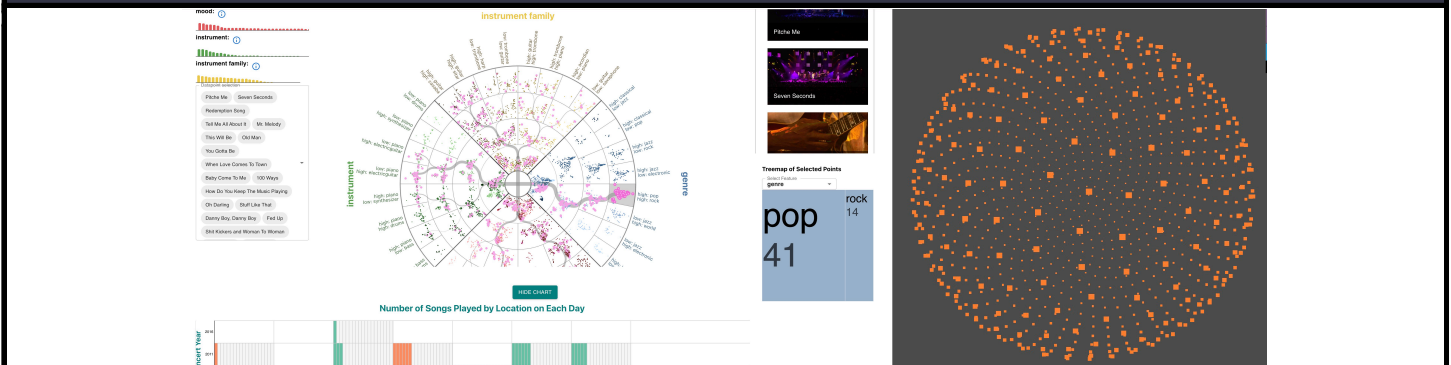


# Master Project: SnakeTrees WebGPU/WebGL Implementation



University of  
Zurich<sup>UZH</sup>



## Introduction

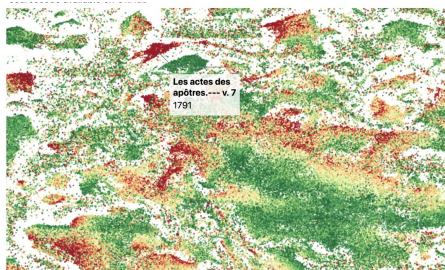
This project aims to enhance the performance and scalability of our existing SnakeTrees interactive visualization system, which currently uses a JavaScript frontend and a Python backend. The current system supports a wide range of interactive viewing operations, such as zooming, panning, filtering, and data selection, but it experiences performance bottlenecks when handling and plotting large datasets. Rendering of many 1000s or 10000 data points is slow and slow interactions limit its usability for real-time data exploration and analysis.

To overcome these limitations, this project should re-implement the visualization layer, in particular the data plotting and visualization currently done with plain D3, which is too slow, using WebGPU [1] or WebGL enhanced D3 instead. WebGPU is a next-generation web graphics and compute API that allows direct access to GPU acceleration from the browser. Compared with traditional WebGL or CPU-based rendering, WebGPU offers significantly improved efficiency in parallel computation and memory handling, enabling smooth and interactive rendering even for large-scale or complex datasets. In [2] it has been demonstrated how D3 can handle large amounts of points with the help of WebGL.

The goal is to achieve high-performance visualization while retaining all interactive capabilities of the existing tool. The outcome will be a GPU-accelerated web application capable of visualizing large data collections in real time, providing an improved user experience and scalability for future data-intensive research applica-

tions.

Important is that the actual plotting of many data points and curves connecting them is improved significantly, and to retain the existing interaction. The combination of technologies to achieve that, and which technology to be used for which part, plotting points and lines or GUI elements and implementing user interaction, are flexible and should be chosen to optimize the overall result.



Rendering large datasets with WebGL and D3.

## Assignment

The main goal of this project is to re-implement the SnakeTrees application exploiting the WebGPU and/or WebGL framework for the display and rendering of large data sets. The new system will consist of the following components:

- Multiple Views and Interactions. Re-implement all views and functionalities of the original SnakeTrees system using the WebGPU or WebGL framework. Integrate multiple coordinated views that support linked brushing and synchronized updates based on user interactions
- Performance. Achieve real-time in-

teraction and rendering for large datasets through optimized GPU memory management and parallel computation.

- Optional: Incorporate progressive or level-of-detail visualization techniques to reduce overplotting in dense regions of scatterplots and improve clarity during exploration.

## Project Type

Master Project

## Requirements

Experience in programming with C++ and JavaScript/TypeScript. Familiarity with WebGPU/WebGL and data visualization concepts is a plus.

## Supervision

Prof. Dr. Renato Pajarola

Xiao Tan (Assistant)

## Workload

- 10% Theory
- 70% Implementation
- 20% Evaluation

## Contact

Email: [xtan@ifi.uzh.ch](mailto:xtan@ifi.uzh.ch)

## References

- [1] W3C. Webgpu specification, 2025. Accessed: 2025-10-22.
- [2] Colin Eberhardt. Rendering one million datapoints with d3 and webgl, May 2020. Accessed: 2025-10-22.