Autonomous Robot Soccer

Planning for Offensive Passing in Robot Soccer

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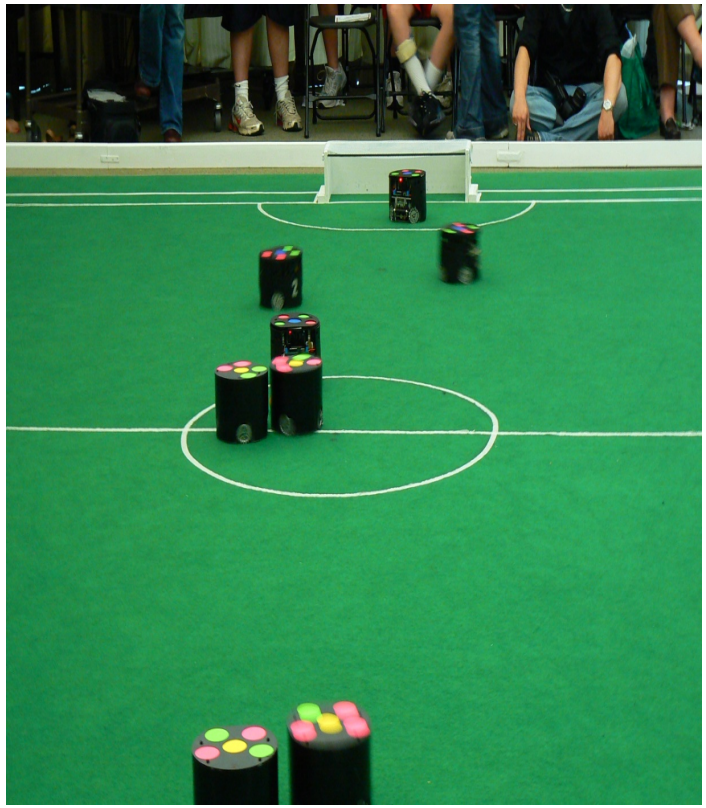
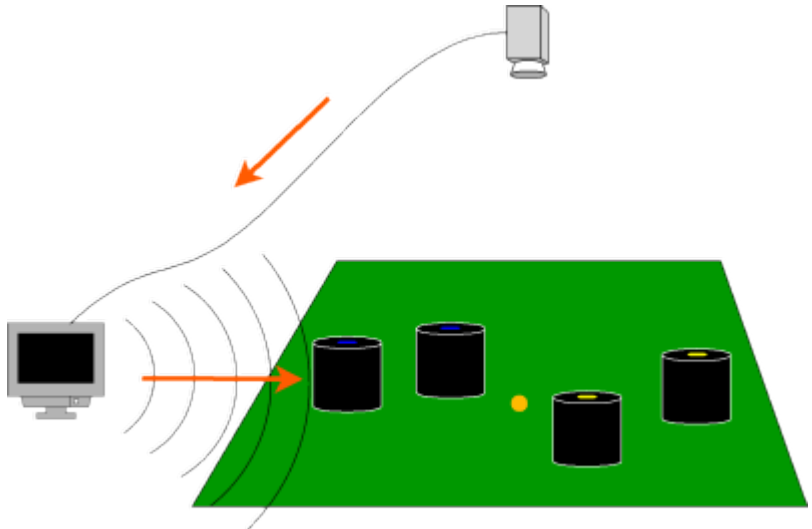
Overview of Small Size League (SSL)

- 5-on-5 fully autonomous robot soccer.
- Centralized control system with overhead vision.
- Ball speed much faster than robot speed (10m/s vs 3m/s)





Problem Description

- The current system uses a hierarchical behavior-based approach to assign roles to individual robots

- There is no strict control of multiple robot interactions, so coordinating passing is very difficult except in trivial cases

