

The Interplay Between Memory and Map-Like Image Input for Exploring Task of AI

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Abstract

The focus of this research is “**map-like external input.**”

It was introduced that cognitive maps are structured in the long-short-term memory (LSTM) during navigation tasks of AI. This presentation shows that the input like a map image increases their performance, without LSTM, and changes the behavior.

1. Introduction

Related works

- (Edward C, 1948) found that rats in a maze memorized the environment and called the maps “cognitive maps”.
- (Wijmans et al, 2023) showed cognitive maps are represented in the memory (LSTM) of an AI model.

Hypothesis | Providing map-like external input changes agents' performance, behavior, and training time.

2. Methodology

What's Agents?

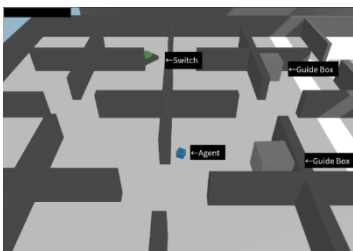
They are the objects in the simulation environment [a, b] controlled by AI. They move randomly at first; they optimize their actions to get higher rewards given to them on reaching the goal on each step as training proceeds. If they finish the task or the time expires, they learn and restart.

Task | Explore the environment and discover the switch and goal. Their performance is measured by the rewards after 3M steps.

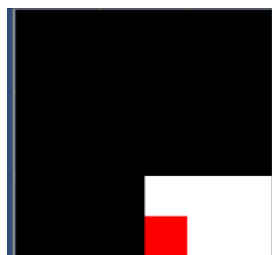
What's a map-like image? | It shows where the agents have visited so they can know.



a. Top view of environment

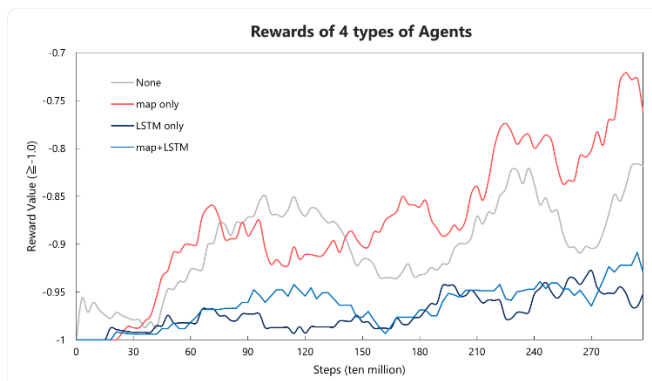


b. Side view of environment



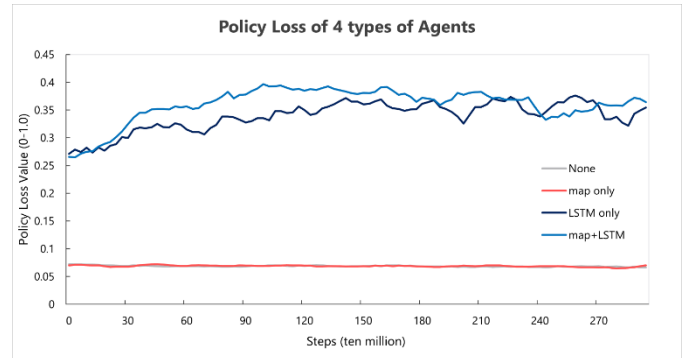
c. map-like image input

3. Result



Statistical hypothesis testing of agents results

	None	map only	LSTM only	LSTM + maps
Reward	-0.8924	-0.8659	-0.9604	-0.9703
S.D.	0.0918	0.1173	0.0513	0.0576
D.F.	187		195	
P	0.0383		0.1002	



Training time and visited areas of agents

	None	map only	LSTM only	LSTM + maps
Training time	1h25m25s	2h44m59s	1h41m35s	2h47m56s
Visited areas per 5min	30.5	31.5	26	28.5

4. Discussion

- External maps improve agents' exploration and are linked to higher rewards without LSTM.
- Using both internal cognitive maps and external map-like input is not effective for performance and training time.

Possible causes

- Internal cognitive maps may decline the benefits of external map-like input.
- Agents with memory struggled to learn within 3 million steps due to its complexity.
- Longer training time or adjustments to hyperparameters may improve performance.

5. Conclusion

External maps improved the performance of agents without memory, but there was little improvement with memory due to the existence of cognitive maps, a few training steps, or incomplete hyperparameters.

Special thanks to Erik Wijmans for his valuable guidance and insights.

*References are written on the handout (document).