Ship Patrol:
Multiagent Patrol under Complex Environmental Conditions

Noa Agmon, Daniel Urieli and Peter Stone
Department of Computer Science
The University of Texas at Austin
{agmon, urieli, pstone}@cs.utexas.edu

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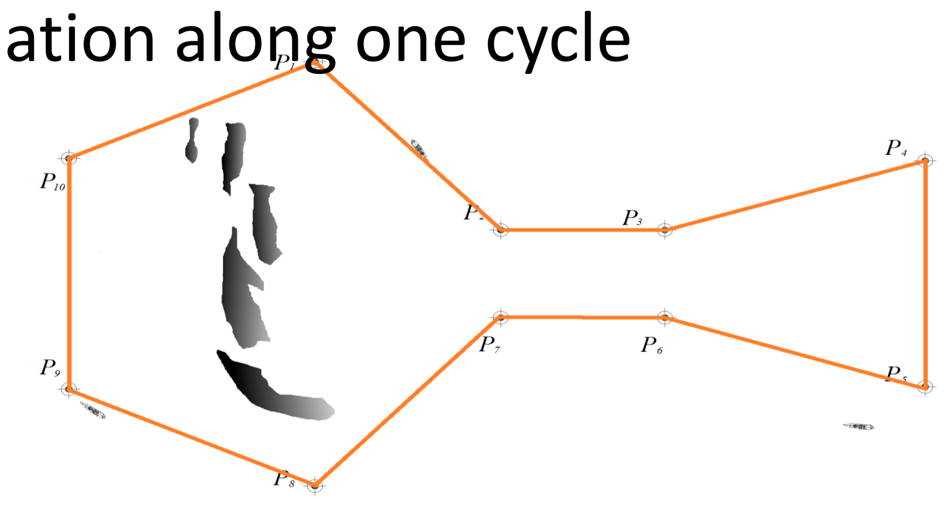
Multiagent Frequency-Based Graph Patrol Problem:
Team of *k* agents should repeatedly visit nodes of graph *G=(V,E)* while minimizing idleness at each node

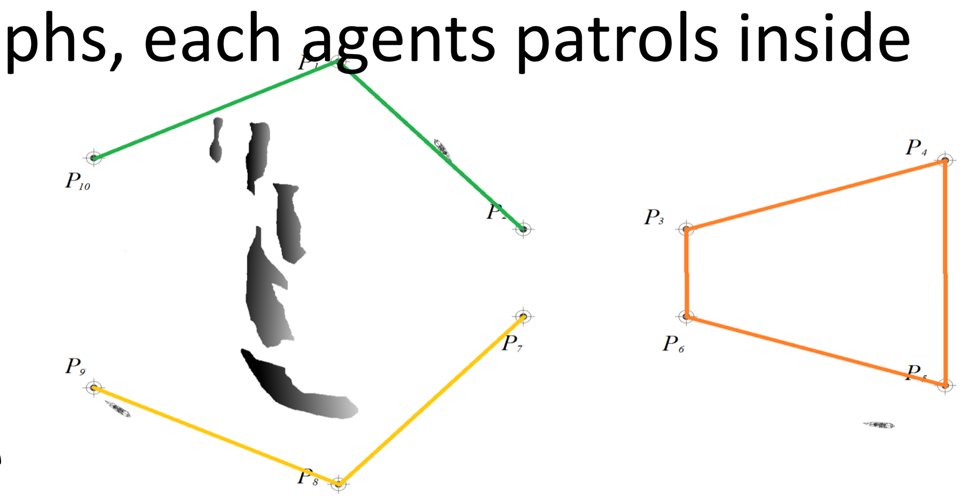
Current Strategies

SingleCycle
All agents travel in coordination along one cycle



Optimal strategy: Intractable

UniPartition
V(G) divided into *k* subgraphs, each agents patrols inside its subgraph



