Northwest Passage Project

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Problem Statement:

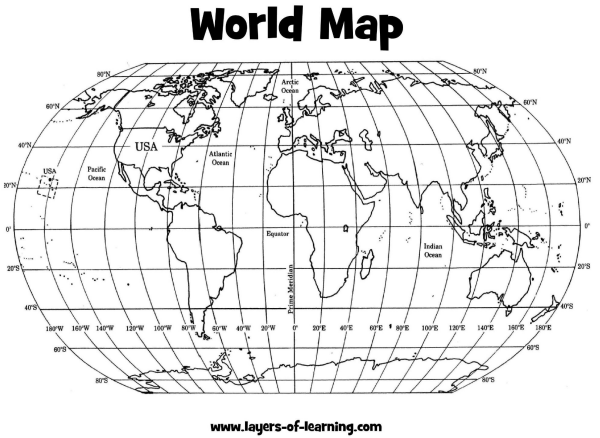
- Use a weighted Dijkstra's algorithm in order to find the most efficient path of travel for ships in the Northwest Passage
  - Bering Strait to Baffin Bay
  - Polar Class of ships and environmental conditions were taken into account
- Archipelago makes it hard to navigate

Data and Imported Modules

- Imported Modules
  - Numpy
  - Netcdf4
  - Emcpy
  - Networkx
- DS (dataset for datafile used)
  - Icedata
  - Latitude, longitude

Algorithm used

- There are 14.7 million rtofs points in each dataset
  - Many of the points are corrected at first, to fit the (-180, 180) range of longitude values
  - All of the rtof points are added to a numpy nodemap
- A for loop goes through all of the points in the nodemap
  - All surrounding points to each point get assigned an edge cost
  - In the chance that there is not a diagonal node in surrounding, other is checked and node edge is added
    - Accommodates for the archipelago seam



