=0, X3=0, X4=0, X5=0, X6=0, X7=0, X8=0  
- Y=1  
- Z1=0, Z2=0, Z3=0, Z4=0, Z5=0, Z6=0, Z7=0, Z8=0  
**Step #4:**  
- X1=26, X2=0, X3=0, X4=0, X5=0, X6=0, X7=0, X8=0  
- Y=1  
- Z1=0, Z2=0, Z3=0, Z4=0, Z5=0, Z6=0, Z7=0, Z8=0  
**Step #5:**  
- X1=26, X2=0, X3=0, X4=0, X5=0, X6=0, X7=0, X8=0  
- Y=2  
- Z1=0, Z2=0, Z3=0, Z4=0, Z5=0, Z6=0, Z7=0, Z8=0

NuGet Gallery | Uno.Wasm.Bootstrap X +

https://www.nuget.org/packages/Uno.Wasm.Bootstrap/

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# Uno.Wasm.Bootstrap 1.0.0-dev.269

This package provides a Wasm bootstrap for netstandard 2.0 projects.

 ⓘ This is a prerelease version of Uno.Wasm.Bootstrap.

⚠ This package has a SemVer 2.0.0 package version.  
This package will only be available to download with SemVer 2.0.0 compatible NuGet clients, such as Visual Studio 2017 (version 15.3) and above or NuGet client 4.3.0 and above. [Read more](#)

Package Manager .NET CLI PackageReference Paket CLI

```
PM> Install-Package Uno.Wasm.Bootstrap -Version 1.0.0-dev.269
```

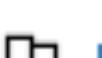


Info  last updated 10 days ago

 [Project Site](#)

 [Source repository](#)

 [Contact owners](#)

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 [Download package \(1.35 MB\)](#)

> Dependencies

## Statistics

↓ 20.331 total downloads

⬇ 55 downloads of current version

↗ 51 downloads per day (avg)

(Demo: Hello, World!)

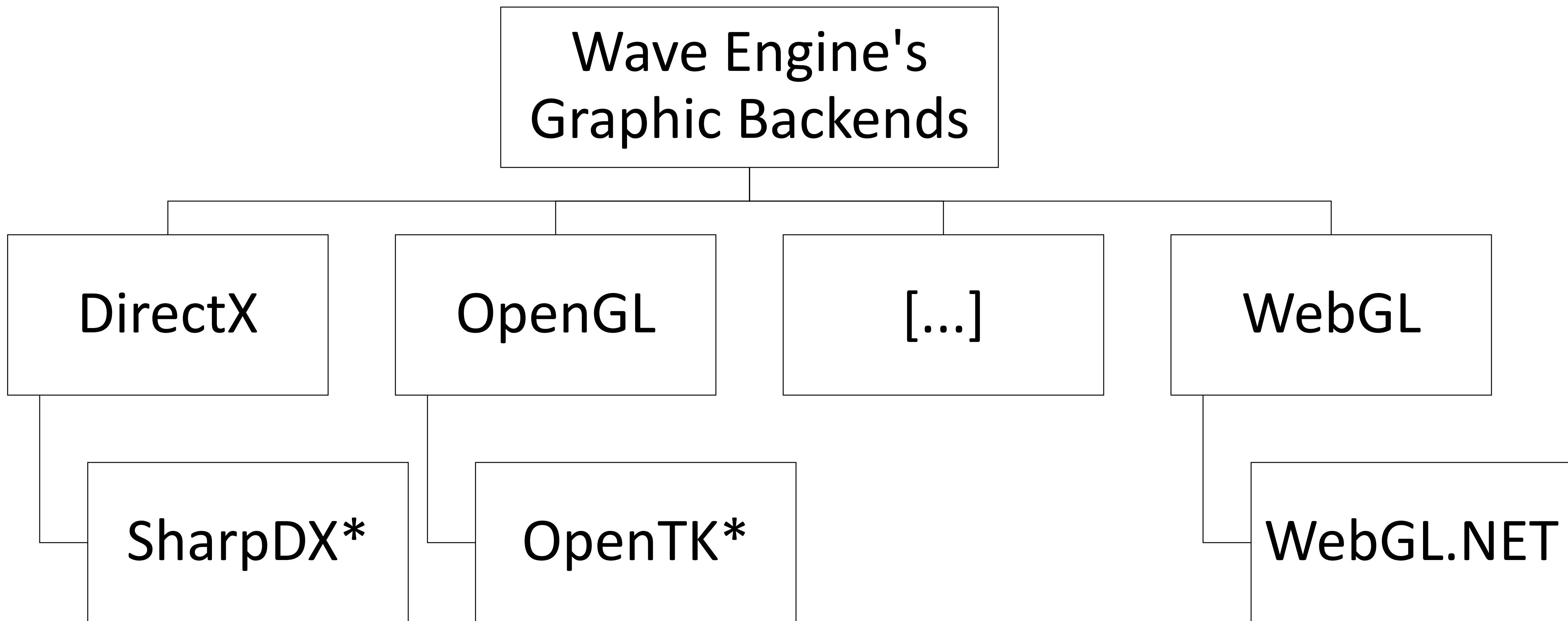
Wasm for machines;  
WAT for us.

```
;; mono.wasm (1.9 MB)

(module
  (type $t0 (func (param i32 i32)))
  (type $t1 (func (param i32 i32 i32) (result i32)))
  (type $t2 (func (param f64 f64) (result f64)))
  (type $t3 (func (result i32)))
  (type $t4 (func))
  (type $t5 (func (param i32)))
  (type $t6 (func (param i32 i32 i32)))
  (type $t7 (func (param i32 i32 i32 i32)))
  (type $t8 (func (param i32 i32 i32 i32 i32)))
  [...]
```

