AI in Your Browser with WebGPU

Commit Your Code
September 2025

bit.ly/CYC25-WebGPU

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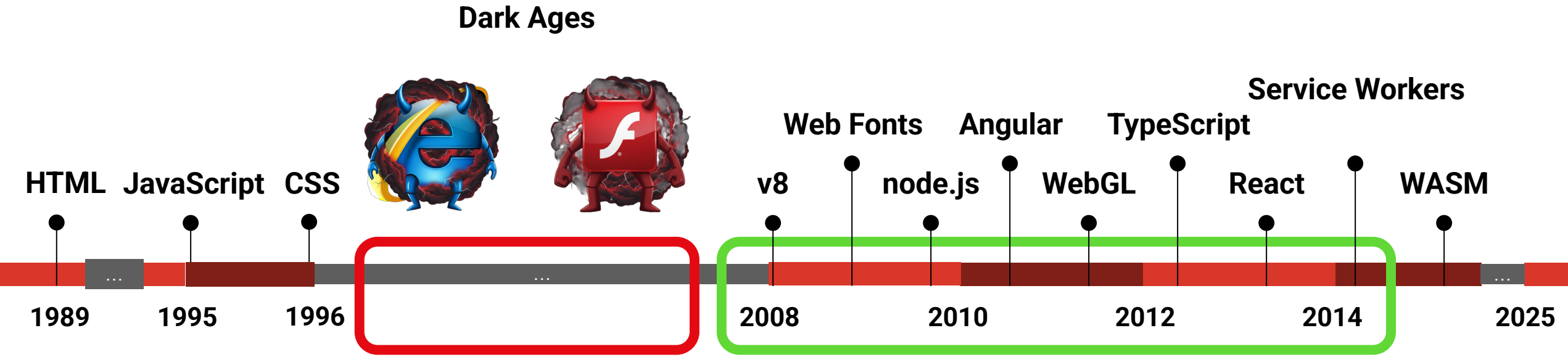
MY INSPIRATION...

AGENDA

- Evolution of the Web
  - How far have we come?
- WebAssembly
  - How did we get to WebGPU?
- WebGPU
  - What is it?
  - How do you use with it?
- Video Captioning System
  - How do you use WebGPU *practically*?
- Live Demo
  - Does it really work?
- The Future
  - What's next?

Evolution of the Web



WebAssembly

How did we get to WebGPU?

WebAssembly

WebAssembly - Hello World

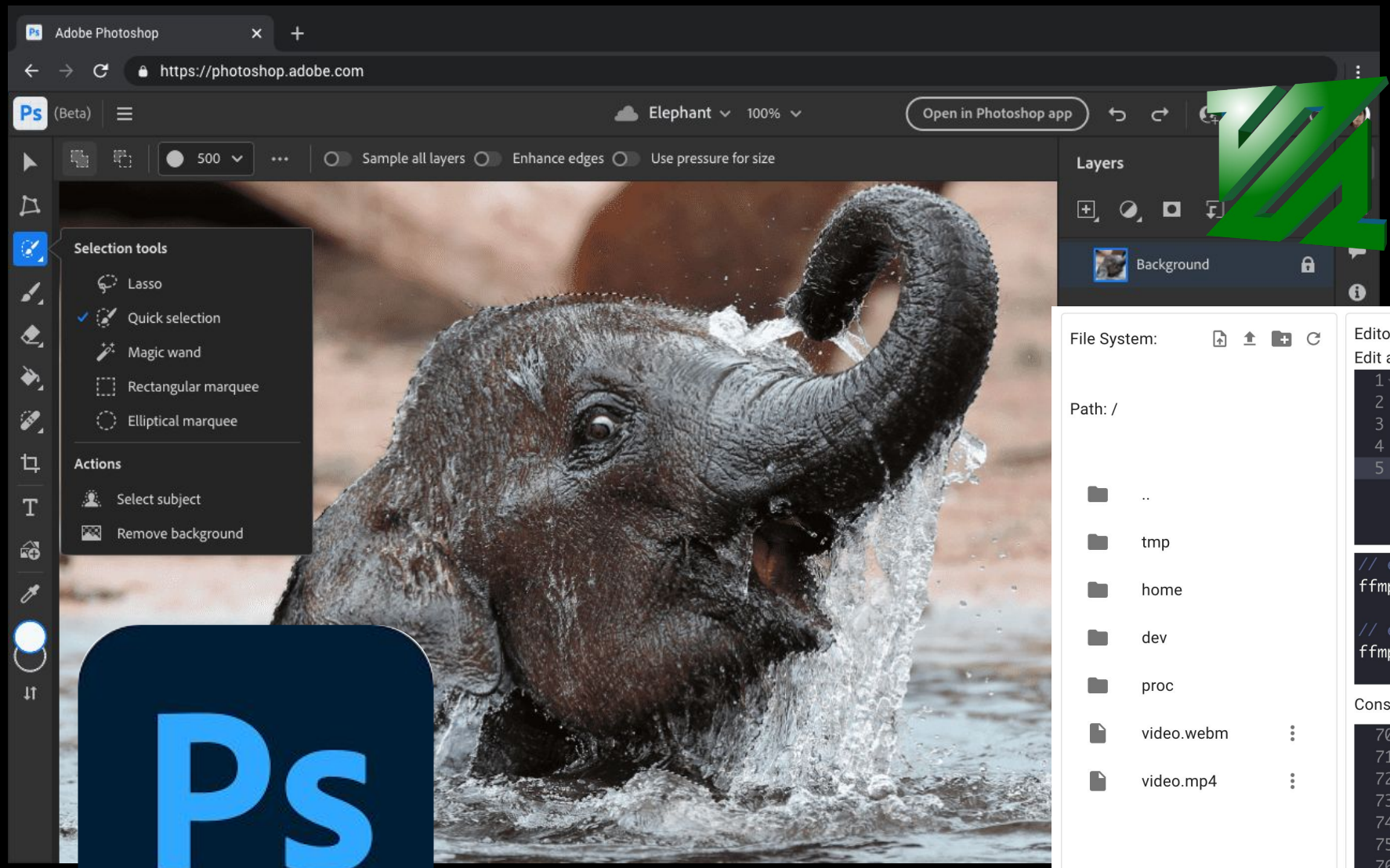
```c
#include <stdio.h>

int main() {
    printf("Hello Web!\n");
    return 0;
}
```

```
$ brew install emscripten
==> Installing emscripten
==> Pouring emscripten--4.0.15.bottle.tar.gz
$ emcc hello_world.c -o hello.html
cache:INFO: generating system library:
system_libs:INFO: compiled 27 inputs in 0.49s
cache:INFO:  - ok
$ ls
hello_world.c hello.html    hello.js      hello.wasm
```

