

# Multi-Modal Cross-Border Route Selector

Presented by: Team Fusion Flow

START

Date: February 2025

# Problem Statement

A small logistics provider needs a fast solution to identify the optimal shipping route for cross-border cargo, using air, sea, land, or their combinations.

Develop a tool that processes shipment details and suggests the best routes based on cost, transit time, and feasibility.

NEXT

## Fusion Flow

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# Our Objectives

- **Gather** clean transport data.
- **Optimizes cross-border routes.**
- Balances **preferences** on **cost, time, emissions, and logistics** scores.
- Based on user requirements and set parameters.
- Provide a user-friendly interface mapping the optimal routes.

**User Inputs :**  
Start and end location.

**Max delivery days**

**efficiency  
sustainability  
optimized cost**

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# Data Collection

A surprisingly hard task!

**Web scraping through,  
Selenium and bs4**

The screenshot shows the SEA-DISTANCES.ORG website. At the top, there's a navigation bar with links for "SEA-DISTANCES.ORG", "Ports Distances", "Voyage Calculator", "Advertise", and "Contact us". Below the navigation is a world map with orange anchor icons indicating major ports. A specific route is highlighted between Germany (Hamburg) and China (Shanghai). On the left, there's a "Port of Departure" section with dropdown menus for "Country" (Germany) and "Port" (Hamburg), and a "Vessel speed, knots:" input field set to 10. On the right, there's a "Port of Arrival" section with a "Country" dropdown (China) and a "Port" dropdown (Shanghai). In the center, under the heading "Result", there are two sections: "Way #1" which shows a distance of 10778 nautical miles via the Suez Canal at 10 knots over 44 days 22 hours; and "Way #2" which shows a distance of 13664 nautical miles via the Panama Canal at 10 knots over 44 days 22 hours. A "Calculate" button is located at the bottom of the form.

N E X T

**Seaports:**  
**71 major seaports**

major trade and transport  
hubs based on GDP

**Airports**  
**105 major airports**

**Sea Routes:**  
Scraped 1932 sea route's  
data from sea-distances.org,

**Trade Relations:**  
Customs score , port dwell  
time , port turnaround time  
WTO

**Real World Shipping Costs:**  
Scrapped Freightos, to get  
Real time shipping cost per  
40ft container through their  
FBX Index.

**Air Routes:**  
Scraped 10920 air route data  
from travelmath.com

**Logistics Score:**  
Import and export tariffs.  
worldbank.org

**Road Routing:**  
Using haversine distance  
calculation and Google MAPS  
API



## FREIGHTOS TERMINAL - FBX

[VIEW PRICING](#)

USD ▾

Frequency

Weekly ▾

Multiple Selection



FBX

Global Container Freight Index

\$2,422 -11% ↘

PACIFIC

FBX01

China/East Asia - North America West Coast

\$2,659 -25% ↘

FBX02

North America West Coast - China/East Asia

\$403 -14% ↘

FBX03

China/East Asia - North America East Coast

\$3,754 -16% ↘

FBX04

North America East Coast - China/East Asia

\$466 +6% ↑

CURRENT FBX

\$ 2,422.4 -11% ↘

VOLATILITY

FBX

FREIGHTOS BALTIC INDEX - GLOBAL

ADD INDEX-LINKED PRICE

Chart Type

Line ▾

3M

1Y

2Y

3Y

All

From

\$11,000

\$6,940

\$3,940

\$940

11-MAR-22

14-OCT-22

19-MAY-23

22-DEC-23

NEXT

# Data Pre-Processing

The screenshot shows a code editor interface with a dark theme. The left sidebar contains a tree view of a project structure under 'FUSIONFLOW\_LOGI...'. The 'src' folder is selected. Inside 'src', there are files like 'graph\_to\_json.py', 'main.py', and 'CSVLint'. The main editor area displays a CSV file named 'flights.csv' with the following header and data:

