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Representing Transit Data in Mobile Applications

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Abstract/Intro/Motivation

Bus transit data is widely provided using the GTFS (General Transit Feed Specification) data format. However, the GTFS component structure does not allow for easy lookups between components, so the data needs to be reformatted into modified data structures in order to be efficiently used in a mobile application.

Background

The primary components of transit data are stops, routes, trips, and buses:

- Stop: a set location that buses will visit to pick passengers up
- Route: a set of stops that cover a certain region and traversed by multiple trips
- Trip: a planned bus journey that visits a subset of the stops in a route, with a set schedule for stop arrivals
- Bus: an item with a dynamic position that moves along a trip

These components work together to define a bus system.

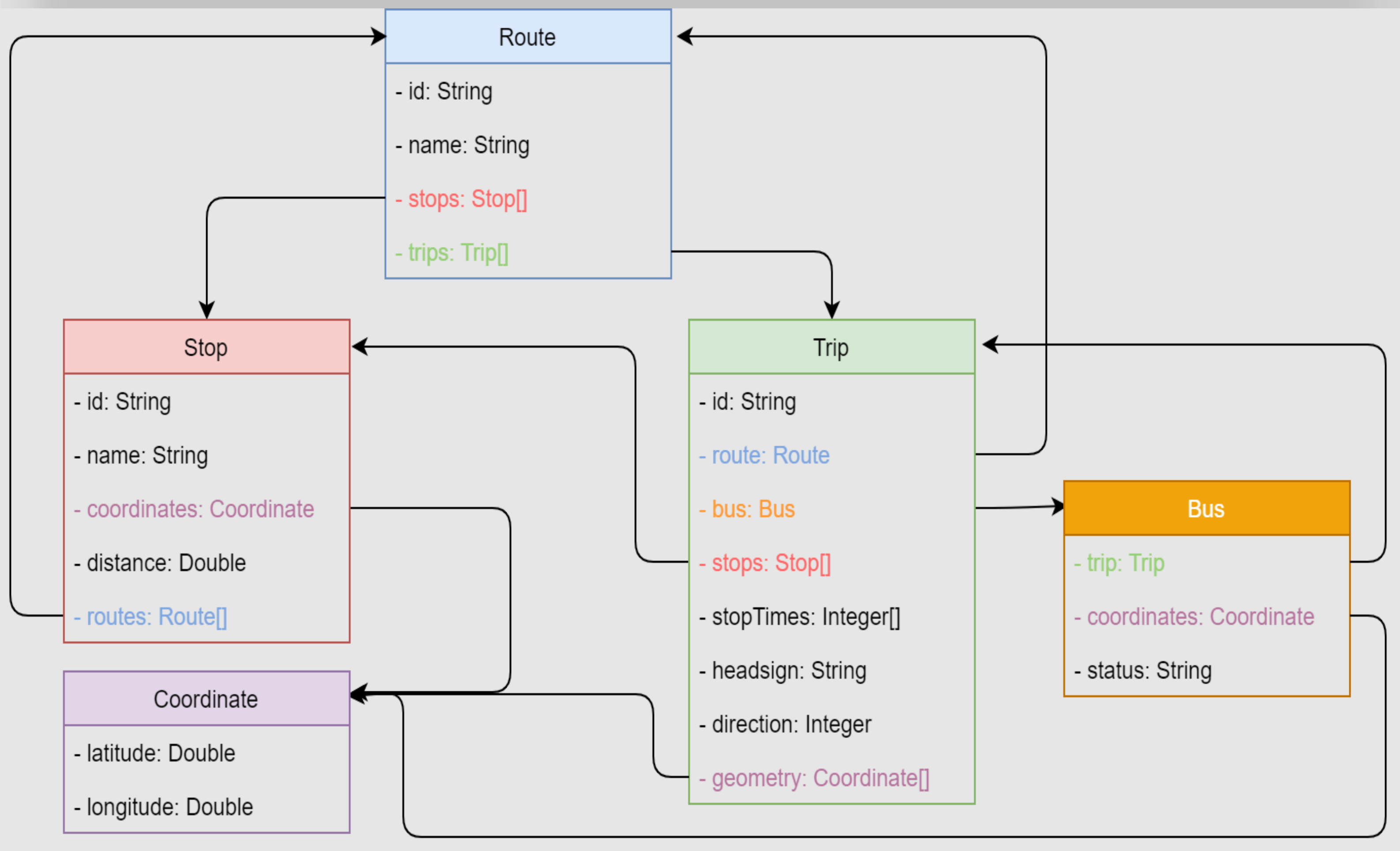
Objectives

This project aims to achieve the following goals:

- Restructure GTFS transit data according to the transit components
- Create algorithms to allow efficient lookups of specific components or data within components
- Create interactive application with user friendly interface to display bus data

Methods

The structural design of the components use object-oriented programming to define objects, which represent components by storing its properties. The objects are centered around the route object, which will hold references to lists of stop and trip objects inside the route. However, the stop and trip objects also hold reverse references back to their parent route. This will allow for a two-way flow of information, where given one component, an application is able to traverse the component map to find information about any other component.



