Planning Competition for Logistics Robots In Simulation

Scenario and Challenges

Tim Niemueller
Knowledge-Based Systems Group, RWTH Aachen University

Erez Karpas
Technion – Israel Institute of Technology

Tiago Vaquero, Eric Timmons, and Brian C. Williams
Massachusetts Institute of Technology

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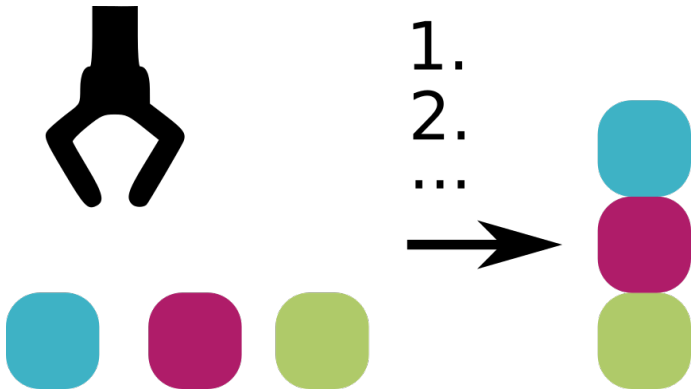
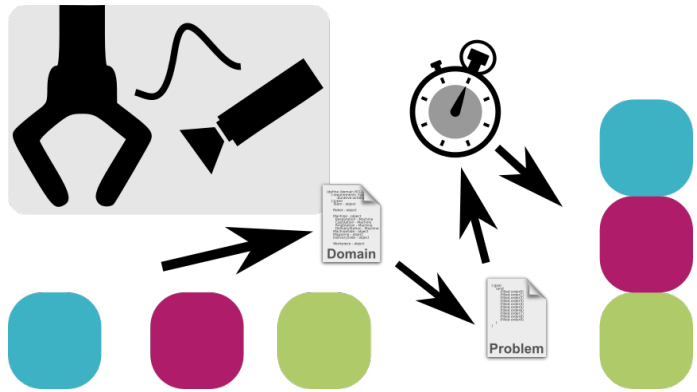
Planning Perspective



- Focus on plan generation
- Robotics not as testbed
- Execution gets less attention

Robotics Perspective



- Focus often on various topics
- Integration for evaluation
- Planning labor-intensive

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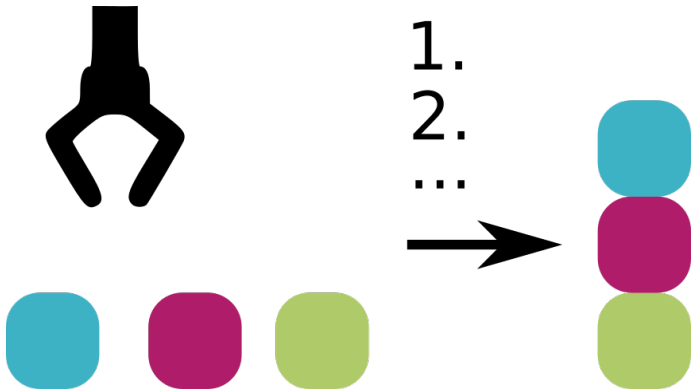

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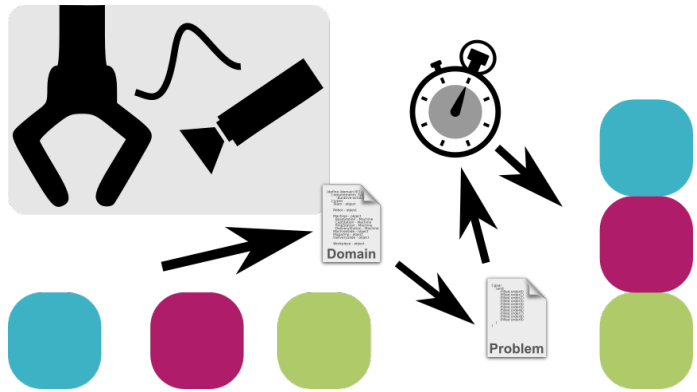