	From_IATA	To_IATA	Flight_Time_Minutes	Distance_km	From_Country	From_Latitude	From_Longitude	To_Country	...
1	CAI,ORD	768	9895.83166	Egypt,30.1140504,31.424546074834208	United States,41.9782523,-87.90923552598412	5.			
8847	CAI,JFK	704	9034.83476	Egypt,30.1140504,31.424546074834208	United States,40.6429479,-73.7793733748521	5.			
8848	CAI,DFW	863	11175.25696	Egypt,30.1140504,31.424546074834208	United States,32.89651945,-97.0465220537124				
8849	CAI,ATL	795	10256.32382	Egypt,30.1140504,31.424546074834208	United States,33.63740085,-84.4298160652235				
8850	CAI,CVG	768	9894.22232	Egypt,30.1140504,31.424546074834208	United States,39.049906449999995,-84.66515749				
8851	CAI,IND	772	9955.37724	Egypt,30.1140504,31.424546074834208	United States,39.7162533,-86.29508388539975				
8852	CAI,ONT	939	12193.96918	Egypt,30.1140504,31.424546074834208	United States,34.0555978,-117.60137102196371				
8853	CAI,SEA	852	11020.76032	Egypt,30.1140504,31.424546074834208	United States,47.4475673,-122.3080158569515				
8854	CAI,IAH	872	11294.34812	Egypt,30.1140504,31.424546074834208	United States,29.9841416,-95.33298595614492				
8855	CAI,SFO	927	12026.59782	Egypt,30.1140504,31.424546074834208	United States,37.622452,-122.38398938548364				
8856	CAI,PHX	724	11991.19234	Egypt,30.1140504,31.424546074834208	United States,33.43284865,-112.0067914565789				
8857	CAI,DEN	853	11032.0257	Egypt,30.1140504,31.424546074834208	United States,39.8606676,-104.68536732610298				
8858	CAI,MSP	775	9990.78272	Egypt,30.1140504,31.424546074834208	United States,44.878019050000006,-93.22092805				
8859	CAI,YYZ	720	9247.26764	Egypt,30.1140504,31.424546074834208	Canada,43.678223599999995,-79.6288046740774				
8860	CAI,YVR	240	10000.32000	Egypt,30.1140504,31.424546074834208	Canada,49.1942692,-123.1783427,6.41109557120				
8861	CAI,YUL	Col 3: Flight_Time_Minutes	1140504	31.424546074834208	Canada,45.4687293,-73.74249704278634,5.161539				
8862	CAI,MEX	954	12388.69932	Egypt,30.1140504,31.424546074834208	Mexico,19.4358083,-99.07128910453795,7.30933				
8863	CAI,GDL	970	12605.96022	Egypt,30.1140504,31.424546074834208	Mexico,20.528865,-103.3136855407796,7.437516				
8864	CAI,YEG	788	10162.9821	Egypt,30.1140504,31.424546074834208	Canada,53.309692600000005,-113.58588330342718				
8865	CAI,YYC	805	10389.89904	Egypt,30.1140504,31.424546074834208	Canada,51.1222604,-114.01354103011823,6.1300				
8866	CAI,FRA	248	2922.56144	Egypt,30.1140504,31.424546074834208	Germany,50.02441255,8.555200257325986,1.72431				
8867	CAI,CDG	270	3212.24264	Egypt,30.1140504,31.424546074834208	France,49.0068908,2.5710819691019156,1.895225				
8868	CAI,AMS	275	3289.49096	Egypt,30.1140504,31.424546074834208	Netherlands,52.32698005,4.74150530038293,1.94				
8869	CAI,LHR	294	3535.71998	Egypt,30.1140504,31.424546074834208	United Kingdom,51.46773895,-0.458780074157118				
8870	CAI,LEJ	242	2846.92246	Egypt,30.1140504,31.424546074834208	Germany,51.4211981,12.229585904866344,1.67968				
8871	CAI,CGN	258	3059.35534	Egypt,30.1140504,31.424546074834208	Germany,50.86778175,7.138960985502128,1.80501				
8872	CAI,BRU	269	3210.6333	Egypt,30.1140504,31.424546074834208	Belgium,50.90089985,4.480964889793517,1.894273				
8873	CAI,LUX	256	3027.16854	Egypt,30.1140504,31.424546074834208	Luxembourg,49.62639055,6.20944584614825,1.78				
8874	CAI,MUC	226	2623.2242	Egypt,30.1140504,31.424546074834208	Germany,48.35396249999994,11.778592469106236				
8875	CAI,MXP	225	2618.39618	Egypt,30.1140504,31.424546074834208	Italy,45.6296273,8.723547468967393,1.54485374				
8876	CAI,MAD	280	3357.08324	Egypt,30.1140504,31.424546074834208	Spain,40.4952269,-3.573373302702902,1.9806791				
8877	CAI,BCN	247	2909.68672	Egypt,30.1140504,31.424546074834208	Spain,41.29694395,2.0790473629813215,1.716715				
8878	CAI,FCO	190	2151.68758	Egypt,30.1140504,31.424546074834208	Italy,41.81539105,12.22648477049777,1.2694956				
8879	CAI,ZRH	235	2745.53404	Egypt,30.1140504,31.424546074834208	Switzerland,47.463388050000006,8.553366081422				
8880	CAI,CPH	268	3196.14924	Egypt,30.1140504,31.424546074834208	Denmark,55.6091282,12.650982248393536,1.88572				
8881									

