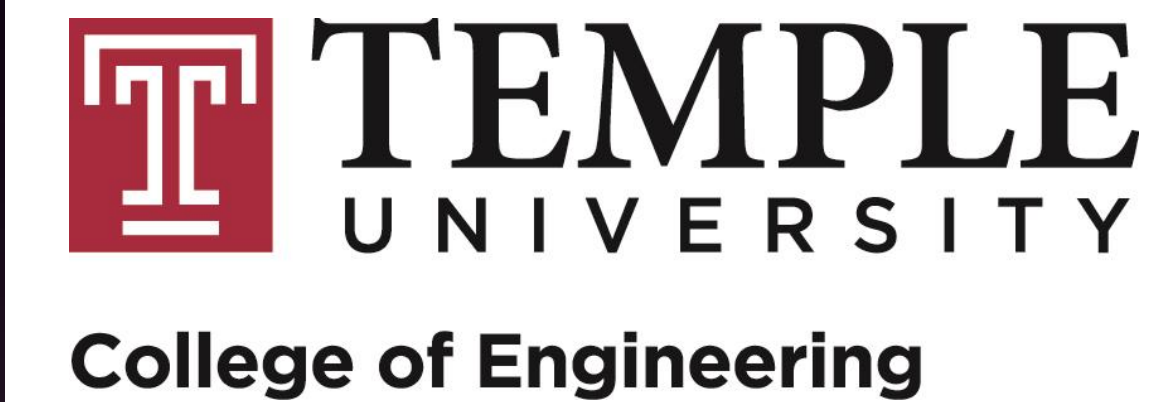


# CAREER: Formalizing the Concept of Teamwork in Heterogeneous Multi-Robot Systems

Philip Dames



## Key Problem

- Multi-Robot Multi-Target Tracking (MR-MTT)
  - Unknown, time-varying number of objects
- Use heterogeneous multi-robot system (MRS)
  - In sensing, actuation, computation, and/or communication
- Examples
  - Disaster response
  - Environmental monitoring

## Research Goals

1. Develop coordination strategies that take advantage of the unique capabilities of each individual platform within a heterogeneous MRS
2. Predict the range of performance of an MRS in a new situation