WebAssembly - Hello World

powered by emscripten

```
Hello Web!
```



FFmpeg

File System:

Path: /

- ..
- tmp
- home
- dev
- proc
- video.webm
- video.mp4

LOAD SAMPLE FILES

Editor:

Edit arguments below to update command:

```
[
  "-i",
  "video.webm",
  "video.mp4"
]
```

```
// equivalent ffmpeg.wasm API call
ffmpeg.exec(["-i","video.webm","video.mp4"]);

// equivalent ffmpeg command line
ffmpeg -i video.webm video.mp4
```

Console Output:

```
[libx264 @ 0xdf6070] i4 v,h,dc,ddl,ddr,vr,hd,vl,hu
[libx264 @ 0xdf6070] i8c dc,h,v,p: 50% 22% 15% 13%
[libx264 @ 0xdf6070] Weighted P-Frames: Y:0.0% UV
[libx264 @ 0xdf6070] ref P L0: 64.1% 18.8% 10.0%
[libx264 @ 0xdf6070] ref B L0: 90.4%  8.2%  1.4%
[libx264 @ 0xdf6070] ref B L1: 96.4%  3.6%
[libx264 @ 0xdf6070] kb/s:217.13
Aborted()
```

Transcoding Progress: 100%

Time Elapsed: 2.82 s

RUN

WEBASSEMBLY

WebGPU

What can it do?

