

## A Experiments

The list of all the experimental scenarios<sup>4</sup> varied across physical goals and social goals for the two agents (yellow robot and red robot), Table 2. Each scenario has agents as having either the same physical goal or different physical goals and one of 7 different scaling factors on each of their social goals (-2, -1, -0.5, 0, 0.5, 1, 2) ( $2 * 7 * 7 = 98$  scenarios). 2 indicates that the social goal is weighted much more than the physical goal, and an agent wants to maximize the other agent’s goal. Similarly for -2, except that an agent wants to minimize another agent’s goal. At 1, agents weigh their own social goals equally with their own physical goals. At 0.5, they put twice as much weight on their physical goals as their social goals. These agents are less likely to help, particularly if helping will cost more time or energy than carrying out the physical goal. Finally, either agent can have the factor set to zero; these agents only have a physical goal and no social goal.

Table 2: An enumeration of all 98 scenarios for different configurations of physical and social goals of the robots.

Scenario Id	Yellow Robot		Red Robot	
	Physical Goal	Social Scaling	Physical Goal	Social Scaling
S1	Tree	-2	Flower	-2
S2	Tree	-2	Flower	-1
S3	Tree	-2	Flower	-0.5
S4	Tree	-2	Flower	0
S5	Tree	-2	Flower	0.5
S6	Tree	-2	Flower	1
S7	Tree	-2	Flower	2
S8	Tree	-1	Flower	-2
S9	Tree	-1	Flower	-1
S10	Tree	-1	Flower	-0.5
S11	Tree	-1	Flower	0
S12	Tree	-1	Flower	0.5
S13	Tree	-1	Flower	1
S14	Tree	-1	Flower	2
S15	Flower	-0.5	Tree	-2
S16	Tree	-0.5	Flower	-1
S17	Tree	-0.5	Flower	-0.5
S18	Tree	-0.5	Flower	0
S19	Tree	-0.5	Flower	0.5
S20	Tree	-0.5	Flower	1
S21	Tree	-0.5	Flower	2
S22	Tree	0	Flower	-2
S23	Tree	0	Flower	-1
S24	Tree	0	Flower	-0.5
S25	Tree	0	Flower	0
S26	Tree	0	Flower	0.5
S27	Tree	0	Flower	1
S28	Tree	0	Flower	2
S29	Tree	0.5	Flower	-2
S30	Tree	0.5	Flower	-1
S31	Tree	0.5	Flower	-0.5
S32	Tree	0.5	Flower	0
S33	Tree	0.5	Flower	0.5
S34	Tree	0.5	Flower	1
S35	Tree	0.5	Flower	2
S36	Tree	1	Flower	-2
S37	Tree	1	Flower	-1

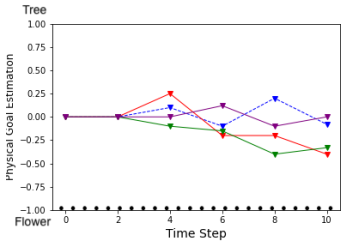
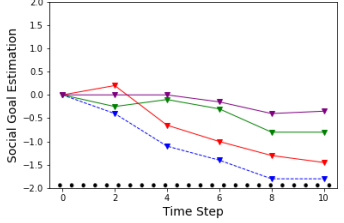
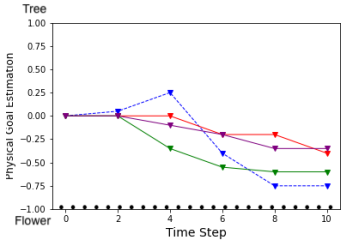
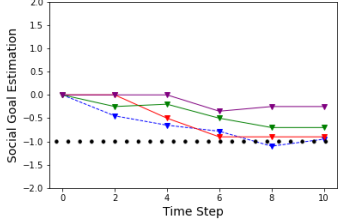
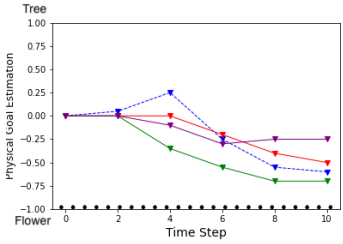
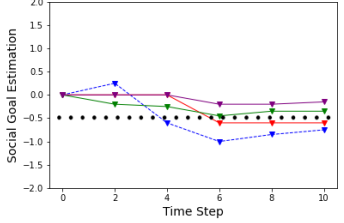
<sup>4</sup>Interactions for the experimental scenarios can be viewed at <https://social-mdp.github.io/scenarios>

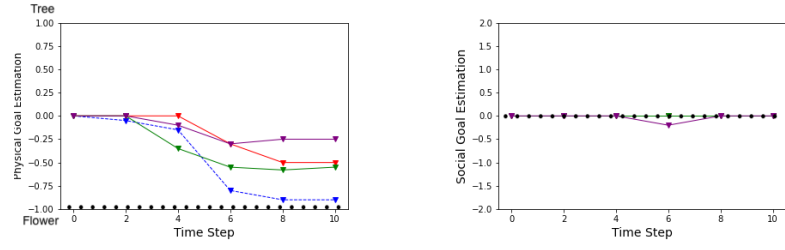
S38	Tree	1	Flower	-0.5
S39	Tree	1	Flower	0
S40	Tree	1	Flower	0.5
S41	Tree	1	Flower	1
S42	Tree	1	Flower	2
S43	Tree	2	Flower	-2
S44	Tree	2	Flower	-1
S45	Tree	2	Flower	-0.5
S46	Tree	2	Flower	0
S47	Tree	2	Flower	0.5
S48	Tree	2	Flower	1
S49	Tree	2	Flower	2
S50	Tree	-2	Tree	-2
S51	Tree	-2	Tree	-1
S52	Tree	-2	Tree	-0.5
S53	Tree	-2	Tree	0
S54	Tree	-2	Tree	0.5
S55	Tree	-2	Tree	1
S56	Tree	-2	Tree	2
S57	Tree	-1	Tree	-2
S58	Tree	-1	Tree	-1
S59	Tree	-1	Tree	-0.5
S60	Tree	-1	Tree	0
S61	Tree	-1	Tree	0.5
S62	Tree	-1	Tree	1
S63	Tree	-1	Tree	2
S64	Tree	-0.5	Tree	-2
S65	Tree	-0.5	Tree	-1
S66	Tree	-0.5	Tree	-0.5
S67	Tree	-0.5	Tree	0
S68	Tree	-0.5	Tree	0.5
S69	Tree	-0.5	Tree	1
S70	Tree	-0.5	Tree	2
S71	Tree	0	Tree	-2
S72	Tree	0	Tree	-1
S73	Tree	0	Tree	-0.5
S74	Tree	0	Tree	0
S75	Tree	0	Tree	0.5
S76	Tree	0	Tree	1
S77	Tree	0	Tree	2
S78	Tree	0.5	Tree	-2
S79	Tree	0.5	Tree	-1
S80	Tree	0.5	Tree	-0.5
S81	Tree	0.5	Tree	0
S82	Tree	0.5	Tree	0.5
S83	Tree	0.5	Tree	1
S84	Tree	0.5	Tree	2
S85	Tree	1	Tree	-2
S86	Tree	1	Tree	-1
S87	Tree	1	Tree	-0.5
S88	Tree	1	Tree	0
S89	Tree	1	Tree	0.5
S90	Tree	1	Tree	1
S91	Tree	1	Tree	2
S92	Tree	2	Tree	-2
S93	Tree	2	Tree	-1
S94	Tree	2	Tree	-0.5
S95	Tree	2	Tree	0
S96	Tree	2	Tree	0.5

S97	Tree	2	Tree	1
S98	Tree	2	Tree	2

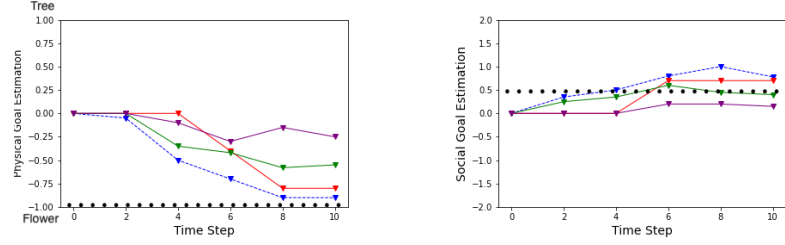
For each of the experiment scenario we show the Yellow robot's estimation of the physical and social goal of the red robot at each time step. The overall performance of Social MDPs and the baselines against the ground truth is reported in Table 1, with Table 3 showing the inferences of the model and baselines.

