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Bayesian Search Study for USW

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Monterey, California: Naval Postgraduate School

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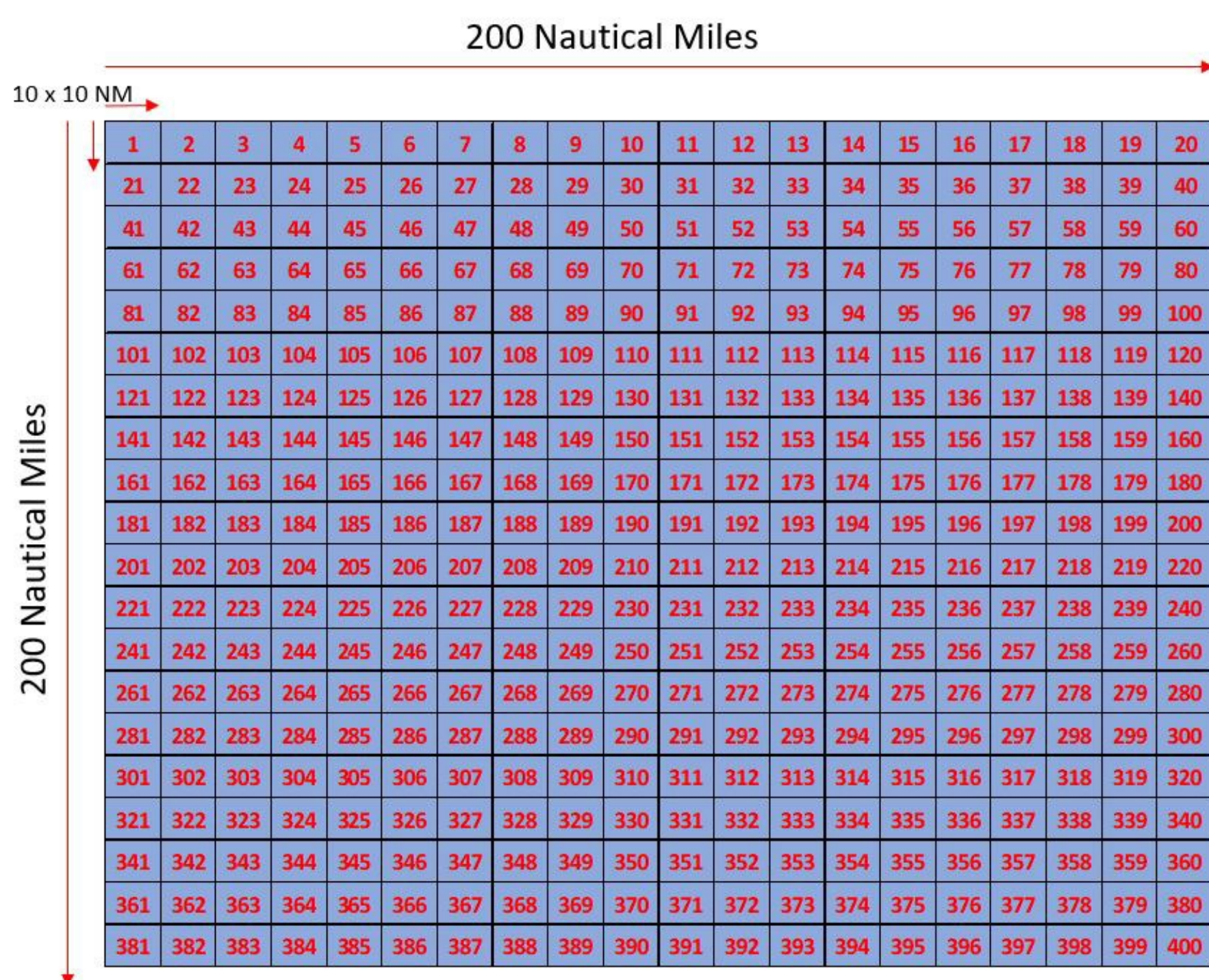
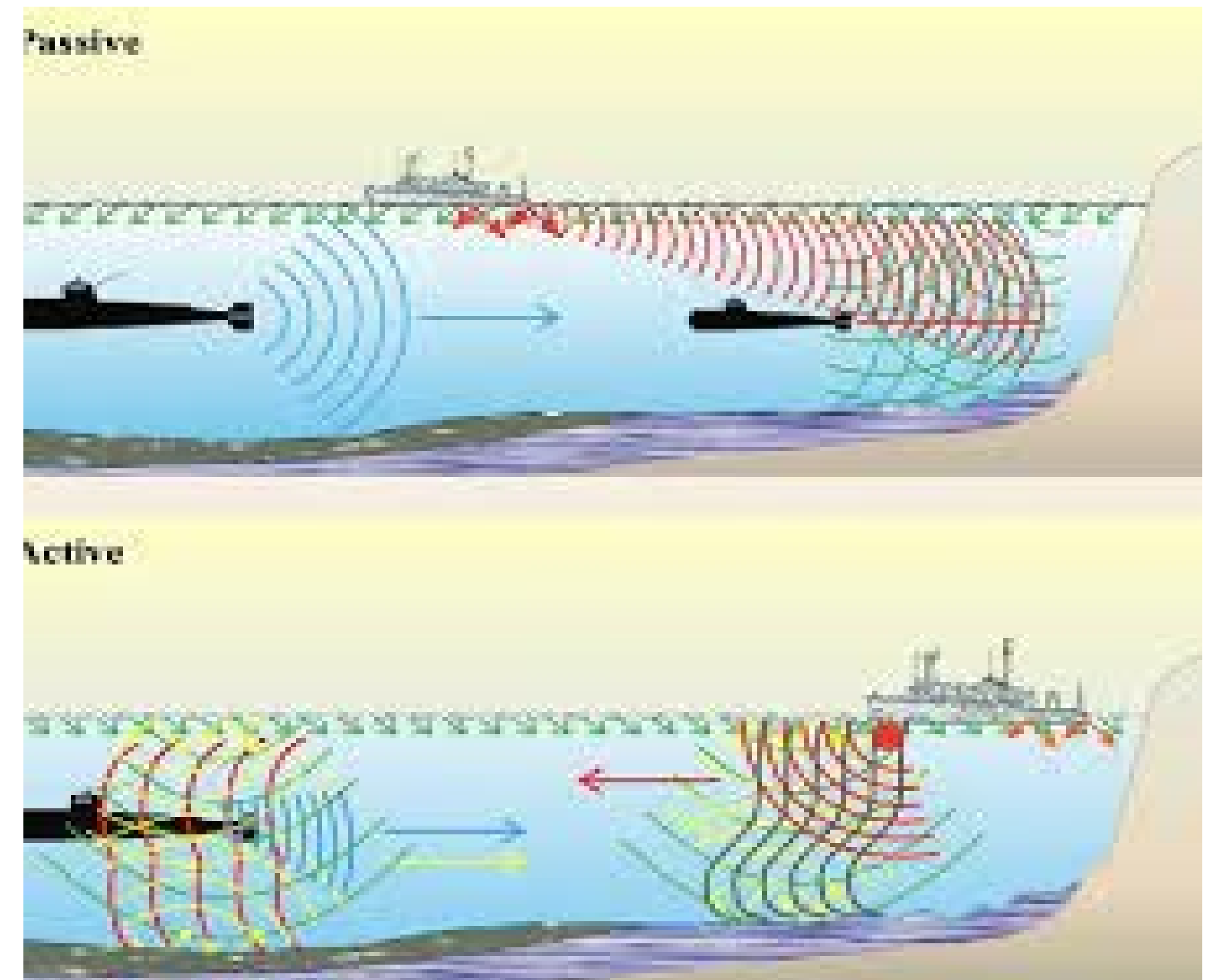
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Research Objective:

To develop search strategies of enemy submarines that attempt to avoid detection.

Approach:

- Red is in a Search Region of size 200 by 200 nautical miles.
- Define a Discrete Time Markov Chain modeling Red's movement.
- Three search algorithms:
 - Network Algorithm (based on Linear Programming (LP))
 - Network Algorithm with Updates (based on LP)
 - A Dynamic Programming model that accounts for the search results to-date.

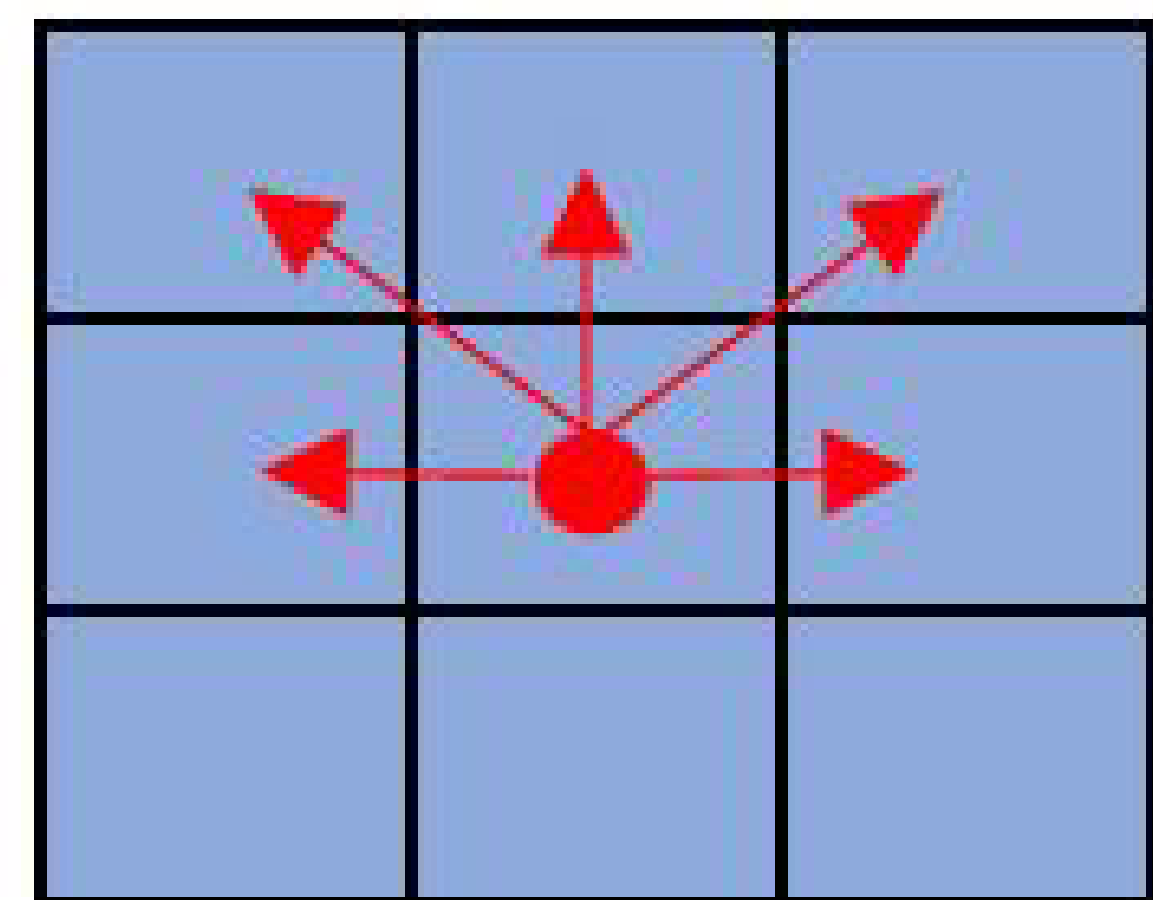


Results and Conclusions:

- The three algorithms produced similar results from a probability of detection perspective.
- The dynamic programming algorithm is solved much more efficiently than the other algorithms, requiring three orders of magnitude fewer CPU cycles than both Network algorithms.
- The results of our research indicate that the Dynamic Programming algorithm is the best for future development. Its performance is consistently similar to that of the Network Algorithm with Updates and has a significantly lower computational cost. When fully developed, this algorithm may be used aboard submarines and implemented in the mission planning tools available to operators.

Impact on Mission:

- There is little work done on searching for non-static and strategic targets in the ASW domain.
- Our work is a first step towards developing search strategies in such setting.
- Our algorithms do not require active human-in-the-loop intervention.
- Our modeling framework can be adapted to more realistic high-side settings.



Future Work:

- Explore non-perfect sensors where there are both false positive and false negative search results, and where the probability of detecting Red if both submarines in the same cell is less than one. We also leave for future work
- Relaxing the assumptions that the Markov transition matrix is known by Blue and using concepts from Game Theory to explore worst-case transition matrices for the searcher
- Applying this work to multiple search assets conducting the search concurrently is an important problem that may well require a different modeling approach.



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 Operations Research
 Topic Sponsor: Undersea Warfighting Development Center

NRP Project ID:
NPS-22-N208-A