World in Vectors

Cross-platform maps rendering using **RUST!** 🦀

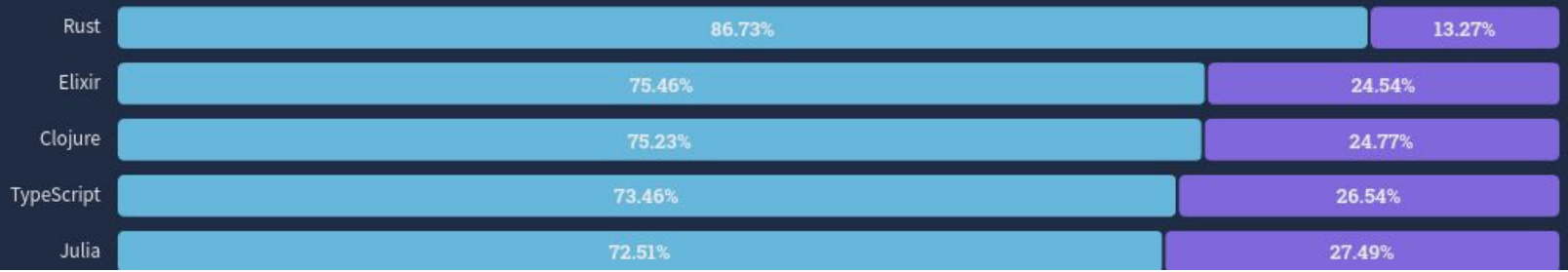
Programming, scripting, and markup languages

Rust is on its seventh year as the most loved language with 87% of developers saying they want to continue using it.

Rust also ties with Python as the most wanted technology with TypeScript running a close second.

Loved vs. Dreaded | Want

71,467 responses

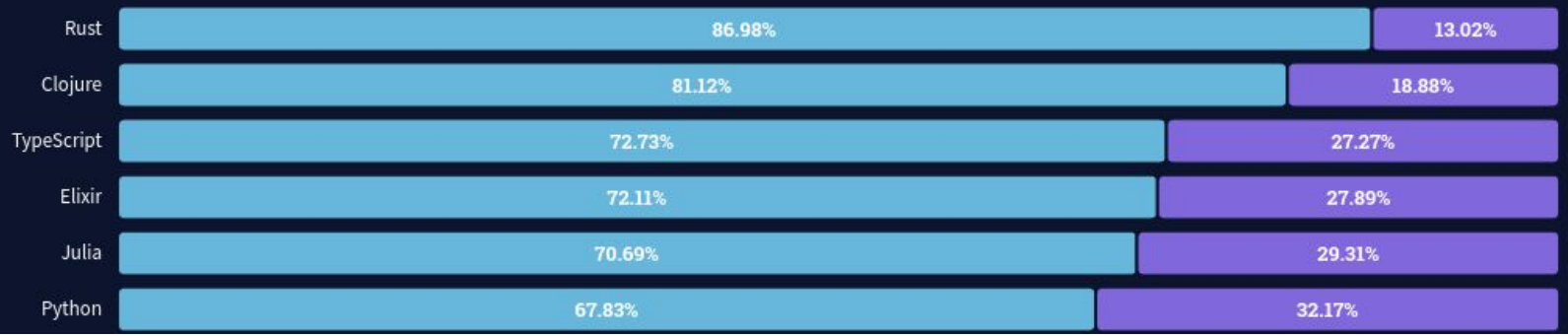


Programming, scripting, and markup languages

For the sixth-year, Rust is the most loved language, while Python is the most wanted language for its fifth-year.

Loved vs. Dreaded | Want

82,914 responses



Most Loved, Dreaded, and Wanted Languages

For five years running, Rust has taken the top spot as the most loved programming language. TypeScript is second surpassing Python compared to last year. We also see big gains in Go, moving up to 5th from 10th last year.

VBA, Objective C, and Perl hold the top spots for the most dreaded languages—languages that had a high percentage of developers who are currently using them, but have no interest in continuing to do so.

If we look at technologies that developers report that they do not use but want to learn, Python takes the top spot for the fourth year in a row. We also see some modest gains in the interest in learning Rust.

Loved | Dreaded | Wanted

% of developers who are developing with the language or technology and have expressed interest in continuing to develop with it

❝ Imagine being able to fly from outer space to any place on Earth.

Being able to discover the world through computers was a groundbreaking idea in the 90s.

TerraVision 1998
NTT InterCommunication Center Tokyo

“What is a Vector Map?”