Table 3: Using Social MDP, at different levels of reasoning, Yellow robot estimates the physical and social goal of the red robot at each time step. The lines in **red** are Human scores, in **blue** is our Social MDP scores, in **green** is Inverse planning [12], in **purple** is the cue-based model [21], and in **dotted** is the ground truth).

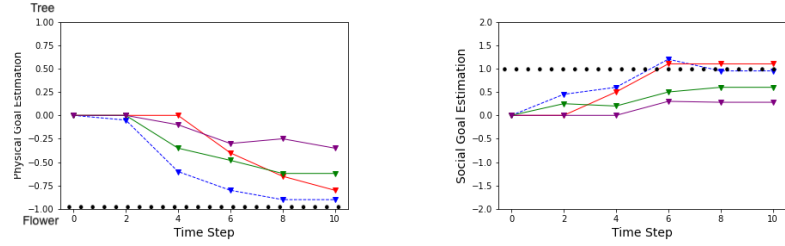
Scenario Id	Physical goal estimation (Level 1)	Social goal estimation (Level 2)
S1	Red robot is initialized with the physical goal of Flower and social goal of -2. Yellow robot is initialized with the physical goal of Tree and social goal of -2.	
		
S2	Red robot is initialized with the physical goal of Flower and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of -2.	
		
S3	Red robot is initialized with the physical goal of Flower and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -2.	
		
S4	Red robot is initialized with the physical goal of Flower and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of -2.	



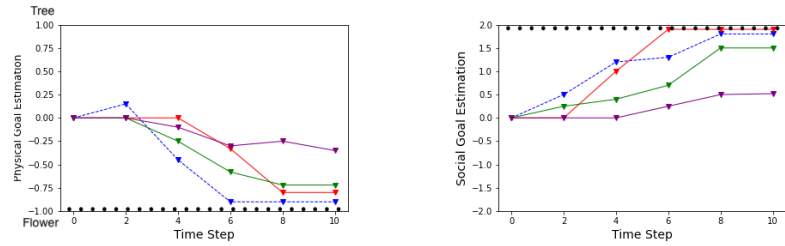
S5 Red robot is initialized with the physical goal of Flower and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



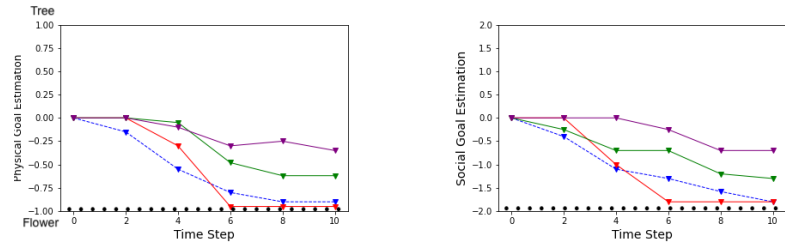
S6 Red robot is initialized with the physical goal of Flower and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



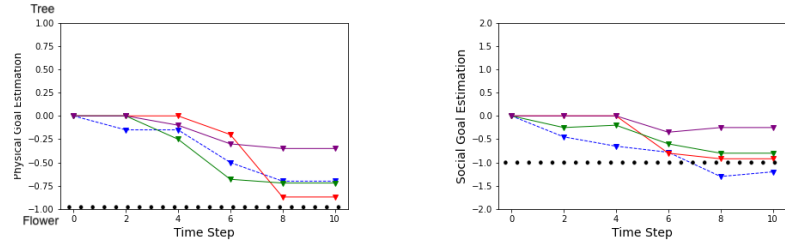
S7 Red robot is initialized with the physical goal of Flower and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



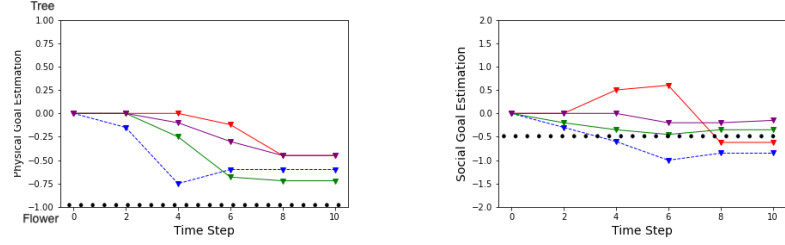
S8 Red robot is initialized with the physical goal of Flower and social goal of -2. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



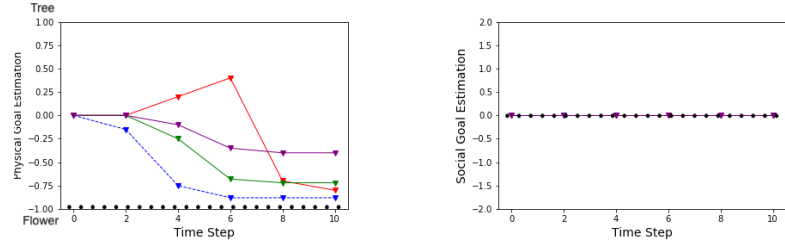
S9 Red robot is initialized with the physical goal of Flower and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



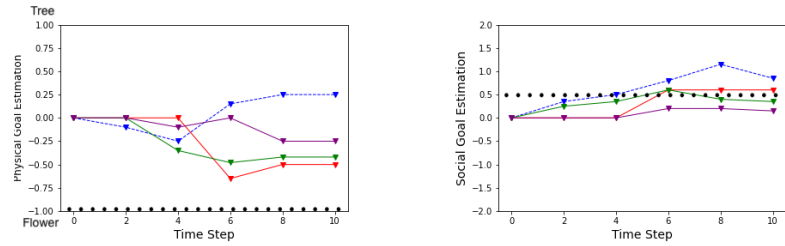
- S10 Red robot is initialized with the physical goal of Flower and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



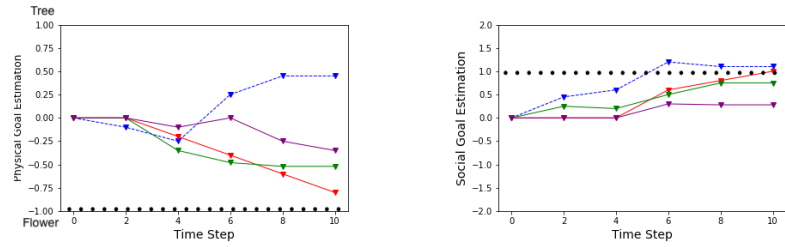
- S11 Red robot is initialized with the physical goal of Flower and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



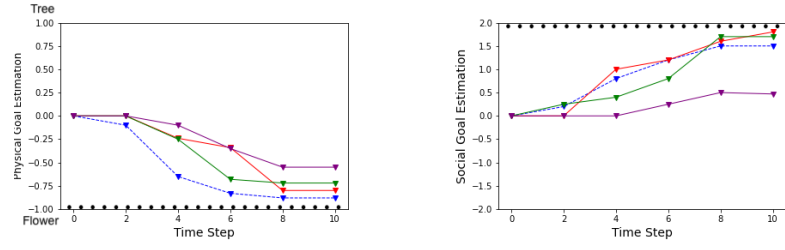
- S12 Red robot is initialized with the physical goal of Flower and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