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Goals

1. Foster closer cooperation among communities
2. Develop grounded expertise with robotic scenarios, platforms, decision architectures, system integration and evaluation

RoboCup Logistics League

RoboCup Logistics League

Game Basics

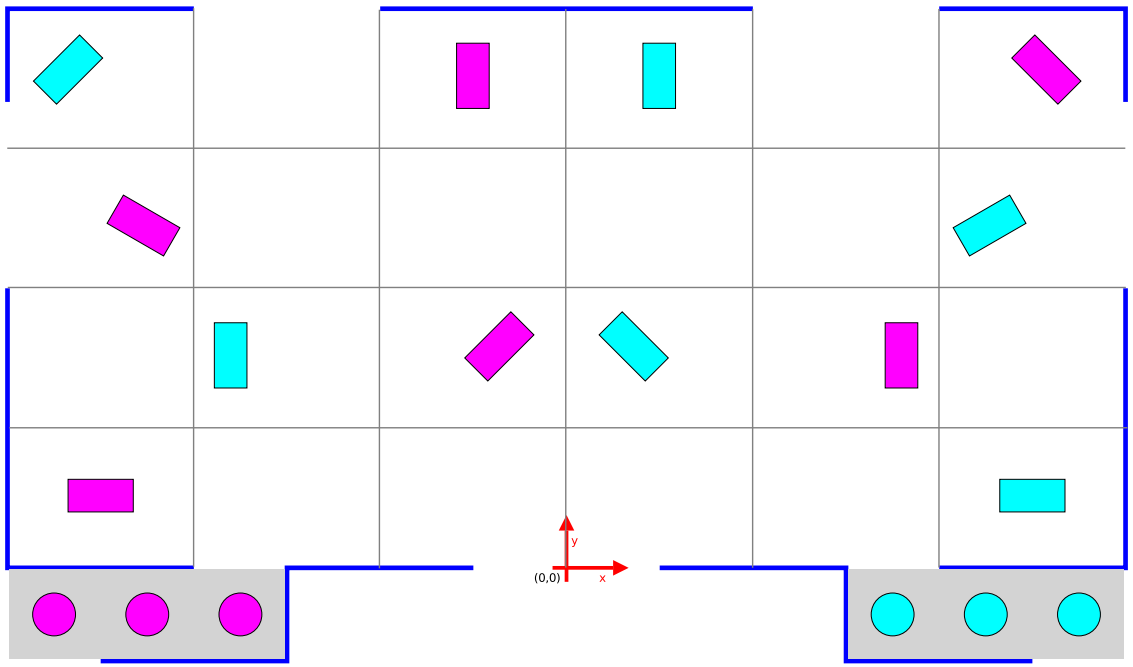
- Task: In-factory production logistics
- Goal: variant production
- Two teams playing on common field
- Each team has 3 robots
- Multi-robot coordination task