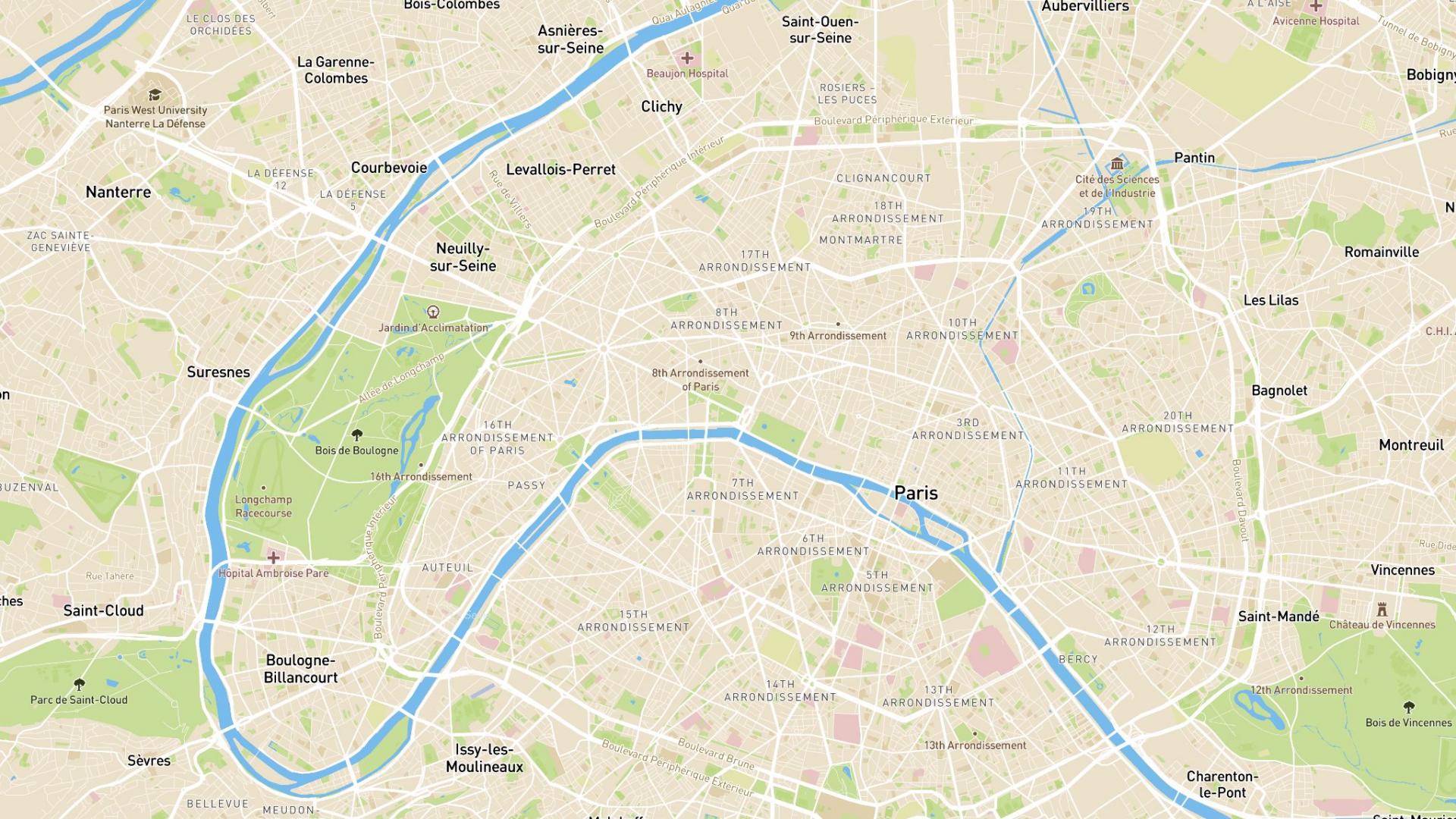
1. Examples of Vector Maps
2. How Map Data is Rendered
3. Data Visualisation Pipeline
4. Overview of maplibre-rs and the Advantages of Using Rust

Disclaimer

I’m NOT an expert in:

- Geoinformatics,
- graphics programming, or
- Rust.