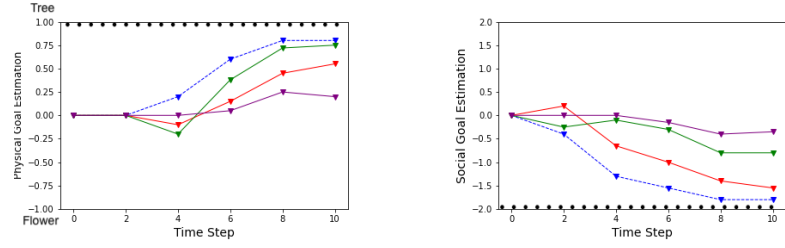
- S13 Red robot is initialized with the physical goal of Flower and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



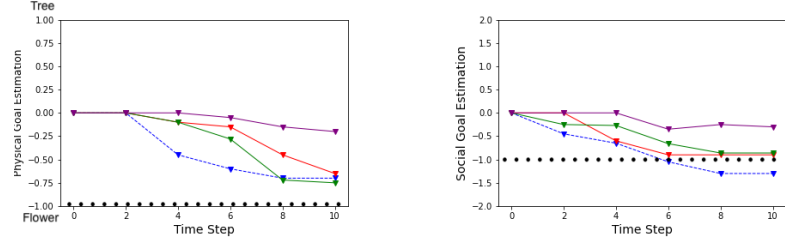
- S14 Red robot is initialized with the physical goal of Flower and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



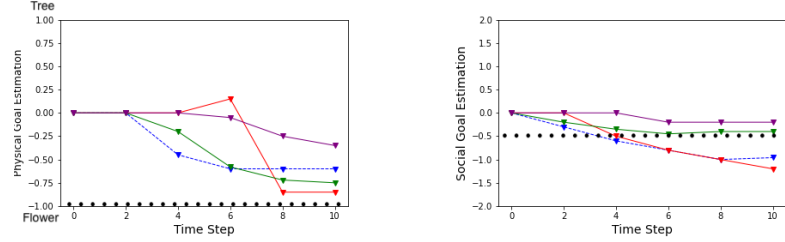
- S15 Red robot is initialized with the physical goal of Tree and social goal of -2. Yellow robot is initialized with the physical goal of Flower and social goal of -0.5.



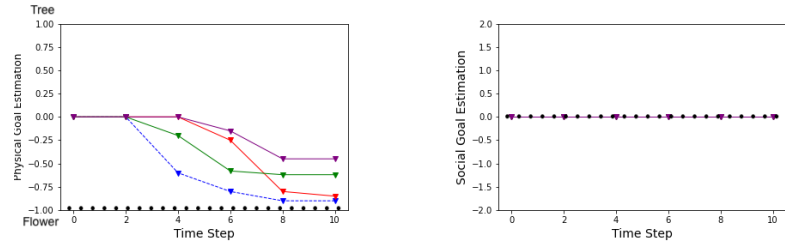
- S16 Red robot is initialized with the physical goal of Flower and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of -0.5.



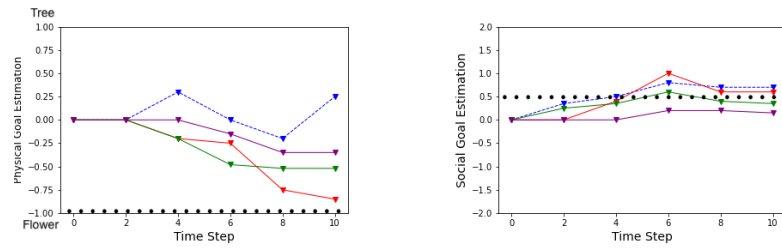
- S17 Red robot is initialized with the physical goal of Flower and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -0.5.



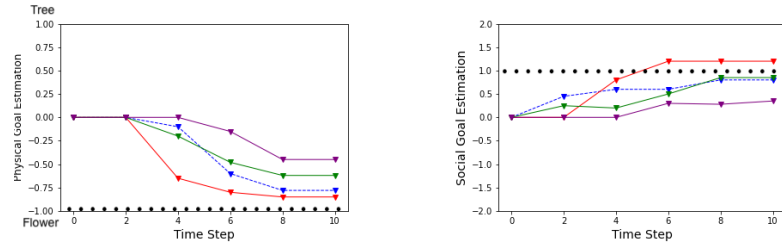
- S18 Red robot is initialized with the physical goal of Flower and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of -0.5.



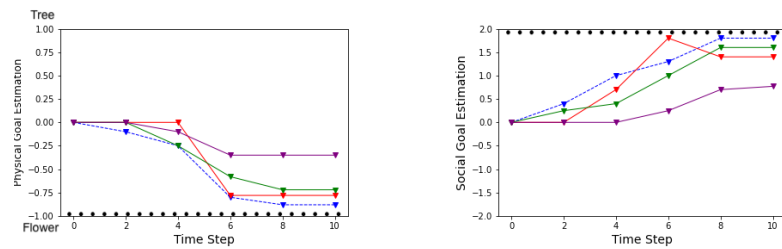
- S19 Red robot is initialized with the physical goal of Flower and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -0.5.



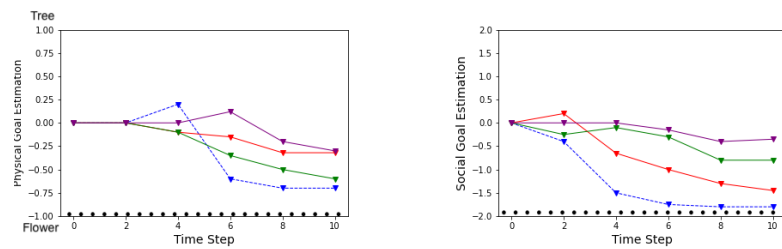
S20 Red robot is initialized with the physical goal of Flower and social goal of 1.  
Yellow robot is initialized with the physical goal of Tree and social goal of -0.5.



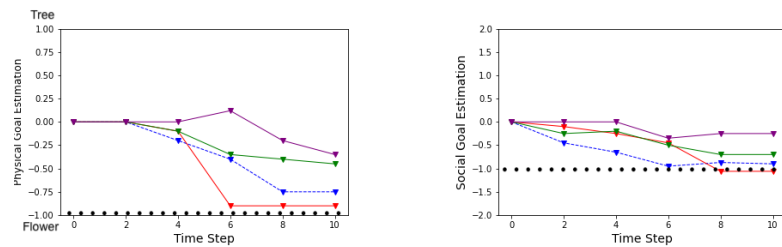
S21 Red robot is initialized with the physical goal of Flower and social goal of 2.  
Yellow robot is initialized with the physical goal of Tree and social goal of -0.5.



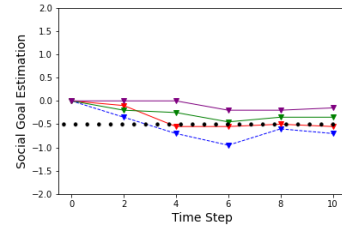
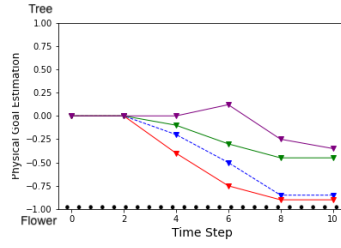
S22 Red robot is initialized with the physical goal of Flower and social goal of -2. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



S23 Red robot is initialized with the physical goal of Flower and social goal of -1.  
Yellow robot is initialized with the physical goal of Tree and social goal of 0.

