

Visualizing the Probabilistic Whereabouts of Moving Objects

Senior Design Project Team 10

Advisor & Client : Professor Goce Trajcevski

Members : Nathan Thoms, Ryan Cook, Mara Prochaska, Eric Jorgensen

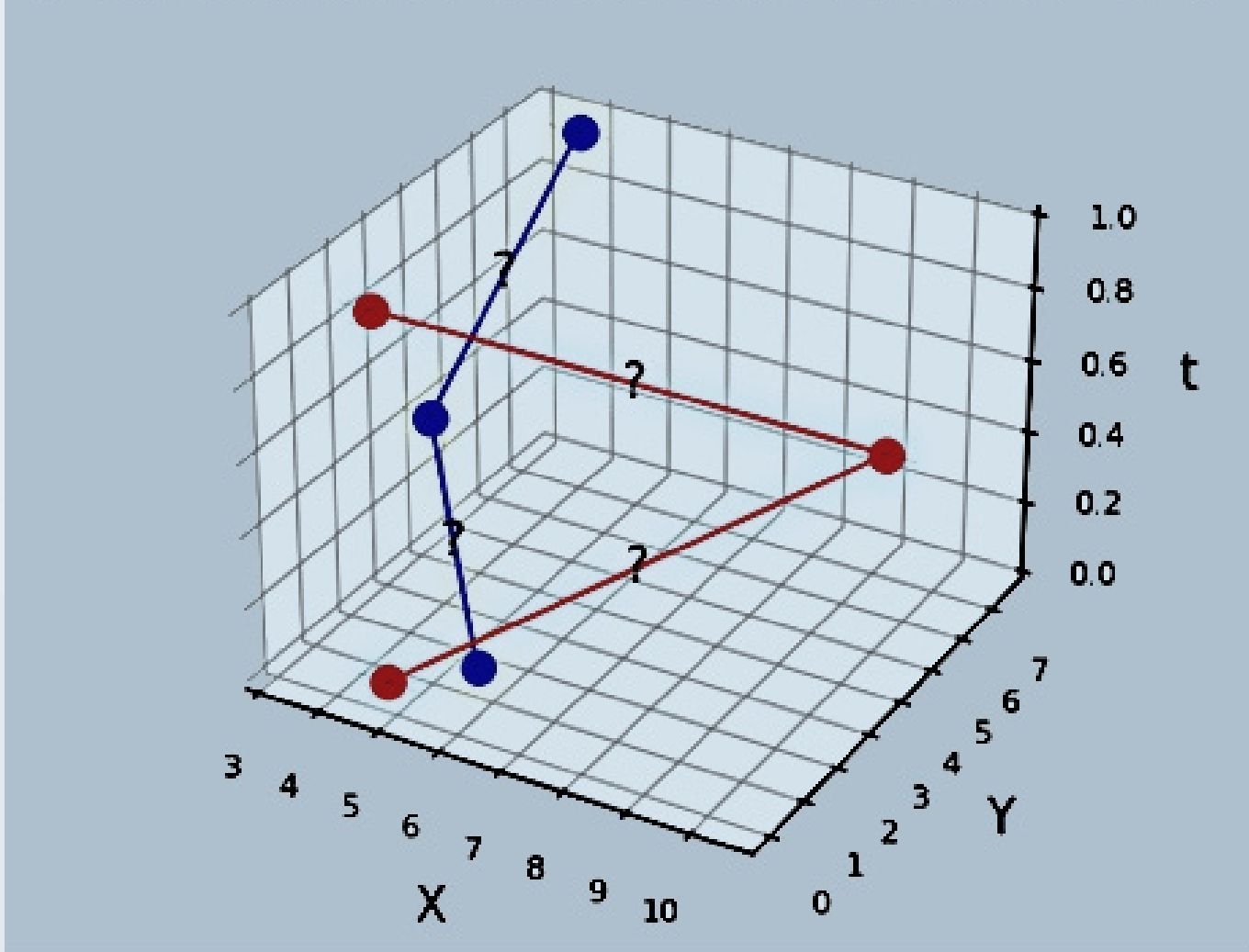
Defining the Problem

Moving objects in the macroscopic world we inhabit have a defined position that may vary over time. Recording the exact location at a given time for all time in a time interval is not possible.