Two Game Phases

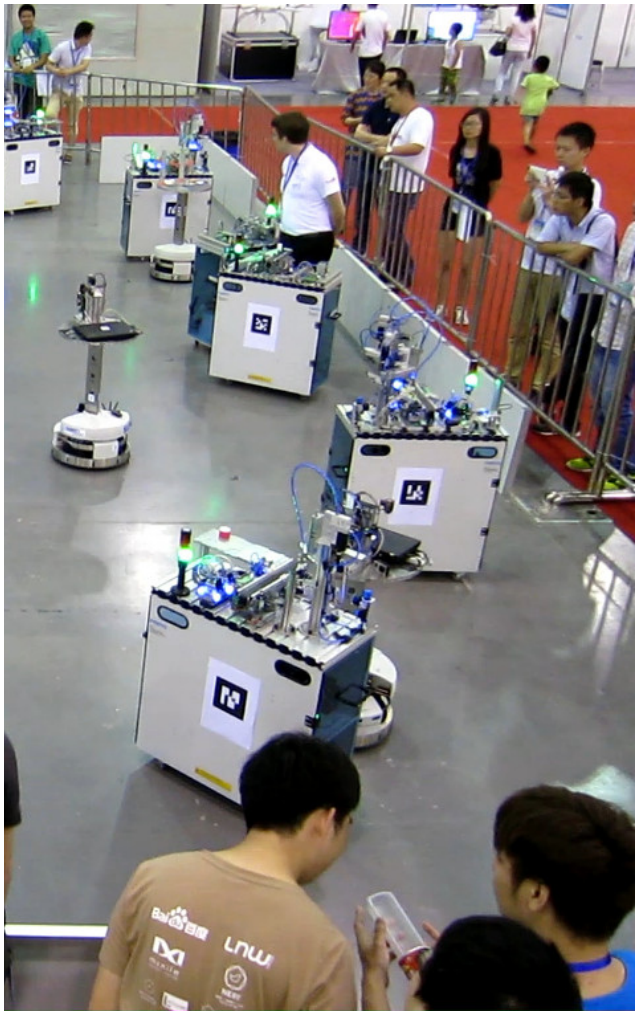
- *Exploration*: detect and report machines
- *Production*: produce and deliver by using processing stations spread across field

RoboCup Logistics League

Playing Field



- Team colors: cyan and magenta
- Exclusive machines spread across field
- Mirrored at middle axis



RoboCup Logistics League – Machines

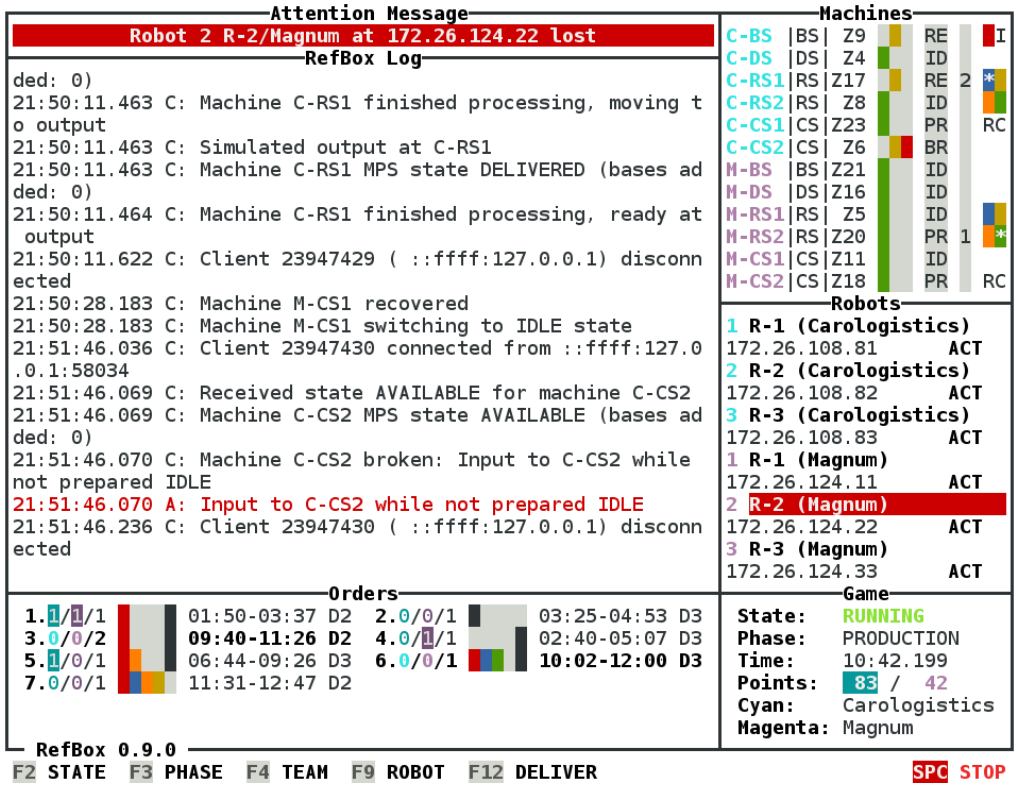
Common

- Based on Festo MPS
- Marker to identify machine
- Signal light to indicate state
- Each team has exclusive set
- Similar handling for all types

