SMART INDIA HACKATHON 2024

VIKRANT

- **Problem Statement ID – 1658**
- **Problem Statement Title- Development of a versatile and fast algorithm for the optimal ship routing**
- **Theme- Transportation & Logistics**
- **PS Category- Software**
- **Team ID-**
- **Team Name (Registered on portal) – EIGHT**

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❖Ship Routing System with Risk Calculation and Optimal Path

➢ Detailed Explanation of the Proposed Solution

I. Divides the Indian oceanic map into **grid-based matrix** with each **cell** representing a geographic area with **risk metrics score**.
II. Integrates **environmental parameters:** temperature, wind speed, wave height, tides and more factors to compute a comprehensive risk score for each cell.
III. Each matrix cell is connected to nearby cells based on **proximity**.
IV. Risk levels are evaluated to determine the **optimal path** that inculcate both safety and fuel efficiency.
V. Utilizes the **A*ALGORITHM** to compute most optimal route by evaluating **risk levels** of each parameters, resulting in minimal maximal efficiency by averting high-risk cells.

➢ How It Addresses the Problem

I. Identifies and avoids high-risk areas(cell), enhancing safety and fuel-efficiency by using risk score in each individual cell.
II. Ensures the most optimal route by using the A* algorithm to evaluate and avoid **high-risk cells**.

➢ Innovation and Uniqueness of the Solution

I. Applies the A* algorithm to generate customized risk score to achieve a **sophisticated balance** between **safety** & **efficiency**.
II. Uses a grid-based matrix to represent the Indian Ocean, allowing for detailed **risk integration** & precise route optimization.
III. Features real-time updates and interactive mapping for an intuitive and responsive way to **adjust routes** based on changing risk metrics.

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TECHNICAL APPROACH

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➢ Technologies to be Used

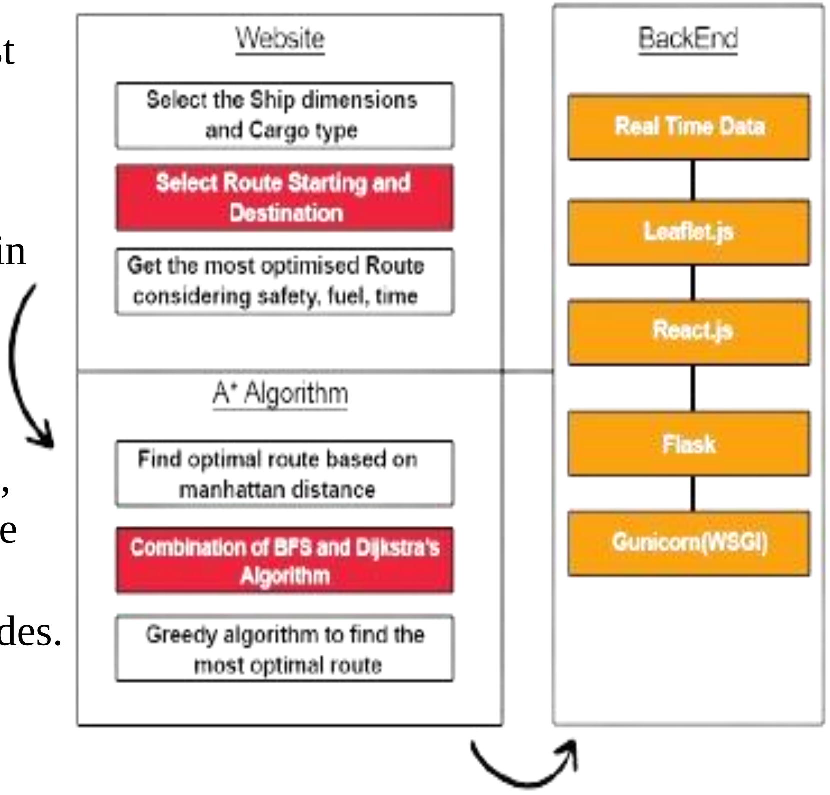
I. React for the user interface, **Leaflet.js** for interactive map visualization.
II. Python Flask for server-side processing Algorithm and **fast APIs** with **Gunicorn(WSGI)**.
III. A* Algorithm combining **BFS** and **Dijkstra's** Algorithm to determine the shortest and safest route.

➢ Methodology and Process for Implementation

I. To use LeafletJs to build a map that **visualizes maritime routes** and risk metrics, updating in real-time(using **synthetic data**) based on environmental changes.

