# Roads of the Sea

## Toward a Readily Available Maritime Route Suggestion and Prediction System

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## Introduction

- Maritime transport comprises 80% of world trade. However, maritime navigation is ambiguous by nature and currently relies on established routes.
- Several groups have attempted to build “roads of the sea”, mapping the most frequently traveled sea routes using historical data representing common maritime traffic.
- The Roads of The Sea project seeks to build an easily maintainable system using these routes to aid maritime vessels in planning safe and efficient routes.
- This system pulls data from a database storing a directed graph of routes, and suggests optimal routes between ports.

## Requirements

- The utilized graph should scale upwards in size with only minimal drops in performance.
- The API should take no more than a few seconds to return, with 99% uptime.
- Users can input a location of departure, a location of arrival, and information about the current vessel and receive the shortest safe route categorized by the systems internal routes
- The user can see calculated routes on an interactive map with an estimated travel distance.
- The user can input information about an unknown vessel to receive the likelihood it is a specific class of vessel.
- Users should be able to update, add, or delete parts of the route network
- Users should be able to query our system for raw route information
- The graph should scale upwards in size without significant drops in performance.
- Route suggestion and ship prediction should take no longer than a few seconds.
- API calls should take no more than a few seconds to return
- The API should be highly available, with 99% uptime

## Design and Implementation

- Our backend service utilizes AWS to create a serverless API. Calls sent to the API Gateway are handled by our Lambda, which queries an Aura Neo4j instance [Fig. 1]. The AWS infrastructure is fully managed as code in our repository.
- Though connected, the frontend is designed to be loosely coupled allowing for changes and improvements on the internal graph while permitting the backend to exist on its own.
- The front-end [Fig. 2] provides access to the system’s services, letting users view routes on an interactive map with estimated travel distances and request the shortest safest route between two locations for specific vessel types.
- The front-end application showcases the API in a practical use case. Users can select from a variety of ports to find suggested routes between them, using Aura’s built-in Dijkstra pathfinding algorithm.

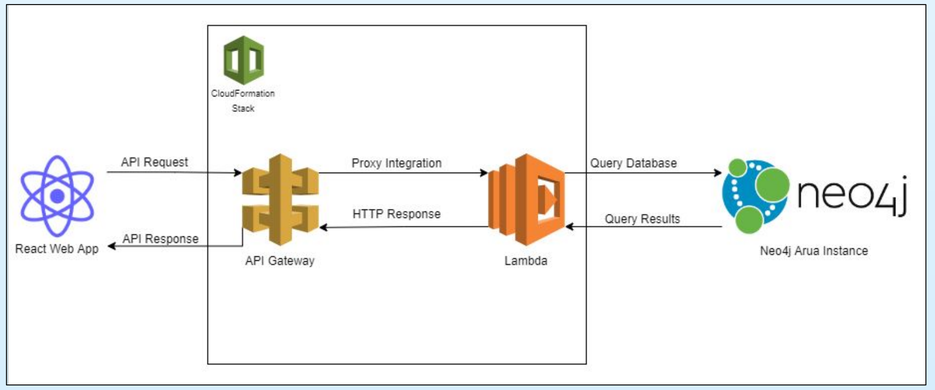


Fig. 1 - Infrastructure Overview


Fig. 2 - Front End UI

## Results and Next Steps

- Turnaround times under a second in most cases, allowing the API to support quick and efficient maritime decision making.
- The API is easily updatable, allowing for new services to be added easily atop existing infrastructure.
- The database currently scales to, at minimum, 7000 nodes and 14000 relationships with no noticeable drops in performance.
- For future additions to the project, it should be noted that we initially tried using EC2 to host our Neo4j database. However, the free t2.micro instance was not able to sustain prototyping. In a production environment, it would be worth analyzing the cost difference of running the database on a more capable EC2 instance. Additionally, this could provide security benefits and a more configurable database versus the enterprise Aura options.
- A future authentication system would add more security to the system by requiring users to have the proper permissions to add and remove data from the graph.
- The system’s maintainability also allows for future groups to add new services, like a suggested prediction system allowing users to see where a ship may be heading given historical data on past vessels of its type around its current location.

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