Machine Types (per team)

1× Base Station (BS): retrieve bases
2× Ring Station (RS): mount colored rings
2× Cap Station (CS): buffer/mount caps
1× Delivery Station (DS): final delivery

Semi-autonomous Referee Box



Tasks

- Determines randomized orders and machine failures
- Posts orders dynamically
- Scoring and evaluation
- Instructs MPS stations

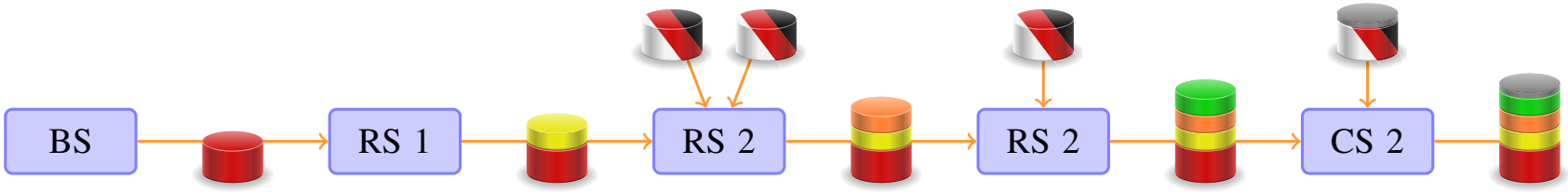
Planning and Benchmarking

- Accountable environment agency
- Same controller in simulation
- Records extensive data
- Limited uncertainty

⇒ **Repeatable benchmarks**

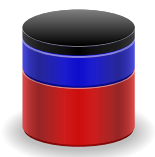
Logs game information and all communication

RoboCup Logistics League – Production



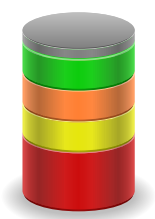
Product Composition

- Products of four complexities (number of rings)
- Base (3 colors) + 0–3 rings (4 colors) + cap (2 colors)
- Order of ring colors is important
- Some ring colors require additional material
- Actual product variants randomized by referee box
- Orders have lead time of a few minutes


Order Elements (posted dynamically by refbox)

- Product to deliver (and number thereof)
- Time window in which to deliver



Planning and Execution Competition (PExC)

RoboCup Logistics League (RCLL)

- In-factory manufacturing logistics in Smart Factory
- Maintain and optimize material flow in production
- Competition under the RoboCup umbrella

RCLL as a Planning Competition and Benchmark

- Cooperative and competitive aspects, partially observable, non-deterministic, dynamic
- Typical: local, distributed, incremental strategy
- Desired: planning for global optimization
- Challenges: coordination, execution, robustness