- Finite Sampling Speeds
- Finite Storage Capacity
- Infinitely Fine Time Precision

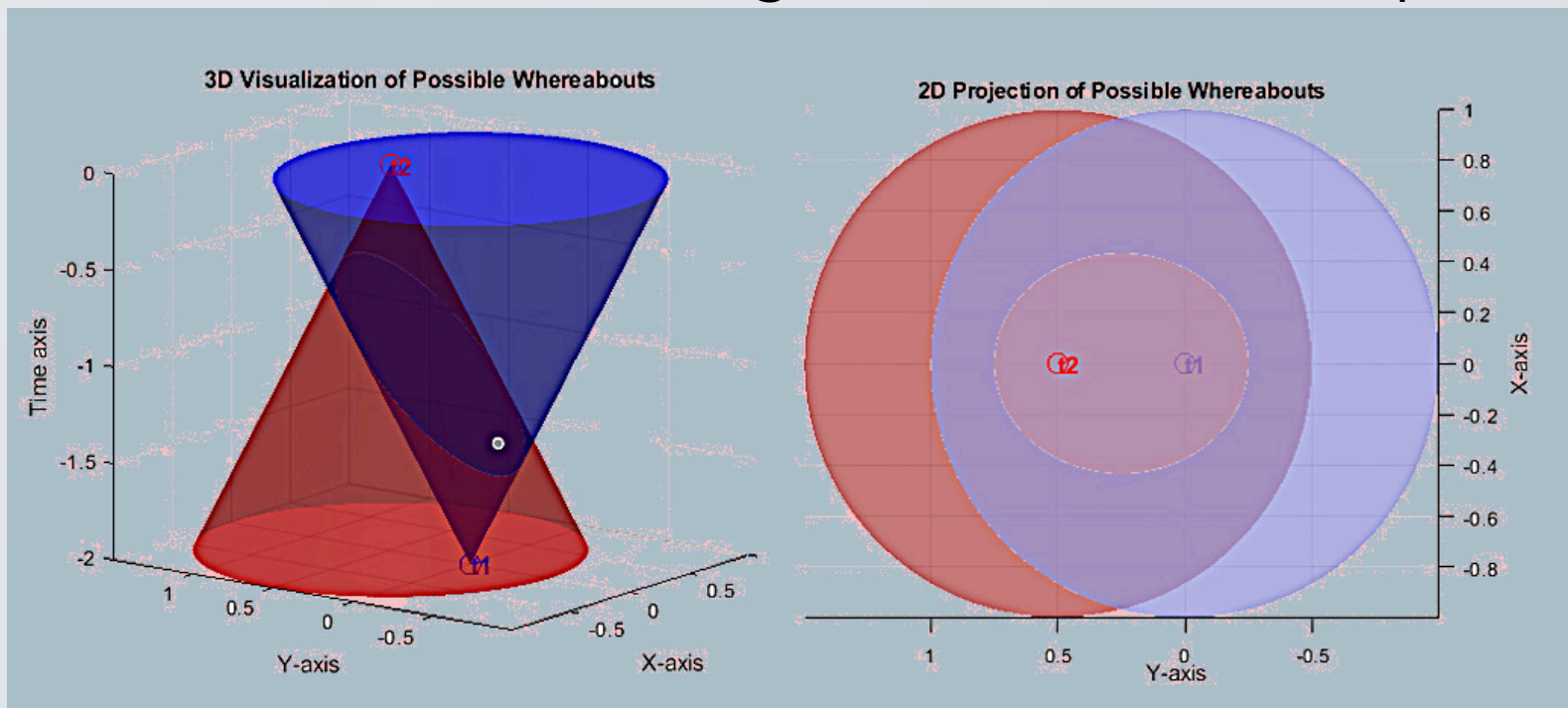