But … I’m a Software Engineer who has a lot of free time!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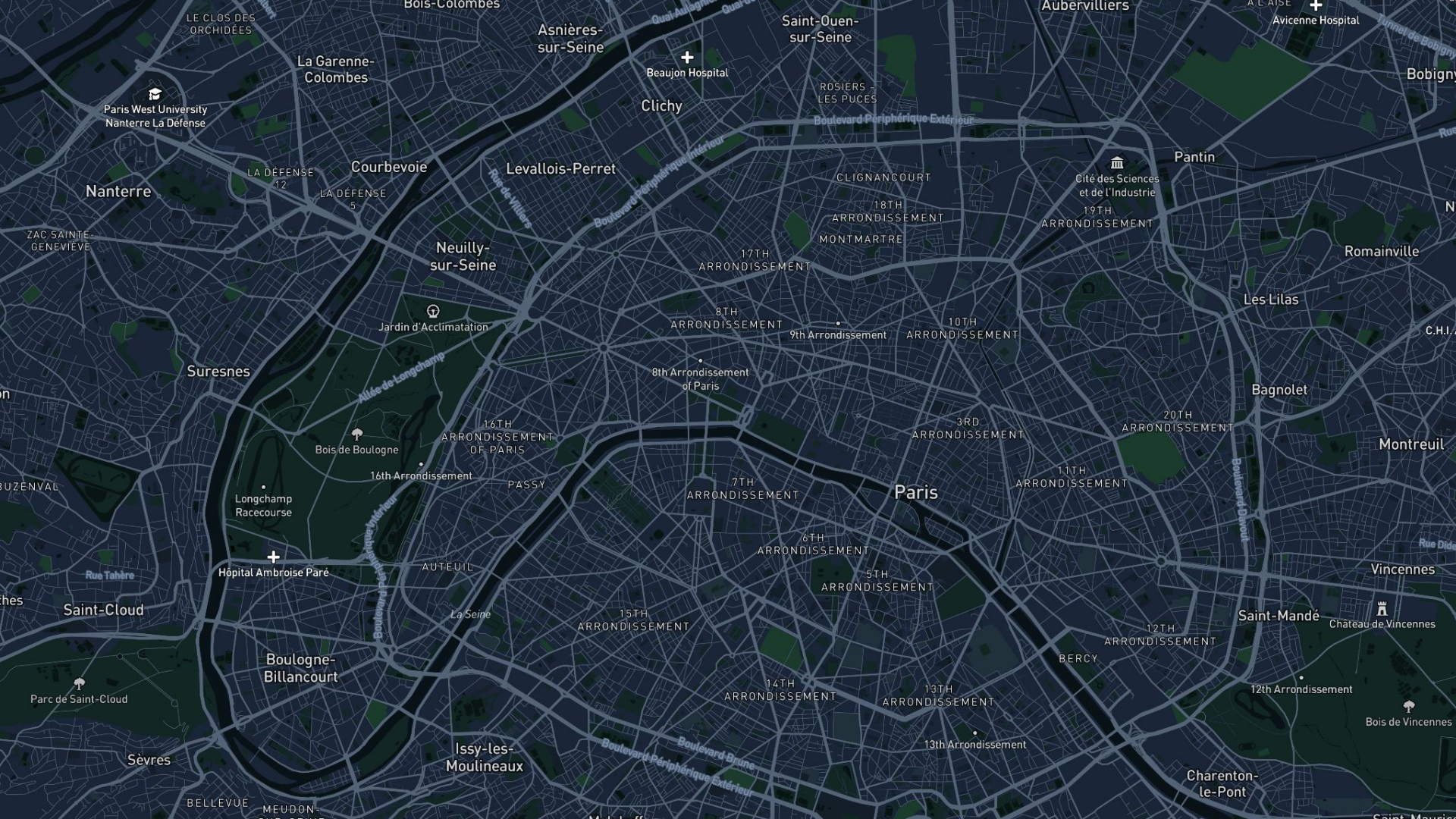
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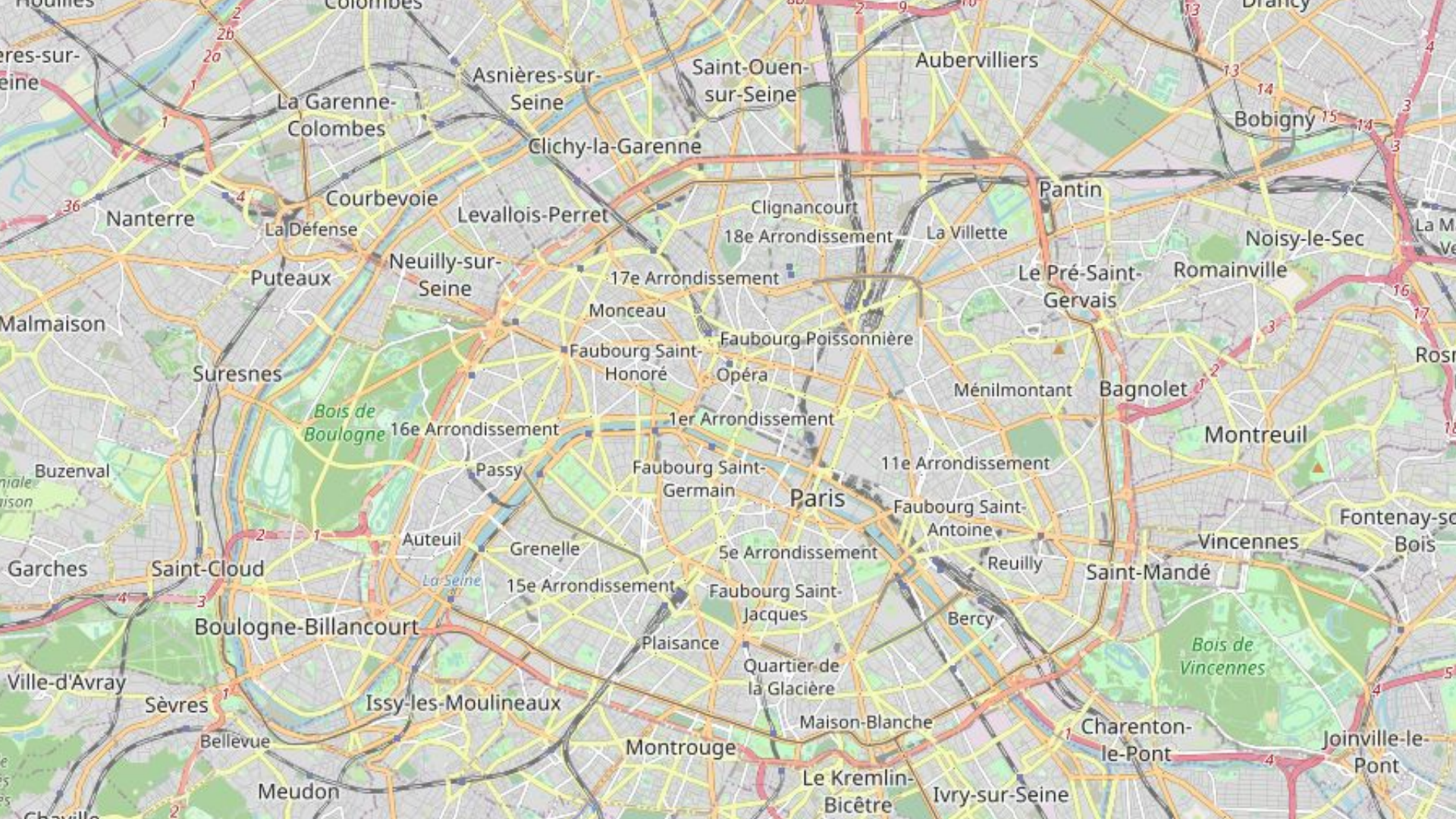
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Montrouge
Meudon
Le Kremlin-Bicêtre
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What did we just see?

- The previous examples are rendered in real-time using a state-of-the-art vector renderer
- The style of the map is decided during the runtime

You probably use one of these regularly:

Comparison

Vector Tiles

Pros:

- Smaller data size and therefore lower disk space requirement
- Better user experience - smooth zooming
- Easy and powerful customization

Cons:

- The map is rendering on the client's side and requires more powerful hardware

Raster Tiles

Pros:

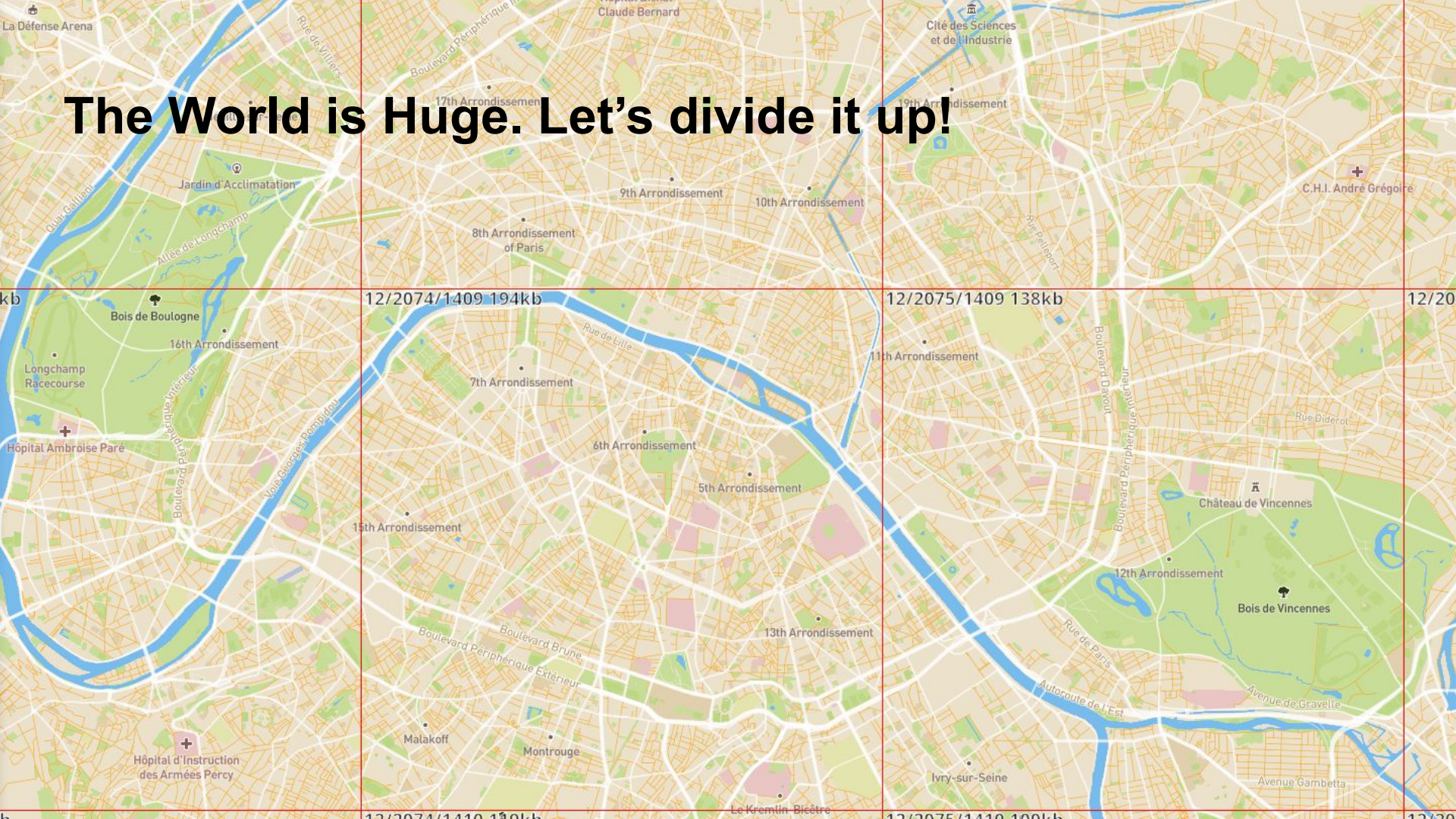
- Suitable for raster data like satellite imagery
- Lower requirements for end-users hardware

Cons:

- A bigger size of each tile

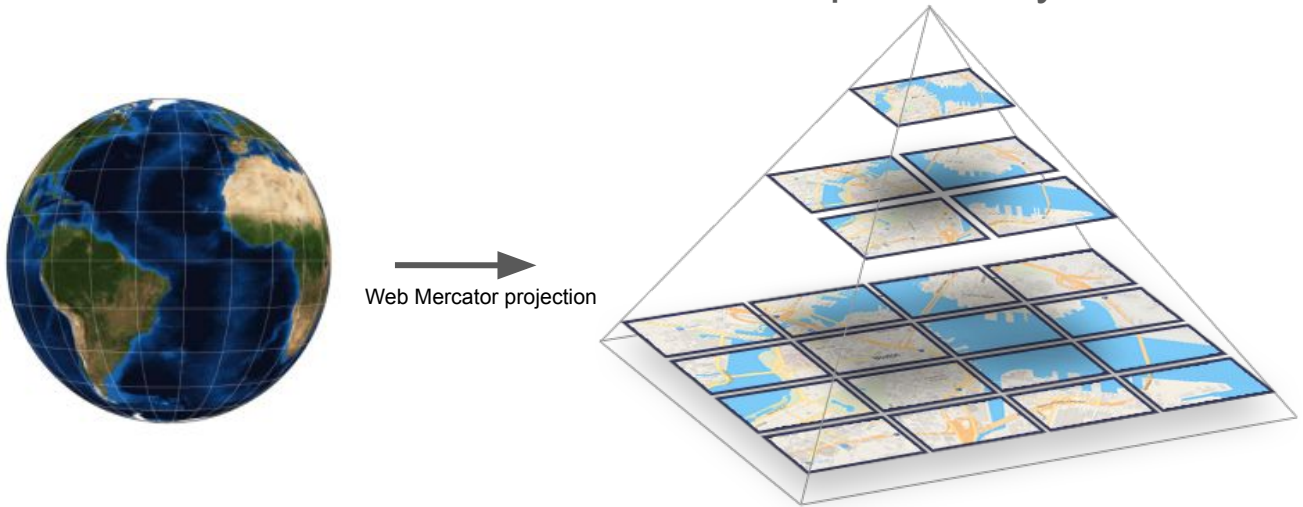
Maptiler: https://www.maptiler.com/news/2019/02/what-are-vector-tiles-and-why-you-should-care/

The World is Huge. Let's divide it up!



The World is Huge. Let’s divide it up!

- Projected world is divided into tiles in X, Y and Z (zoom level) direction
- The zoom level influences the extent of the world
- Per zoom level the count of tiles increases exponentially: 2^0, 2^1, 2^2, 2^3 …



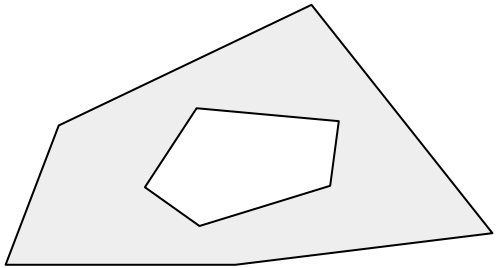
Maptiler: https://www.maptiler.com/news/2019/02/what-are-vector-tiles-and-why-you-should-care/

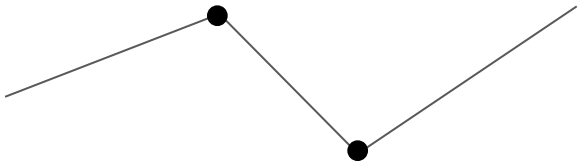
Different Kind of Tiles

Maptiler: https://www.maptiler.com/news/2019/02/what-are-vector-tiles-and-why-you-should-care/

What is a Vector Tile?