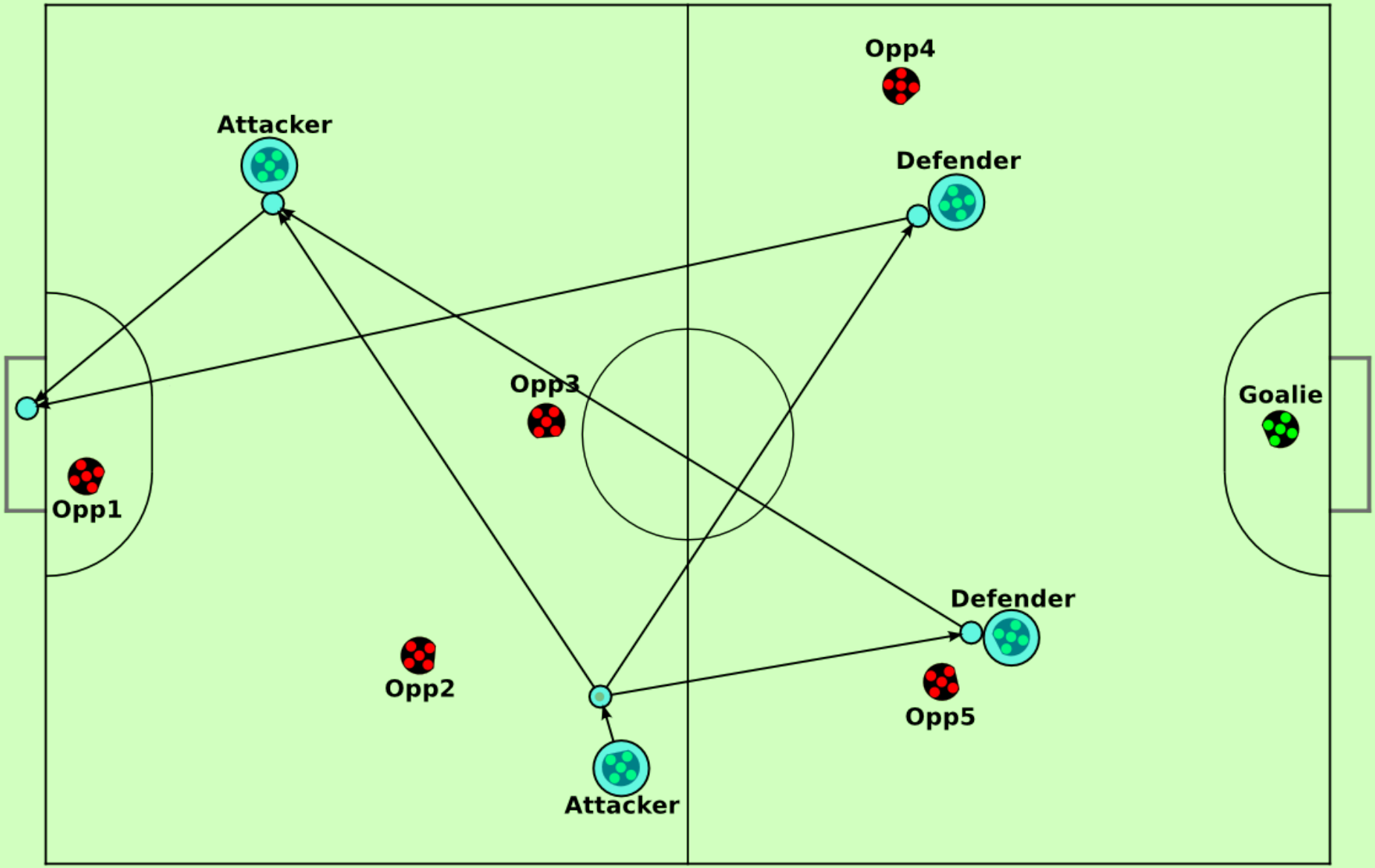
Our Approach

Four-stage pass planning and execution:

- Create graph structure of potential passes.
- Select a subset of the passes that are “best”.
- Perform nonlinear optimization on the pass plan to improve robot positioning.
- Execute the plan using a variety of low-level controllers