## Societal Impacts

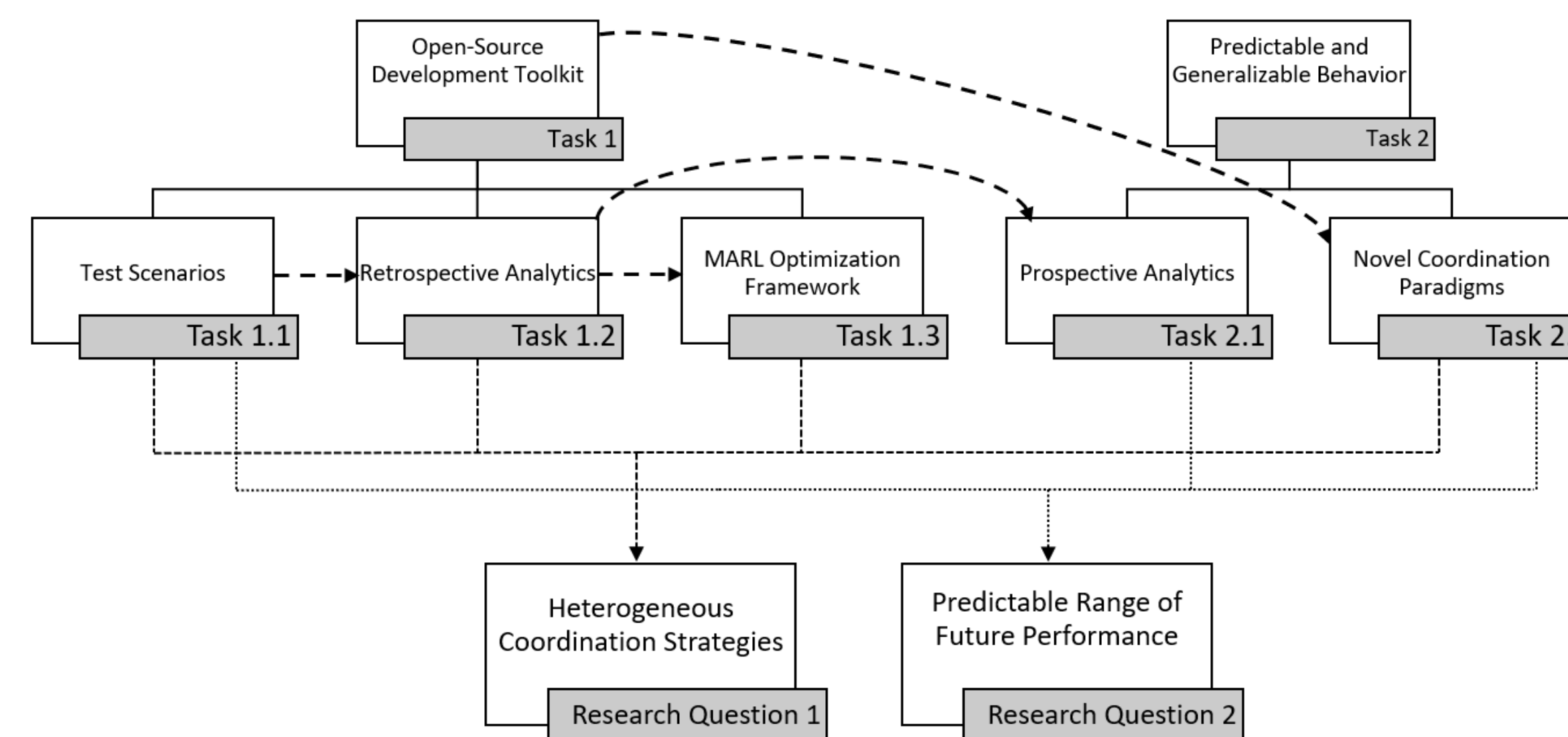
- Improve ability of MRS to autonomously search
- Allow practitioners to create effective MRSs within a budget

## Broader Impacts

- Provide quantitative tools to relate MRS performance to team composition
- Improve credit assignment in multi-agent RL