- Each “feature” on the map is represented by a geometry (line, polygon or point with text)





- A vector tile encodes geographic geometries in a lossless way

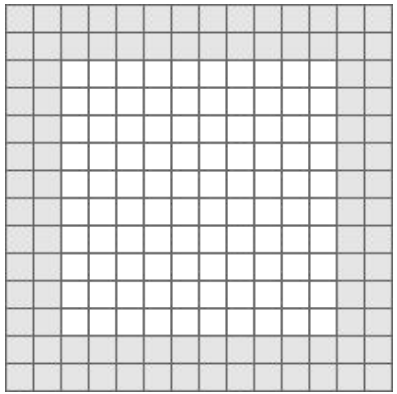
Essentially: Vector Tile = SVG Path

Encoding Step 0: An empty vector tile

The vector tile to the right is a 10x10 grid with 2 cell buffer.

Let's encode some geometry to the grid starting with a blue polygon.

The following commands will be relative to the pen.

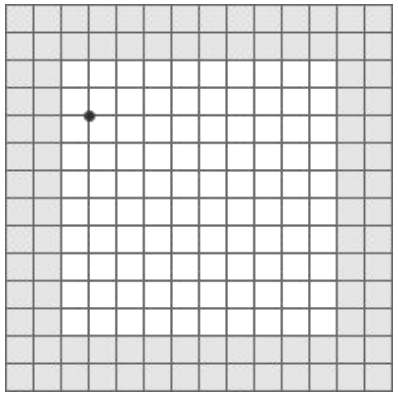


Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Encoding Step 1: MoveTo(1,2)

The first action when encoding a polygon is to point the command to a starting point.

This uses the MoveTo(x,y) command. The pen is at 1, 2 starting at the top left of the grid

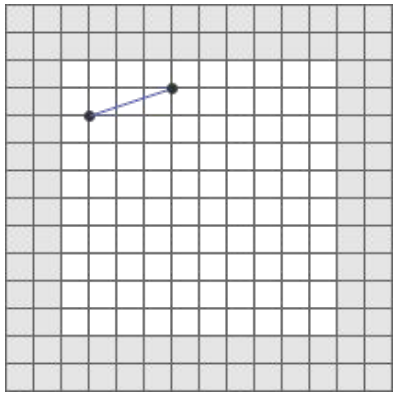


Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Encoding Encoding Step 2: LineTo(3,-1)

In order to move from a starting position, we use a LineTo(x,y) command.

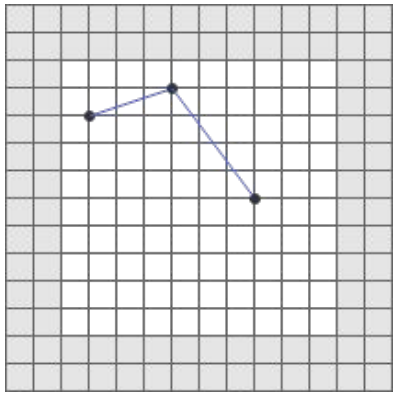
The X and Y values are relative to the previous command, rather than the origin of the grid, to keep file size down.



Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Encoding Step 3: LineTo(3,4)

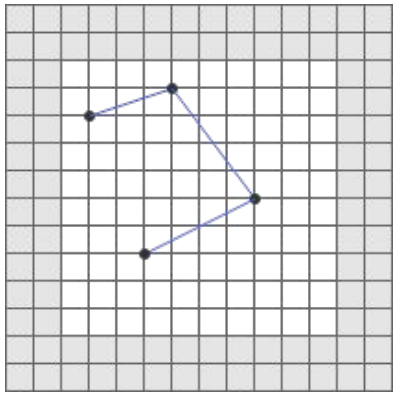
Drawing another path of the blue polygon.



Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Encoding Step 4: LineTo(-4,2)

Drawing another path of the blue polygon.

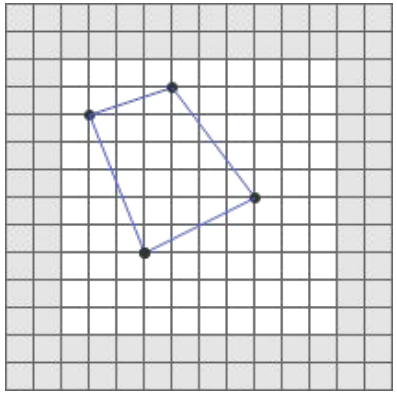


Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Encoding Step 5: ClosePath()

Finally, we close a path. This uses the ClosePath() command that closes the path to most recently used MoveTo(x,y) command, which is our starting point.

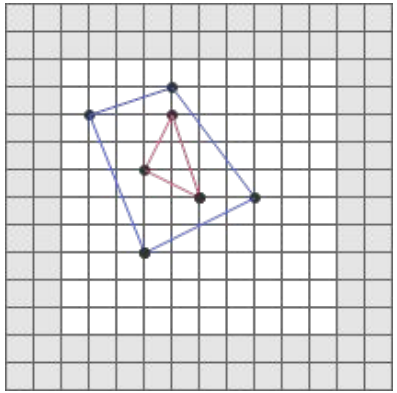
This DOES NOT move the pen.



Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Encoding Step 6

Let’s draw another polygon in the opposite direction.



Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Encoding Step 7

Encoding is complete!

Decoding works the same way just in opposite direction.