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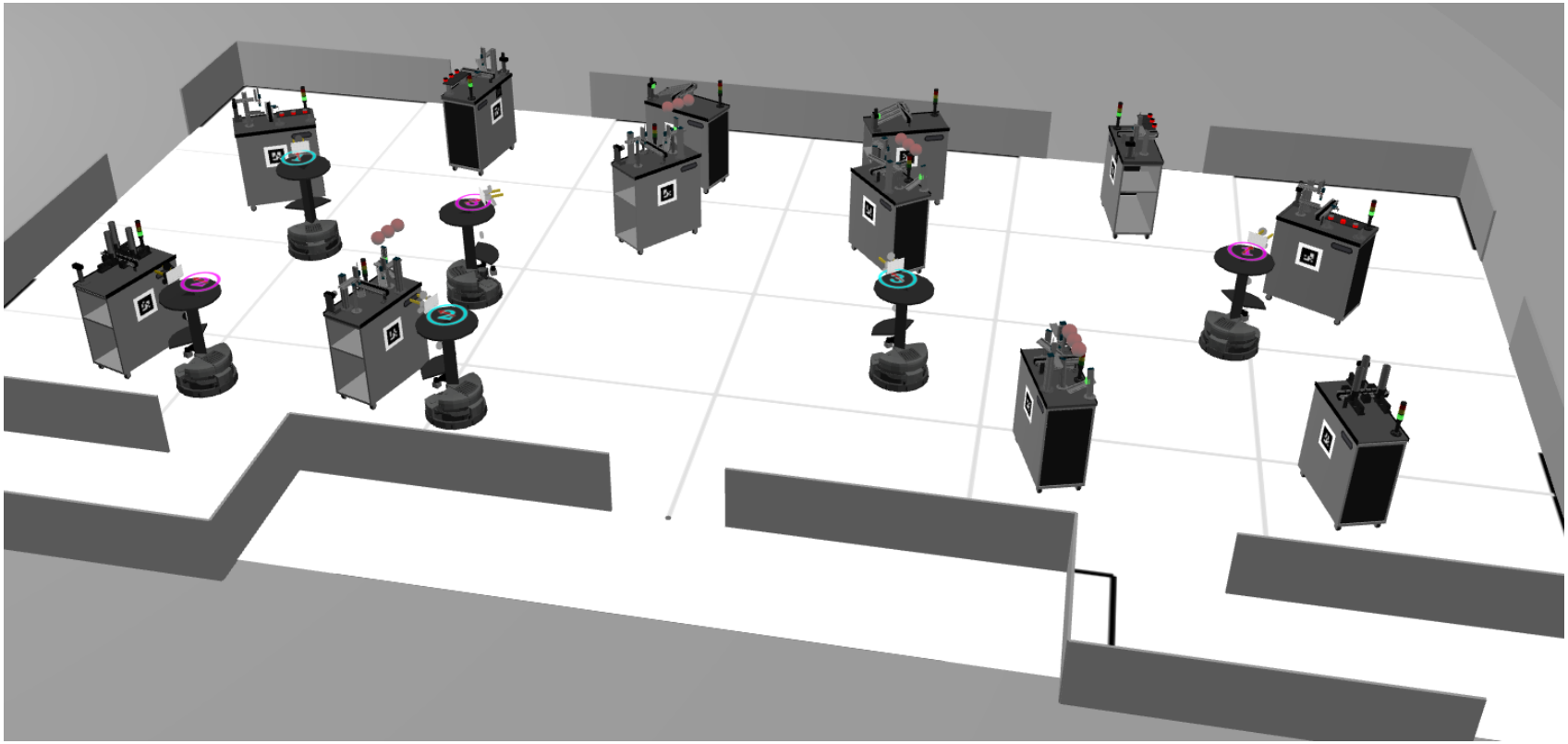
Medium complex benchmark domain focusing on efficient *planning/scheduling* and **execution integration**

RoboCup Logistics League – Simulation



- Readily integrated 3D simulation with environment agency
- In competition in Kubernetes cloud setup

System Integration

Fawkes Robot Software Framework

- Functional software components
- Lua-based Behavior Engine for skill execution
- Path planning and locomotion