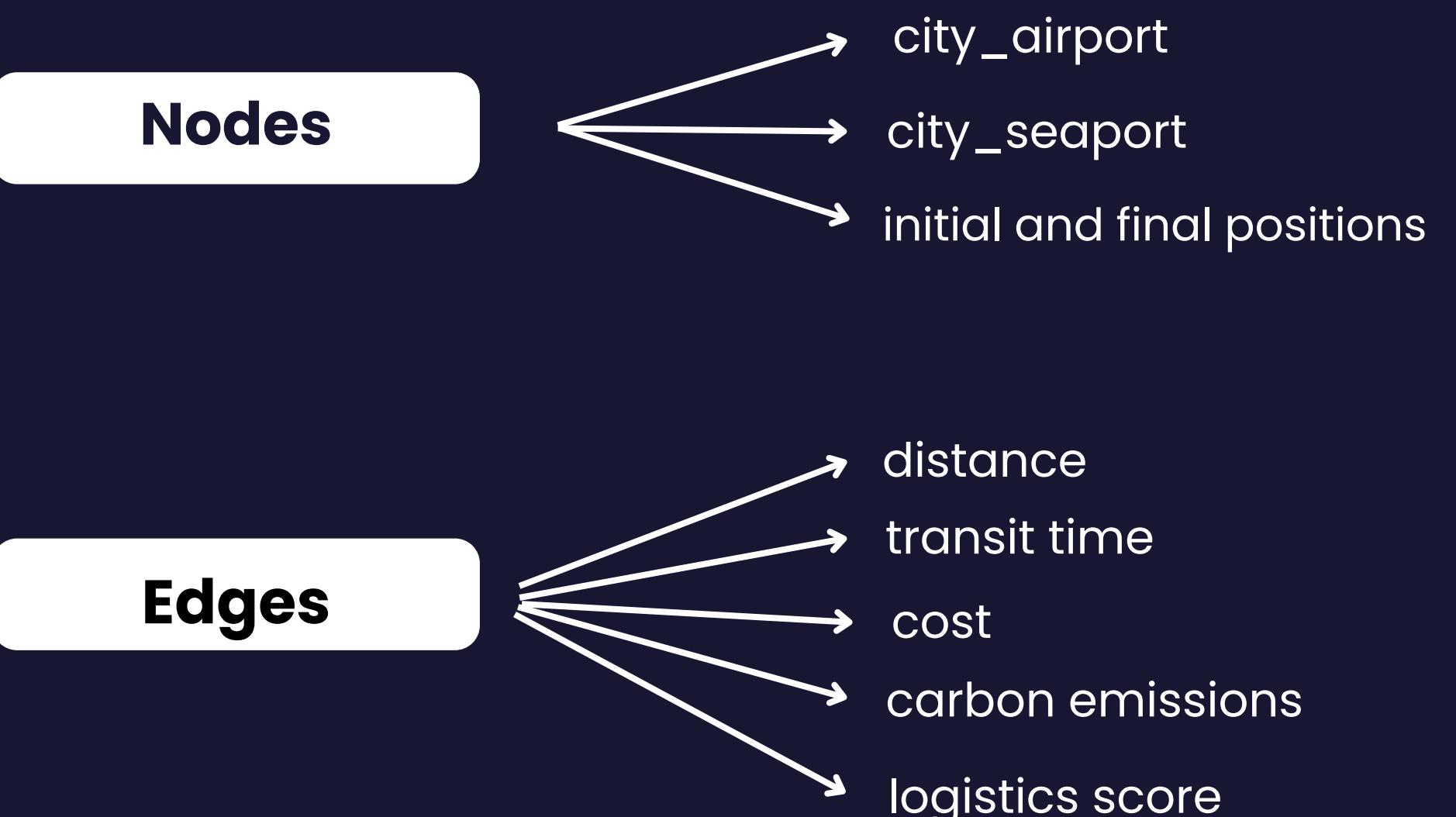
**cleaning and removing  
duplicates**

**standard location names**

**calculating carbon emissions**

**dynamic real world data set**

# Modelling with graphs

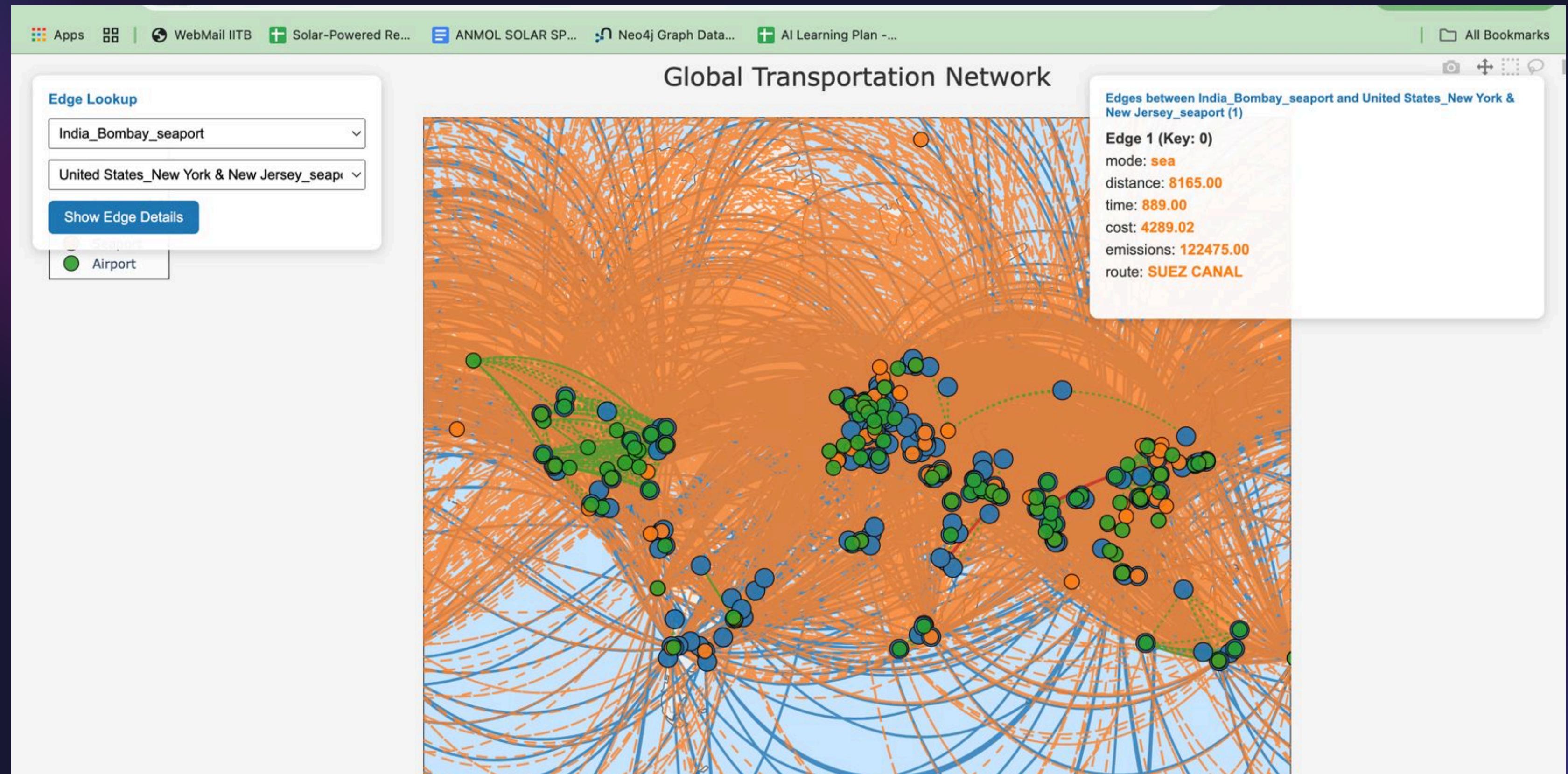


**Fully Connected Network:**  
interlinks seaports,  
airports, and even road  
segments within countries

**Dataset for no trade  
restrictions between  
neighboring countries,  
extend the network to include  