## Methodology

- Draw inspiration from advanced sports analytics
  - Retrospective and prospective player analytics
  - Team-building to maximize chance of success (i.e., finding all targets)



## Current Research

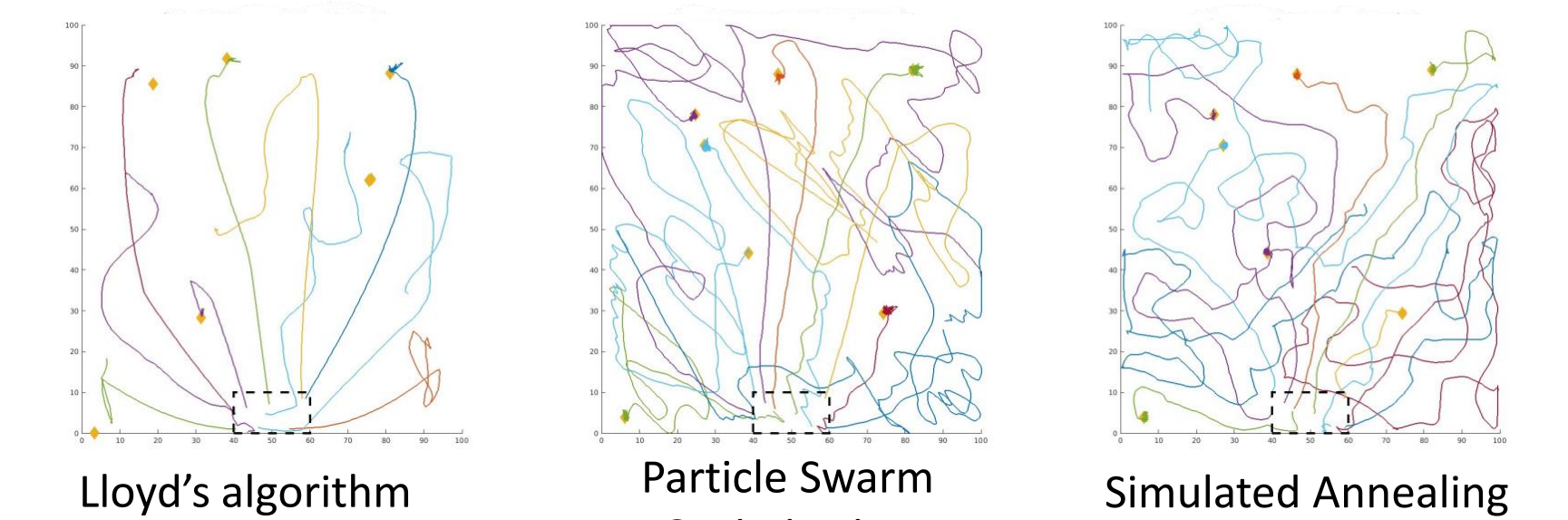
- Find parametric relationship between robot/environment parameters and MRS tracking accuracy/speed