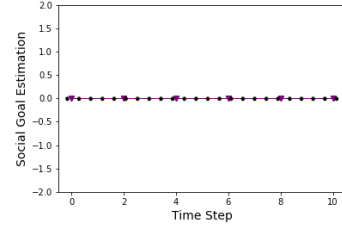
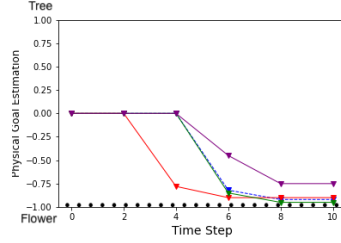


S24	Red robot is initialized with the physical goal of Flower and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 0.
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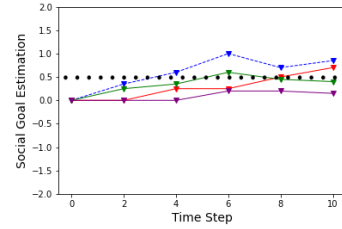
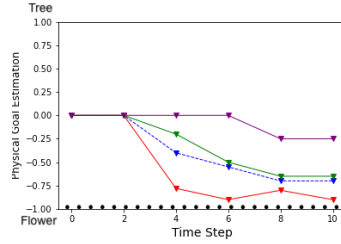
S25

Red robot is initialized with the physical goal of Flower and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



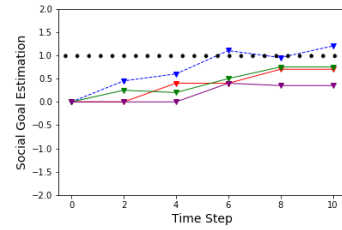
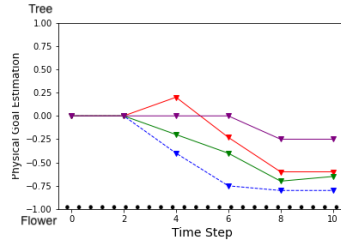
S26

Red robot is initialized with the physical goal of Flower and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



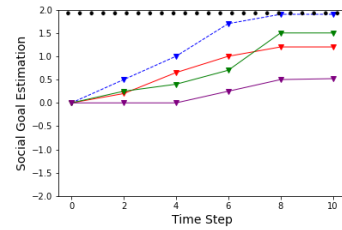
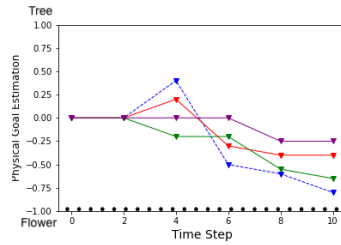
S27

Red robot is initialized with the physical goal of Flower and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



S28

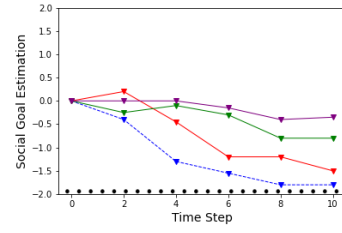
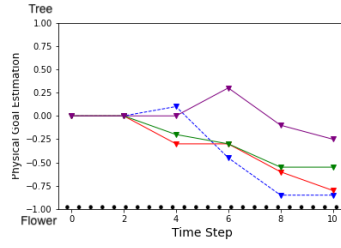
Red robot is initialized with the physical goal of Flower and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



S29

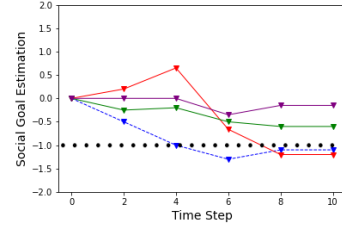
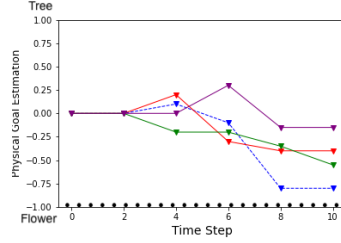
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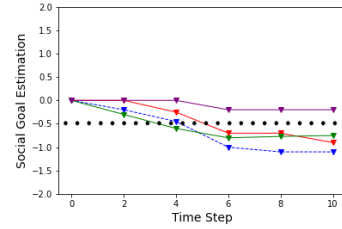
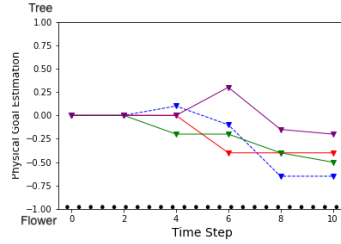
S30

Red robot is initialized with the physical goal of Flower and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of 0.5.



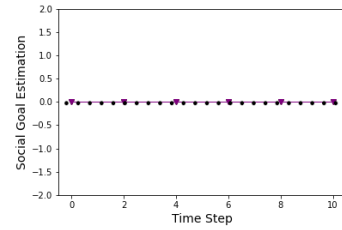
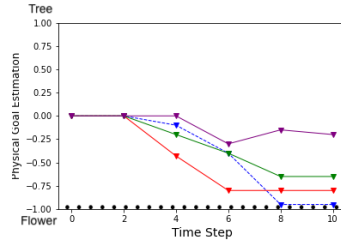
S31

Red robot is initialized with the physical goal of Flower and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 0.5.



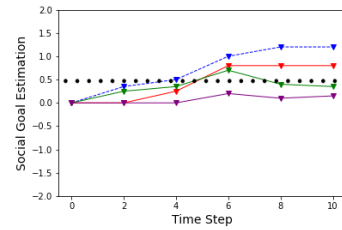
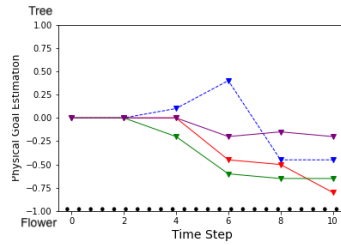
S32

Red robot is initialized with the physical goal of Flower and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of 0.5.



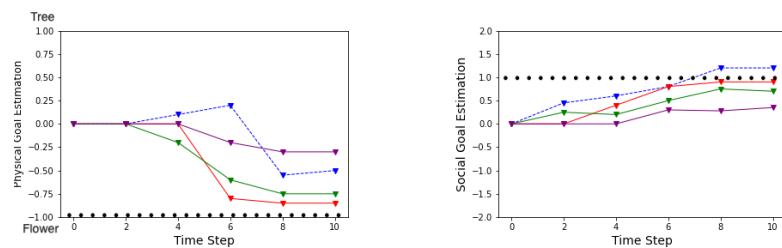
S33

Red robot is initialized with the physical goal of Flower and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 0.5.

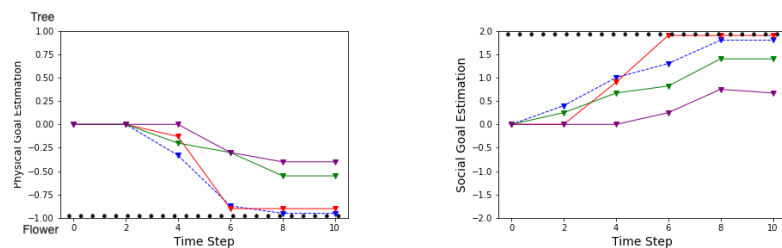


S34

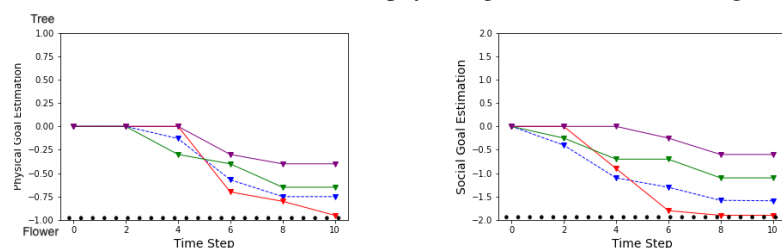
Red robot is initialized with the physical goal of Flower and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of 0.5.



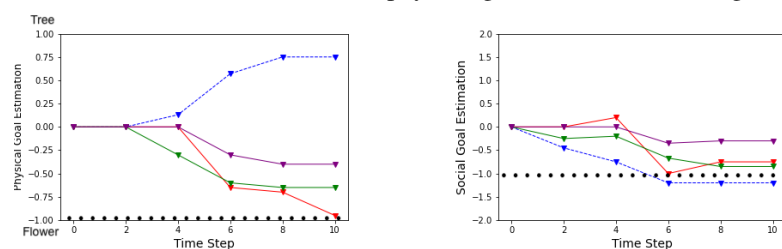
S35 Red robot is initialized with the physical goal of Flower and social goal of 2.  
Yellow robot is initialized with the physical goal of Tree and social goal of 0.5.



