Ship Route Corridor Prediction Based on Benefit Model

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Introduction

Conditions:

- International event information
- Some parameters (ship performance, etc.)
- Trajectory data in the last few days
- Historical trajectory dataset

Problem:

- How to predict the destination of this voyage?

Methods

Two premises:

- The states are relatively rational, and national decision-making with significant economic impact is prudent and based on certain rules.
- The economic cost and expected economic benefits of each mission are huge.

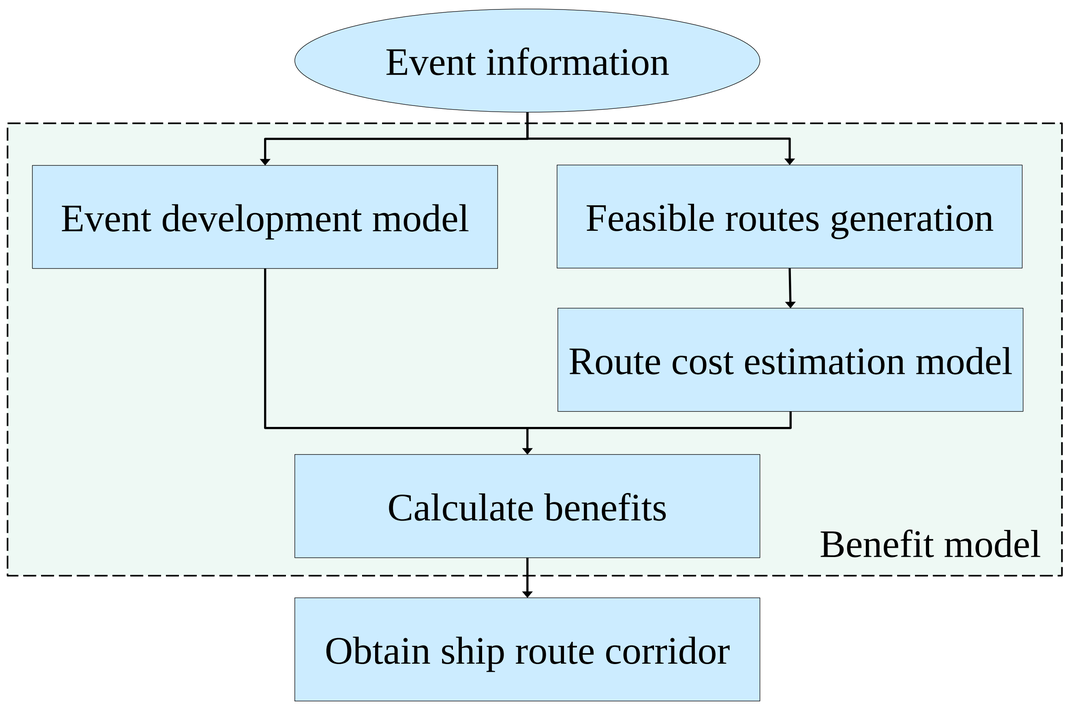

Fig. 1. Flow chart of ship route corridor prediction method

Event development model:

$$\dot{R}_{\mathrm{CA}} = a_{\mathrm{CA}} R_{\mathrm{CA}} + b_{\mathrm{CA}} R_{\mathrm{CB}}$$

$$\dot{R}_{\mathrm{CB}} = b_{\mathrm{CB}} R_{\mathrm{CA}} + a_{\mathrm{CB}} R_{\mathrm{CB}}$$

Route cost estimation model:

$$C_{float} = C_{fuel} + C_{pay} + C_{\mathrm{climate}}$$

Fuel cost — Port and canal charge — Additional cost for weather effects

where

$$\begin{cases} C_{\mathrm{fuel}} = P_H m_H + P_L m_L \\ m_H = (0.7355 D^{2/3} v^3 / 24Cf) / 1000 \\ C_{\mathrm{climate}} = k_m \cdot C_{dm} \cdot [1 - \tanh(R / R_{\mathrm{climate}})] \end{cases}$$

Results

Each feasible route:

Fig. 3. is frequency histogram using Monte Carlo method to estimate route cost in Fig. 2. for 500 times. The confidence interval with $\alpha = 0.05$ for route cost is $[73.95, 73.98] \cdot 10^4$ dollars.