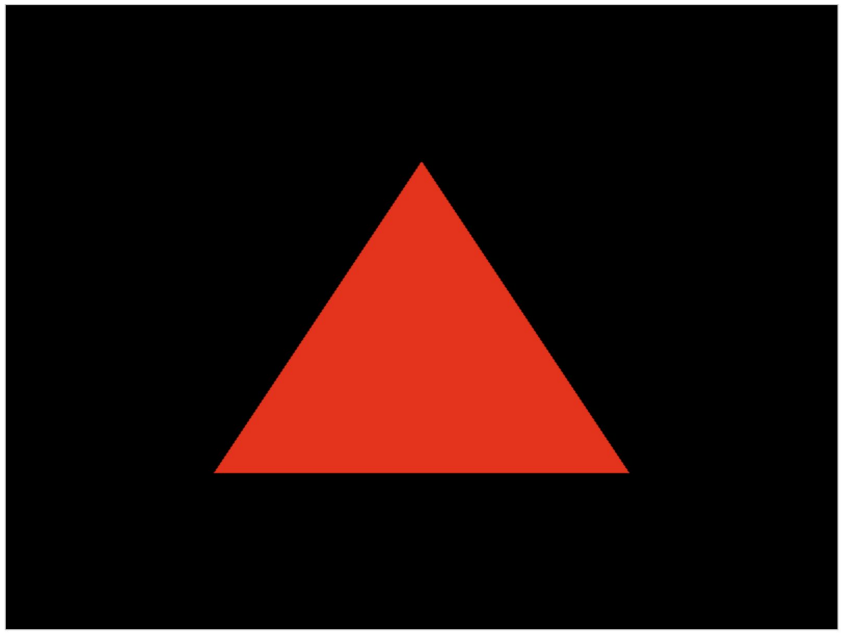
WebGPU

- *Direct* access to GPUs' parallel compute
- Not just for graphics, general purpose parallel computing API
- **2023** - Shipped in Chrome
- **2025** - Shipped across browsers (Firefox in July, Safari in macOS Tahoe)

WebGPU - Hello Triangle

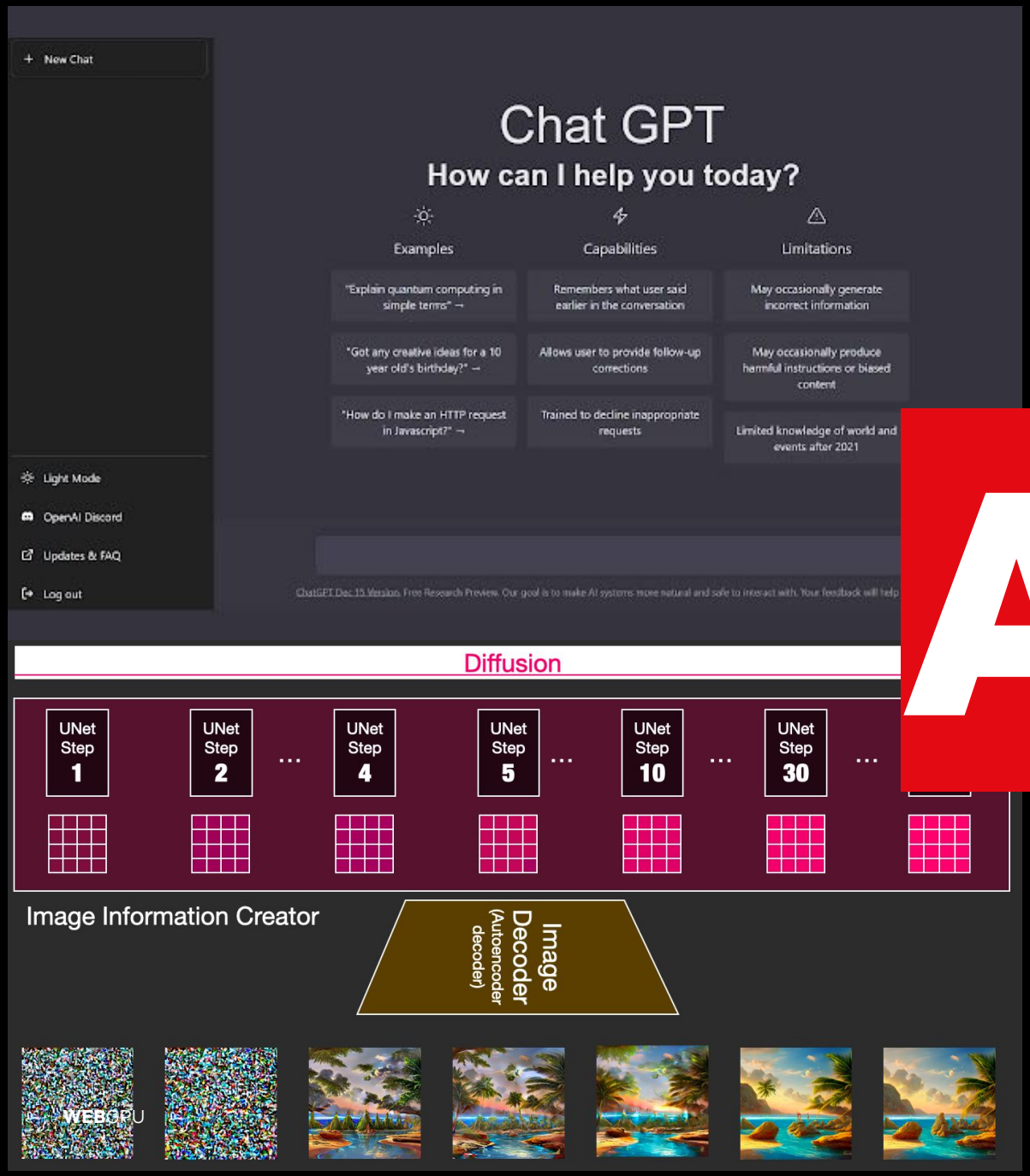
```
const adapter = await navigator.gpu.requestAdapter();
const device = await adapter.requestDevice();

const vertexShader = device.createShaderModule({
  code: `
    @vertex fn main(@builtin(vertex_index) vertexIndex: u32)
      -> @builtin(position) vec4<f32> {
      // Triangle vertices
      var pos = array<vec2<f32>, 3>(
        vec2(0.0, 0.5),
        vec2(-0.5, -0.5),
        vec2(0.5, -0.5)
      );
      return vec4<f32>(pos[vertexIndex], 0.0, 1.0);
    }`
});

// CHEATING: ~100 more lines of render pipeline boilerplate...
```