Route
- id: String
- name: String
- stops: Stop[]
- trips: Trip[]

Stop
- id: String
- name: String
- coordinates: Coordinate
- distance: Double
- routes: Route[]

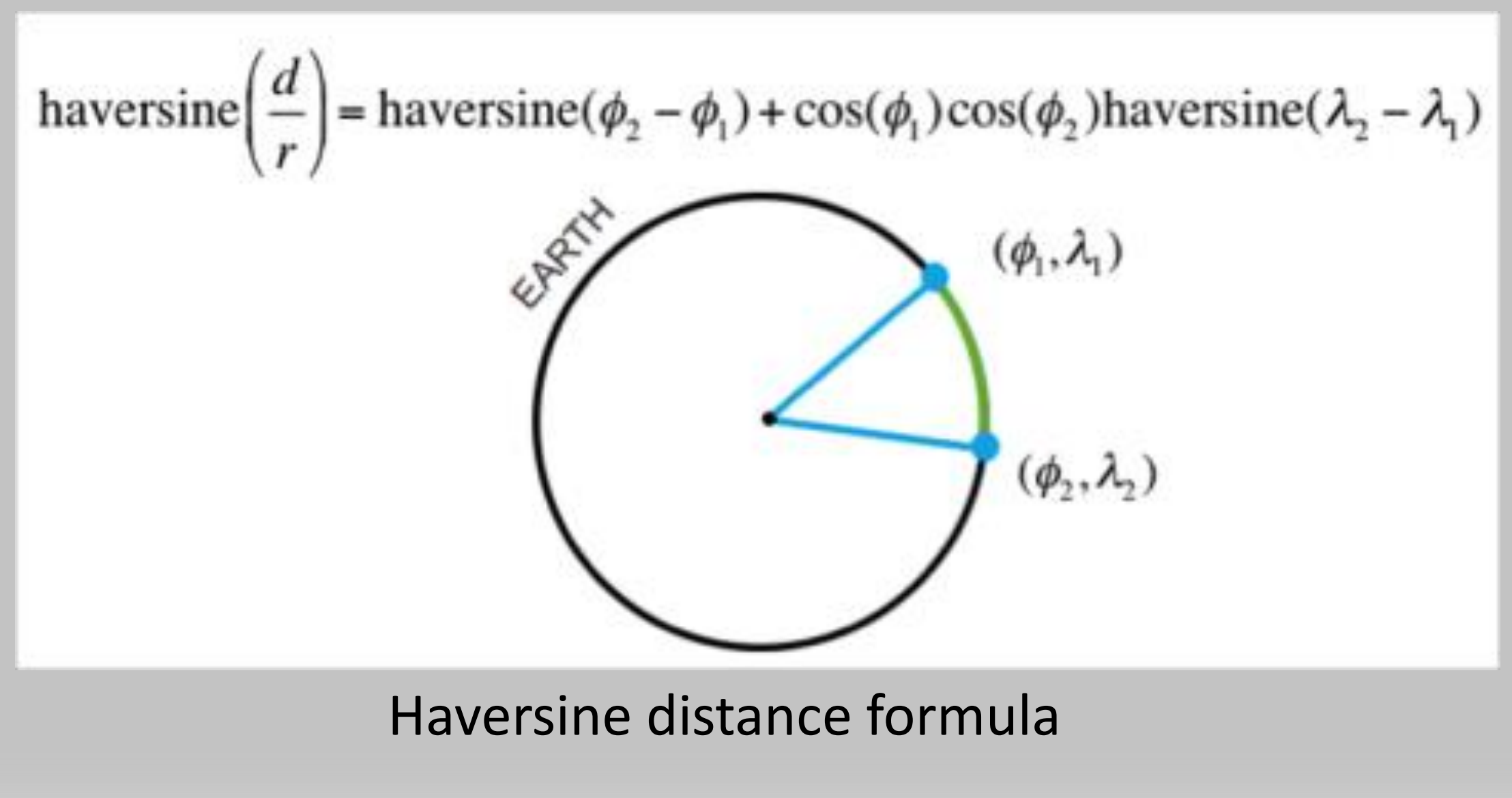
Trip
- id: String
- route: Route
- bus: Bus
- stops: Stop[]
- stopTimes: Integer[]
- headsign: String
- direction: Integer
- geometry: Coordinate[]