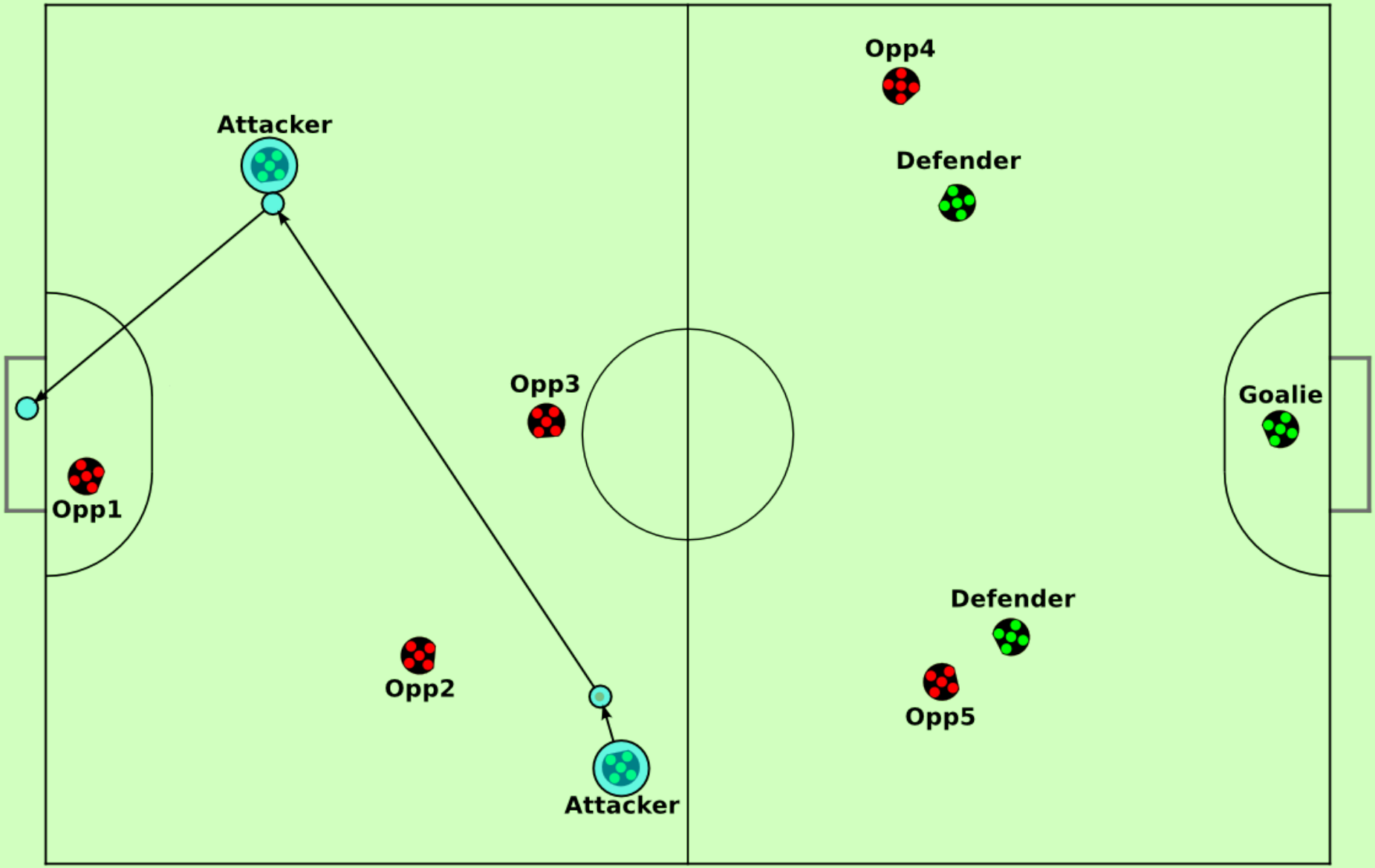
Step 1: Potential passes

Examples of feasible solutions:



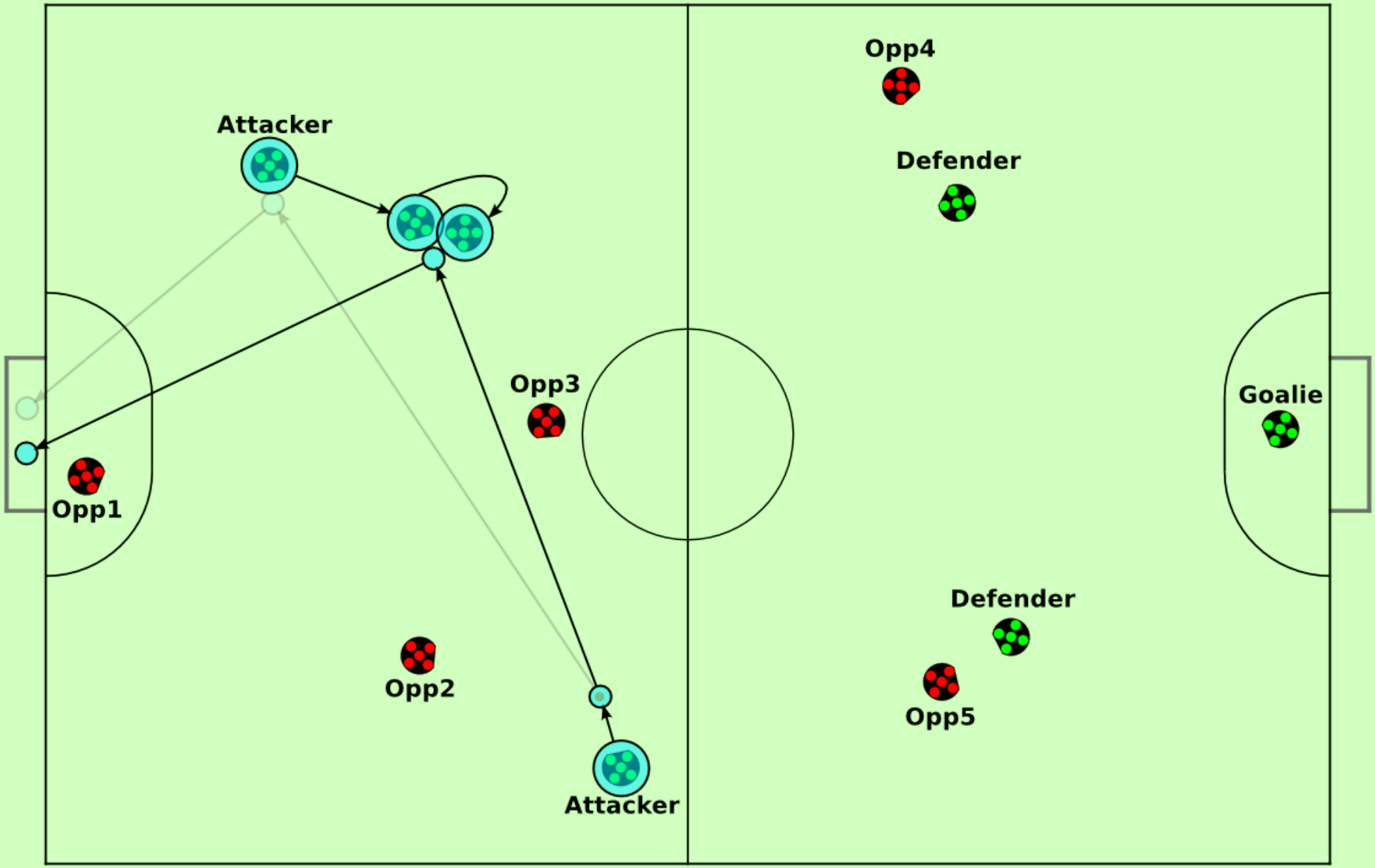
Step 2: Feasible Subset

This pass would considered “good”:



Step 3: Optimization

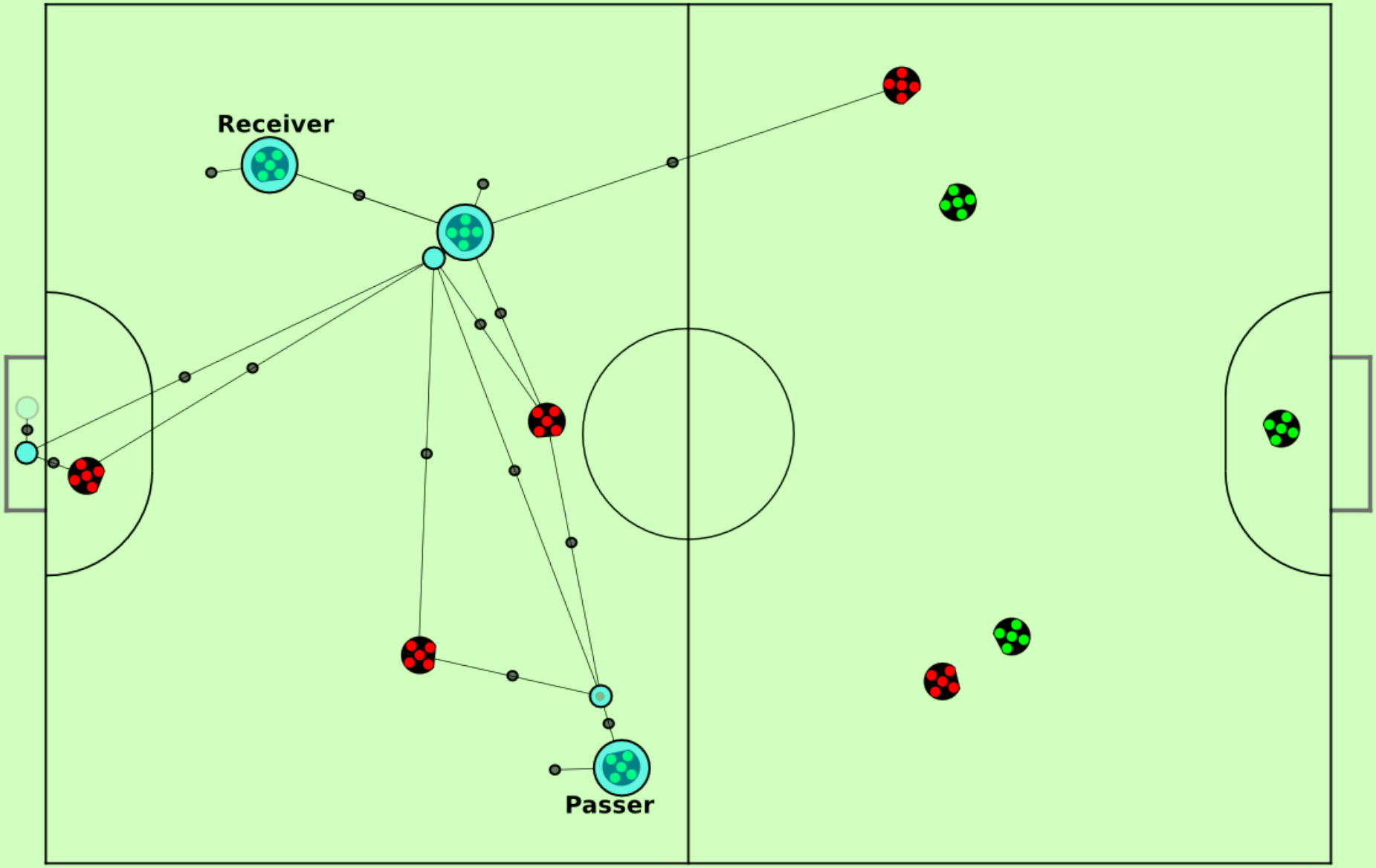
Adjust position of the receiver to improve speed



Optimization Method

- We perform nonlinear constrained simultaneous multi-variable optimization
- We construct a cost function to minimize using a graphical model to relate variables
- The system can then optimize the cost function for better robot positions using Sequential Quadratic Programming
- These tools are usually used for Simultaneous Localization and Mapping