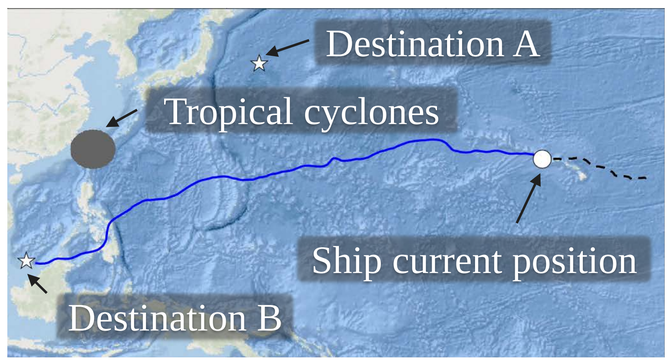

Fig. 2. A feasible route

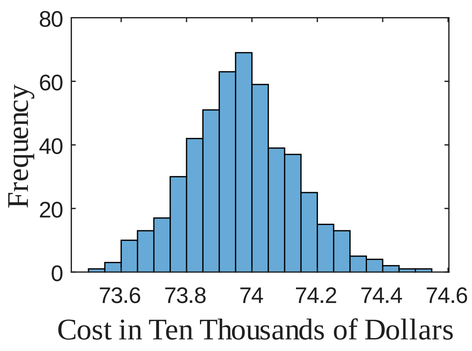

Fig. 3. Route cost

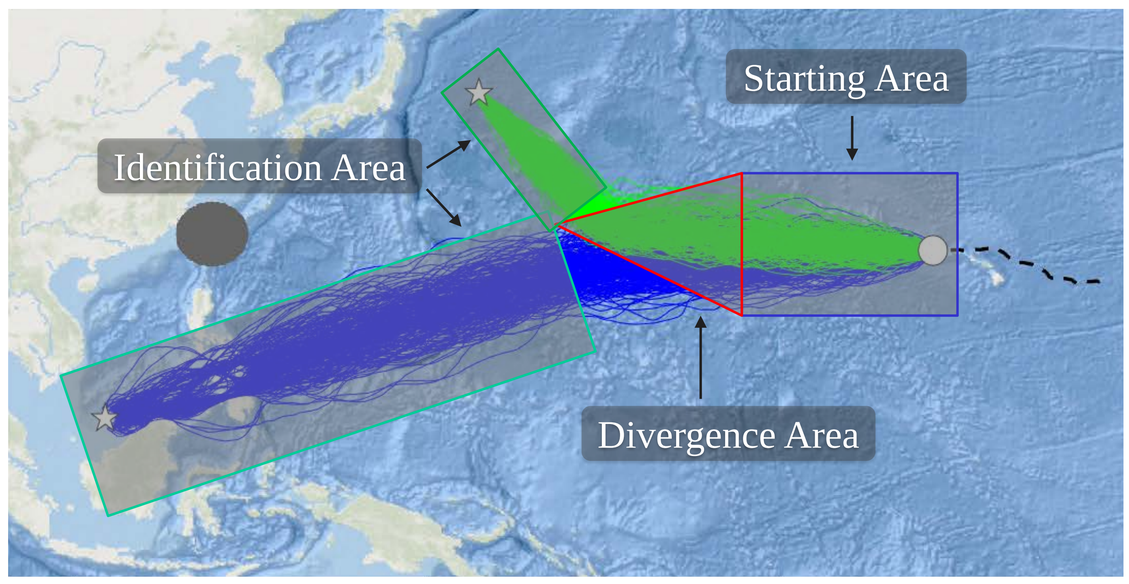

Fig. 4. Ship route corridor

Ship route corridor:

Filtering all feasible routes based on route cost and benefits, a cluster of feasible routes, named ship route corridor, can be obtained.

Conclusions

Functions for this method:

- Possible locations of the ship can be predicted at any time.
- Destination can be predicted once the ship enters an identification area.

Compare with other methods:

- Less historical trajectory dataset
- Less dependence on trajectory data in the last few days
- Larger time span for prediction