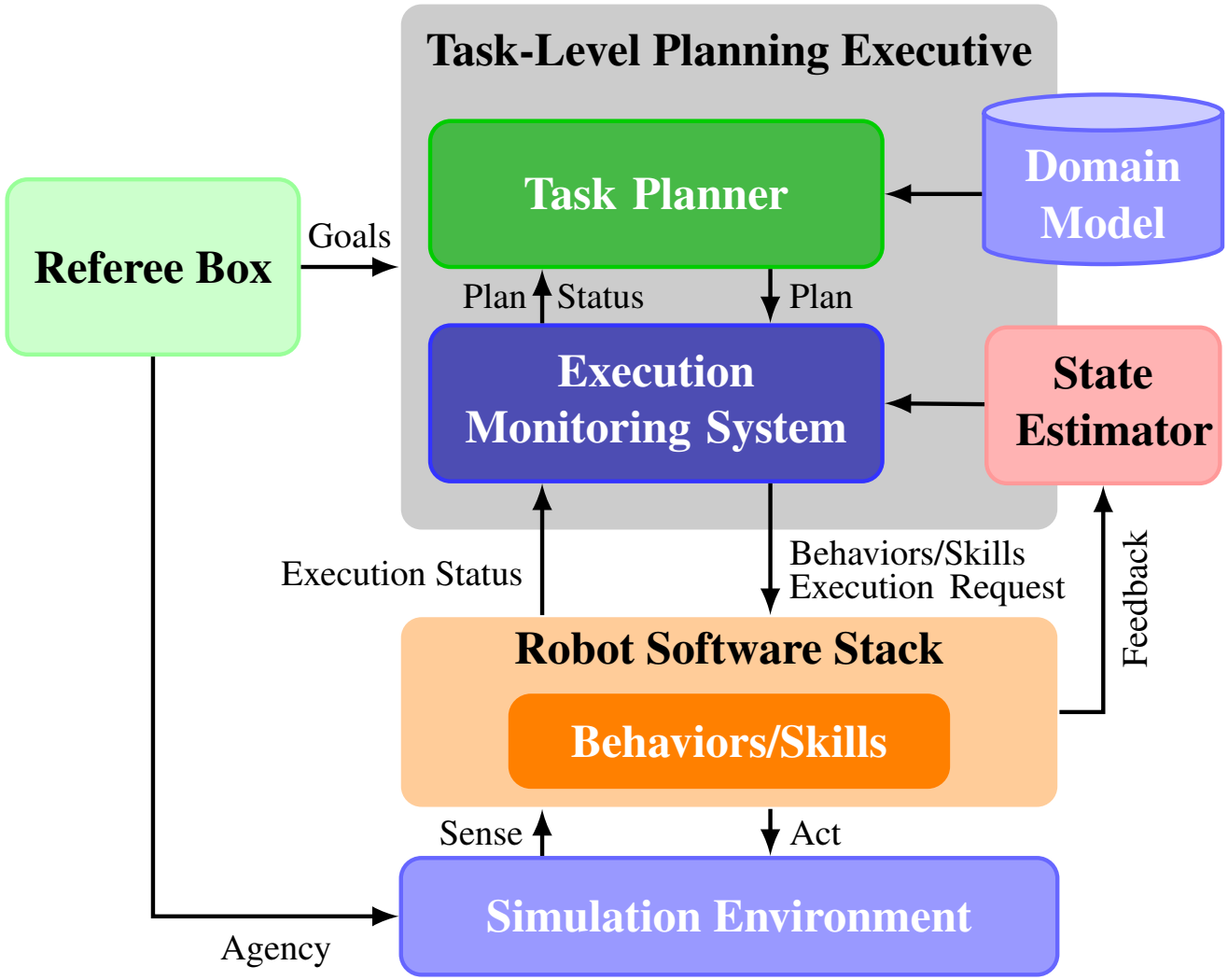
ROS

- Full integration with simulation
- Encapsulates communication with referee box
- Visualization tool

Pre-defined (extensible) Actions

- Basic set of actions required
- Extensible by custom actions

Planning System Architecture



Logistics Robots Competition

Challenge

Integrated planning and execution in a medium complex simulated robotics industry-inspired scenario