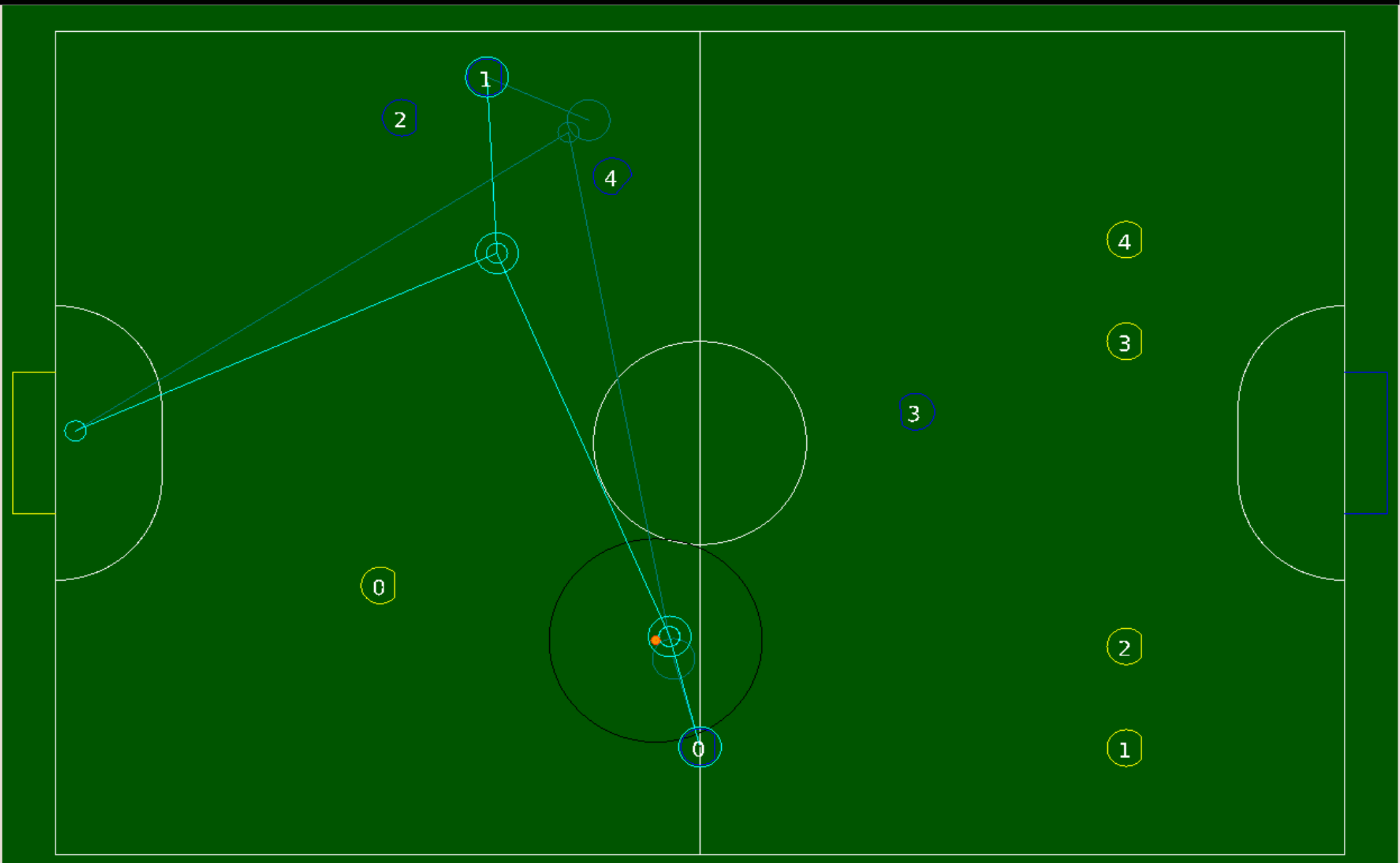
Optimization Factor Graph



Low-Level Control

- To execute actions, we reuse low-level behaviors and motion controllers
  - Movement: Executed using an RRT-based controller, with manual path and velocity control available
  - Kicking: Uses a mix of commands to aim and shoot the ball when ready
- These controllers have been tuned to provide effective control using more detailed motion models

Results



Results

Video of execution of pass with static opponent.