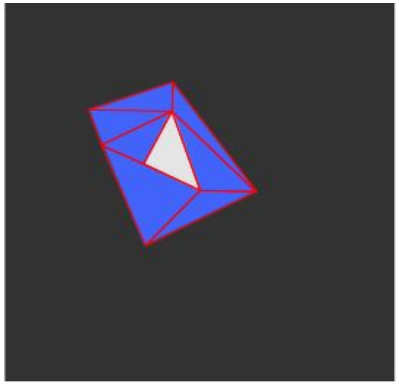
Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Tessellation for GPU

GPUs work with triangles.

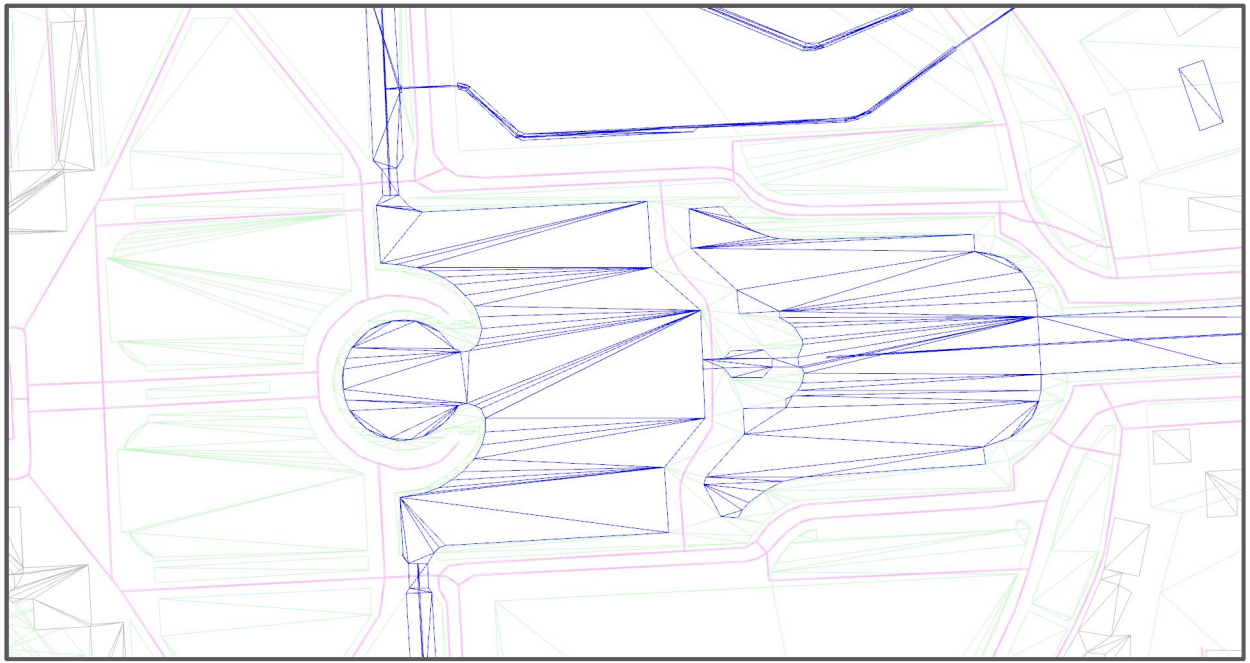
Some algorithm has to create a mesh of “vertices” which are in fact vectors.

The term tessellation has its origin in the tessellation of mosaiks.



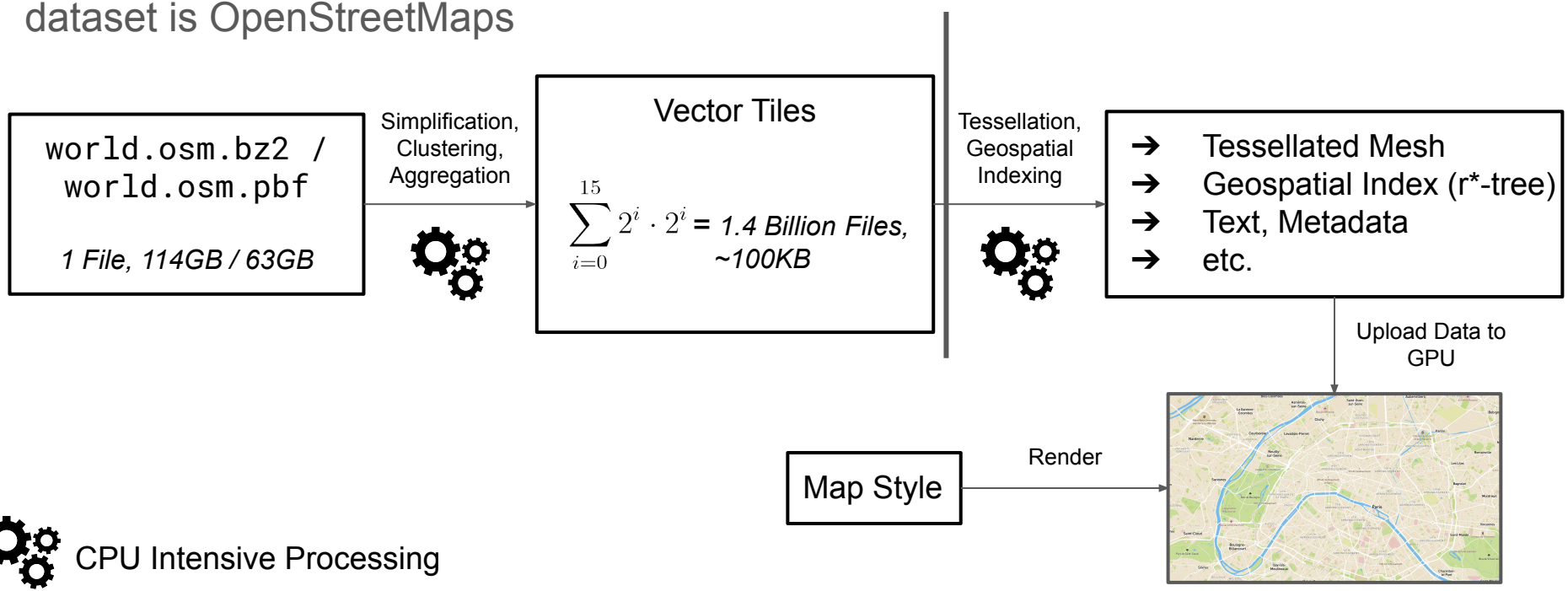
Mapbox: https://docs.mapbox.com/data/tilesets/guides/vector-tiles-standards/

