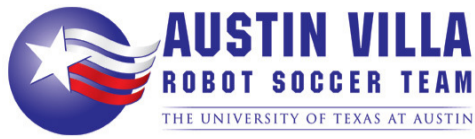


The RoboCup 2013 Drop-In Player Challenges: A Testbed for Ad Hoc Teamwork



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How can an agent cooperate with unknown teammates?

Ad Hoc Teamwork

- Only in control of single agent
- Unknown teammates
- Shared goals
- No pre-coordination



Example: Pick-up soccer game

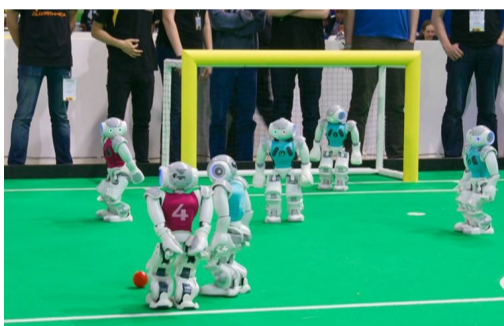
Drop-in Player Challenge

- Pick-up soccer game challenge held across three leagues at the 2013 RoboCup autonomous robot soccer competition
- Games between teams consisting of different randomly chosen players from participants in the competition
- **No pre-coordination** between teammates, teammates/opponents unknown before start of a game
- **Teams provided standard communication protocol**
- Testbed for ad hoc teamwork

Drop-in player team creation performed with **greedy algorithm** using the following drop-in player selection preferences:

1. Played fewer games
2. Played against fewer of the opponents
3. Played with fewer of the teammates
4. Played a lower maximum number of games against any one opponent or with any one teammate
5. Played a lower maximum number of games against any one opponent
6. Played a lower maximum number of games with any one teammate
7. Random

Standard Platform League (SPL)



SPL Drop-In Player Challenge

- Use Aldebaran Nao robots
- Field = 9m X 6m
- Teams contributed 1-2 drop-in players per 5 vs 5 game
- Games were played for only 5 minutes
- Robots can communicate over wifi
- Players **scored as combination of normalized average goal difference (AGD) and average score of human judges (AHS) between 0-10**

Final scores (average goal difference (AGD), normalized goal difference (NGD), average judge score (AJS)) and rankings (goal (G) and judge (J)) for the SPL drop-in challenge and also relative rankings in the main RoboCup competition.

Team	Drop-In				Main	
	AGD	NGD	AJS	Score	Rank (G,J)	Rank
B-Human	1.17	10.00	6.67	16.67	1 (1,1)	1
Nao Devils	0.57	4.90	6.24	11.14	2 (3,2)	4
rUNSWift	0.67	5.71	5.22	10.94	3 (2,4)	3
UTAustinVilla	-0.29	-2.45	6.00	3.55	4 (4,3)	2
UPennalizers	-0.57	-4.90	4.48	-0.42	5 (5,5)	6
Berlin United	-1.29	-11.02	3.38	-7.64	6 (6,6)	5

2D Simulation League



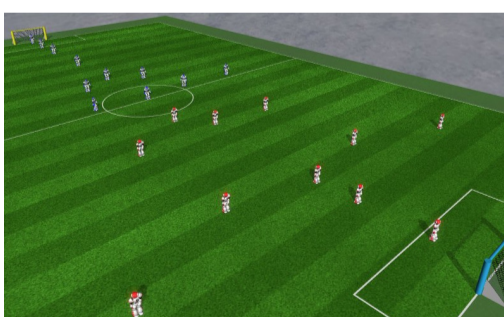
2D Drop-In Player Challenge

- Agents use primitives of "dash", "kick", and "turn" to interact with 2D environment
- Teams contribute 2 drop-in players per 7 vs 7 game (each team given a standard goalie)
- Games are 10 minutes (two 5 minute halves)
- Agents receives noisy visual information about environment
- Agents can communicate with each other over limited bandwidth channel
- Players **scored on average goal differential** across all games played

Rankings (R) and average goal difference (AGD) with standard error shown in parentheses for both the 2D drop-in player challenges and the main RoboCup competition with results given for both RoboCup (RC) and games played after the competition.