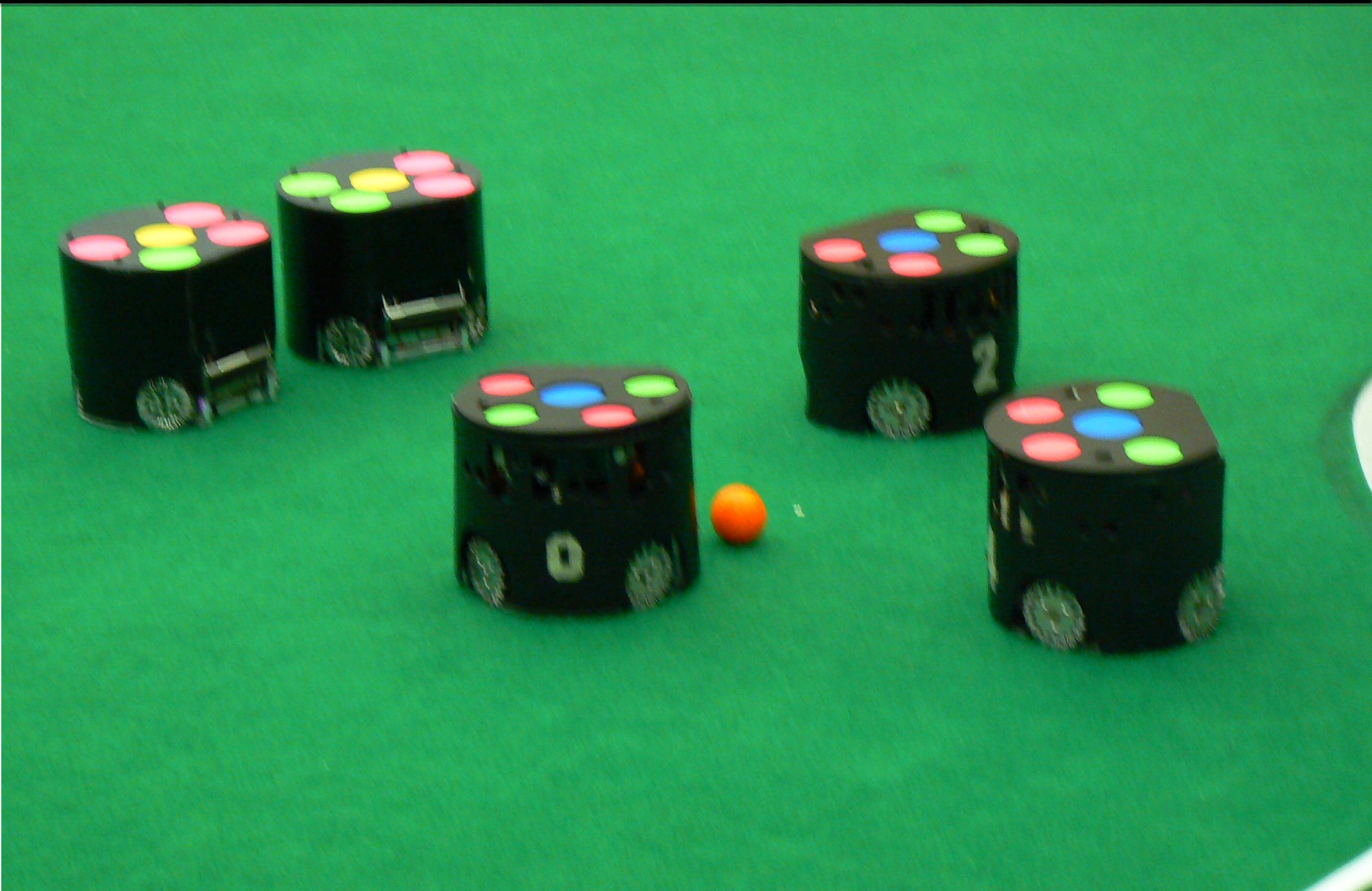
Results

Video of optimized execution with an active opponent.

Conclusions and Future Work

- The multi-stage planner allows evaluation of plans we would not have been able to find otherwise
- While the current optimization approach uses a simpler cost function, the system is very scalable
- We need to improve the interactions between the low-level control and the planner outputs

Questions?



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