



Traffic Visualization Dashboard

By: Team 7:

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Course: CS 4624 HyperText/Multimedia

Instructor: Mohamed Farag

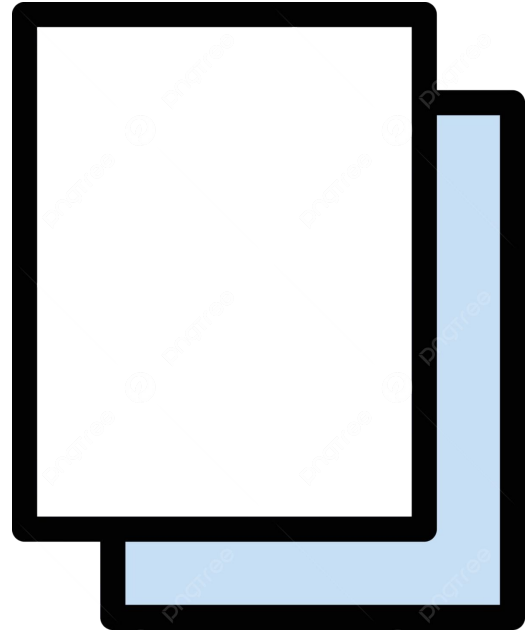
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Client : Mohamed Farag

- Dr. Farag is a research associate in the Center for Sustainable Mobility (CSM).
- His research interests include intelligent transportation systems, connected/automated vehicles, C-V2X, machine learning, large-scale data analysis, large-scale system analysis and design, big data, and information retrieval.



Problem

- The Virginia Tech Transportation Institute has developed a Traffic Simulation Tool:
<https://sites.google.com/a/vt.edu/hrakha/software>
- It is hard to visualize input data for a traffic environment, from raw data.
- It is harder to make meaningful observations from the raw output data.



```
QNET CARNATION 3600.01
Total Statistics:
1 4700.00 0.00 0.00 0.00 0.00 4700.00 - vehicle trips
2 4700.00 0.00 0.00 0.00 0.00 4700.00 - person trips
3 16206.21 0.00 0.00 0.00 0.00 16206.21 - vehicle-km
4 16206.21 0.00 0.00 0.00 0.00 16206.21 - person-km
5 10096.87 0.00 0.00 0.00 0.00 10096.87 - vehicle-stops
6 1745214.25 0.00 0.00 0.00 0.00 1745214.25 - vehicle-secs
7 1745301.50 0.00 0.00 0.00 0.00 1745301.50 - person-secs
8 1114617.38 0.00 0.00 0.00 0.00 1114617.38 - total delay
9 256542.17 0.00 0.00 0.00 0.00 256542.17 - stopped delay
10 858077.38 0.00 0.00 0.00 0.00 858077.38 - accel/decel delay
11 166127264.00 0.00 0.00 0.00 0.00 166127264.00 - accel-noise
12 1309.52 0.00 0.00 0.00 0.00 1309.52 - fuel (l)
13 0.00 0.00 0.00 0.00 0.00 0.00 - Energy (Kwh)
14 0.00 0.00 0.00 0.00 0.00 0.00 - HC (g)
15 0.00 0.00 0.00 0.00 0.00 0.00 - CO (g)
16 0.00 0.00 0.00 0.00 0.00 0.00 - NOx (g)
17 3051183.00 0.00 0.00 0.00 0.00 3051183.00 - CO2 (g)
18 0.00 0.00 0.00 0.00 0.00 0.00 - PM (g)
19 47622.00 0.00 0.00 0.00 0.00 47622.00 - crashes*10e-6
20 22848.16 0.00 0.00 0.00 0.00 22848.16 - injury crashes
21 230.27 0.00 0.00 0.00 0.00 230.27 - fatal crashes
22 2649.92 0.00 0.00 0.00 0.00 2649.92 - no damage
23 19406.70 0.00 0.00 0.00 0.00 19406.70 - minor damage
24 15042.53 0.00 0.00 0.00 0.00 15042.53 - moderate damage
25 0.00 0.00 0.00 0.00 0.00 0.00 - dollars of toll

Average Statistics:
1 1.0000 0.0000 0.0000 0.0000 0.0000 1.0000 - vehicle trips
2 1.0000 0.0000 0.0000 0.0000 0.0000 1.0000 - person trips
3 3.4481 0.0000 0.0000 0.0000 0.0000 3.4481 - vehicle-km
4 3.4481 0.0000 0.0000 0.0000 0.0000 3.4481 - person-km
5 2.1483 0.0000 0.0000 0.0000 0.0000 2.1483 - vehicle-stops
6 371.3222 0.0000 0.0000 0.0000 0.0000 371.3222 - vehicle-secs
7 371.3408 0.0000 0.0000 0.0000 0.0000 371.3408 - person-secs
8 237.1526 0.0000 0.0000 0.0000 0.0000 237.1526 - total delay
9 54.5834 0.0000 0.0000 0.0000 0.0000 54.5834 - stopped delay
10 182.5697 0.0000 0.0000 0.0000 0.0000 182.5697 - accel/decel delay
11 35346.2266 0.0000 0.0000 0.0000 0.0000 35346.2266 - accel-noise
12 0.2786 0.0000 0.0000 0.0000 0.0000 0.2786 - fuel (l)
13 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 - Energy (KWh)
14 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 - HC (g)
```