Example from the Rendering Engine



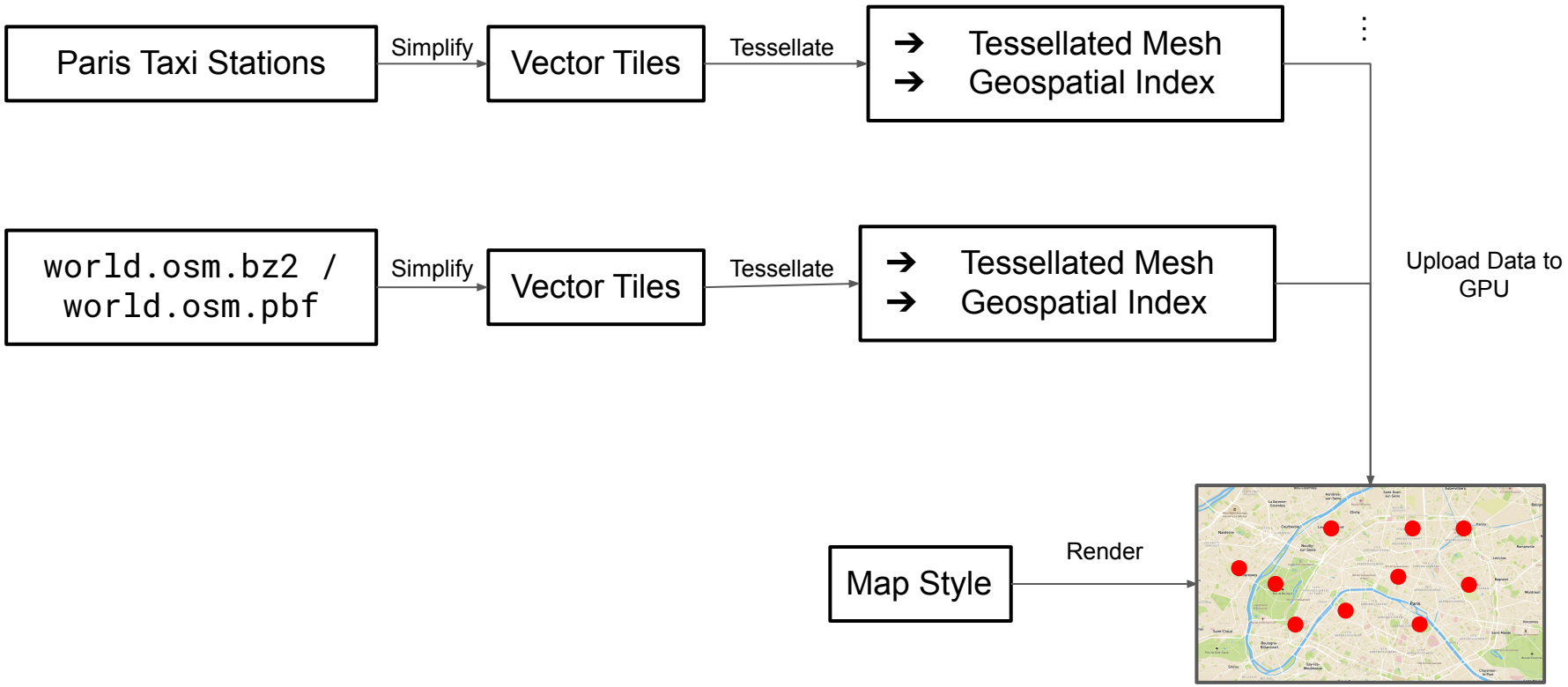
Overview of the Data Visualisation Pipeline

Rendering maps is in fact data visualisation, where the dataset is OpenStreetMaps