their ports and airports.**

**NetworkX :**  
graph building in python

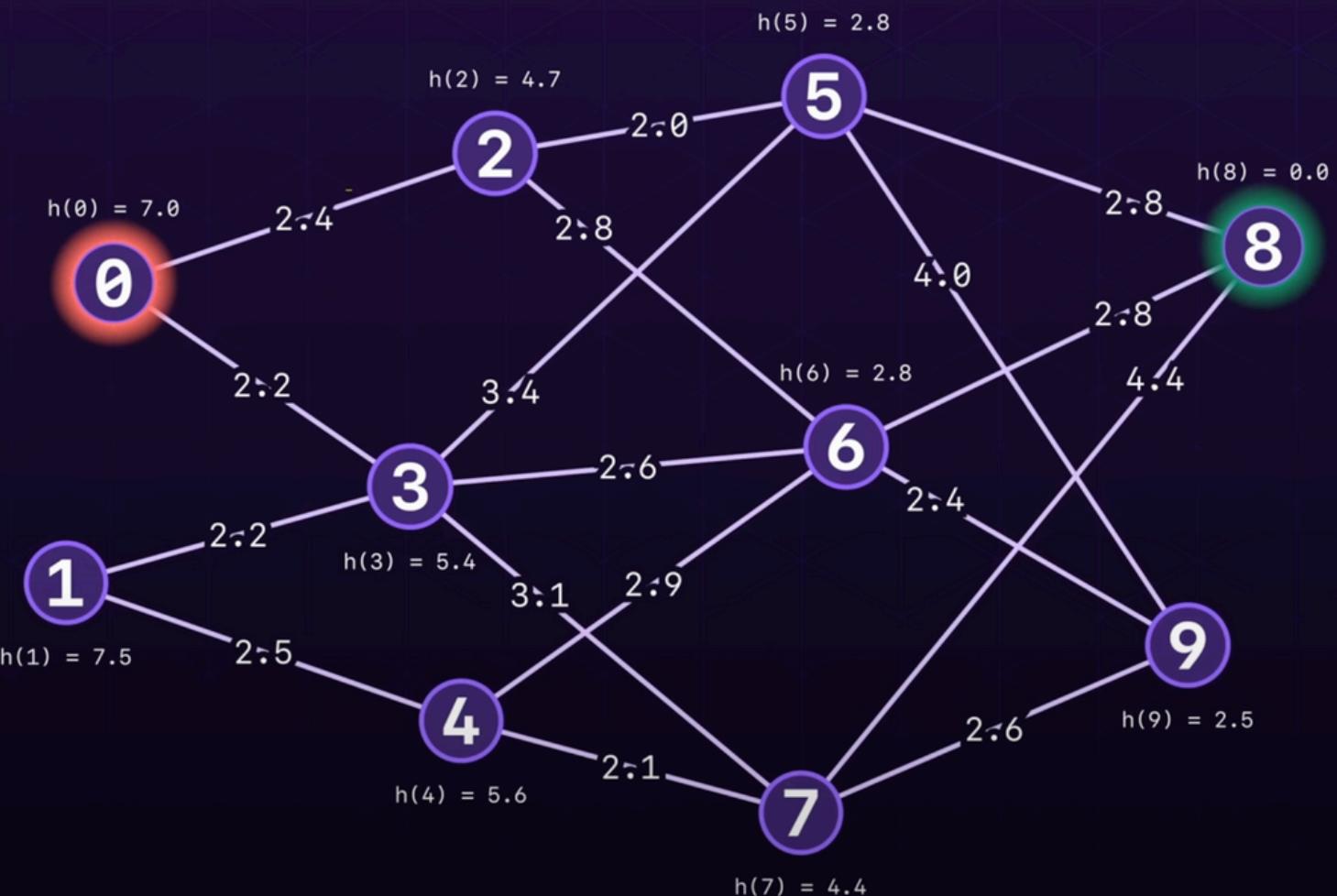
# Graph Visualization



# Multi-objective A\* Search Algorithm

$g(n)$  = cost from start to node n

$h(n)$  = estimate from node n to goal



$$f^*(n) = g^*(n) + h(n)$$

$f^*(n)$  = f score

$g^*(n)$  = weighted sum of cost, time, emissions and logistics score

$h(n)$  = heuristic function which computes haversine distance between current node and goal.