Motivation

- The goal is to build a visualization dashboard to creatively visualize the data of the Integration Traffic Simulator
- The dashboard contains different charts that allow the end users to gain insights from the output data.





Deliverables

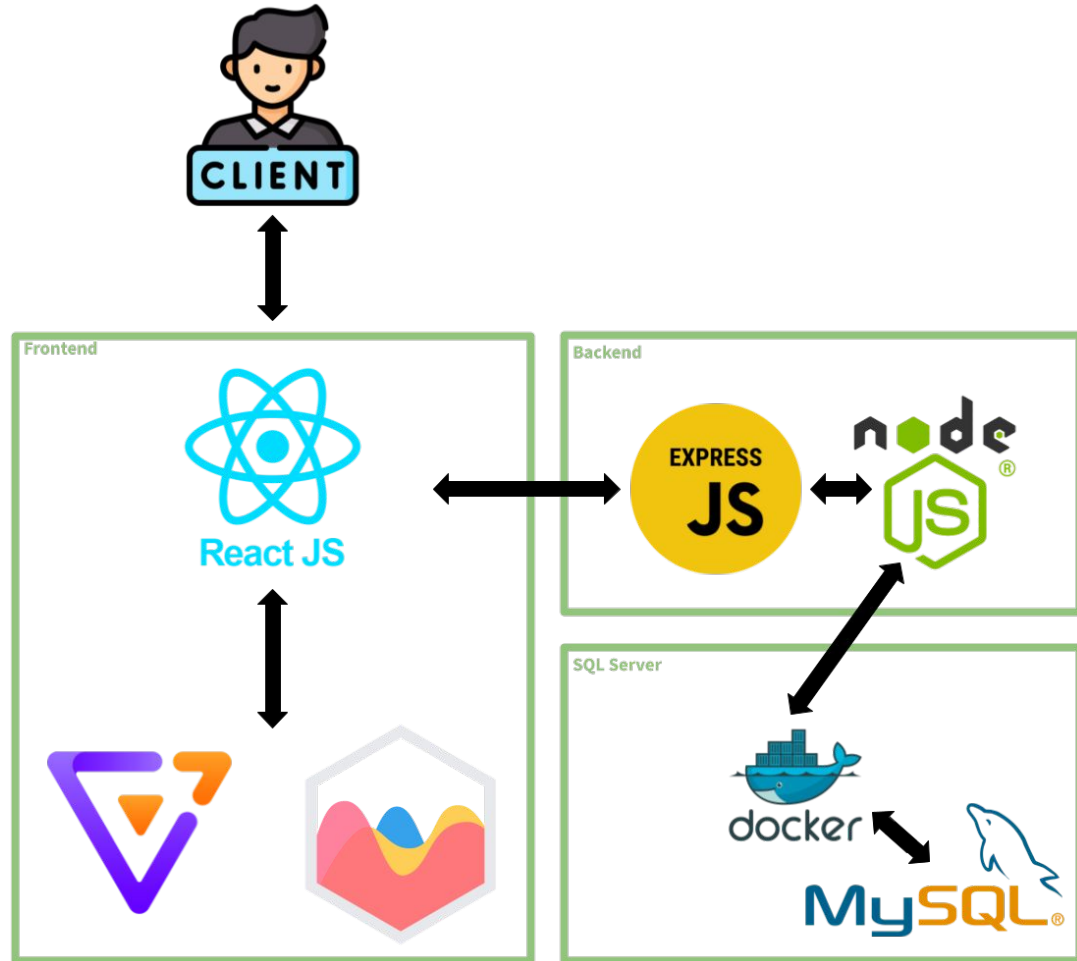
- User Login and Token System
- Back End Endpoint to Database Server Storage
- Collection Uploads
- Collection Selection
- Parsing of Uploaded Files
- Visualization Selection
- Customizable Visualizations