Bus
- trip: Trip
- coordinates: Coordinate
- status: String

Coordinate
- latitude: Double
- longitude: Double

Component map of the transit data objects

A device equipped with GPS was used to obtain location data used for lookup algorithms. Since positional data is represented using latitude-longitude, it is necessary to use the haversine formula for all distance calculations.



$$\text{haversine}\left(\frac{d}{r}\right) = \text{haversine}(\phi_2 - \phi_1) + \cos(\phi_1)\cos(\phi_2)\text{haversine}(\lambda_2 - \lambda_1)$$

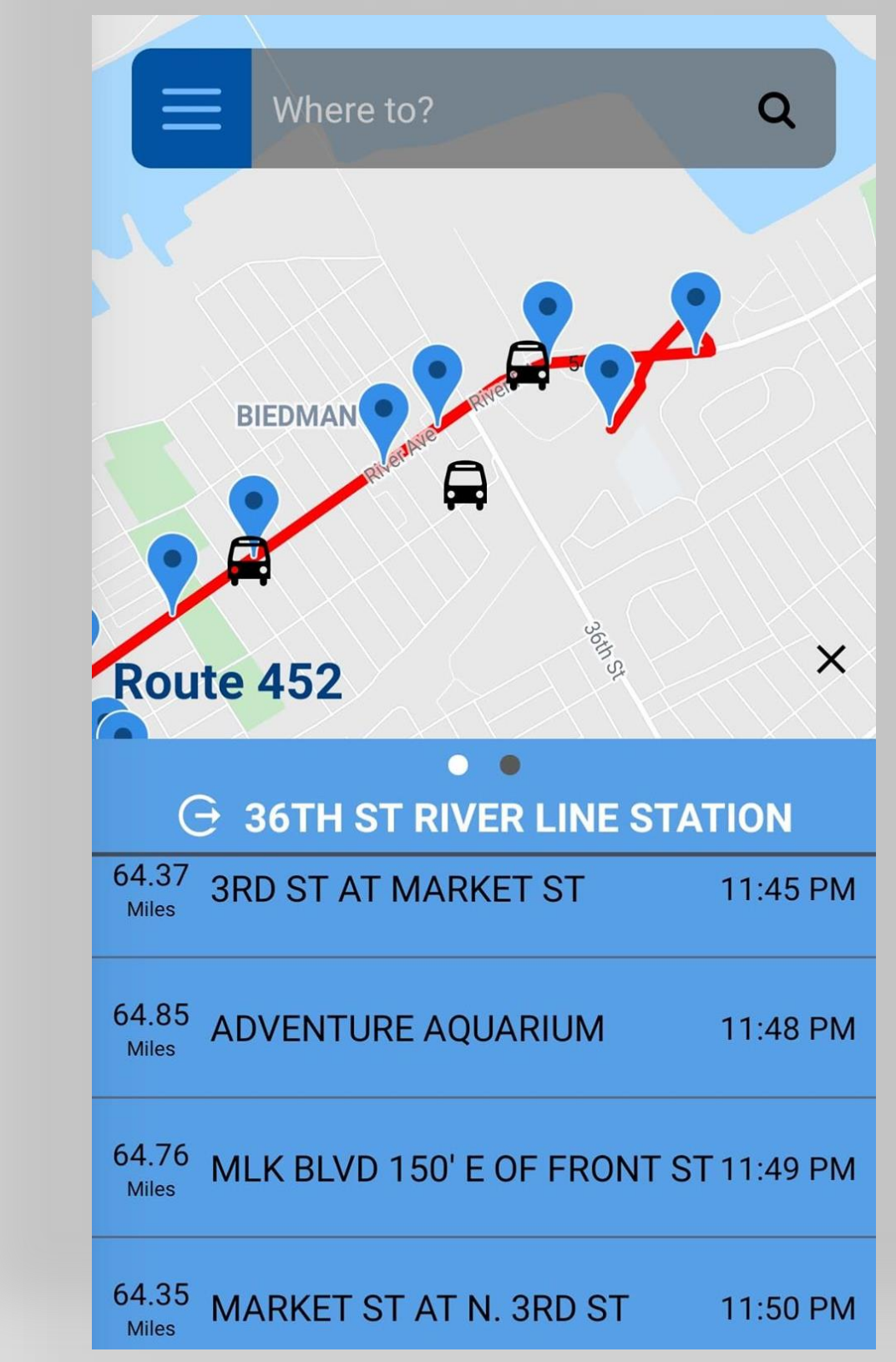
Haversine distance formula

Results/Discussion

Without restructuring raw GTFS data, there would be no way to search through the data to retrieve information. However, using the designed class structure, the following lookups are possible:

- Get next trip that will arrive at a given stop for a specific route
- Get schedule for a given active trip in a specific route
- Get schedule for a given stop in a specific route
- Find routes that operate nearby a given location