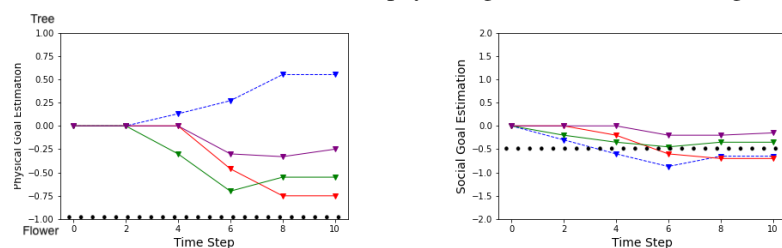
S36 Red robot is initialized with the physical goal of Flower and social goal of -2.  
Yellow robot is initialized with the physical goal of Tree and social goal of 1.



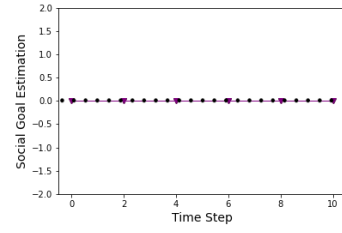
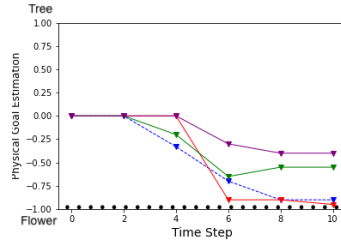
S37 Red robot is initialized with the physical goal of Flower and social goal of -1.  
Yellow robot is initialized with the physical goal of Tree and social goal of 1.



S38	Red robot is initialized with the physical goal of Flower and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 1.
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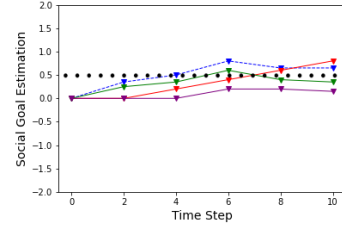
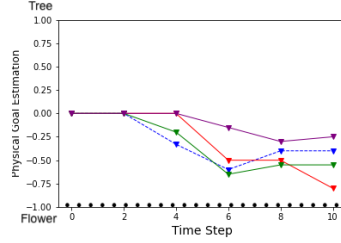


S39	Red robot is initialized with the physical goal of Flower and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of 1.
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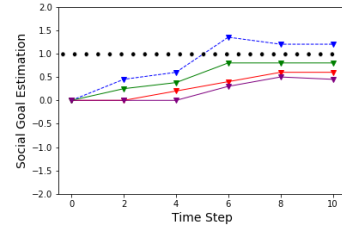
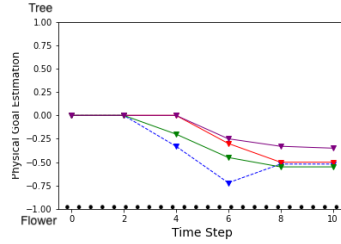
S40

Red robot is initialized with the physical goal of Flower and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 1.



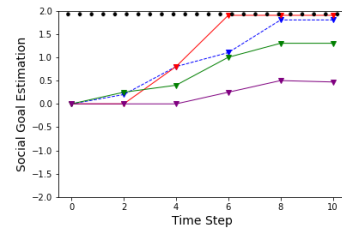
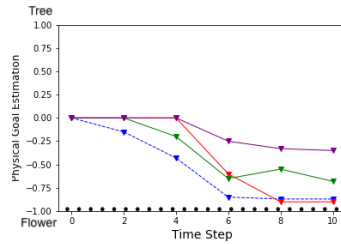
S41

Red robot is initialized with the physical goal of Flower and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of 1.



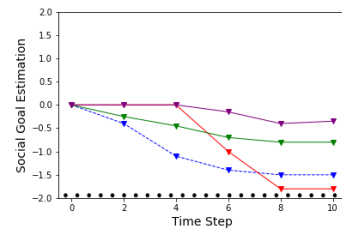
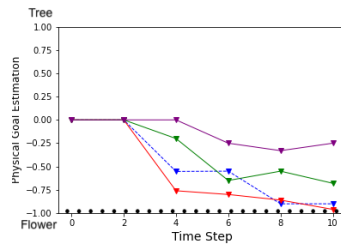
S42

Red robot is initialized with the physical goal of Flower and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of 1.



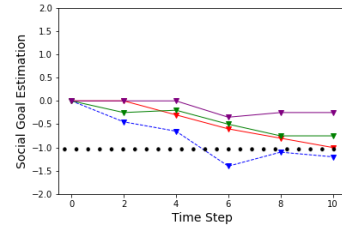
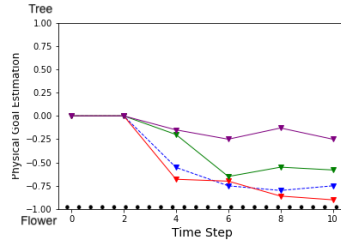
S43

Red robot is initialized with the physical goal of Flower and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of 2.



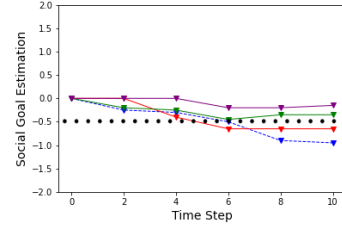
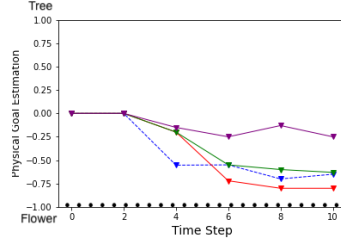
S44

Red robot is initialized with the physical goal of Flower and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of 2.



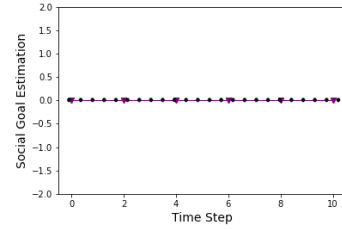
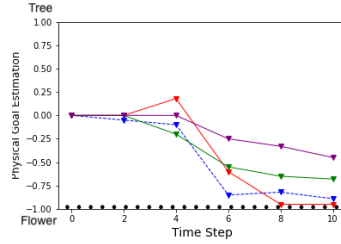
S45

Red robot is initialized with the physical goal of Flower and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 2.



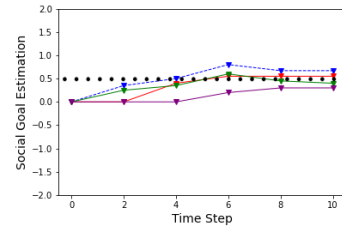
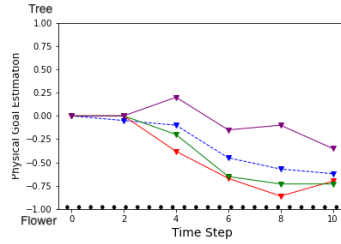
S46

Red robot is initialized with the physical goal of Flower and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of 2.



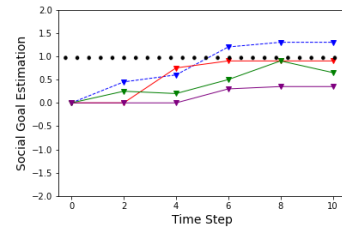
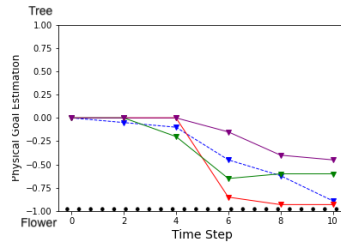
S47

Red robot is initialized with the physical goal of Flower and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 2.