Technology Stack

React is our base for the front end. It uses Antv/Charts for help with visuals.

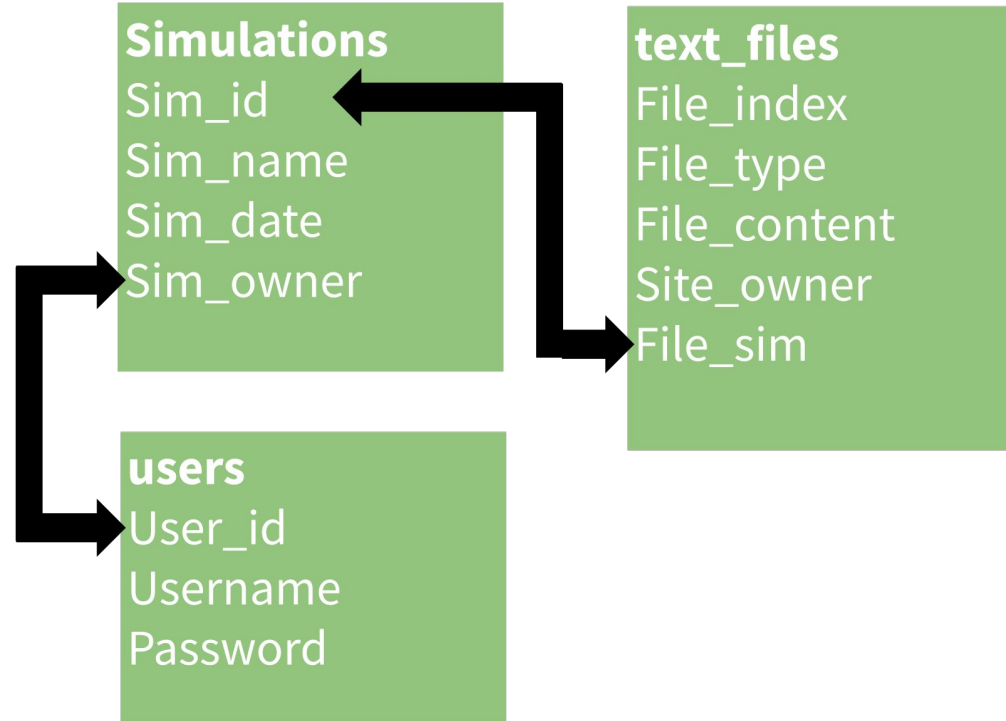
Node.js is our primary backend. Express js is the middle man communicating with React.

MySQL Server stores our data and is stored in a docker container for simple deployment.





DB Schema





Scope Growth

- Starting the group was using unfamiliar technologies, so completion seemed out of grasp.
- The Goal was to set up a workable frontend and backend, which would allow visuals to be plugged in.
- After the first month, goal was within sight, so the scope grew to make as many visuals as possible.
- We were also asked to change from single file uploads, to zip uploads.



GROWTH



Accomplishments

Deliverables have been achieved!

- There is a functioning user sign up/login interface, with tokening operations that span the front and backend. It looks good!
- A protected route protects the home page from trespassers and a loading screen in between.
- You can name and upload a zip file of the simulation data, where it is parsed in the backend, stored, and shown/reflected in the front end. There is even a cool loading animation for it.