single weighted A\* search

**balances multiple goals  
(cost, time, emissions) based  
on user-defined weights.**

**uses a heuristic search for fast  
and efficient pathfinding.**

**searches the graph, node by  
node, over various routes,  
applicable to real world  
optimization.**

**computationally efficient for  
even large network graphs**

# User Interface

 **Fusion Flow**

Home About Contact Login Sign Up

### Shipment Details

Weight (kg)

Fragile  Perishable

### Route Points

Start Position

Sops

End Position

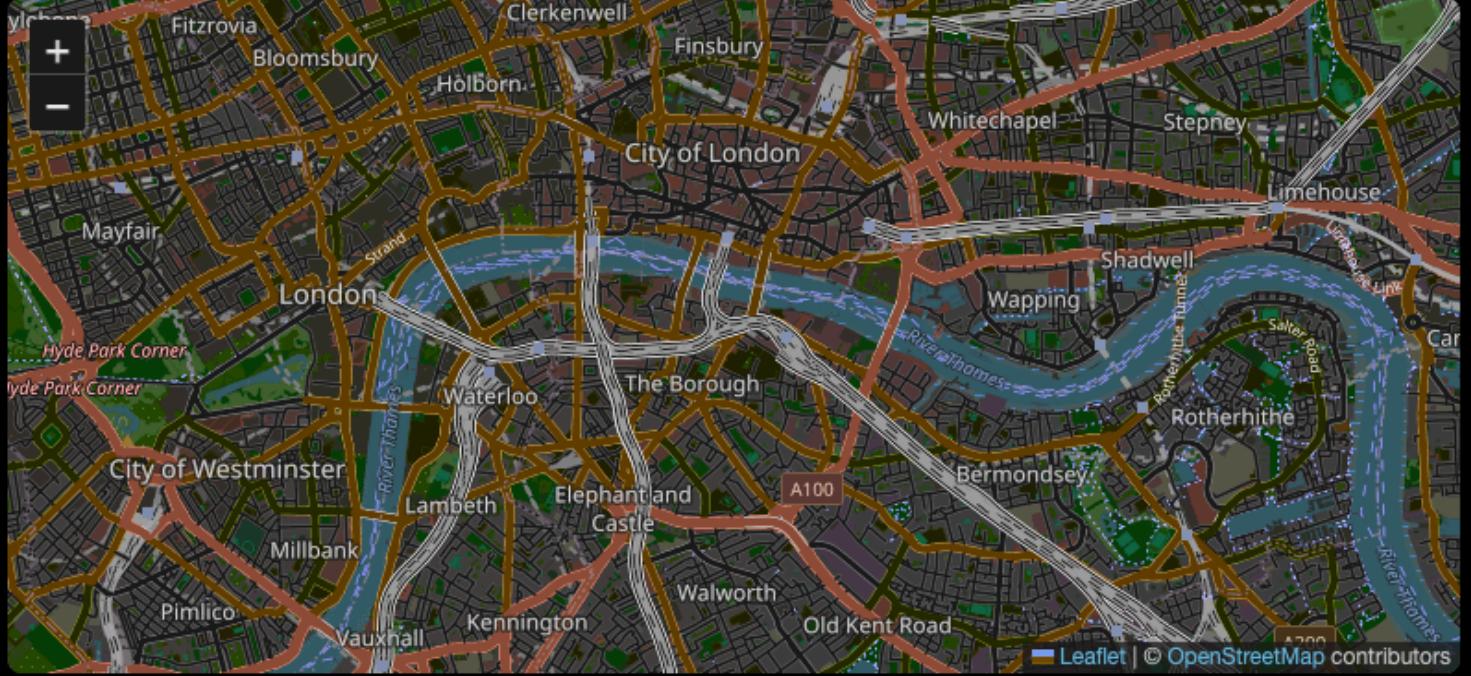
### Time Considerations

Start Date  End Date

### Priority Preferences

- Cost-Efficient
- Time-Efficient
- Balanced

**Find Optimal Routes**



A detailed map of central London, showing the River Thames flowing through the city. Numerous red lines represent different shipping routes, connecting various districts like Fitzrovia, Bloomsbury, Clerkenwell, Finsbury, Holborn, City of London, Whitechapel, Stepney, Limehouse, Shadwell, Wapping, Bermondsey, Rotherhithe, Elephant and Castle, Walworth, Old Kent Road, Vauxhall, Kennington, Millbank, Lambeth, Waterloo, The Borough, and the City of Westminster. The map also shows major roads like the A100 and the London Underground network.