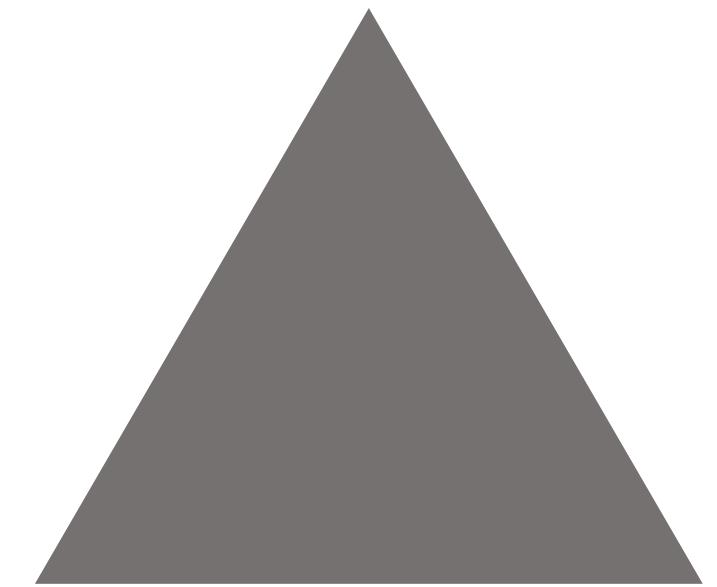
# WebGL.NET





**DotNet**2019

# DotNet2019



```
using (var document = (JSObject)Runtime.GetGlobalObject("document"))
using (var body = (JSObject)document.GetObjectProperty("body"))
{
    var canvas = (JSObject)document.Invoke("createElement", "canvas");
    canvas.SetObjectProperty("width", width);
    canvas.SetObjectProperty("height", height);
    // [...]
    return canvas;
}
```



<https://open.gl>

WebGL API

WebGLRenderingContext

Properties

canvas

drawingBufferHeight

drawingBufferWidth

Methods

activeTexture()

attachShader()

bindAttribLocation()

bindBuffer()

bindFramebuffer()

bindRenderbuffer()

bindTexture()

blendColor()

blendEquation()

blendEquationSeparate()

blendFunc()

# Syntax

```
// WebGL1:  
void gl.bufferData(target, size, usage);  
void gl.bufferData(target, ArrayBuffer? srcData, usage);  
void gl.bufferData(target, ArrayBufferView srcData, usage);  
  
// WebGL2:  
void gl.bufferData(target, ArrayBufferView srcData, usage, srcOffset, length);
```

## Parameters

### target

A `GLenum` specifying the binding point (target). Possible values:

- `gl.ARRAY_BUFFER`: Buffer containing vertex attributes, such as vertex coordinates, texture coordinate data, or vertex color data.
- `gl.ELEMENT_ARRAY_BUFFER`: Buffer used for element indices.
- When using a [WebGL 2 context](#), the following values are available additionally:
  - `gl.COPY_READ_BUFFER`: Buffer for copying from one buffer object to another.
  - `gl.COPY_WRITE_BUFFER`: Buffer for copying from one buffer object to another.
  - `gl.TRANSFORM_FEEDBACK_BUFFER`: Buffer for transform feedback operations.
  - `gl.UNIFORM_BUFFER`: Buffer used for storing uniform blocks.