Hello WebGPU Triangle




WebGPU
Stats - fps: 60
Rendering Options
renderLightSprites
renderEnvironment
environmentLights
metaballLights
metaballMethod
metaballStyle
metaballResolution
WEBGPU

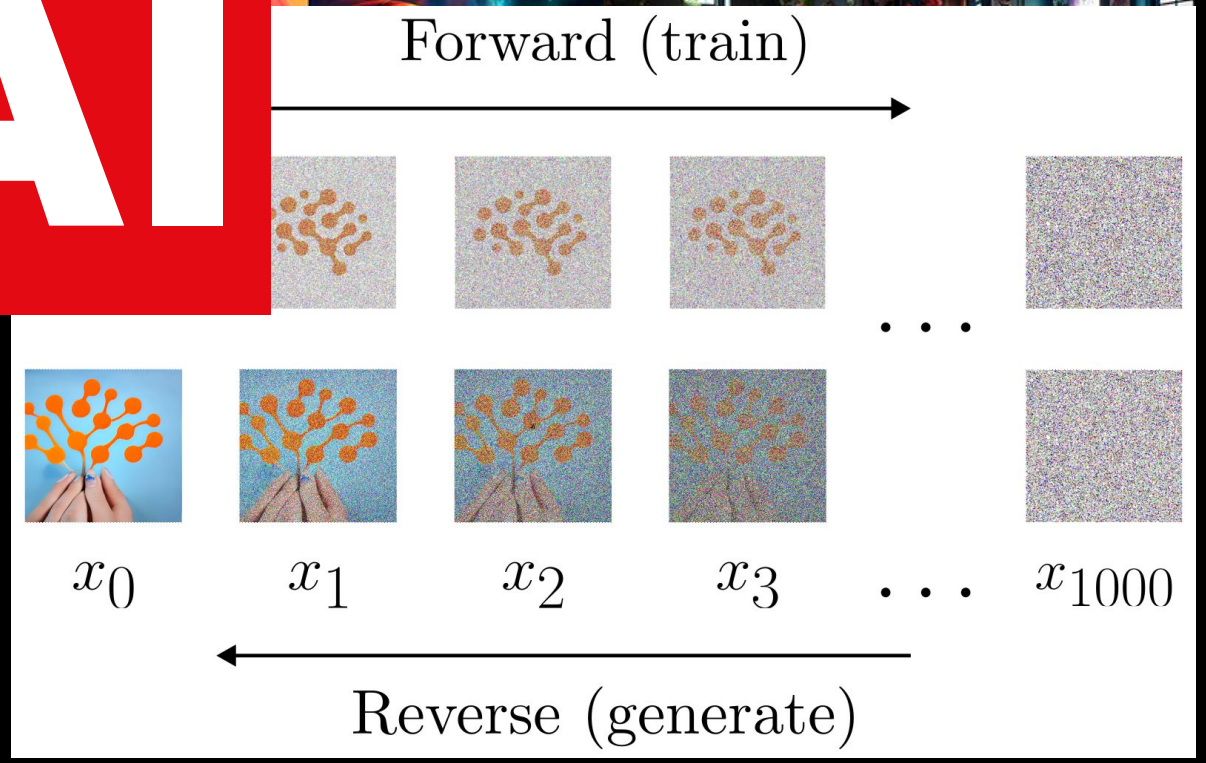

SCORE: 2000
LIVES: 2


New Chat
Chat GPT
How can I help you today?
Examples
Capabilities
Limitations
"Explain quantum computing in simple terms" →
Remembers what user said earlier in the conversation
May occasionally generate incorrect information
"Got any creative ideas for a 10 year old's birthday?" →
Allows user to provide follow-up corrections
May occasionally produce harmful instructions or biased content
"How do I make an HTTP request in Javascript?" →
Trained to decline inappropriate requests
Limited knowledge of world and events after 2021
Light Mode
OpenAI Discord
Updates & FAQ
Log out
ChatGPT Dec 15 Version. Free Research Preview. Our goal is to make AI systems more natural and safe to interact with. Your feedback will help