Upload Collection Zip

Enter Collection Name:

Choose File No file chosen

Upload

Uploaded Collections

more

x

more2

x

Simulation Details

Average Traffic
Conditions

Traffic Conditions

Paths

Summary

MORE Accomplishments

- There is an interactive collection selection interface, that highlights the data types within.
- A dynamic visualization window appear on collection selection, allowing for easy visualization choice. It only show visualizations you have data for.

Select Visualization

Simulation Details

Average Traffic
Conditions

Traffic Map

Avg Crashes

Avg CO2

Traffic Conditions

Paths

Summary

Trip Completion
Probes

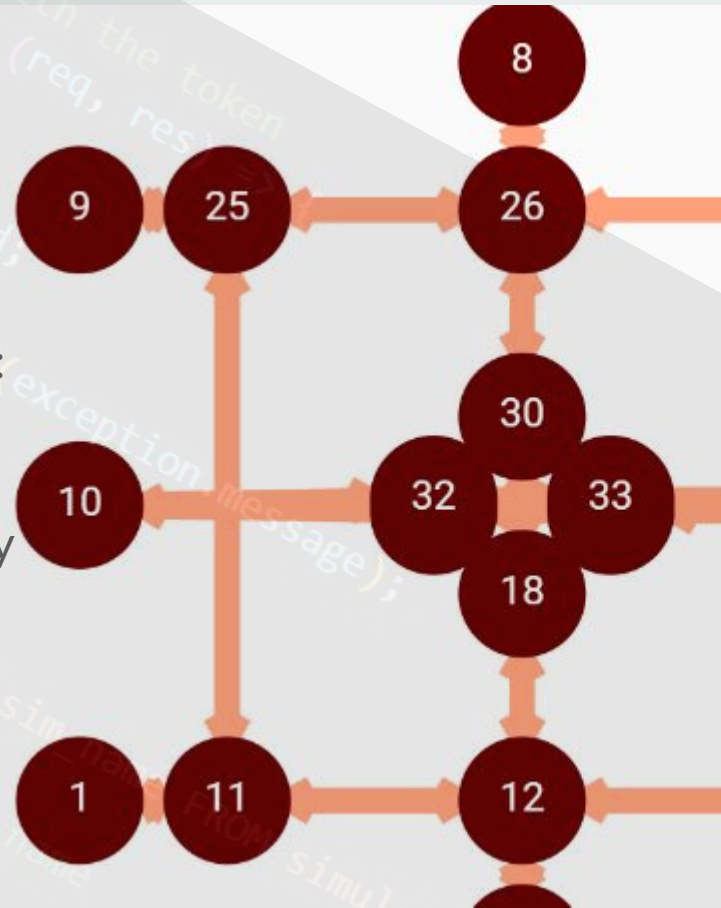
Client Meetings

Is the project done.



Yes Uhm... Wait, There's More

- There is at least one visualization for each file type : 10, 11, 12, 13, 15, 16, summary
- We even designed a new graph to show the traffic mapped out, some visualizations build on this. Many are highly interactive, allowing interesting insights, and easy to query info.
- Having a slide for each one is boring when we can demo and explain.



Demo Video Given In Attached File Named : traffic_visual_demo.mkv


Demo Time!



Challenges

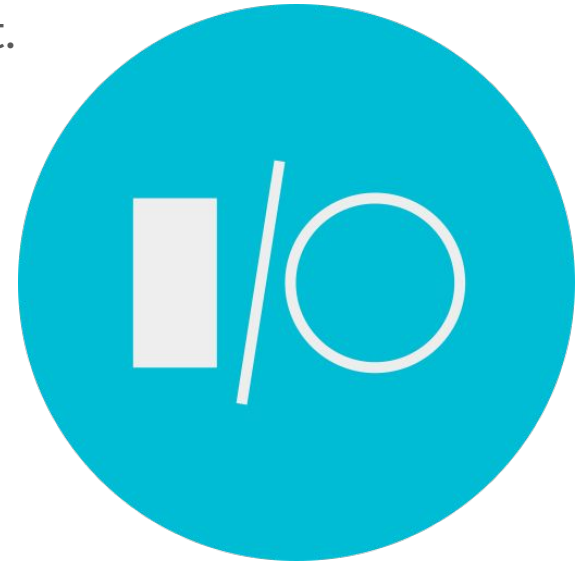
- We as a group for the most part were unfamiliar with Node.js at first, so there was a time of learning at first that slowed our progress.
- There were also much time messing with newer undocumented versions of Antv that also wasted much of our time.
- Occasionally there were pushes that destroyed progress with Github, making paranoia checking commits, before pulling.