**Route 1** Cost: \$1,234 Time: 5 days

Risk Analysis: Moderate delay risk at border crossing

Carbon Footprint:

**Route 2** Cost: \$1,234 Time: 5 days

Risk Analysis: Moderate delay risk at border crossing

Carbon Footprint:

**Route 3** Cost: \$1,234 Time: 5 days

**Shipment Details**

Initial Position

Berlin

Latitude: 52.5200065999999  
Longitude: 13.404954  
Country: Germany

Final Position

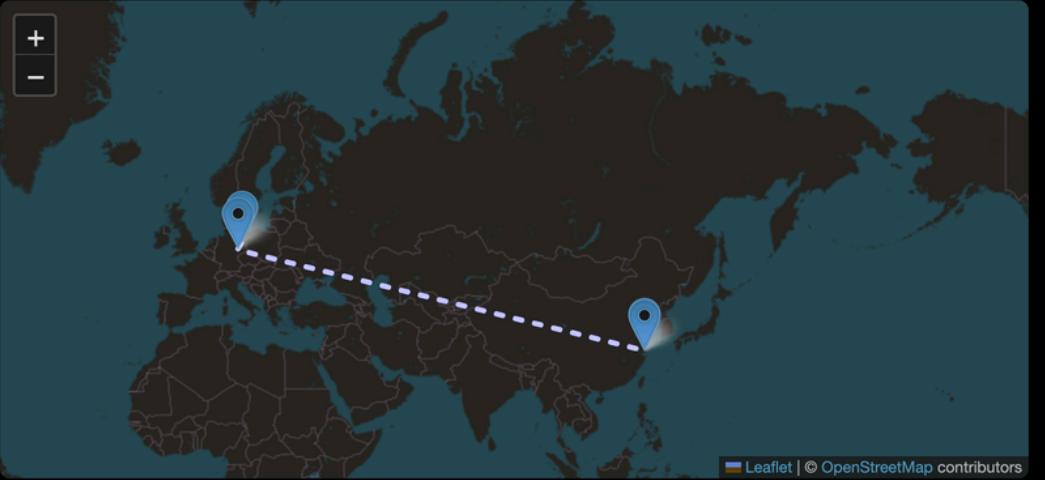
Shanghai

Latitude: 31.230416  
Longitude: 121.473701  
Country: China

Max Days (Optional)  
50

Preferred Optimization

- Time
- Cost
- Emissions
- Logistics Score
- Custom Weights



Leaflet | © OpenStreetMap contributors

**Route 1** Air Cost: \$1,162.14 Time: 0.59 days

Route: Berlin → Germany\_Schkeuditz\_Airport → China\_Shanghai\_Airport → Shanghai

Carbon Footprint: 546.58 kg CO<sub>2</sub>

Cost Breakdown:

**snapshot of the user interface**

**has weight and volume constraints**

**eco-friendly routing options**

**provides you optimized route for perishable goods also**

**Calls Google Maps API to get Coordinates of start & end**

**Route 1** Sea Cost: \$916.62 Time: 47.55 days

Route: IIT Bombay → India\_Bombay\_Seaport → Canada\_Vancouver\_Seaport → Stanford University

Carbon Footprint: 15.55 kg CO<sub>2</sub>

Cost Breakdown:

Canada_Vancouver_Seaport -> Custom_37.42766_-122.17006_End	\$514.97
Custom_19.1330605_72.9151061_Start -> India_Bombay_Seaport	\$2.91
India_Bombay_Seaport -> Canada_Vancouver_Seaport	\$398.74

Time Breakdown:

Canada_Vancouver_Seaport -> Custom_37.42766_-122.17006_End	0.92 days
Custom_19.1330605_72.9151061_Start -> India_Bombay_Seaport	0.01 days
India_Bombay_Seaport -> Canada_Vancouver_Seaport	46.62 days