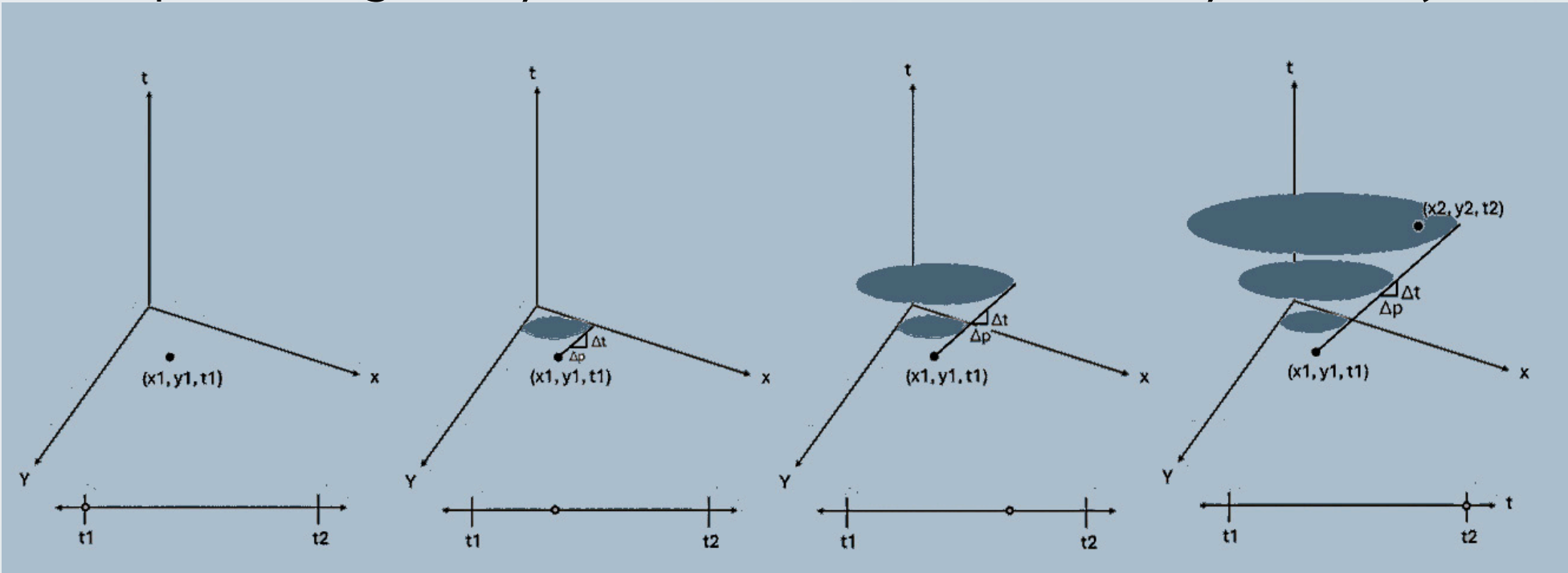
This gives rise to the problem - positional uncertainty inbetween any two measurements.