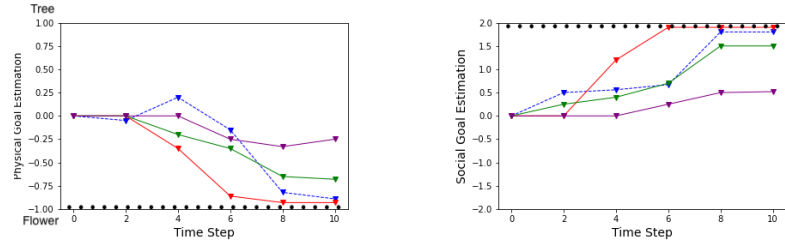
S48

Red robot is initialized with the physical goal of Flower and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of 2.

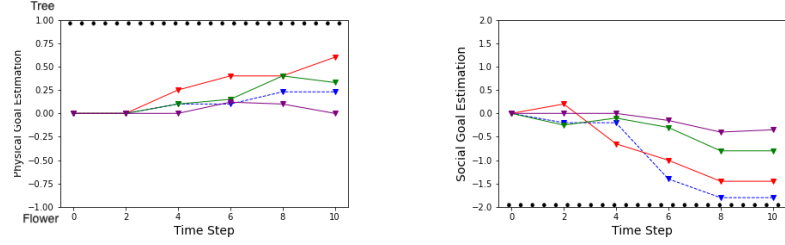


S49

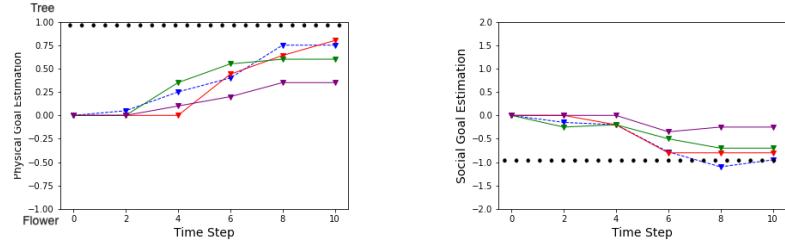
Red robot is initialized with the physical goal of Flower and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of 2.



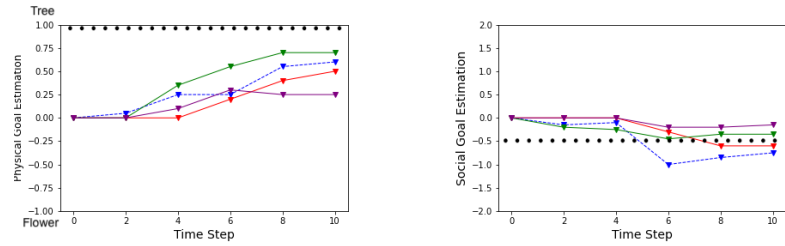
S50 Red robot is initialized with the physical goal of Tree and social goal of -2. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



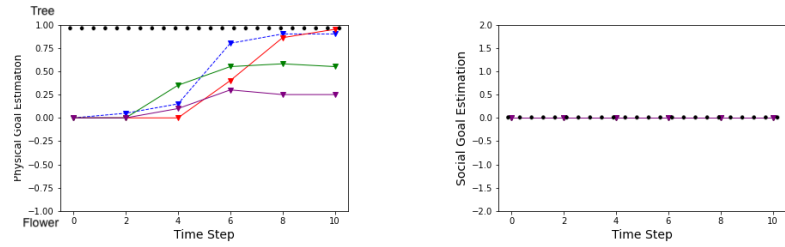
S51 Red robot is initialized with the physical goal of Tree and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



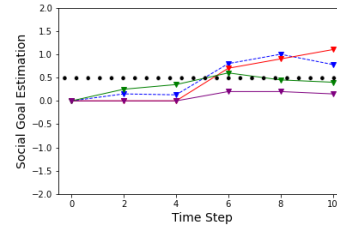
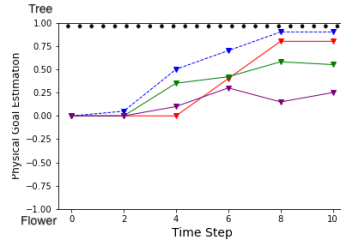
S52 Red robot is initialized with the physical goal of Tree and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



S53 Red robot is initialized with the physical goal of Tree and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of -2.

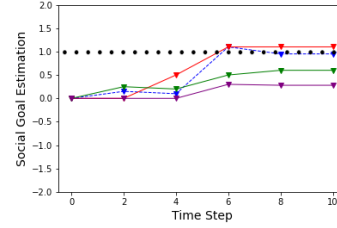
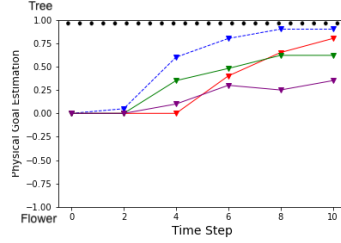


S54 Red robot is initialized with the physical goal of Tree and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



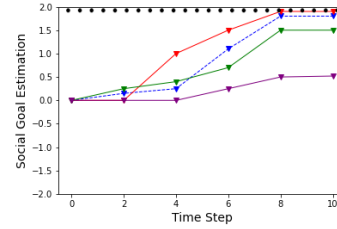
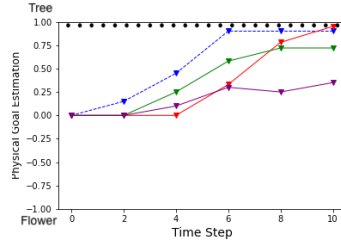
S55

Red robot is initialized with the physical goal of Tree and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



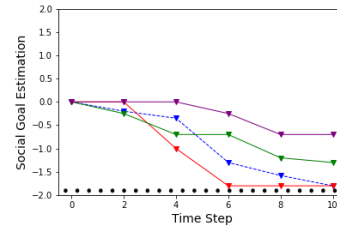
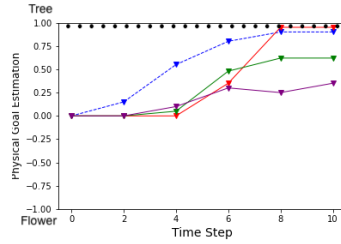
S56

Red robot is initialized with the physical goal of Tree and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of -2.



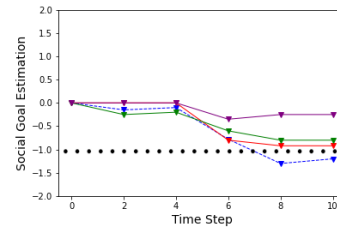
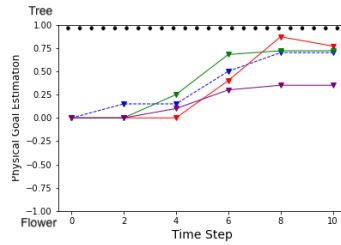
S57

Red robot is initialized with the physical goal of Tree and social goal of -2. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



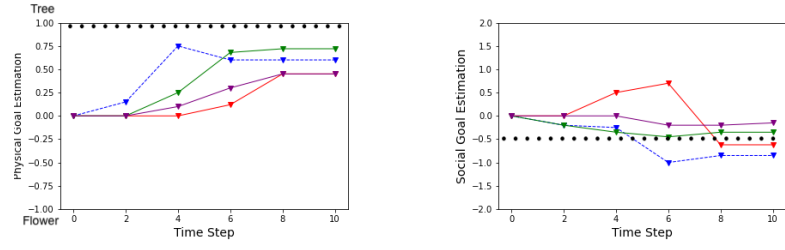
S58

Red robot is initialized with the physical goal of Tree and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



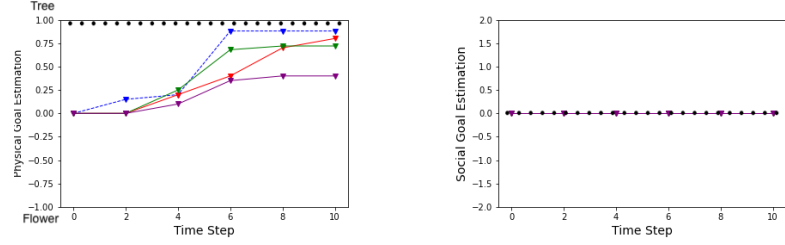
S59

Red robot is initialized with the physical goal of Tree and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



