An Active-Logic Based Agent's Reasoning for Avoiding Futile Action Repetition

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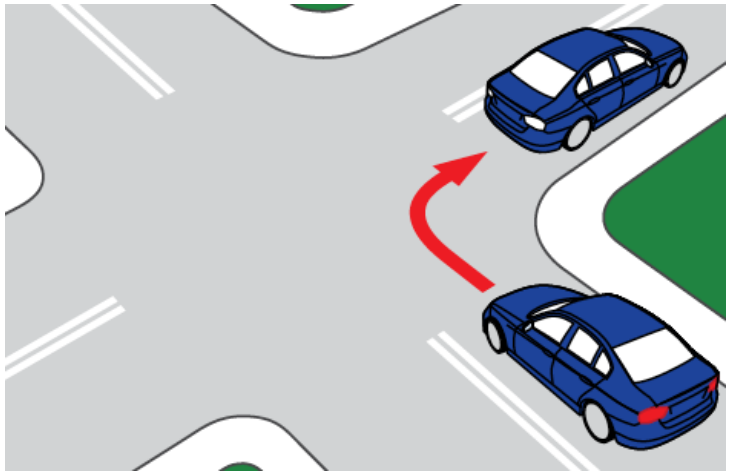
- His research area fits under the fields of cognitive agents, artificial intelligence, robotics, and machine learning.

Repeated Actions

- Actions whose post-conditions are already met.
- When executed, the action generally will not lead to task completion.
- Time is still moving while performing these repeated actions.
- Repeated actions should primarily only be used when they can benefit the goal.

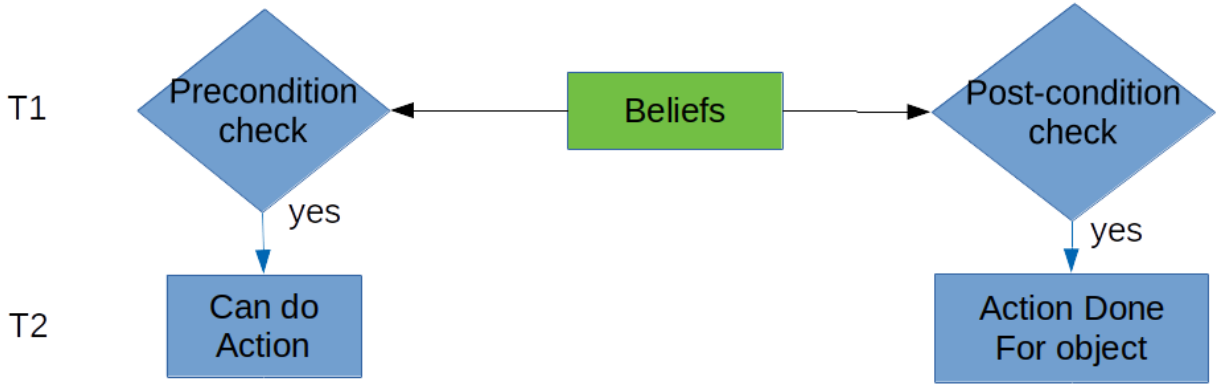


Active Logic

- Agent's internal reasoner based on first order logic.
- Able to keep track of history, time, and contradictions.
- Based on the clock rule, now(*t*) -> now(*t*+1).
- Contradiction detection and handling through contra(P,~P).
- We created six axiom sets for avoiding repeated actions that use active logic.

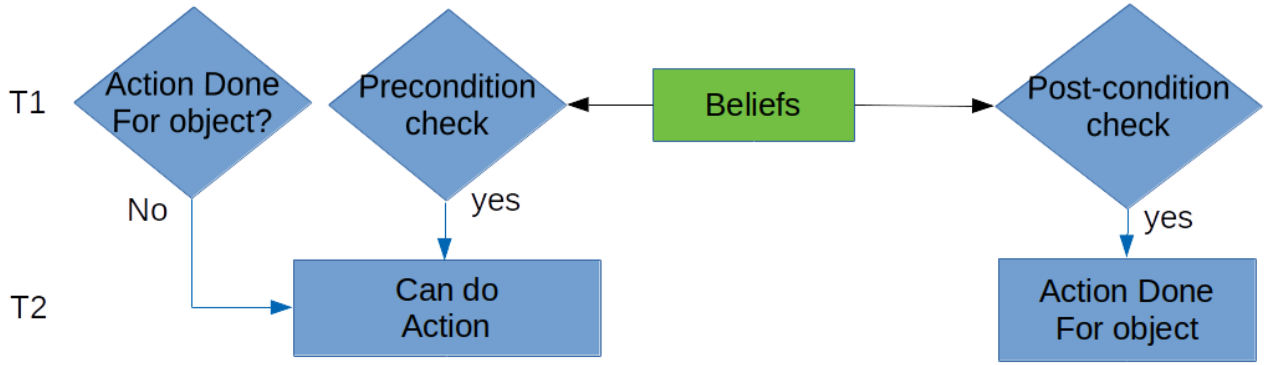
Baseline Action Selection (Naïve)