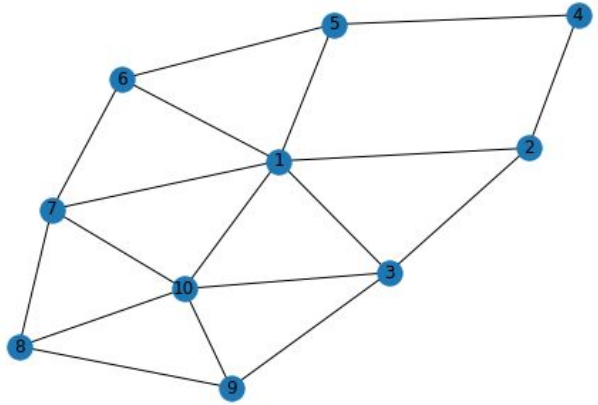
Edge Weight Function

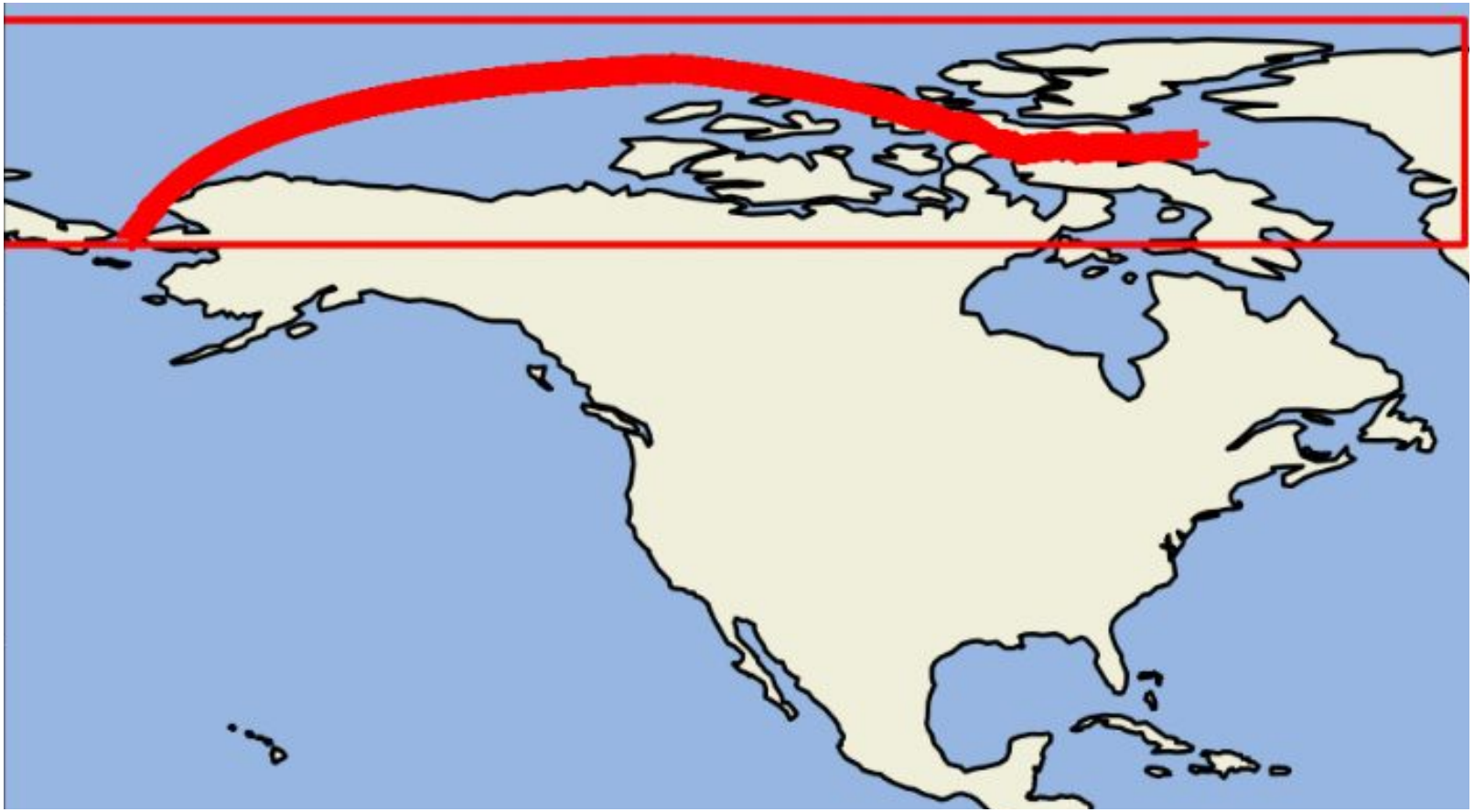
- The program first asks for the Polar Class of the user's ship (1-7)
  - The polar class of the ship determines how thick the ice can be for the ship to traverse
- The Polar Classes are put into 3 groups: (1-4), (5-6), and 7
  - 1-4 can handle every level of thickness, but will have a higher cost associated with thicker ice
  - 5-6 can handle up to 120 cm of ice
  - 7 can handle up to 70 cm of ice
- Edge weight = distance between 2 nodes + x * (ice concentration * 10)
  - X represents either 2, 4, or 6 based off of how thick the ice is for the polar class