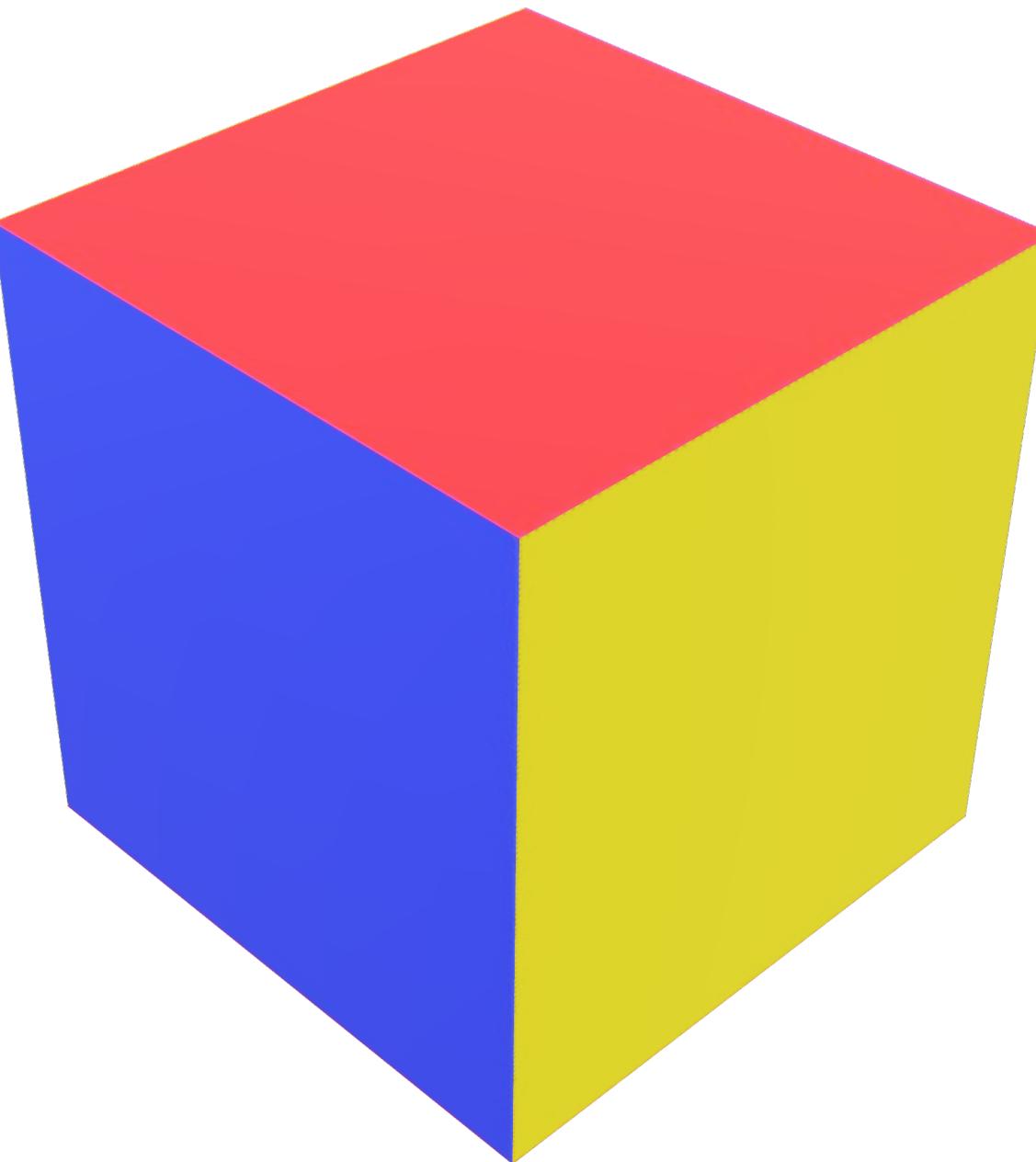
```
var vertices = new float[] { -0.5f, 0.5f, [...] };  
[...]  
gl.BufferData(  
    WebGLRenderingContextBase.ARRAY_BUFFER,  
    vertices,  
    WebGLRenderingContextBase.STATIC_DRAW);
```

```
public ITypedArray CastNativeArray(object managedArray)
{
    var arrayType = managedArray.GetType();
    ITypedArray array;
    [...]
    else if (arrayType == typeof(float[]))
    {
        array = Float32Array.From((float[])managedArray);
    }
    [...]
    return array;
}
```