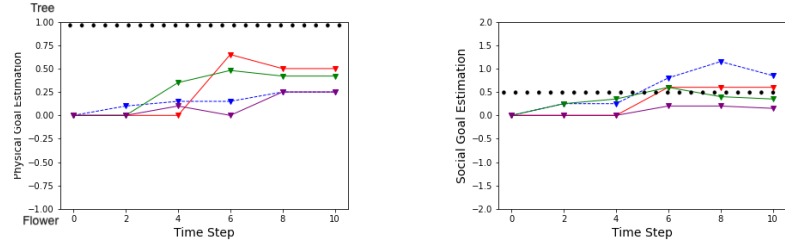
S60

Red robot is initialized with the physical goal of Tree and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



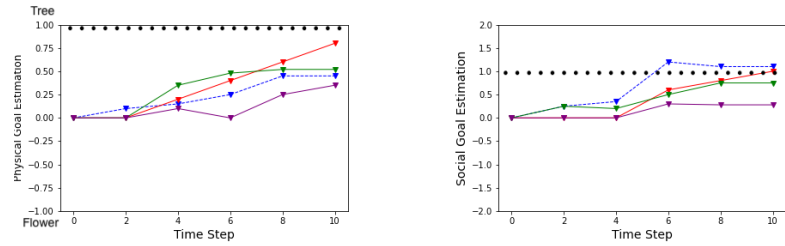
S61

Red robot is initialized with the physical goal of Tree and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



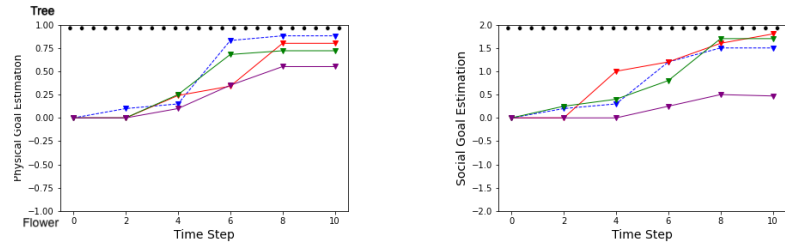
S62

Red robot is initialized with the physical goal of Tree and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of -1.



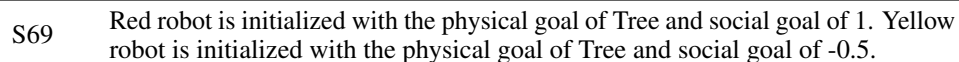
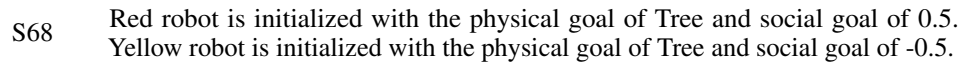
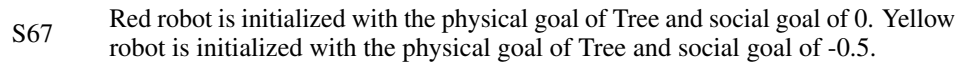
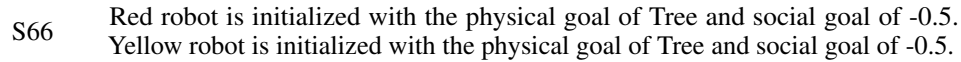
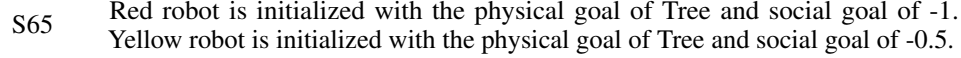
S63

Red robot is initialized with the physical goal of Tree and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of -1.

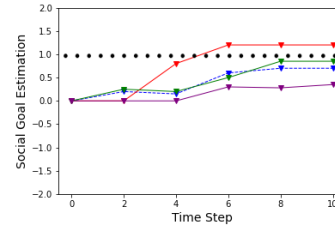
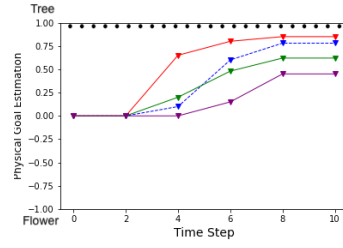


S64

Red robot is initialized with the physical goal of Tree and social goal of -2. Yellow robot is initialized with the physical goal of Tree and social goal of -0.5.

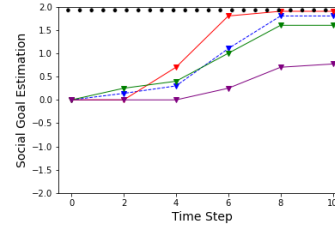
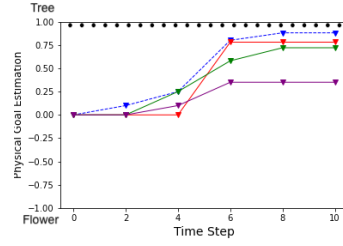






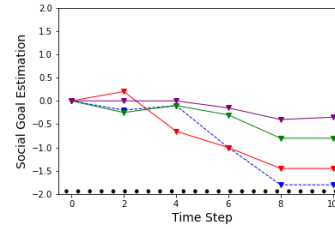
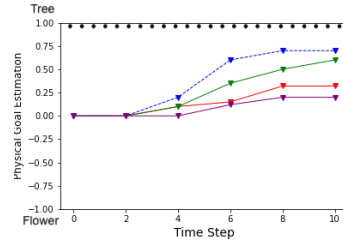
S70

Red robot is initialized with the physical goal of Tree and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of -0.5.



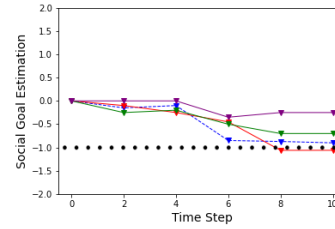
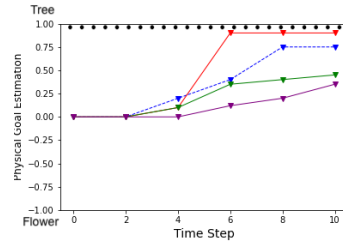
S71

Red robot is initialized with the physical goal of Tree and social goal of -2. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



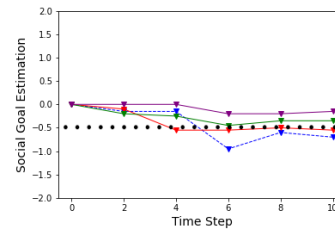
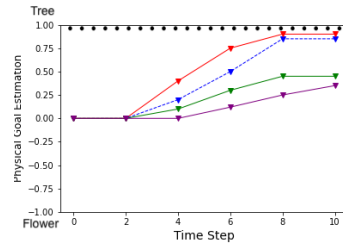
S72

Red robot is initialized with the physical goal of Tree and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



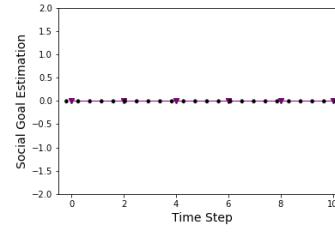
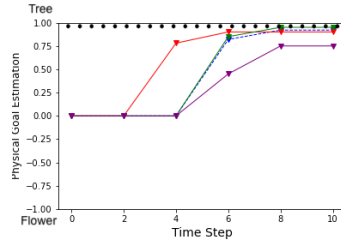
S73

Red robot is initialized with the physical goal of Tree and social goal of -0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