- Requires both the precondition and post-condition to be met.
- Selects actions in two time steps.
- During search, agent would act randomly.
- Extremely bold agent.



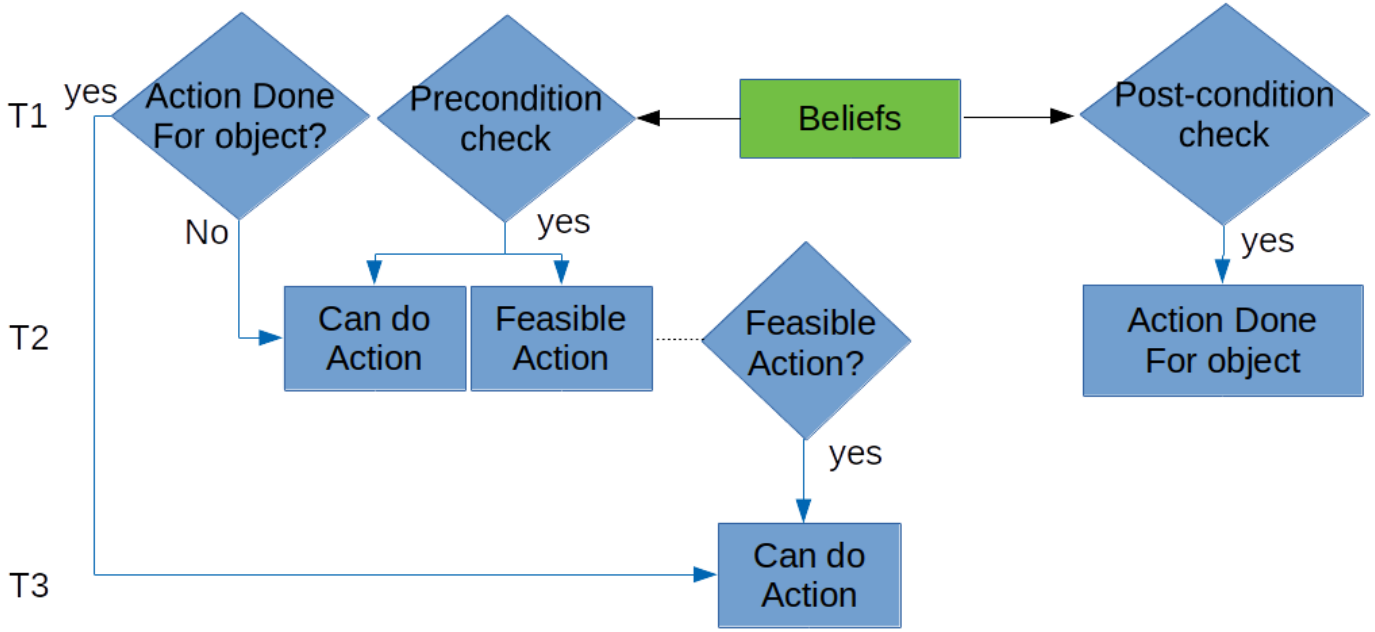
Redundancy Avoidance 2 (RA 2)

- Will only select an action that is new.
- Agents can become boxed in while searching.
- Acts like Naïve when performing new actions.



