Comparing Rendering Performance of Common Web Technologies for Large Graphs

Tom Horak, Ulrike Kister, Raimund Dachselt

Motivation and Basic Idea

- Web-based visualization interfaces are getting increasingly popular
- For a high usability, an interface must always run smoothly
- Especially challenging with high number of displayed elements, e.g., in large graph visualizations or big multiple coordinated views apps
- Comparing ***SVG***, ***Canvas***, and ***WebGL***
- Measuring the interface performance as ***frames per second*** (FPS) during user interactions

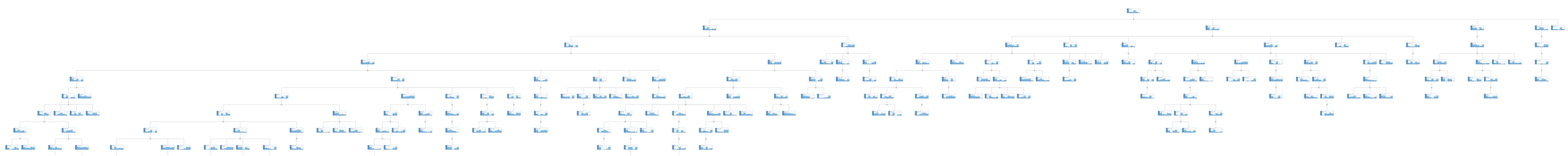
How to Compare Web-Visualizations

Measuring Performance through FPS:

- FPS can more accurately represent the perceived performance
- Longer loading time may be acceptable
- But: slow-acting or laggy interface is not

Using Tree Visualizations as Example:

- Consist of a large number of nodes and can easily be scaled
- Here: tree visualization similar to Value Driver Trees

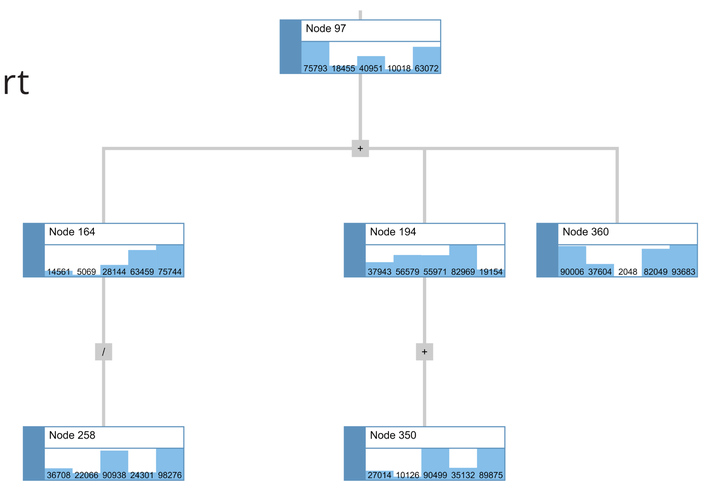


Nodes and Edges (right):

- Each node holds an embedded bar chart
- 1 node = 15 graphical elements
- 1 edge = line plus box with label

Implementation and Libraries:

- D3.js for SVG version
- No library for Canvas version
- PixiJS for WebGL version

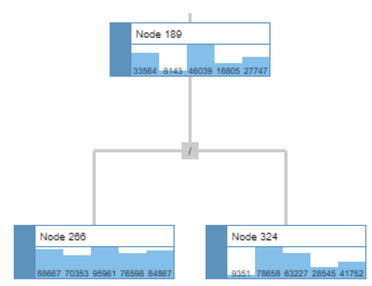


Static and pre-defined Layout Algorithm (top):

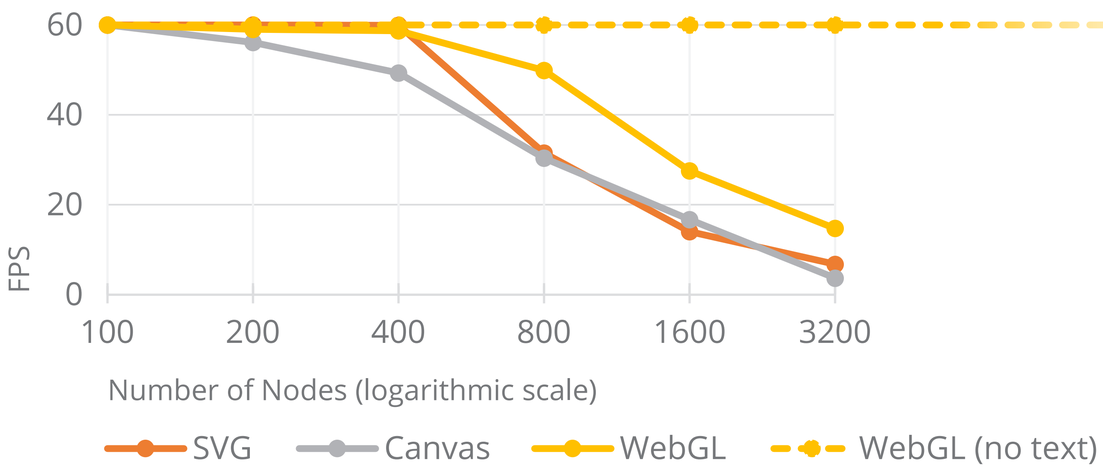
- Rendering used a pre-defined layout algorithm
- Example with 200 nodes shown above

Text in WebGL (right):

- Text rendering is complex in WebGL
- Blurry text caused by bit-map-based rendering



Findings: ▸ WebGL faster than SVG and Canvas ▸ SVG on par with Canvas



Browser Dependency:

- No notable differences regarding FPS between browsers
- Exception: Initial lag in Firefox for SVGs caused by applying CSS

Performance loss above 400 nodes:

- Performance losses started above 400 nodes for all technologies
- Corresponds to ca. 8,000 graphical elements

SVG and Canvas are on par, WebGL faster:

- Surprisingly, SVG and Canvas perform almost equally
- Contradicting general assumption that Canvas is faster than SVG
- Drop for WebGL (with text) less extreme

WebGL is optimal without text:

- WebGL performance drop caused by bitmap-based text handling
- Almost constant FPS without text (50 FPS measured for extreme setup of 400,000 nodes; ca. 8 million graphical elements)

Strategies for Performance Improvements

Flexible Level of Detail:

- Not all elements are of interest to the user
- *Idea*: remove elements (e.g., details, labels) when zoomed out
- *Effect*: fewer graphical elements; speeds up rendering performance

Combined Approaches:

- *Idea*: Combine different technologies, e.g., WebGL for graphic elements and a separate Canvas for text elements
- *Challenge*: keep both scenes synchronized

Asynchronous Tile Loading:

- *Idea*: Asynchronous tile loading similar to map applications
- Rendering efforts are split up across multiple threads
- Improved web standards allow for a client-side implementation
- *Implementation*: client starts multiple threads (Webworker API) running headless browser rendering instances (Offscreen Canvas API)
- *Effect*: Interface runs constantly at 60 FPS
- Latency for loading tiles becomes main performance indicator

TECHNISCHE UNIVERSITÄT DRESDEN

INTERACTIVE MEDIA LAB DRESDEN

Contact Information

Tom Horak *horakt@acm.org*

Ulrike Kister *ukister@acm.org*

Raimund Dachselt *dachselt@acm.org*

IEEE VIS 2018