➢ Pathfinding Implementation

I. A **Grid-based matrix** with nodes representing geographic areas and associated risk metrics, based on proximity, **with high-risk nodes** assigned higher **costs** to avoid and guide the route search.
II. Combines path cost from start and estimated cost to goal, with higher costs for high-risk nodes.
III. Expands nodes by evaluating neighbors using a priority queue to prioritize nodes with the lowest estimated total cost.
IV. Time Complexity **O(b^d)**, where b is the branching factor and d is the depth of the shortest path.
V. Space Complexity **O(b^d)** due to node storage in the priority queue and visited nodes.



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FEASIBILITY AND VIABILITY

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- <u>Analysis of the feasibility of the idea</u>

  I. Technical Feasibility: A* is well-suited for pathfinding, using a heuristic to efficiently find optimal routes.

  II. Adaptation: The ocean can be represented as a grid, with the cost of moving between cells influenced by base parameters (e.g., wind speed, currents). A* can handle dynamic conditions by recalculating paths as needed.

- <u>Potential challenges and risks</u>

  I. Operational Feasibility: can be integrated with existing navigation systems, leveraging real-time data for dynamic route adjustments.

  II. Economic Viability: Cost-Benefit: While development and maintenance costs are significant, potential fuel savings and increased safety offer a strong ROI.

  III. User Experience: The system needs a user-friendly interface, with clear route suggestions that crews can easily follow. Viability of Using A Algorithm for Ship Route Optimization

- <u>Strategies for overcoming these challenges</u>

  I. Pilot Testing: Implement a pilot project with a select group of ships to evaluate the system’s performance, measure fuel savings, and gather feedback on safety improvements. Use this data to refine the system and estimate the ROI.

  II. Partnership Framework: collaborate on research and development initiatives to innovate and refine the system based on feedback from various maritime institutions (public & private). Could involve joint workshops, brainstorming sessions, and pilot projects to test new features or improvements.

IMPACT AND BENEFITS

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Potential Impacts on Target Audience

I. **Improved Safety:** ability to predict and avoid dangerous weather conditions, such as storms, high waves, and ice formation, would reduce the risk of accidents, collisions, and damage to the ship, cargo, and crew

II. **Increased Fuel Efficiency:** By optimizing routes based on wind speed, currents, and other environmental factors, ships can minimize fuel consumption, reducing operational costs.

III. **Reduced Voyage Time:** Optimizing for favourable currents and weather conditions can lead to faster voyages, minimizing delays and improving the efficiency of shipping schedules.

IV. **Adaptability to Change:** The real-time adjustment of routes based on evolving weather conditions ensures that ships can continuously follow the optimal path, even as conditions change during the voyage.

V. **Environmental Impact:** Optimizing for fuel efficiency and safer routes reduces the carbon footprint of the shipping industry and minimizes the risk of environmental disasters, such as oil spills

Benefits of Solution

I. Positive contribution to global efforts in combating climate change, enhanced corporate social responsibility, and compliance with international environmental regulations

II. Shipping companies can achieve substantial savings on fuel and maintenance by avoiding hazardous conditions that could lead to wear and tear on the ship

III. The application provides shipping companies with a robust tool to make informed decisions about route planning, enabling more strategic and data-driven operations.

IV. Companies using the application can offer more reliable and cost-effective services, gaining an edge over competitors who may not have access to such advanced routing technology

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RESEARCH AND REFERENCES

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- **Textbook**
  - Weather Routing of Ships" by L. D. H. R. Thomas
- **Case Studies**
  - The Derbyshire Incident: A bulk carrier that was lost in a typhoon in 1980. The investigation into the loss highlighted the importance of accurate weather routing information for safe navigation.
- **Documentation:**
  - ISO 28000:2007 Specification for security management systems for the supply chain, which includes aspects related to ship routing and safety.
- **Websites and Online Resources:**
  - National Oceanic and Atmospheric Administration (NOAA) - Provides weather forecasts, data, and tools relevant to maritime navigation.
  - International Maritime Organization (IMO) - Offers guidelines and regulations for maritime safety, including weather routing
  - International Association of Classification Societies (IACS) Guidelines - Provides standards for ship safety and operational
  - procedures, including weather routing considerations.
  - Optimum Track Ship Routing (OTSR): A service used by the US Navy that employs short-range and extended-range Weather Routing Inc. (WRI): A company that provides weather routing services to the shipping industry.
- **Technological Tools:**
  - Weather Facsimile Recorder: A device used on ships to receive weather maps and forecasts.
  - Gyro, Accelerometer, and Strain Gauges: Sensors used on modern ships to monitor movements and environmental conditions.