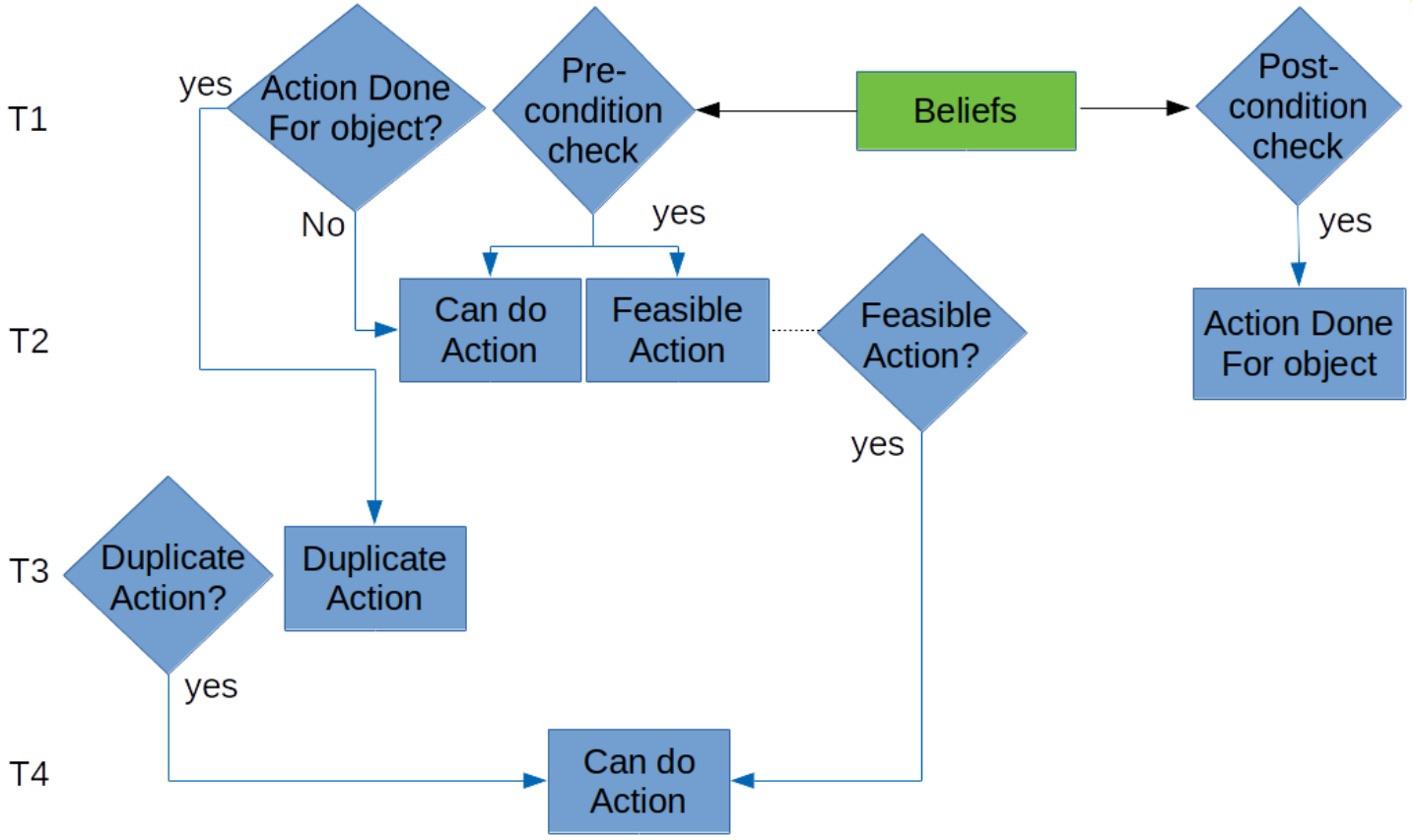
Redundancy Avoidance 2-3 (RA 2-3)

- Can select actions in 2 (best case) or 3 (worst case) time steps.
- Only selects a repeated action if the action is also feasible.
- Selects actions without noting whether the action is a new action or a repeated action.
- Balanced agent with slight boldness.