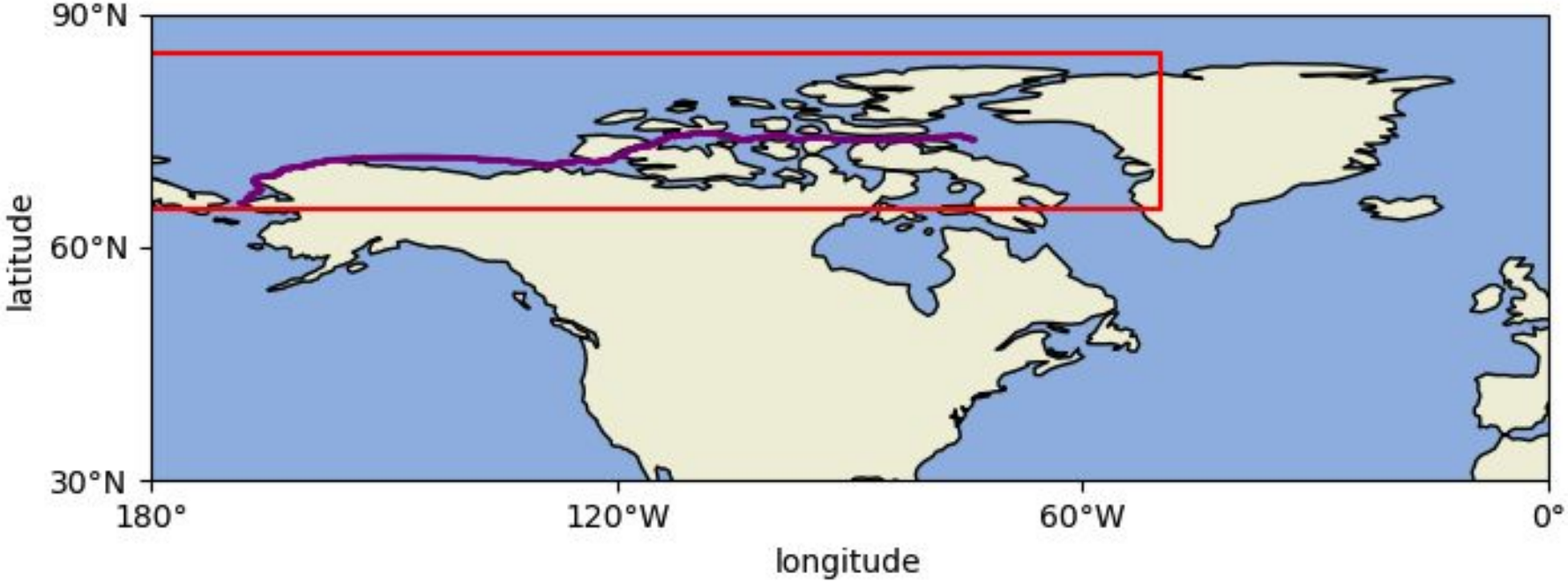
Polar Class (PC)	Ice Description
PC 1	Year-round operation in all polar waters
PC 2	Year-round operation in moderate multi-year ice (>120 cm) conditions
PC 3	Year-round operation in second-year ice (>120 cm), which may include multi-year ice inclusions
PC 4	Year-round operation in thick first-year ice (>120 cm), which may include old ice inclusions
PC 5	Year-round operation in medium first-year ice (70–120 cm), which may include old ice inclusions
PC 6	Summer/autumn operation in medium first-year ice (70–120 cm), which may include old ice inclusions
PC 7	Summer/autumn operation in thin first-year ice (30–70 cm), which may include old ice inclusions

Dijkstra's Algorithm Implementation

- Networkx was used to implement Dijkstra's algorithm
  - G.add_edge, G.add_node, G.dijkstra_path
- Based off all the given weights of node edges -> shortest path from Bering Strait to Baffin Bay
  - Typical distance will be >4000 km

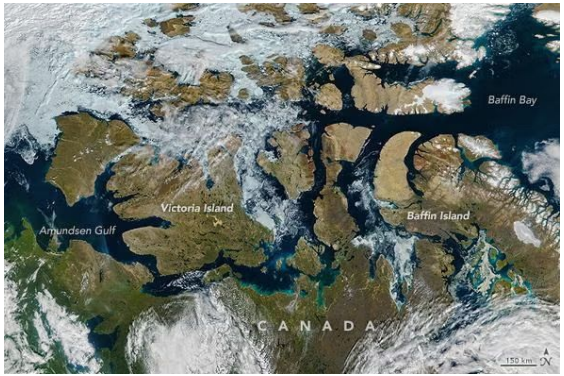





90°N
60°N
30°N
latitude
180°
120°W
60°W
0°
longitude

Why Now?

- Due to climate change, the Northwest Passage has become a lot more open
  - "...since roughly 2006, the southern route has been navigable in the summer almost yearly," (Di Liberto).
- So why is this important?
  - If we can find a navigable path through the Northwest Passage, it would be a huge shortcut to ships passing through North America
    - "Usually, ship traffic must go through is the Panama Canal or south around the southern tip of South America. Passing through the Canadian Arctic would cut shipping distances by more than 4,000 miles,"(Di Liberto)



Citations:

Di Liberto, Tom. “Northwest Passage Clear of Ice Again in 2016.” NOAA Climate.Gov, www.climate.gov/news-features/event-tracker/northwest-passage-clear-ice-again-2016. Accessed 17 Sept. 2023.