National Aeronautics and Space Administration

D-MATADOR: Distributed Multi-Agent Task Allocation and Determination for Robotic systems

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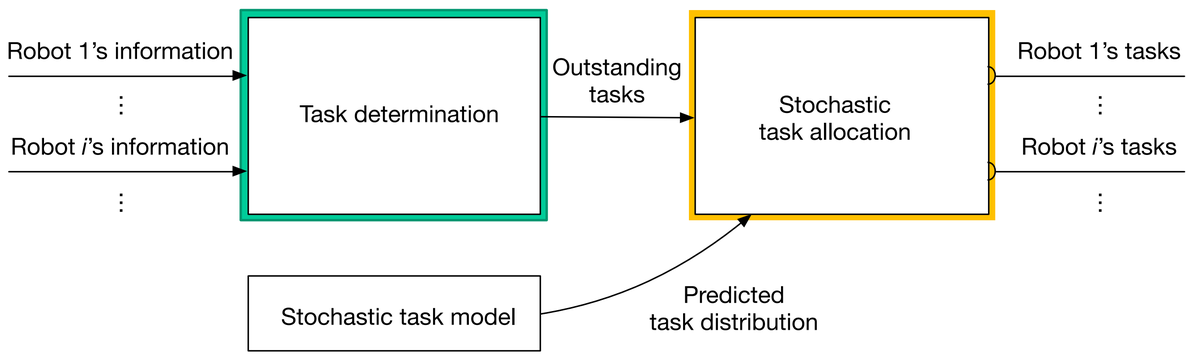
Overview

GOAL: develop models and distributed algorithms to solve the complementary problems of *task determination* and *predictive task allocation* in heterogeneous **multi-robot** teams



Task Determination

Determine tasks that should be performed exchanging only **relevant information** and observations

Task Allocation

Distributed task allocation for **heterogeneous** agents that accounts for **stochastic** distribution of future tasks

Distributed Task Determination

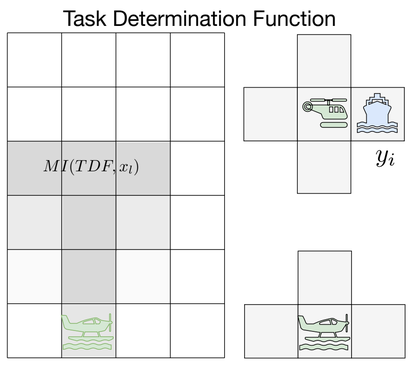
Approach 1: information-theoretical

$$\text{Maximize} \sum_{i \in \text{Agents}} \sum_{k \in TDF(i)} MI(TDF_k^I; \cup_{\{j:C(j,i) \text{is True}\}} y_j)$$

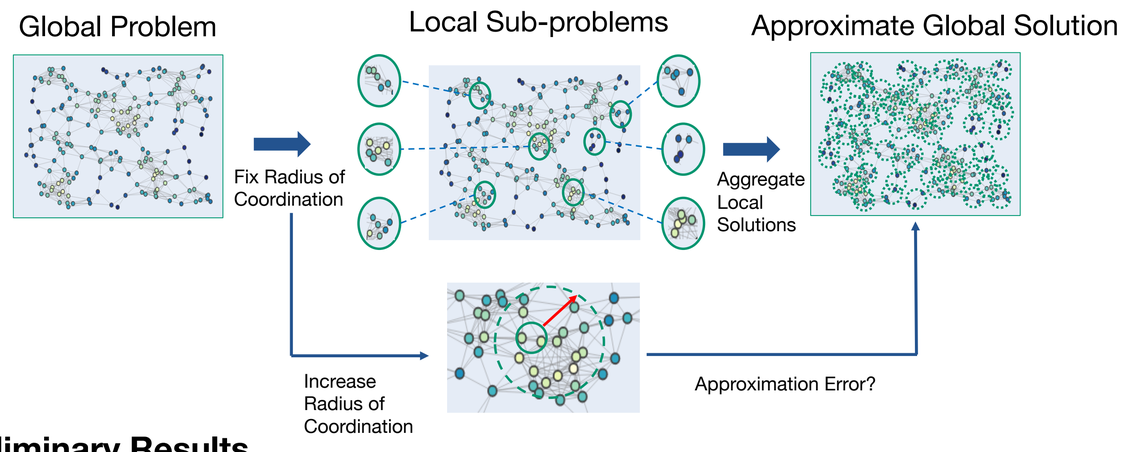
s.t. C(i,j) satisfies communication constraints

Captures:

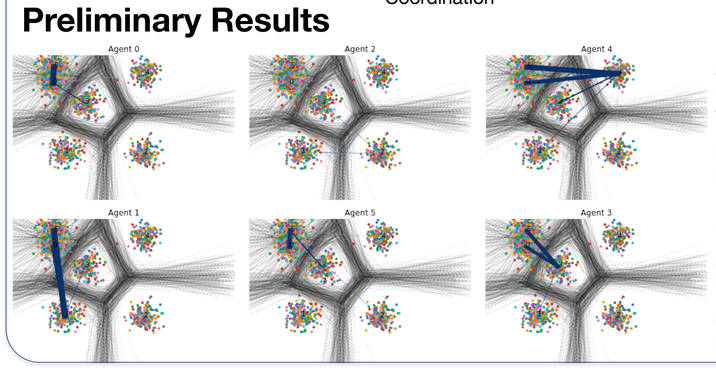
- uncertainty on other agents' location
- unreliable communication