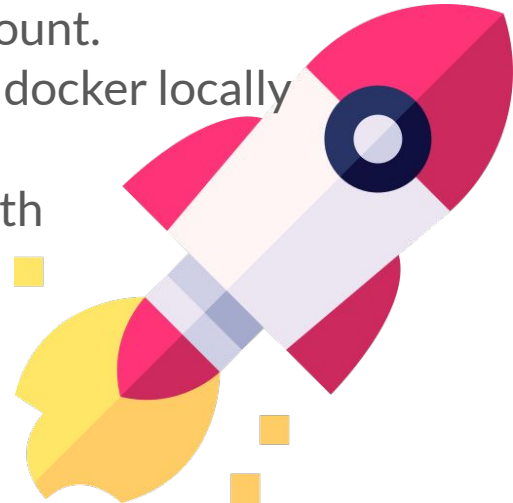
Challenges Cont.

- We also only had one set of corresponding IO files from the simulator and some, single files unrelated to the rest.



Deployment

- This was also a challenge.
- First attempt was to move it as is, there were problems: Installing node js. Installing MySQL Server exclusively for my account.
- After much trouble shooting and getting everything on docker locally it worked, but not on the server.
- Peer/Farag help, enabled me to get Node js installed with an older version of Node js. Luckily MySQL Server was best in the docker and worked.



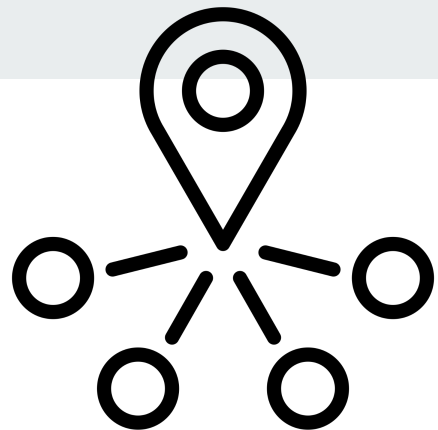


Lessons Learned

- Docker is amazing for MySQL Server Deployment
- Using older versions of libraries is always worth looking into, for installation issue and documentation if there are significant changes.
- Leading a team looks different depending on your members.
- Importance of planning



Contribution



Brett Noneman : Lead Front End Developer, Visualization Designer, and some Back End Assistance.

Matt Borghese : Strong Back End Development, especially Parsing, and Optimizing some systems.

Xinchen Liao : Visualization Designer of 12, 11, and the initial trenches of AntV learning.

Gabriel Worsley : Back End Developer, Front End Developer, Project Lead/Coordinator, Presentation Coordinator, Visualization Designer