**fig: ranked routes with detailed metrics**

## Route 1



Cost: \$351.23  
Time: 37.45 days

**Route: IIT Bombay → India\_Bombay\_Seaport → Germany\_Bremerhaven\_Seaport → Berlin**

Carbon Footprint: 4.2 kg CO<sub>2</sub>



## Route 2



Cost: \$375.13  
Time: 35.03 days

**Route: IIT Bombay → India\_Bombay\_Seaport → Poland\_Gdansk\_Seaport → Berlin**

Carbon Footprint: 4.48 kg CO<sub>2</sub>



## Route 3



Cost: \$384.08  
Time: 0.46 days

**Route: IIT Bombay → India\_Bombay\_Airport → Germany\_Schkeuditz\_Airport → Berlin**

Carbon Footprint: 140.52 kg CO<sub>2</sub>



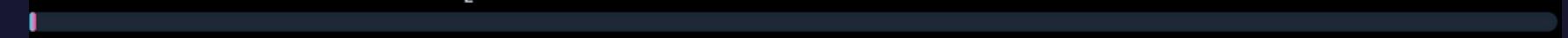
## Route 6



Cost: \$465.2  
Time: 31.82 days

**Route: IIT Bombay → India\_Bombay\_Seaport → Belgium\_Antwerp\_Seaport → Berlin**

Carbon Footprint: 4.11 kg CO<sub>2</sub>



## Route 5



Cost: \$456.19  
Time: 31.76 days

**Route: IIT Bombay → India\_Bombay\_Seaport → Netherlands\_Rotterdam\_Seaport → Berlin**

Carbon Footprint: 4.11 kg CO<sub>2</sub>



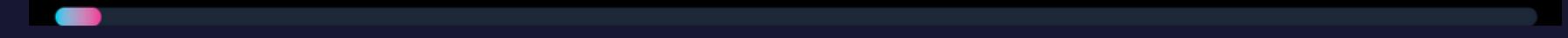
## Route 4



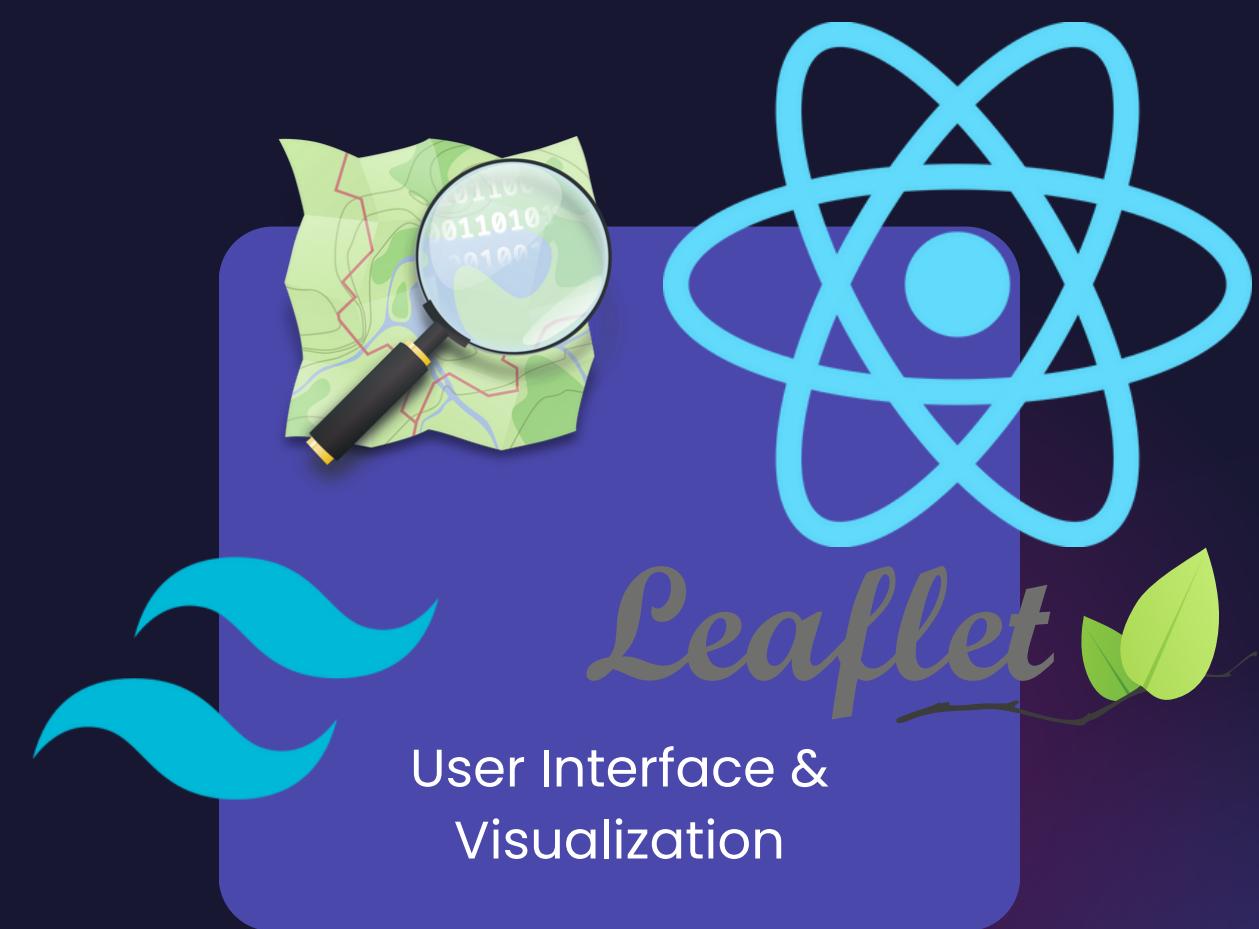
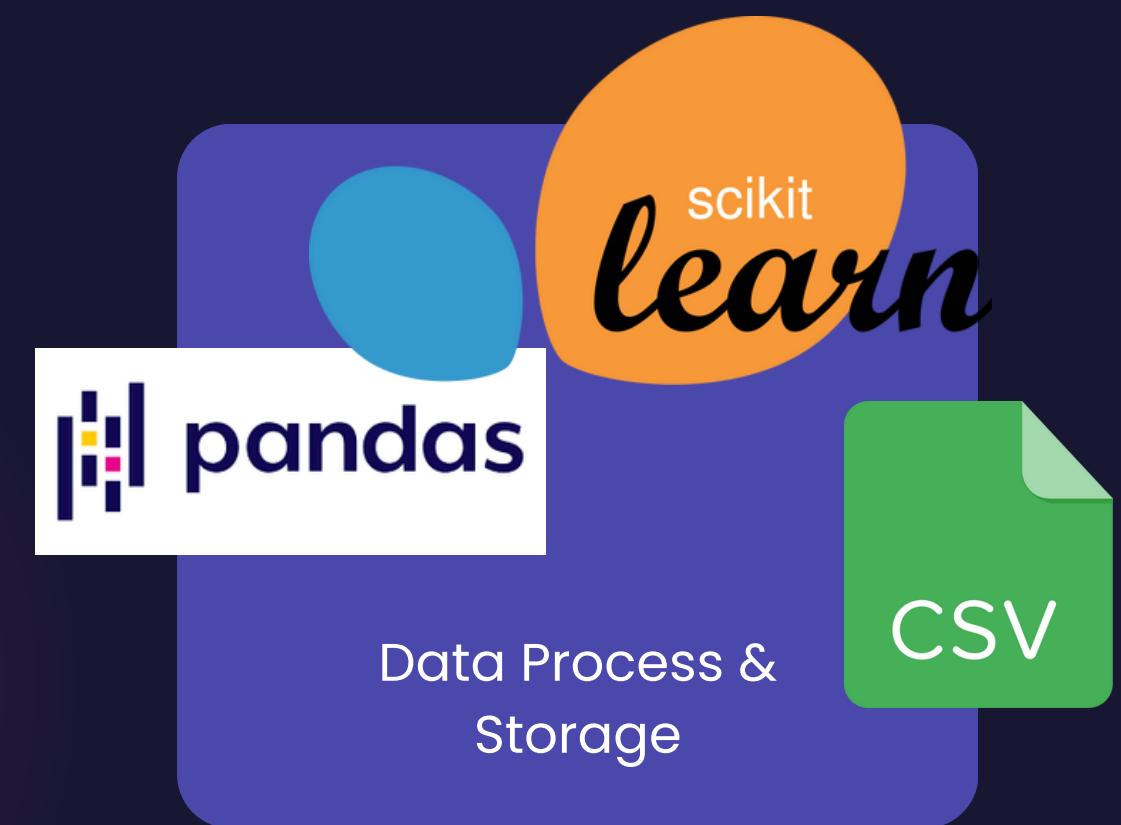
Cost: \$435.26  
Time: 37.32 days