2-Dimensional Position Data Varied in Time



Project Context

Reducing the intermediate positional uncertainty without assuming a specific trajectory for the object can be accomplished given you know the max-velocity the object could have been traveling between two samples.



Positional Bounds of Object Moving Object

Time is moving forward in the vertical direction. The possible whereabouts in a 2D space grows radially from the start in measurement. A cone geometry emerges, with the slope of the cone equal to $(1 / (\text{Max Velocity}))$.

Objective

Construct a web-application that enables a user with positional data to visualize the possible whereabouts of their moving object of interest. Additionally they should be able to form queries with respect to the whereabouts.

****A user is an individual with positional data****

Geometric Interpretation

- Blue Cone - The possible locations the object could be during the time interval between samples given a max travel speed.
- Red Cone - The possible locations the object could have come from in the time interval between samples given a max travel speed.
- Cone Intersection Projection - An ellipse in the figure on the right (the shape inbetween the two larger circles); the possible locations for the object inbetween sampled points.

About the Desgin

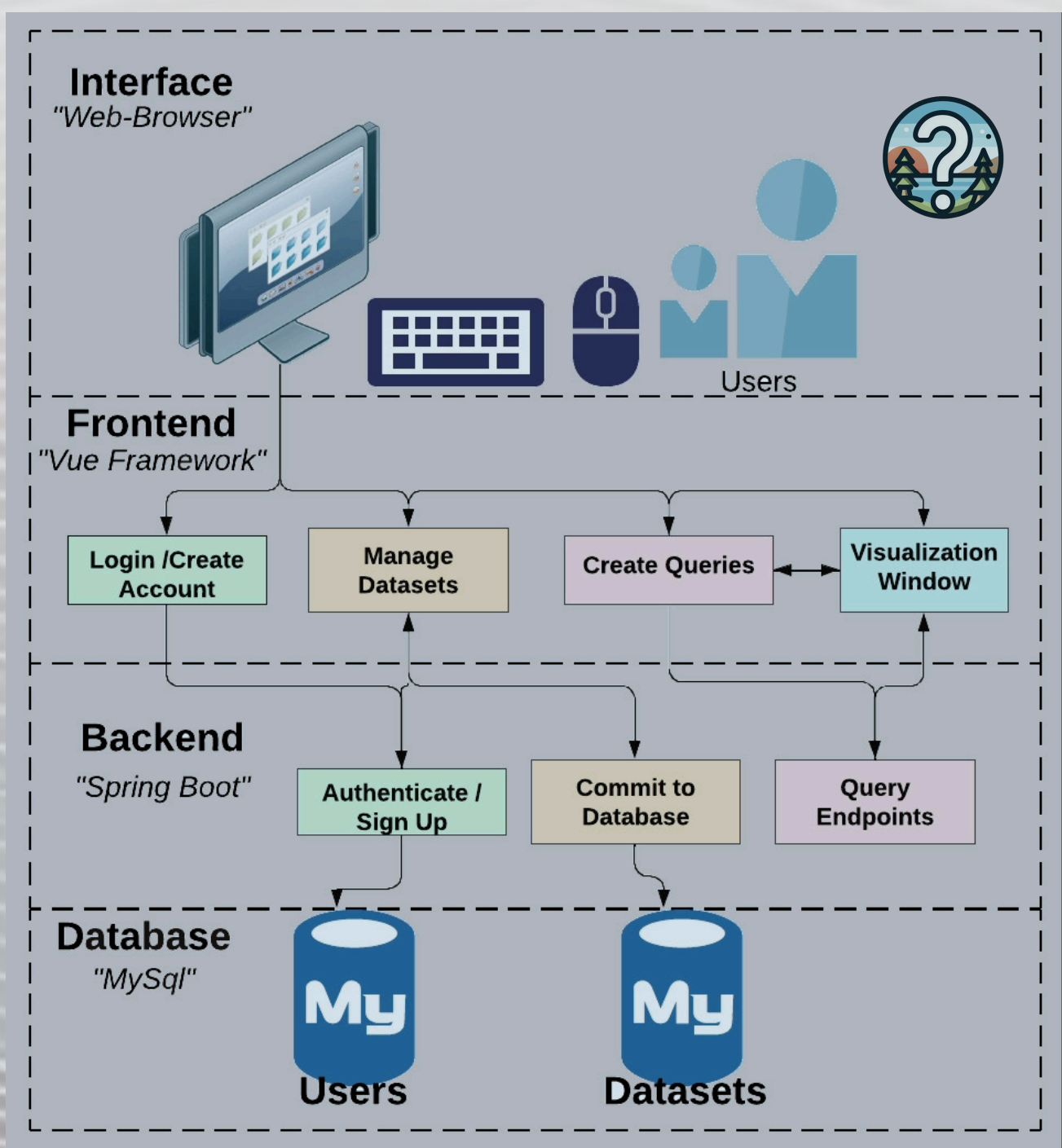
Web-Application - Client Server Model

A user can access the application from their web-browser by requesting server resources via a URL.

- Login/Authentication for limiting dataset accesss by user
- Allowing the user to upload a time stamped positional dataset.
- User credentials and uploaded dataset storage for access across user sessions.
- Interactive visualization window aiding in the creation of queries regarding object whereabouts.

Technical Details

- Vue Framework Frontend - Modular interface design
- Spring-Boot Backend - Java based server development
- MySQL Database - Persistent storage utility
- MapBox - Map library for in browser visualization



Implementation

Included Functionality

- Dataset Support - CSV formatted data files.
- Dataset Position Dimensionality - Two Dimensions
- Dataset Coordinate System - Latitude/Longitude
- Dataset Objects - Supports Multiple Moving Objects
- Supported Query Types - Contact & Range Queries

Image Description

Depicting a **contact query** visualization. Two objects possible whereabouts at a given time denoted by black shaded area. Having a non-zero probability of coming in **contact** at that time; denoted by overlapping of black regions.