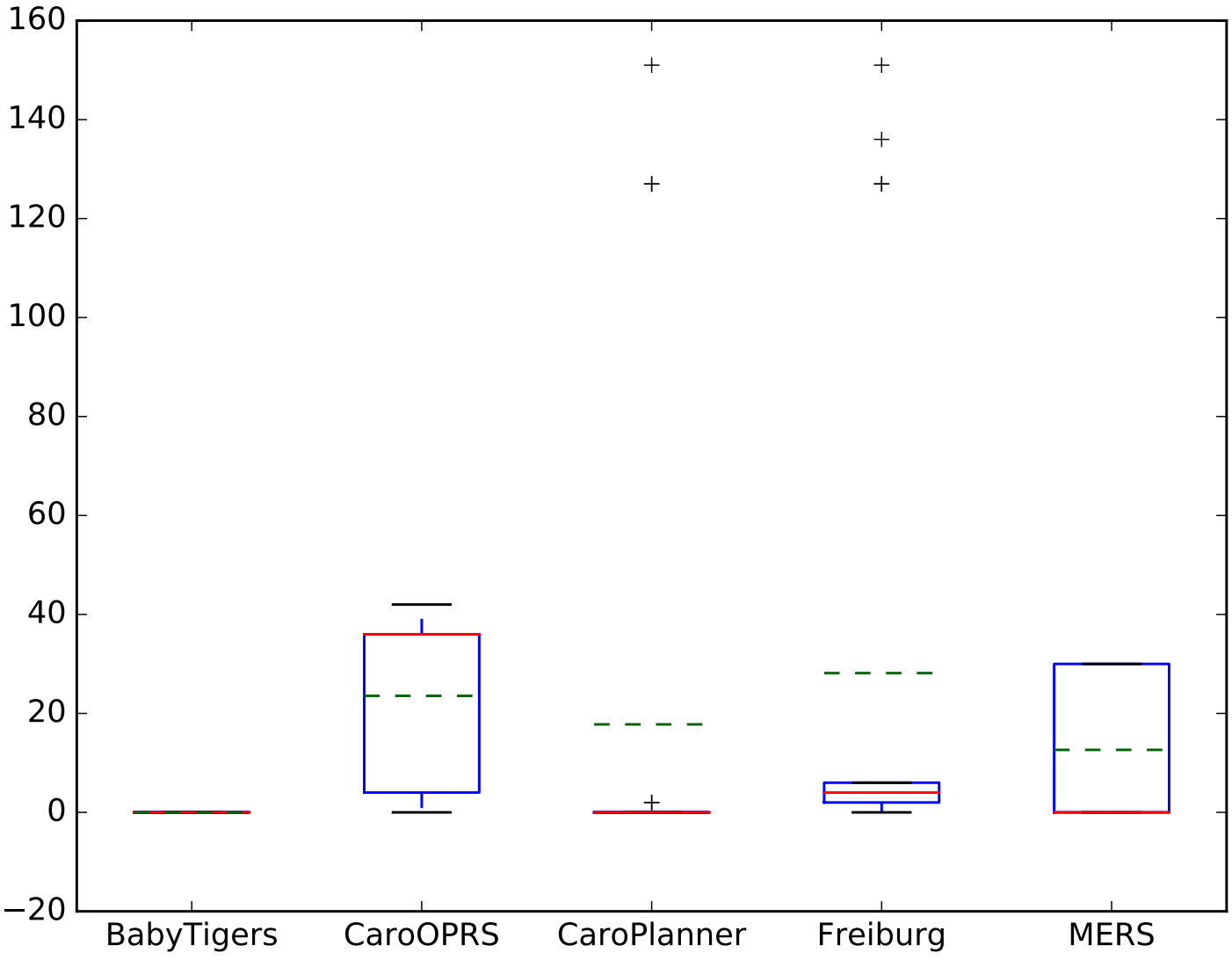
Focus

- Multi-robot Task Planning and Coordination
- Planning and Execution Integration