CPU Intensive Processing

Multiple Datasets



Project: maplibre-rs

> maplibre-rs is a portable and performant vector maps renderer written in Rust

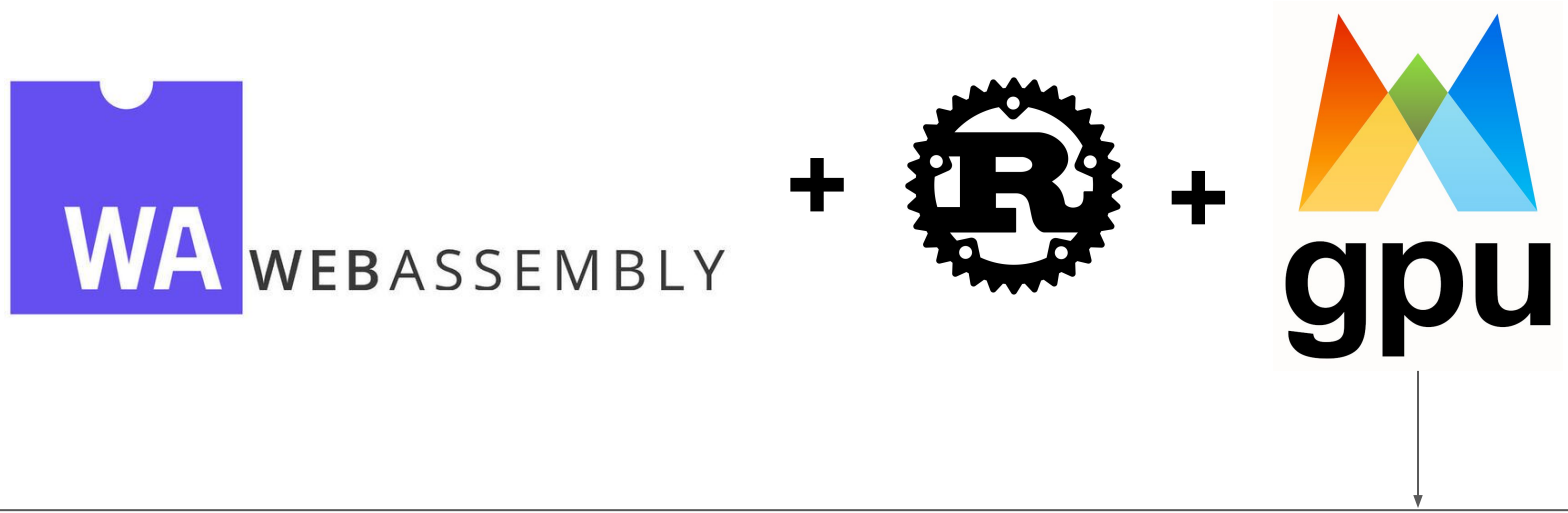
Goals of maplibre-rs

- Aims to support the web, mobile and desktop applications with a single code base
- Create a truly FLOSS experience to render vector tiles
- Experiment with new (web) technologies

Non-goals:

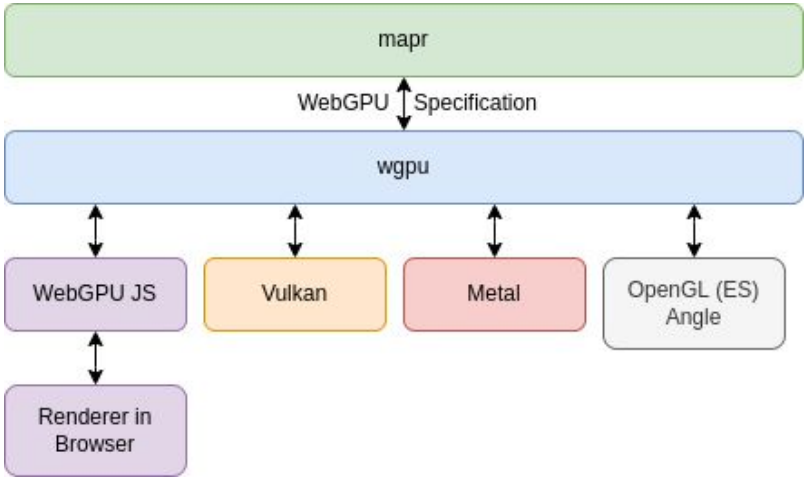
- Compete with quality of Google and Apple

Rendering Stack



What is WebGPU?

- Upcoming technology in 2023-2025
- Platform independent 3D graphics API
- Quite unstable specification
- Possibly support for multi-threaded rendering in the browser.
- Plenty of native implementations are already available.



Multi-Threading Support

- Important feature because we need to offload heavy work from the render thread

- Multi-threading support in browsers and on bare metal
  - Browser: WebWorker
  - Linux/Windows/macOS/iOS/Android: plain POSIX threads

- Communication between threads via shared memory
  - Support for `std::sync` including `Mutex`, mpsc channels, `Arc` etc.

Shared Memory in Browsers

- Rust supports s*hared memory* and *atomic instructions* in Browsers!
- *Shared memory* can be accessed from several web workers.

Without *shared memory* we would have to stick to multi-processing primitives.

Other Rust Ecosystem Benefits

- Performant tessellator for polygons called **lyon**
- **winit** for handling mouse or touch input
- Native and simple crates for handling geospatial data by the **GeoRust** project and community
- Plenty of crates like **glam**, **cgmath** for linear algebra operations available, including SIMD support
- **Tokio** for scheduling tasks on POSIX threads
- **reqwest** for HTTP requests
- **wasm-bindgen** for communication between Rust and JavaScript

lyon

GeoRust

Side-artifacts of maplibre-rs

- Crate for a **thread pool** based on **WebWorkers** *in-progress*
- Tools for handling **MBTiles** (tile container) databases *in-progress*
- Blog posts on **WebGPU** and 3D Rendering *done and planned*
- Contributions to **GeoRust** projects *planned*
- Novel and state-of-the-art solution to **render text** *planned*

State of the Project

- Multi-threaded rendering engine works but is very barebones.

- Proof of concept is done.
  - Runs at > 60FPS in debug mode
  - It’s running smooth on iOS, Android, WebGL, WebGPU, Linux, Windows and macOS (yes also M1)

- Continuous Integration works for all platforms.

What is missing?

- Text/font rendering

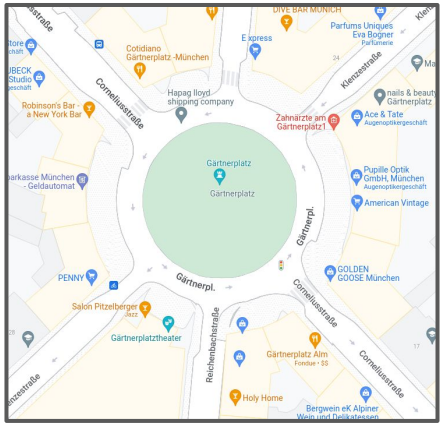
- Feature rich rendering engine which supports outlines, transparency or “per-feature” styling

- A logo! (If you haven’t noticed: I like logos!)

Future Work

- Smooth geometries in pre-processing and render Bézier curve (yields proper circles)

- Focus on accessibility (impaired vision)



Google Maps
with beautiful circle

The Billion Dollar Code

2021 | 12 | 1 Season | Courtroom TV Programmes

In 1990s Berlin, an artist and a hacker invented a new way to see the world. Years later, they reunite to sue Google for patent infringement on it.

Starring: Mark Waschke,Mišel Matičević,Leonard Scheicher

Reach out to us or try maplibre-rs out yourself!

Matrix: matrix.to/#/#maplibre:matrix.org
Twitter: maxammann_
Github: github.com/maplibre/maplibre-rs
Web: maplibre.org

I’m happy about any feedback about maplibre-rs!

Explore Europe at:
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https://maplibre-rs-demos.pages.dev/webgpu/ (requires Firefox Nightly or Chrome Canary)