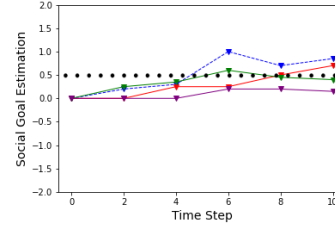
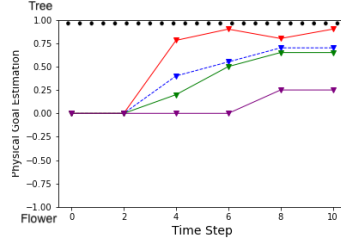
S74

Red robot is initialized with the physical goal of Tree and social goal of 0. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



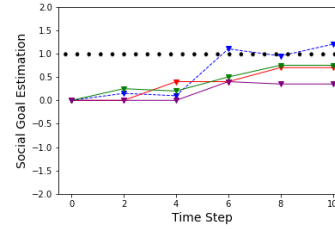
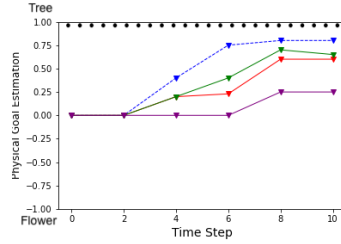
S75

Red robot is initialized with the physical goal of Tree and social goal of 0.5. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



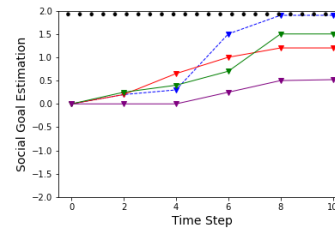
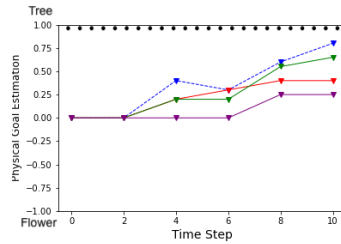
S76

Red robot is initialized with the physical goal of Tree and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



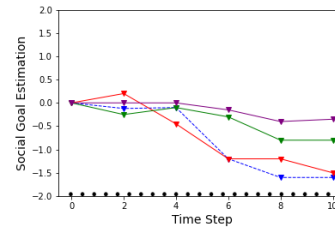
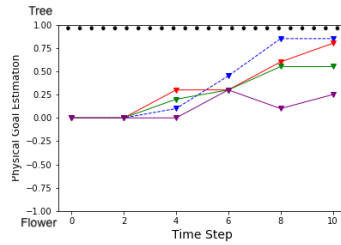
S77

Red robot is initialized with the physical goal of Tree and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of 0.



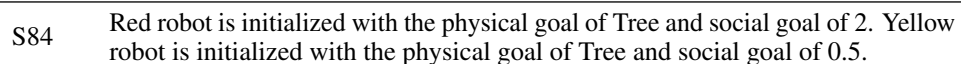
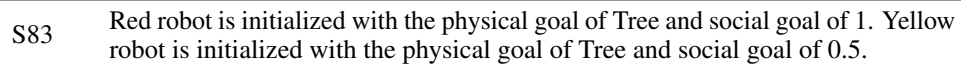
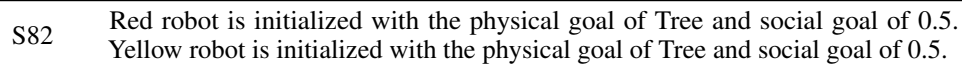
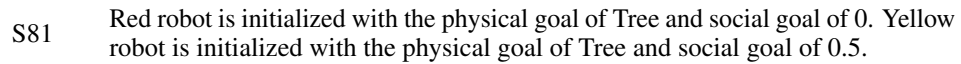
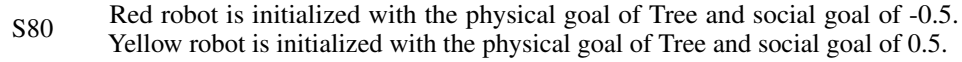
S78

Red robot is initialized with the physical goal of Tree and social goal of -2. Yellow robot is initialized with the physical goal of Tree and social goal of 0.5.

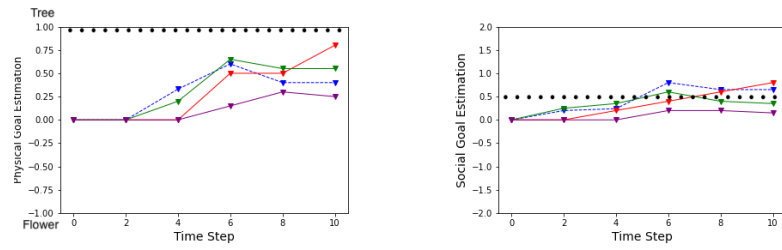


S79

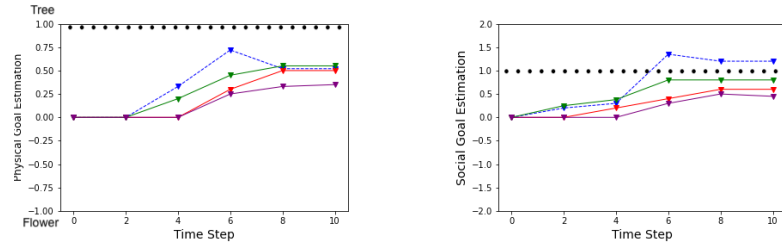
Red robot is initialized with the physical goal of Tree and social goal of -1. Yellow robot is initialized with the physical goal of Tree and social goal of 0.5.



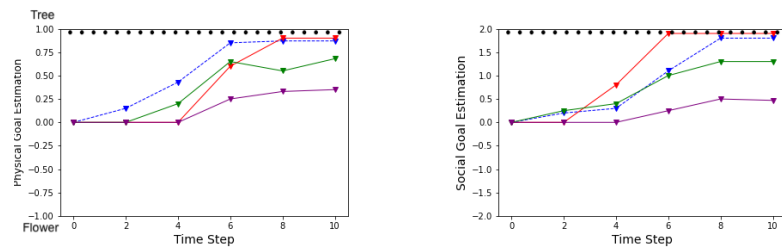




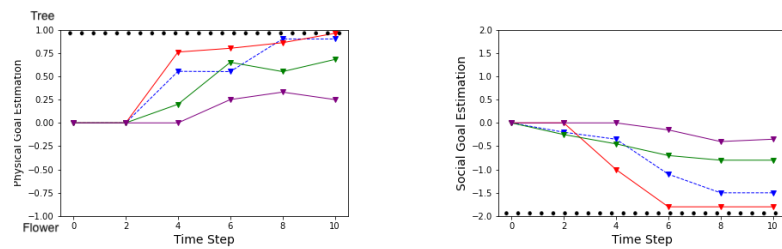
S90 Red robot is initialized with the physical goal of Tree and social goal of 1. Yellow robot is initialized with the physical goal of Tree and social goal of 1.



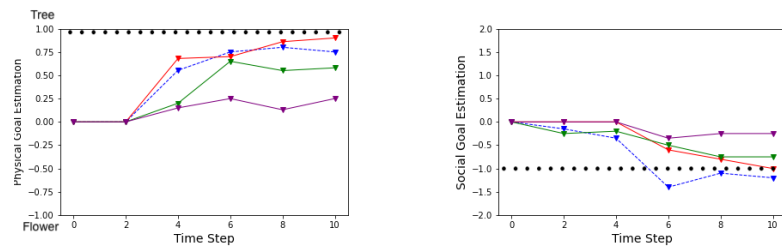
S91 Red robot is initialized with the physical goal of Tree and social goal of 2. Yellow robot is initialized with the physical goal of Tree and social goal of 1.



S92 Red robot is initialized with the physical goal of Tree and social goal of -2.  
Yellow robot is initialized with the physical goal of Tree and social goal of 2.



S93 Red robot is initialized with the physical goal of Tree and social goal of -1.  
Yellow robot is initialized with the physical goal of Tree and social goal of 2.



S94 Red robot is initialized with the physical goal of Tree and social goal of -0.5.  
Yellow robot is initialized with the physical goal of Tree and social goal of 2.