Team	Drop-In				Main		
	RC	AGD	R	AGD	RC	Vs UTAustinVilla	AGD
FCPerspolis	1	2.40	1	3.025 (0.142)	5	4	3.127 (0.059)
Yushan	2	2.25	2	2.583 (0.141)	2	3	4.034 (0.065)
ITAndroids	3	2.00	5	1.379 (0.152)	7	7	0.505 (0.063)
Axiom	4	1.20	6	1.315 (0.148)	3	5	1.800 (0.074)
UTAustinVilla	5	0.25	4	1.659 (0.153)	8	8	0.000 (self)
HfutEngine	6	-0.20	7	-2.076 (0.153)	9	9	-6.027 (0.184)
WrightEagle	7	-1.60	9	-6.218 (0.129)	1	1	6.176 (0.287)
FCPortugal	8	-2.20	8	-3.379 (0.150)	6	6*	*
AUTMasterminds	9	-2.80	3	1.711 (0.152)	4	2	5.111 (0.117)

3D Simulation League



3D Drop-In Player Challenge

- Agents modeled after Aldebaran Nao robot
- Realistic physics using Open Dynamics Engine (ODE)
- Teams contribute 2 drop-in players per 10 vs 10 game (no goalies)
- Agents receives noisy visual information about environment
- Agents can communicate with each other over limited bandwidth channel
- Players **scored on average goal differential** across all games played

Rankings (R) and average goal difference (AGD) with standard error shown in parentheses for both the 3D drop-in player challenges and the main RoboCup competition with results given for both RoboCup (RC) and games played after the competition.

Team	Drop-In				Main		
	RC	AGD	R	AGD	RC	Vs UTAustinVilla	AGD
BoldHearts	1	1.50	4	0.178 (0.068)	T5	6	-1.607 (0.029)
FCPortugal	T2	0.75	1	1.159 (0.060)	3	2	-0.465 (0.023)
Bahia3D	T2	0.75	7	-0.378 (0.068)	10	10	-9.800 (0.110)
Apollo3D	T2	0.75	5	0.159 (0.068)	1	3	-0.698 (0.027)
magmaOffenburg	5	0.25	3	0.254 (0.068)	T5	5	-1.447 (0.026)
RoboCanes	6	-0.50	6	-0.286 (0.068)	T5	7	-1.828 (0.031)
UTAustinVilla	T7	-0.75	2	0.784 (0.065)	2	1	0.000 (self)
SEUJolly	T7	-0.75	9	-0.613 (0.066)	4	4	-1.133 (0.027)
Photon	T7	-0.75	8	-0.425 (0.068)	8	8	-4.590 (0.081)
L3MSIM	10	-1.25	10	-0.832 (0.065)	9	9	-6.050 (0.098)

UTAustinVilla Drop-In Player Challenge Strategies

- **Standard Platform League (SPL):** Assign roles to players based on communicated positions on field
- **2D Simulation League:** Use dynamic role assignment to adapt to teammates and assume positions on the field not already occupied
- **3D Simulation League:** Evaluate teammates' communicated information to determine if they are trustworthy and assume support position if not closest to ball

Analysis

- Considerable noise makes it **hard to evaluate players** with only a **small number of games**
- Teams better at regular soccer do better at the drop-in player challenge: **open question on how to best judge teamwork**
- **Dynamic role assignment good** when players have **equal skills** (2D); **detrimental** when **range in skill level** (3D)

2014 RoboCup Drop-In Player Challenges

- **Standard Platform League (SPL):** Mandatory participation and attempting to standardize human judge scoring
- **2D Simulation League:** Interest in holding the challenge again but no decision on this has been made yet
- **3D Simulation League:** Challenge will be held again with similar rules to 2013

Videos at <http://www.cs.utexas.edu/~AustinVilla/sim/3dsimulation/AustinVilla3DSimulationFiles/2013/html/dropin.html>