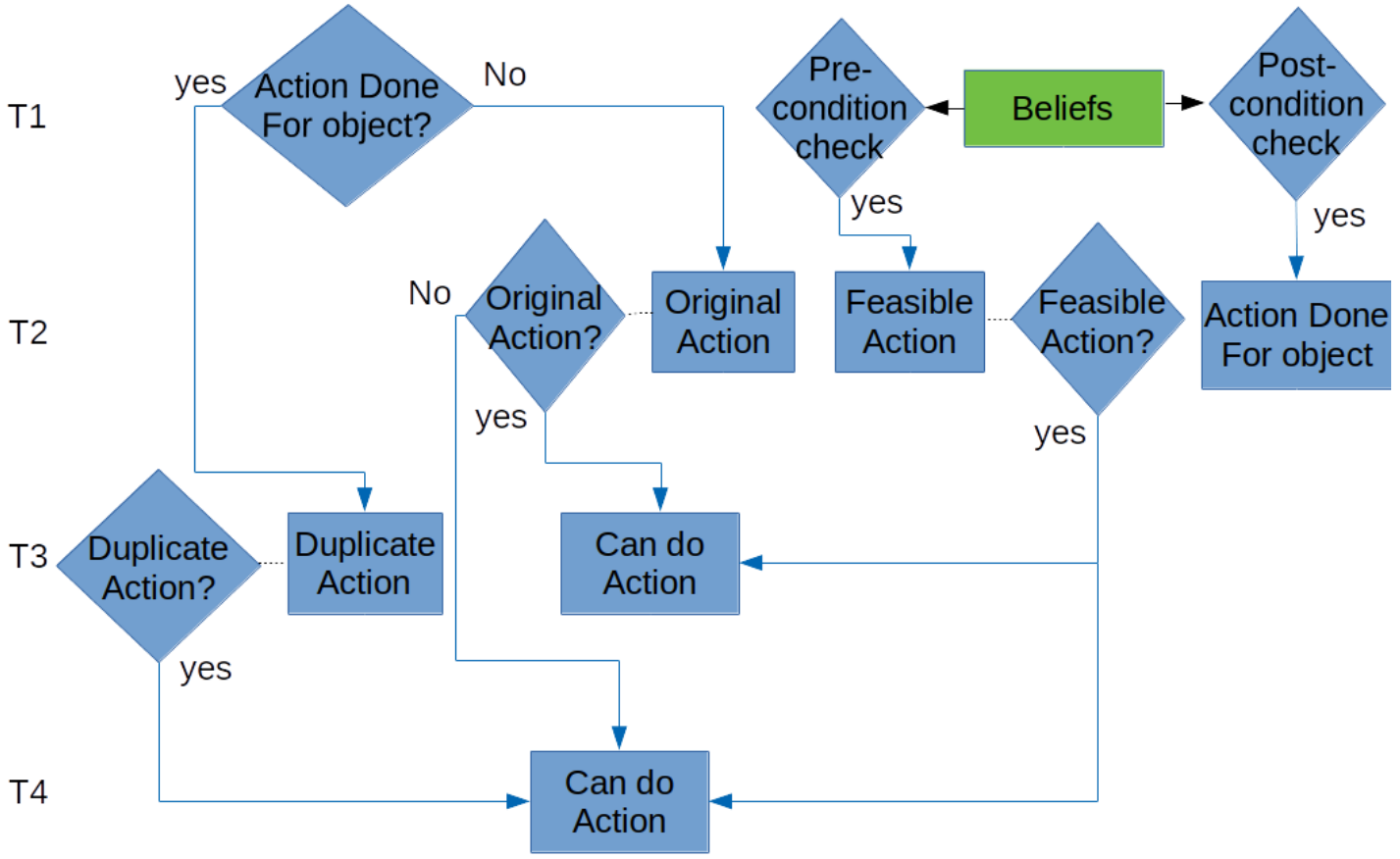
Redundancy Avoidance 2-4 (RA 2-4)

- Can select actions in 2 (best case) or 4 (worst case) time steps.
- Repeated actions are no longer selected immediately.
- Agent notes that a repeated action will be selected.
- Balanced agent with a slight lean toward caution.