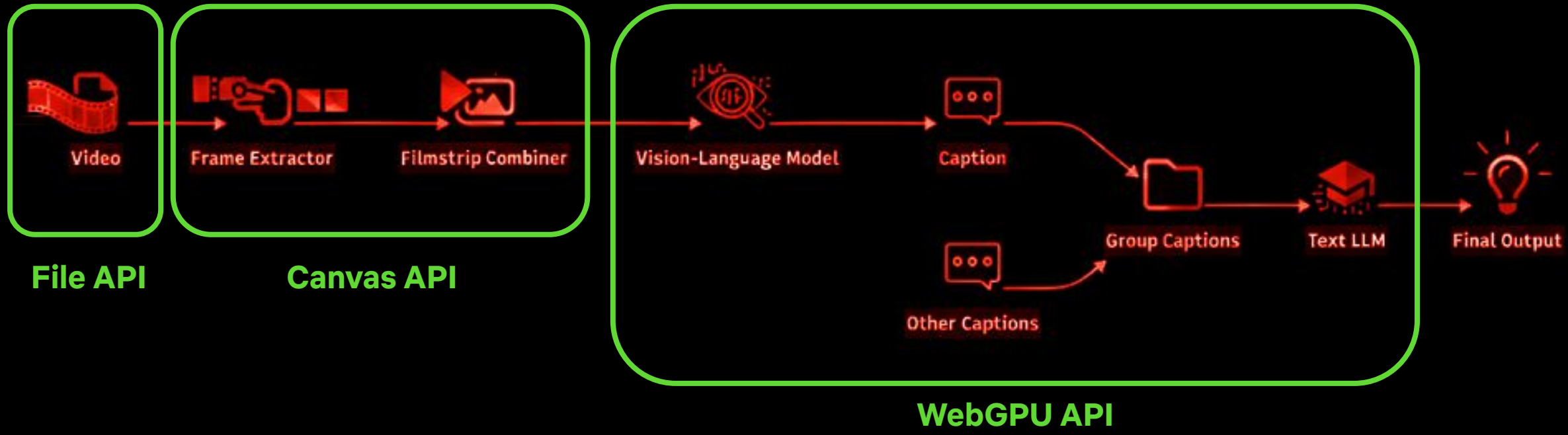
Diffusion
UNet Step 1
UNet Step 2
UNet Step 4
UNet Step 5
UNet Step 10
UNet Step 30
Image Information Creator
Image Decoder (Autoencoder decoder)
WEB3PU


Midjourney

AI


Forward (train)
x_0
x_1
x_2
x_3
x_{1000}
Reverse (generate)

MEDIA SEARCH: VIDEO CAPTIONING



File API

HTML

```
<input id="da-video" type="file" />
```

JavaScript

```
const fileInput = document.getElementById('da-video');

fileInput.addEventListener('change', async (event) => {
  const file = event.target.files[0];
  const video = document.createElement('video');
  video.src = URL.createObjectURL(file);
  document.body.append(video);
  video.play();
});
```

Canvas API

```
function extractFrames(video: HTMLVideoElement) {
  const canvas = document.createElement('canvas');
  const ctx = canvas.getContext('2d');

  canvas.width = video.videoWidth;
  canvas.height = video.videoHeight;

  const frames = [];
  const timestamps = [0, video.duration/2, video.duration]; // Start, middle, end

  timestamps.forEach(time => {
    video.currentTime = time;
    ctx.drawImage(video, 0, 0);
    frames.push(canvas.toDataURL());
  });

  return frames;
}
```

A Pythonic Diversion - Transformers

```python
from transformers import AutoModelForCausalLM, AutoTokenizer
import torch

# Create a text generation pipeline
tokenizer = AutoTokenizer.from_pretrained("microsoft/DialoGPT-medium")
model = AutoModelForCausalLM.from_pretrained("microsoft/DialoGPT-medium")

# Encode the message
msg_tokens = tokenizer.encode(
  "Hello, how are you?" + tokenizer.eos_token,
  return_tensors='pt'
)

# Generate a response
output = model.generate(msg_tokens, max_length=100, num_return_sequences=1)
print(tokenizer.decode(output[0], skip_special_tokens=True))
```