**Route: IIT Bombay → India\_Bombay\_Seaport → Germany\_Bremerhaven\_Seaport → Germany\_Schkeuditz\_Airport → Berlin**

Carbon Footprint: 31.01 kg CO<sub>2</sub>



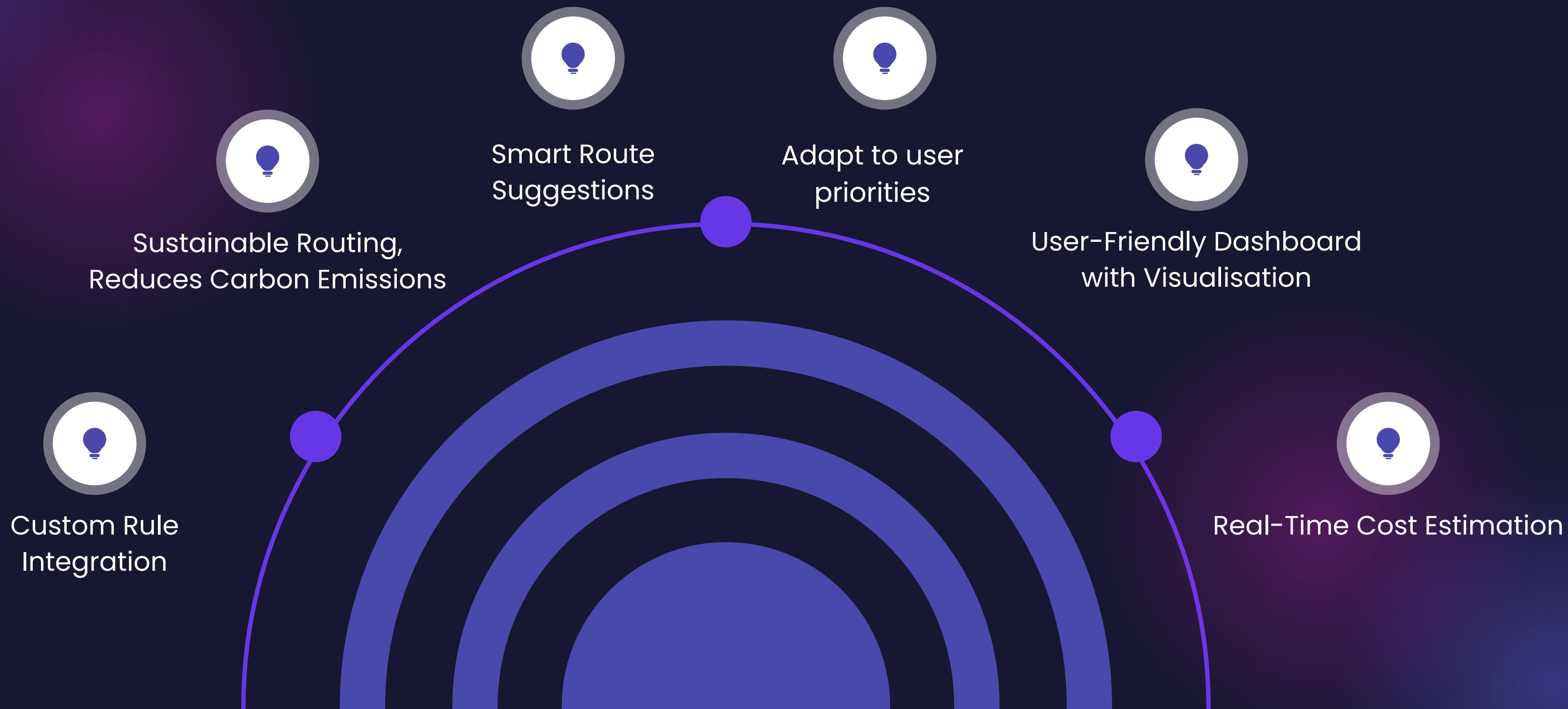
# Tech-stack



N E X T

The features of this project include the following...

# Features



# LogiTHON

# Thank You!

by Fusion Flow



IEOR, IIT BOMBAY