Xi Chen : Visualization Designer of 10 and 13

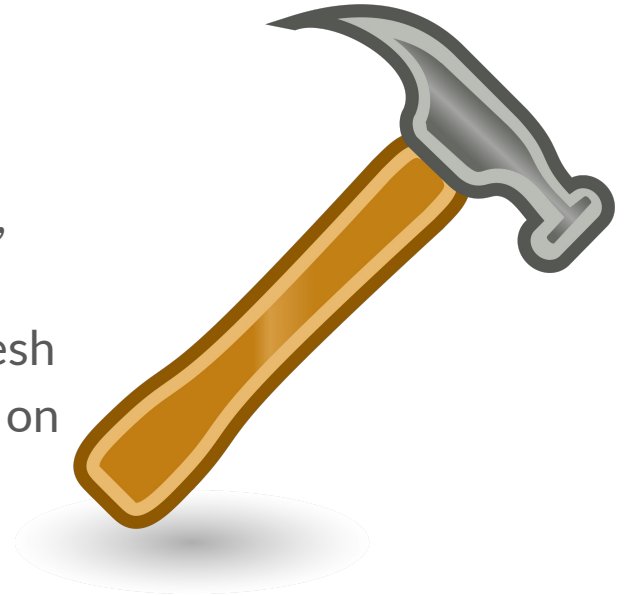
Future Work

- Make visualization dependant on not just output files, but also input files.
- Read and Parse file 14 (We were not provided 14, mostly due to time and scope)
- Read and Parse other input file to make/invent more meaningful kinds of graphs.
- More unified visualizations



Future Work Part 2

- Break up server.js into multiple logical files
- Make Front End File Type names more flexible, currently tied to the backend naming scheme.
- Force user logout, on token expiration, or refresh token, currently fine since nothing can happen on token expiration.
- Database password encryption.



Summary File Improvement

- Improving the graph to make it more intuitive
- Comparison of summary files between collections
 - Reworking the custom summary chart to display data from more than one collection for direct comparison of values





File 10 Improvement

- **Add bar chart to compare the Arrival Flow to the Saturation Flow**
 - Understand the level of traffic congestion by comparing actual flow to maximum capacity
- **Add pie chart and bar chart to show the percentages of Y-critical lane(%), Y-critical approach(%), and Y-critical sum(%)**
 - Highlight how critical lanes contribute to overall intersection efficiency.
- **Add line chart to illustrate the progression of phase over time**, such as Phase Start (sec) to Phase End (sec), and highlight Green Phase (sec) and Intern Green (sec)
 - Show how signal phases are sequenced and the duration of each phase



File 11 Improvement

- Animation on the traffic map
 - Add two way road icon on the edge
 - Add cars on it, using number of cars showing traffic flow
- Give pop information page more meaningful mini charts, which can show this value in this edge is low or high or the same compare to the one in the other edges

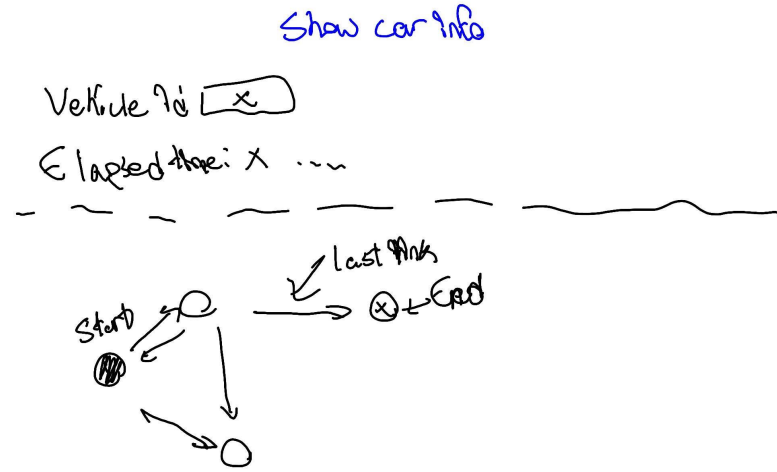


File 13 Improvements

- Make tooltip and popup data more meaningful for users analyzing the minimum path tree.
- Replace or supplement current edge information with number of crashes per edge to aid in path selection.
- Highlighting crash statistics helps users prioritize safer routes while finding the minimum path tree.
- Provides actionable insights for informed decision-making.

File 15 Improvement

- Car Information Filter Ideally should be able to show the id of every vehicle ID, used. This is so it could be used in the second planned graph
- It would comparisons on a smaller scope of cars showing their entire routes and perhaps contrasting to another car.
- May require a backend update to query for vehicle ID.





File 16 Improvement

- Additional, more detailed visualizations to provide deeper insight into:
 - Fuel use
 - Greenhouse gas emissions
 - Crash rates, and injury rates/fatalities for those crashes
 - Speed
- Speed heatmaps, safety maps, speed maps, emission maps, etc.



Questions?



Acknowledgements

- To Professor Farag for all his help and support throughout the semester!