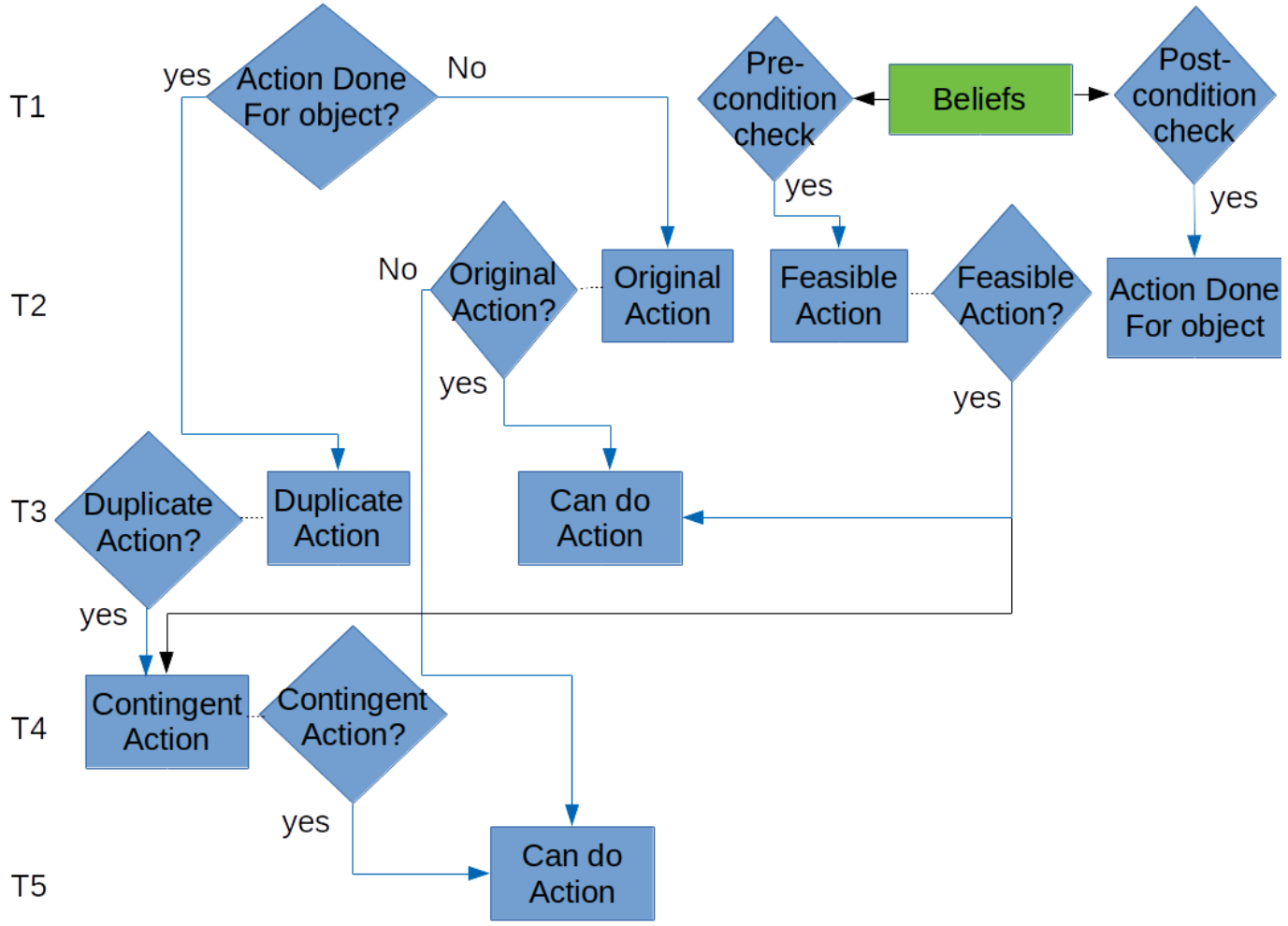
Redundancy Avoidance 3-4 (RA 3-4)

- Can select actions in 3 (best case) or 4 (worst case) time steps.
- Both new and repeated actions are noted.
- Fixes the issues with all the previous axiom sets at the cost of speed.
- Original actions can be asserted too late in some situations.
- Cautious agent



Redundancy Avoidance 3-5 (RA 3-5)

- Can select actions in 3 (best case) or 5 (worst case) time steps.
- Repeated actions are selected one time step later to give the agent time to think.
- Waiting more time steps could lead to a slippery slope.
- Extremely cautious agent.