WebGPU Transformers.js

```
import { pipeline } from '@huggingface/transformers';

// Create a text generation pipeline
const generator = await pipeline(
  'text-generation',
  'microsoft/DialoGPT-medium',
  { device: 'webgpu' }
);

// Generate a response
const output = await generator('Hello, how are you?', {
  max_length: 50,
  num_return_sequences: 1,
});

console.log(output[0].generated_text);
```

VISION
LANGUAGE MODEL (VLM)

a **multimodal** large language model capable of processing **both images and text**

FastVLM

(Apple, CVPR 2025)

a small and fast vision language model that’s 10x faster on mobile devices than prior state-of-the-art

FastVLM Transformers.js

```
import { pipeline } from '@huggingface/transformers';

// Create a text generation pipeline
const generator = await pipeline(
  'image-to-text',
  'apple/FastVLM-7B',
  { device: 'webgpu' }
);

// Generate a response
const output = await generator(imageElement, {
  prompt: 'Describe what's happening in this video frame',
  num_return_sequences: 1,
});

console.log(output[0].generated_text);
```

VIDEO CAPTIONING

Filmstrip Method

LIVE DEMO

bit.ly/CYC25-WebGPU-Demo

The Future

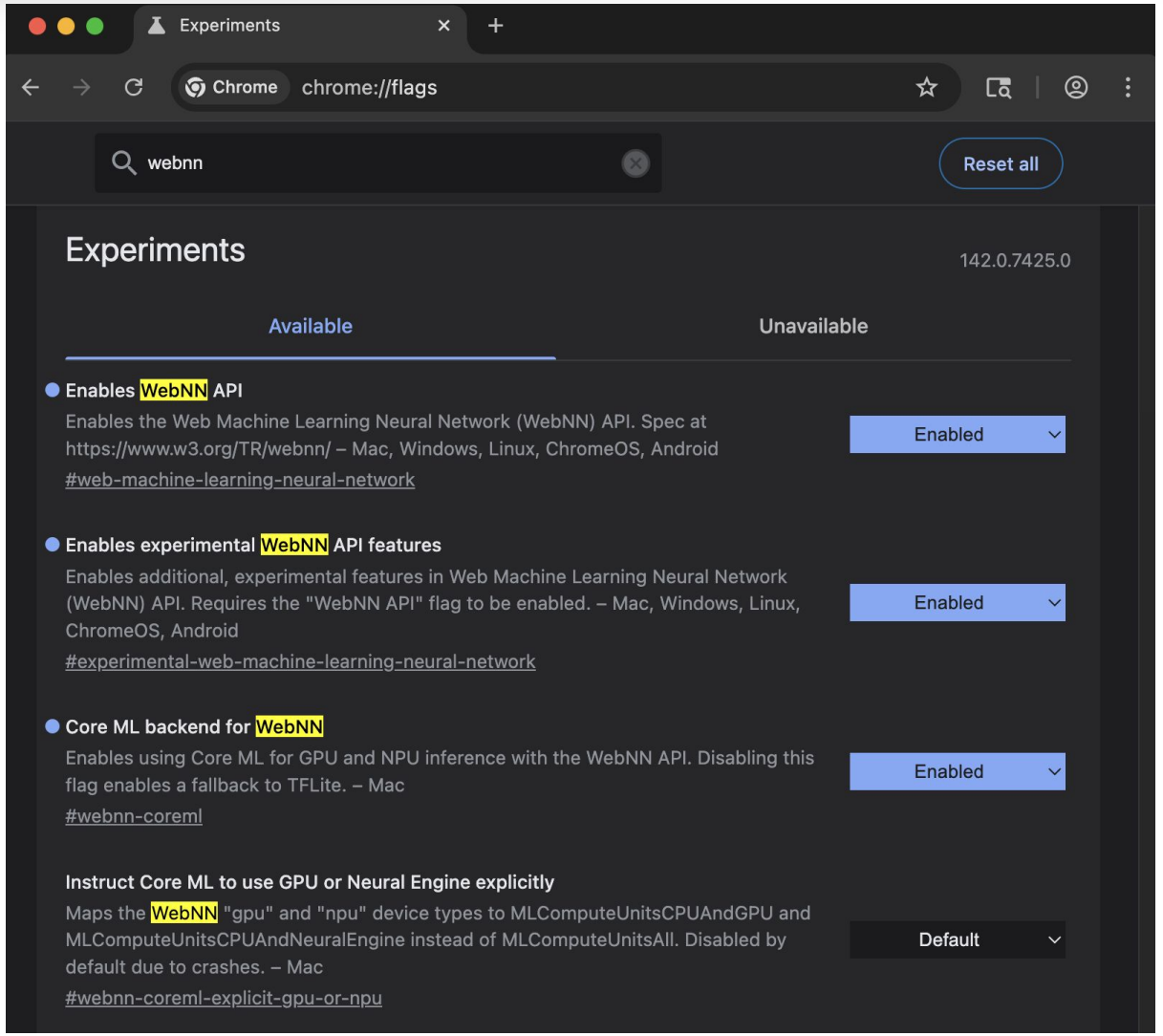
What’s on the horizon?