## Education and Outreach

- Course integration
- 9-12 MRS Challenge
  - Challenge @ intersection of robotics and sports
  - Students from Temple's Upward Bound Math and Science program
- Workforce development
  - Interface with local robotics companies to create job pipeline and inform curriculum design

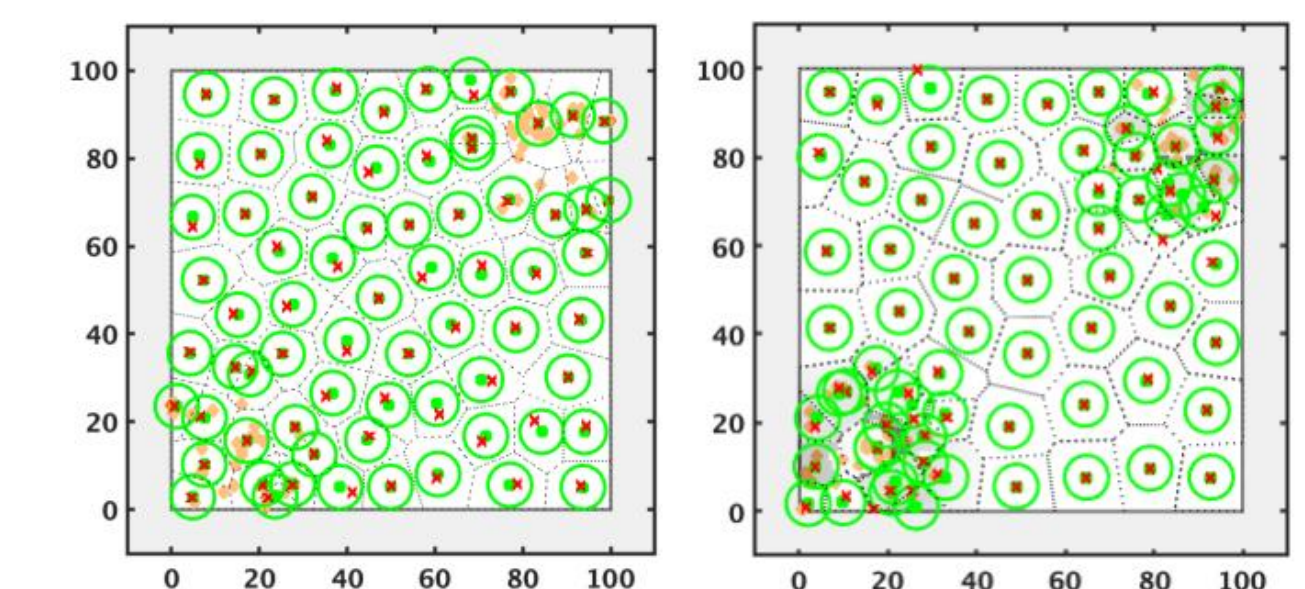
## Results

- Collect dataset of MRS performance
  - Different search strategies



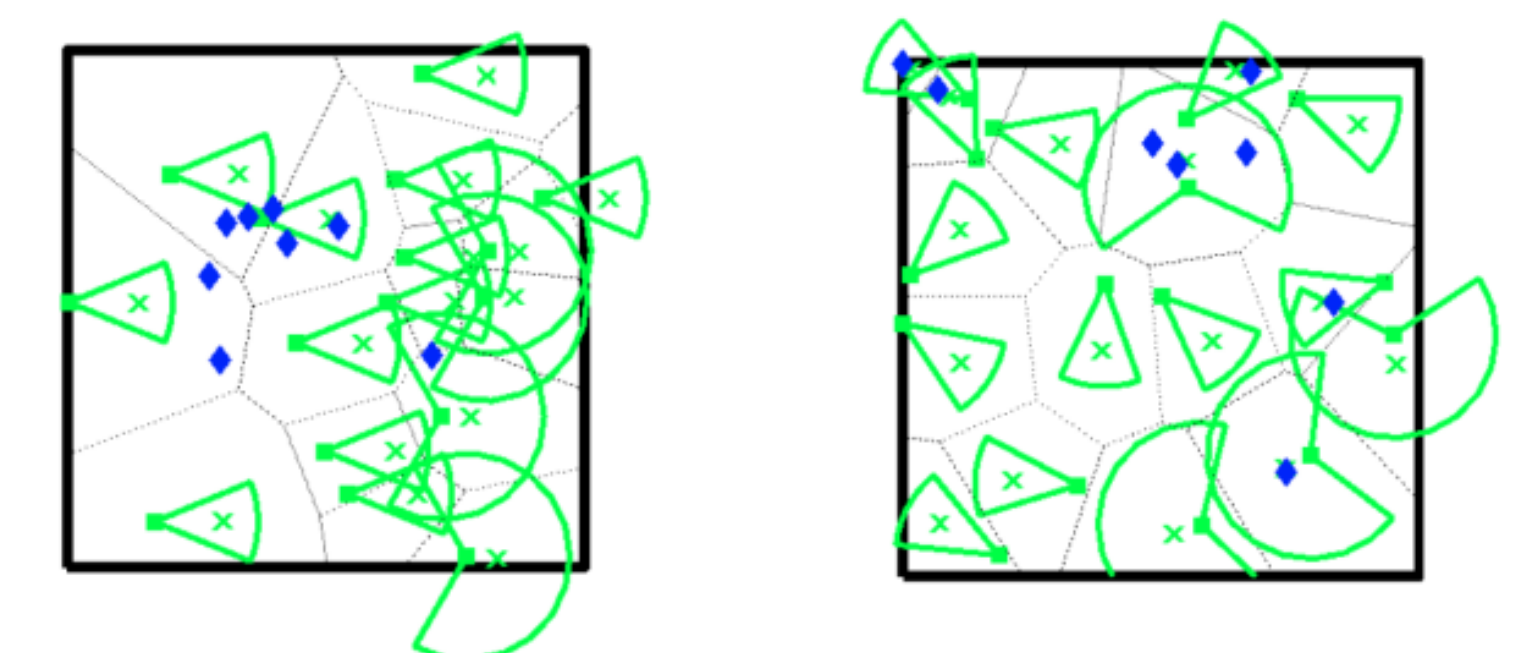
Pujie Xin and Philip Dames. "Comparing Stochastic Optimization Methods for Multi-Robot, Multi-Target Tracking." *International Symposium on Distributed and Autonomous Systems (DARS)*, 2022.

- Different robot/target distributions



Jun Chen, Philip Dames, and Shinkyu Park. "Distributed Multi-robot Tracking of Unknown Clustered Targets with Noisy Measurements." *International Symposium on Distributed and Autonomous Systems (DARS)*, 2022.

- Different sensors across the team



Jun Chen and Philip Dames. "Distributed Multi-Target Tracking for Heterogeneous Mobile Sensing Networks with Limited Field of View." *IEEE International Conference on Robotics and Automation (ICRA)*, 2021.