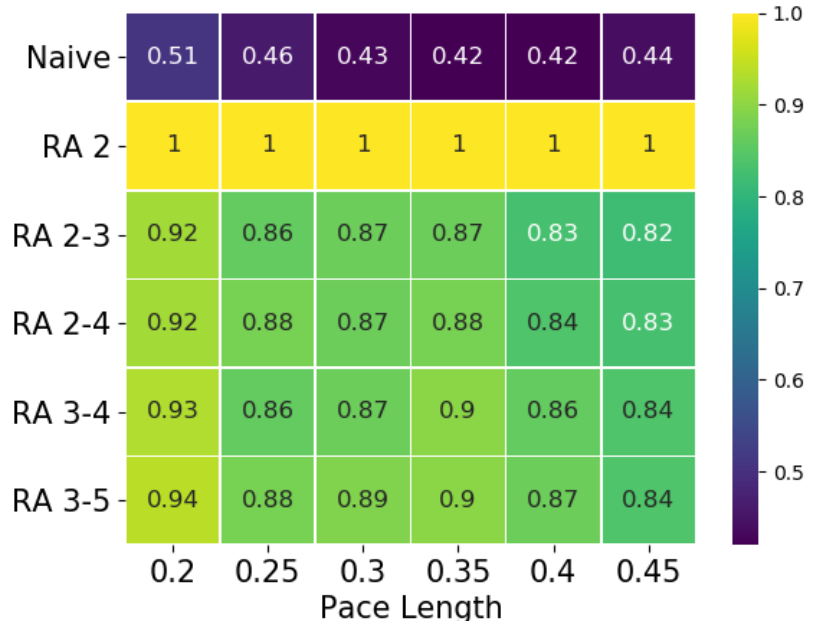


Experiment

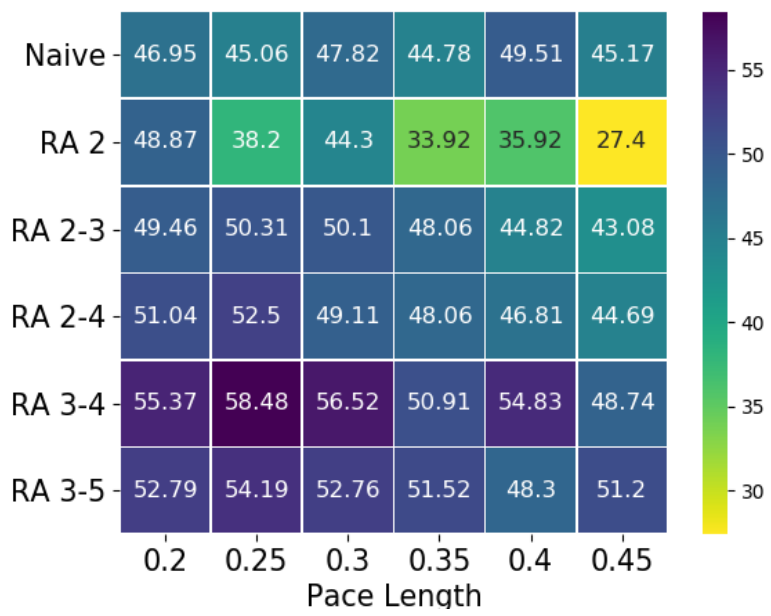
- Task: find a unique object within the environment.
- Pace length, axiom set, and starting locations are controlled.
- Six pace lengths used: .2, .25, .3, .35, .4, .45.
- 20 trials with different starting locations for the agent and/or target.
- Total of 1,800 trials per axiom set.
- Virtual environment: AI2-THOR

Results

Average accuracy for finding the target



Average new moves selected



Average time steps to find the target

Conclusion and Future Work

- Demonstrated methods for avoiding futile repeated actions within a search task setting.
- Discussed the strengths and weaknesses of each axiom set.
- Further work includes analyzing the behavior of multi-agents during a search task and adjusting the experiment for better results.

References

- D. P. Josyula, A. Herron, and K. M'Bale, "Implementing a task-oriented time-situated agent," in Eighth Annual Conference on Advances in Cognitive Systems, 2020
- D. Perlis, J. Brody, S. Kraus, and M. Miller, "The internal reasoning of robots," in Thirteenth International Symposium on Commonsense Reasoning, 2017
- D. Perlis, K. Purang, D. Purushothaman, C. Andersen, and D. Traum, "Modeling time and meta-reasoning in dialogue via active logic," in Working notes of AAAI Fall Symposium on Psychological Models of Communication, 1999.
- J. J. Elgot-Drapkin and D. Perlis, "Reasoning situated in time i: basic concepts," Journal of Experimental Theoretical Artificial Intelligence, vol. 2, pp. 75–98, 1990
- A. Herron, D. P. Josyula, "An Analysis of the Deliberation and Task Performance of an Active Logic Based Agent (Student Abstract)" in 37th AAAI Conference on Artificial Intelligence, 2023