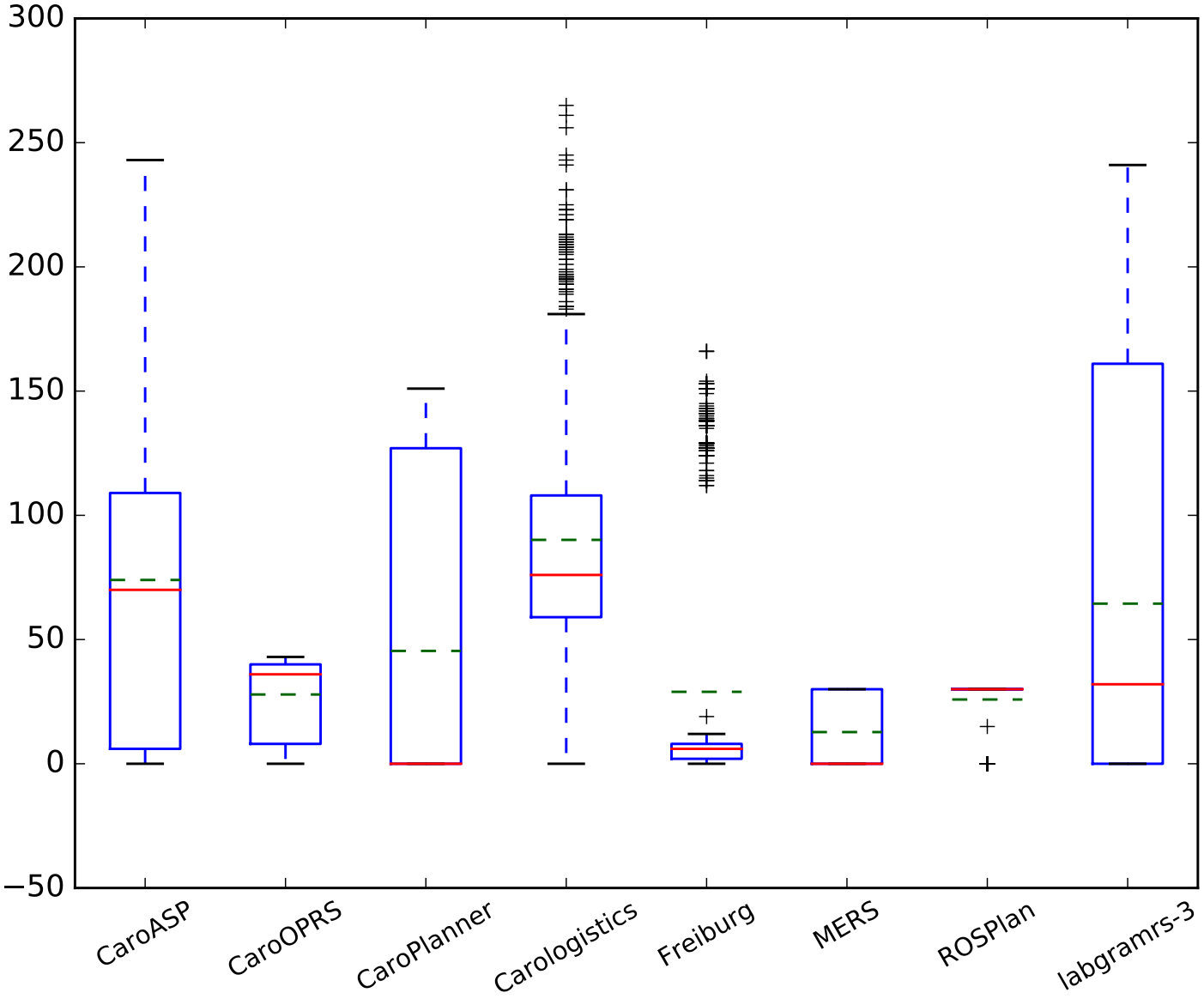
Timeline

February: Call for Participation
May: Qualifiers
June: Competition at ICAPS

Results 2017



Results 2017



Hands-on Production Example