Approach 2: clustering for distributed optimization



Preliminary Results

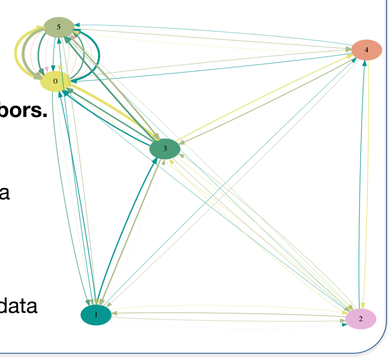


Agents must compute their **Voronoi neighbors.**

Other agents' locations are represented in a **particle filter.**

Left: mutual information

Right: optimal data exchange



JPL Applications to Multi-Robot Systems

Identification and observation of science targets of opportunity

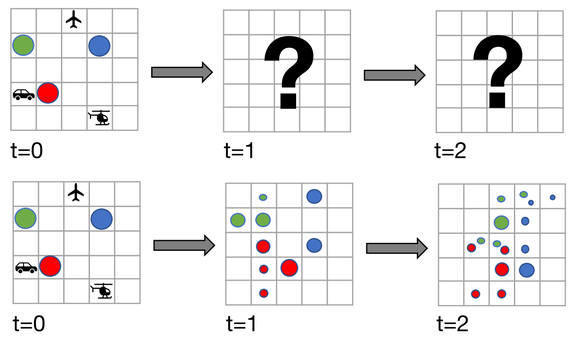
- Dust devils on Mars
- Plumes on Enceladus
- Weather phenomena on Earth

Tracking and monitoring of

- Wildfire monitoring
- Animal tracking
- Patrolling

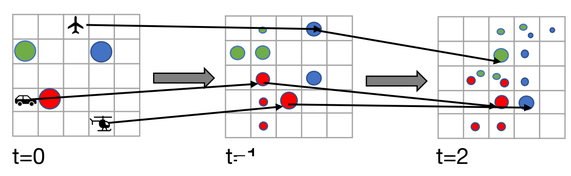
Predictive Task Allocation

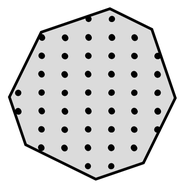
Allocation of agents to **time-varying** and **uncertain** tasks
- Agents are rewarded for *task execution*
- Agent's motions incur *penalties*



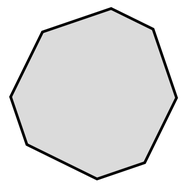
Given the posterior distribution on the evolution of tasks we may obtain its **expected** behavior

We design a **predictive task allocation strategy** that achieves **optimal expected behavior**

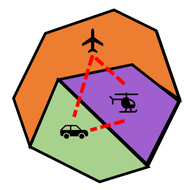




We formulate the problem as an **Integer Linear Program**

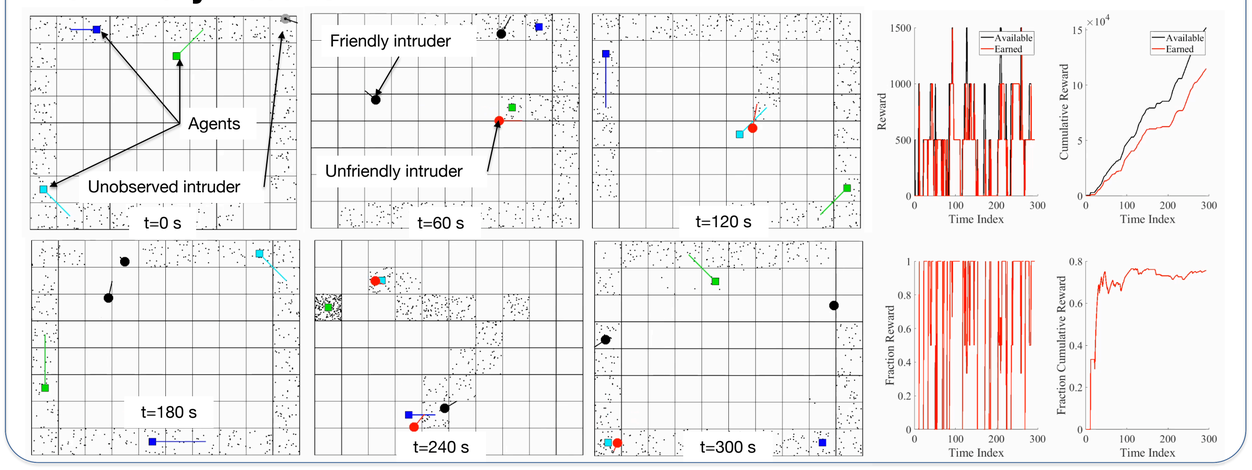


We than **relax** the problem into an LP



The LP is solved in a **distributed** manner

Preliminary Results



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