(Sample: Triangle)

**DotNet**2019

# DotNet2019



WaveEngine.Common.Math.Mat X +

fuget.org Search Packages

https://www.fuget.org/packages/WaveEngine.Common/2.5.0.39/net45/lib/WaveEngine.Com

# WaveEngine.Common by waveengineteam

v2.5.0.39

2.5.0.39 (30 Jul 18) API Diff WaveEngine.Common.2.5.0.39.nupkg nuget.org www.waveengine.net License

<PackageReference Include="WaveEngine.Common" Version="2.5.0.39" />

Frameworks: mono, monoandroid, net45 (selected), uap10.0, xamarin.ios, xamarin.mac

Dependents: WaveEngine, WaveEngine.Components, WaveEngine.Framework, WaveEngine.Materials, WaveEngine.Vuforia

.NET API 481,792 bytes

Search

## Assemblies

- protobuf-net.dll
- WaveEngine.Common.dll

## Namespaces

- WaveEngine.Common
- WaveEngine.Common.Attributes
- WaveEngine.Common.Attributes.Conve

## Matrix

public struct Matrix : IEquatable<Matrix>

Represents a 4x4 matrix.

Documentation

public float M11

(Demo: Wave Engine's Matrix)

```
public override void Update(double elapsedMilliseconds)
{
    base.Update(elapsedMilliseconds);

    [...]

    var elapsedMillisecondsFloat = (float)elapsedMilliseconds;
    var rotation = Quaternion.CreateFromYawPitchRoll(
        elapsedMillisecondsFloat * 2 * 0.001f,
        elapsedMillisecondsFloat * 4 * 0.001f,
        elapsedMillisecondsFloat * 3 * 0.001f);
    worldMatrix *= Matrix.CreateFromQuaternion(rotation);
}
```

(Sample: RotatingCube)