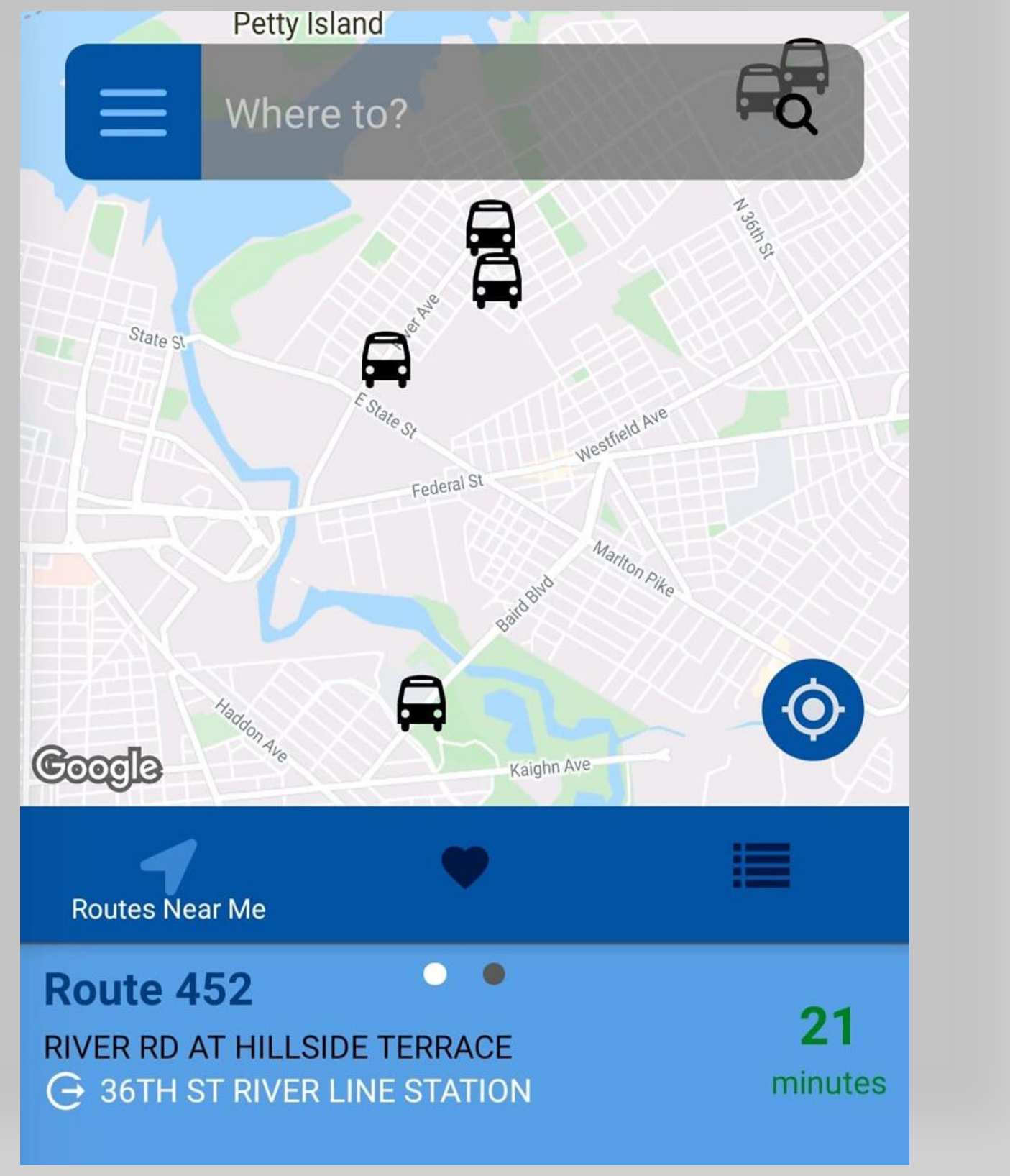
The final product of this project was a mobile application to provide users data about bus routes as well as a live feed of positional transit data. Processing the GTFS data to create an object-oriented structure enables the different functionalities that contribute to an interactive and informative transit application.



Route 452

36TH ST RIVER LINE STATION

64.37 Miles 3RD ST AT MARKET ST 11:45 PM
64.85 Miles ADVENTURE AQUARIUM 11:48 PM
64.76 Miles MLK BLVD 150' E OF FRONT ST 11:49 PM
64.35 Miles MARKET ST AT N. 3RD ST 11:50 PM



Route 452
RIVER RD AT HILLSIDE TERRACE
36TH ST RIVER LINE STATION
21 minutes

Future Directions

Although the data framework has been designed and established, some research must still be dedicated into creating an efficient loading procedure, as there is a lot of data to be requested by the application, which can hinder the user’s experience because nothing can be displayed until all the data is loaded. This application will hopefully eventually be adopted by a transit bus company to communicate bus information with their customers.