Optimal strategy: Intractable

Complex Environments

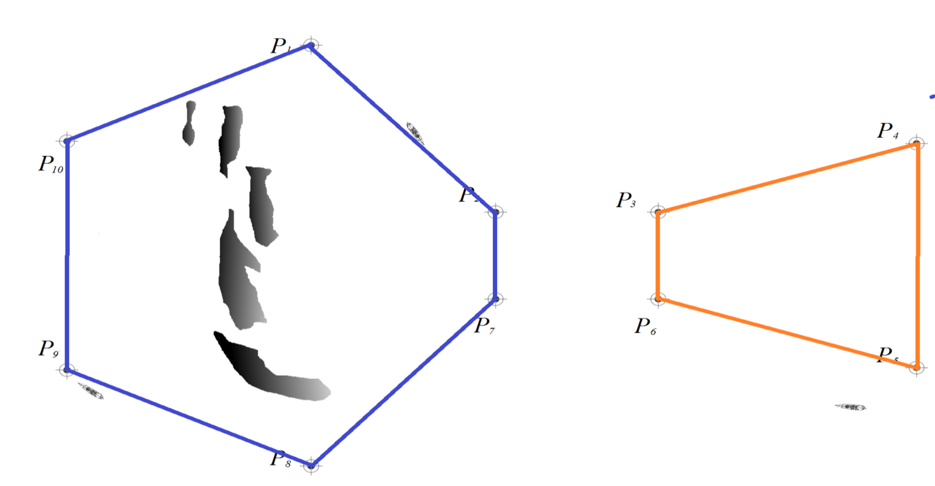
Example: Marine Environments

Time of travel does not correspond to physical distance
- Influenced by water currents, winds, waves
- No triangle inequality → Cannot use common approximation algorithms

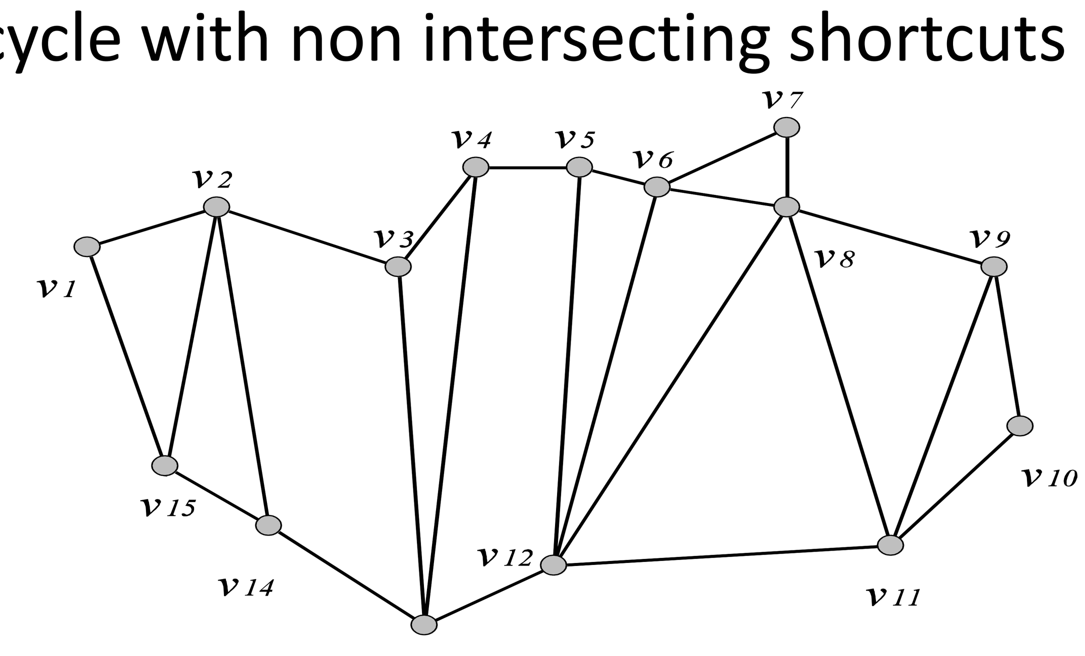
Current strategies are not necessarily suitable

New, General Strategy

MultiPartition
V(G) divided into *m≤k* subgraphs, with possibly more than one agent patrolling in each subgraph



Biconnected Outerplanar Graphs
A cycle with non intersecting shortcuts



MultiPartition Optimal Strategy Intractable

Finding an optimal MultiPartition strategy that minimizes worst idleness in G is NP-Hard.
Solving the problem in biconnected outerplanar graphs is also intractable → Use heuristic algorithm

UTSeaSim

Custom-designed naval surface navigation simulator

Realistic 2D physical models of marine environment and sea vessel

Contains three modules:
1. Sea Environment wind, currents, obstacles
2. Ship physical properties, sensing and actuators
3. Decision Making autonomous agent controlling the ship

Algorithm HeuristicDivide

1. Examine all divisions of the given cycle into two or three cycles
2. Choose division that improves **and** minimizes idleness
3. Continue recursively with each cycle in the division

Implemented in UTSeaSim
Significantly improves idleness compared to:
1. SingleCycle
2. Trivial adjustments
(SinglePatrition cannot be computed)