**DotNet2019**

# DotNet2019



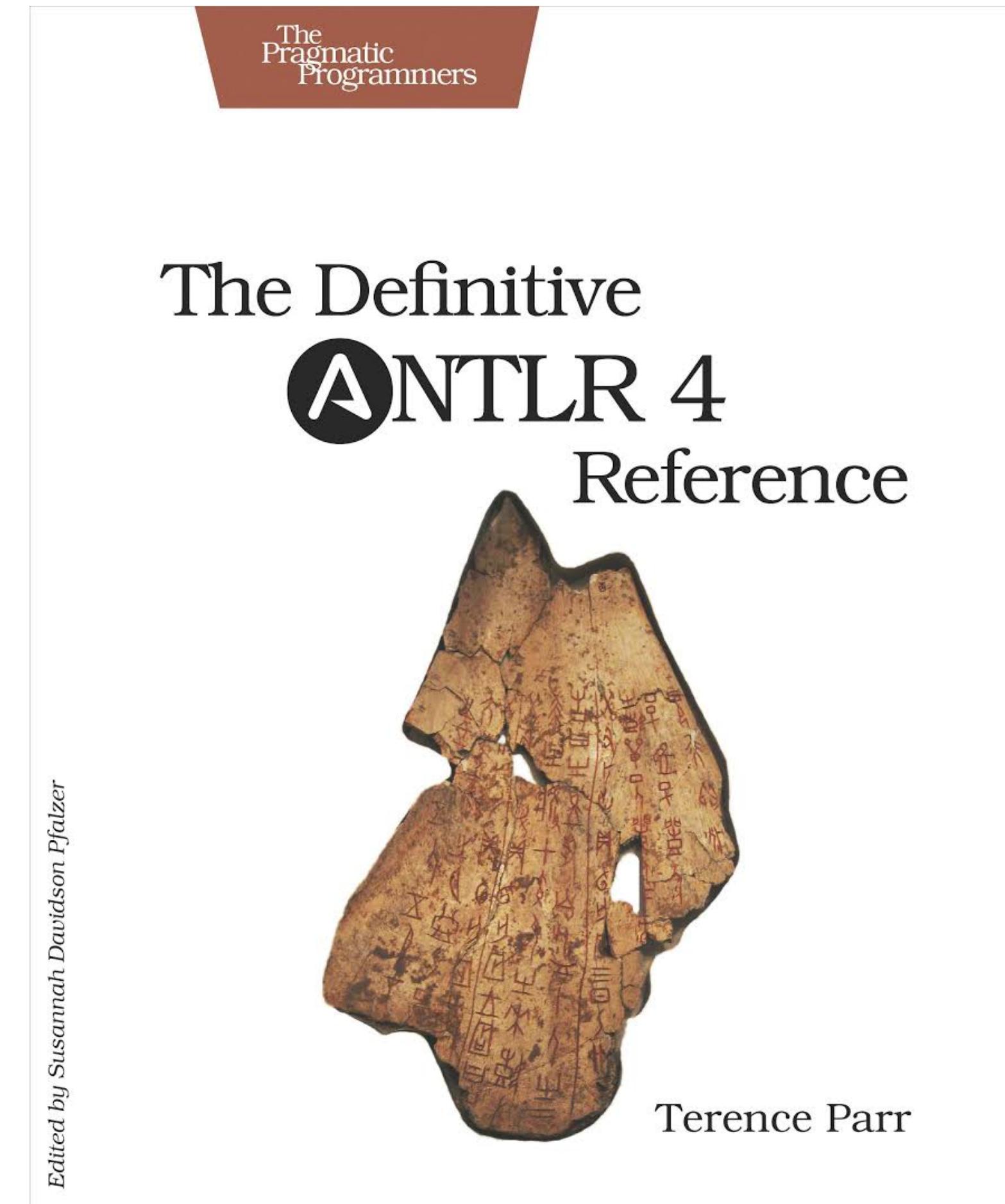
```
// FIXME  
File.Open("http://localhost:8000/foo.bin");
```

(Demo: HttpClient)

(Sample: Texture2D, TexturedCubeFromAssets)

```
// AUTOGENERATED FILE -- DO NOT EDIT -- SEE Makefile
//
// WebGL IDL definitions scraped from the Khronos specification:
// https://www.khronos.org/registry/webgl/specs/latest/
//
// This IDL depends on the typed array specification defined at:
// https://www.khronos.org/registry/typedarray/specs/latest/typedarrays.idl

typedef unsigned long GLenum;
typedef boolean GLboolean;
[...]
```



ANTLR: Lessons from my pet project GoTo

```
public override void ExitConst_([...] WebIDLParser.Const_Context context)
{
    base.ExitConst_(context);

    var type = TranslateType(context.constType().GetText());
    var rawName = context.IDENTIFIER_WEBIDL().GetText();
    outputStream.WriteLine($" public");
    [...]
    outputStream.WriteLine(
        $" const {type} {rawName} = {context.constValue().GetText()};");
    outputStream.WriteLine();
}
```

Thanks so much Kenneth Pouncey (@kjpou1)!

# And now, what?



# Conclusions

- WIP Wave Engine's WebGL backend
- No JIT, no AOT: room for improvement
- No fast JPG decompression nowadays
- Mono's Wasm grows fast: SDK, template, etc.
- Wasm it-self too: threads, WASI, etc.
- 2 h on Tuesdays, 2 h on Thursdays ☺

# Questions & Answers





*The future belongs to those who believe  
in the beauty of their dreams*

---

Eleanor Roosevelt

Thanks and ...  
See you soon!



Thanks also to the sponsors.  
Without whom this would not have been possible.

**plain concepts<sup>5</sup>**