WebNN to the Rescue

- **Web N**eural **N**etwork API already landed in Chrome/Edge
- Leverages any available hardware including **N**eural **P**rocessing **U**nits (NPUs)
- The marketing fluff “AI PC” will finally become useful!

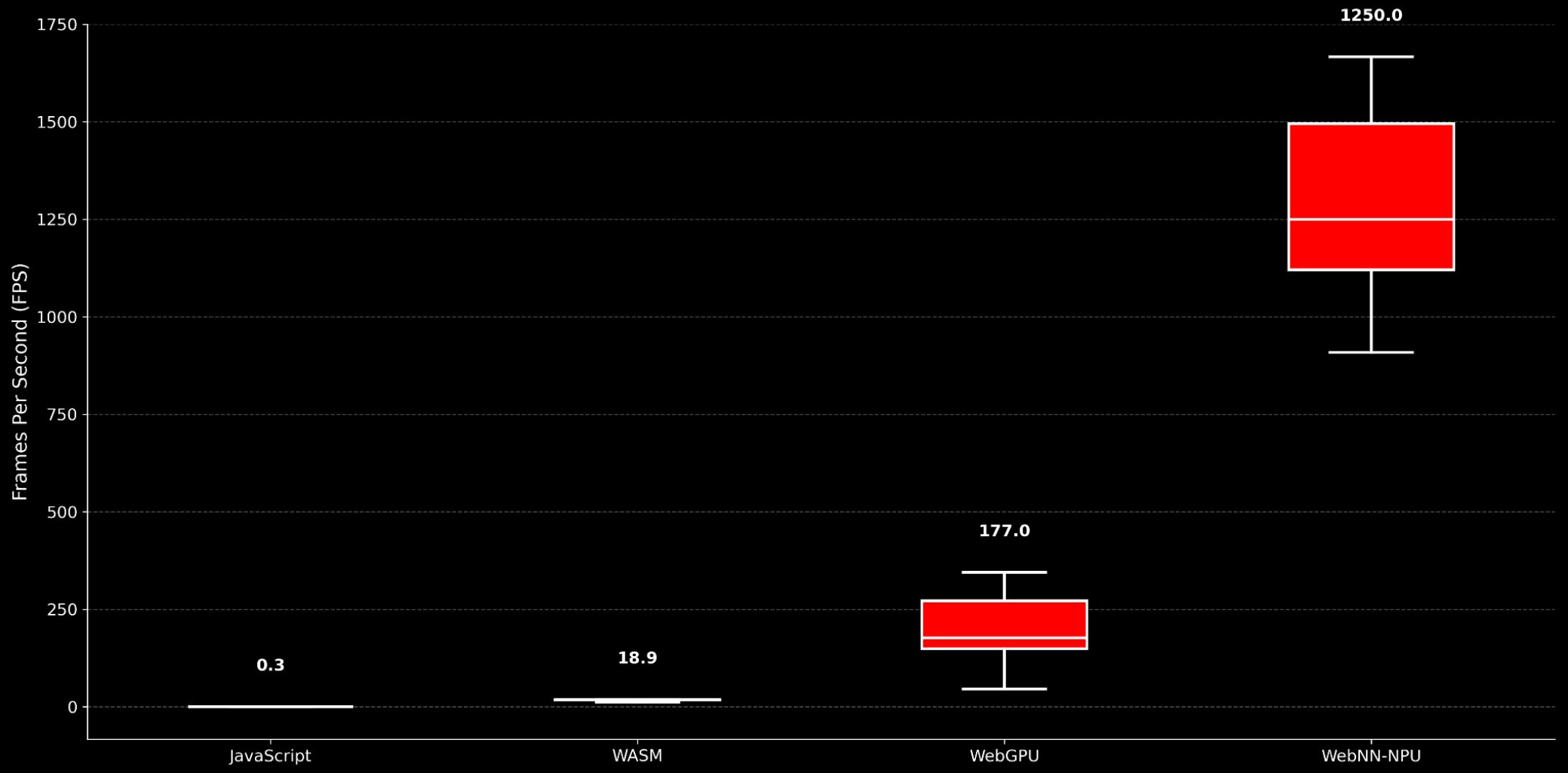
WebNN to the Rescue

1. Go to chrome://flags
2. Search for “WebNN”



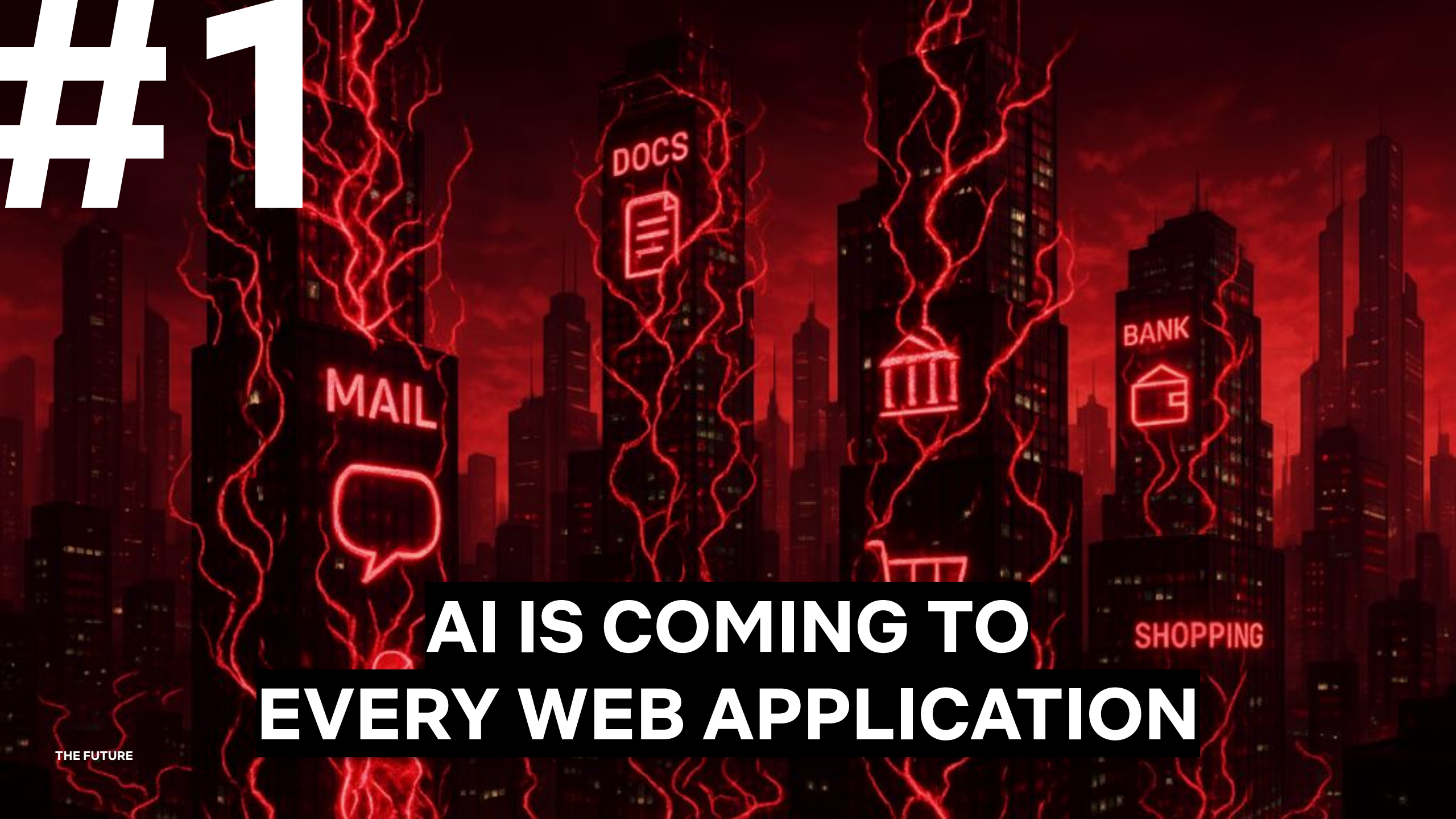
WebNN vs. WebGPU

Image Classification Frames per Second, Macbook M3 Pro



Limitations

- Models are BIG
  - “Tiny” FastVLM is a ~300MB download
- Accuracy leaves a lot to be desired
  - Not close to frontier models (GPT-5, Gemini, Claude)
- Choose the appropriate performance-privacy-cost tradeoff for you!


#1
DOCS
MAIL
BANK
SHOPPING
AI IS COMING TO
EVERY WEB APPLICATION
THE FUTURE

#2

PRIVACY PRESERVING AI

THE FUTURE


#3
YOU get AI
YOU get AI
AI
AI
AI
AI
ACTUAL DEMOCRATIZATION
THE FUTURE

Thank You.

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