Large Language Models as Commonsense Knowledge for Large-Scale Task Planning

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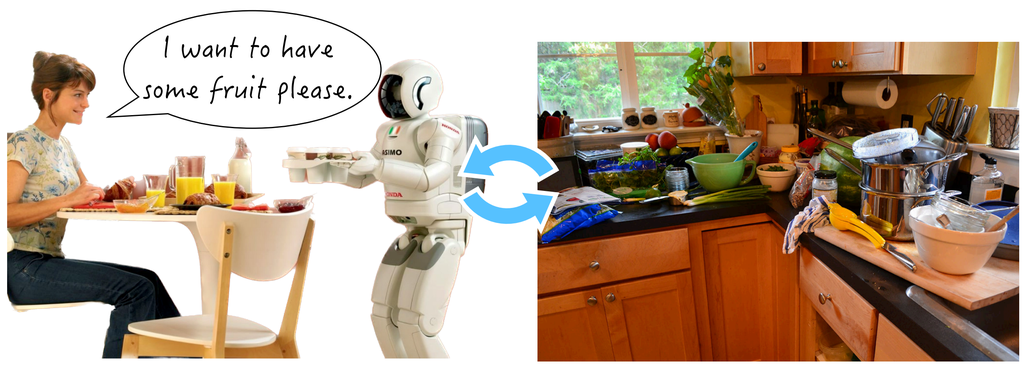
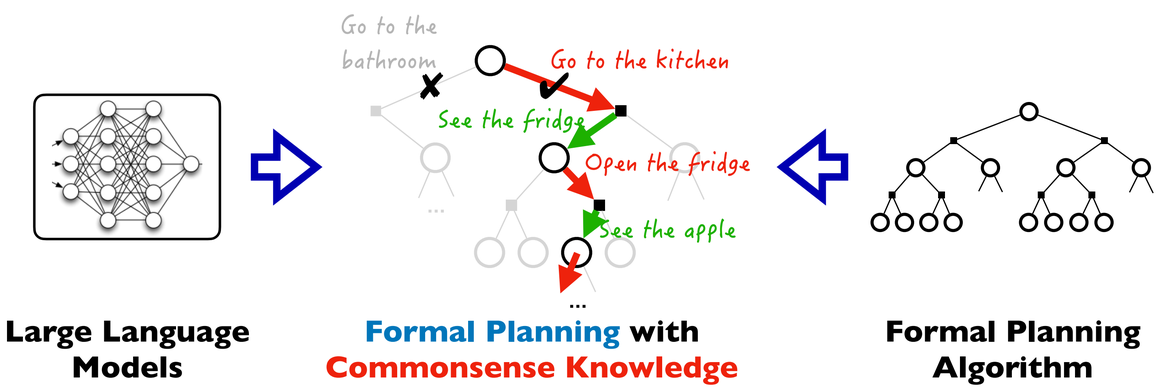
Motivation

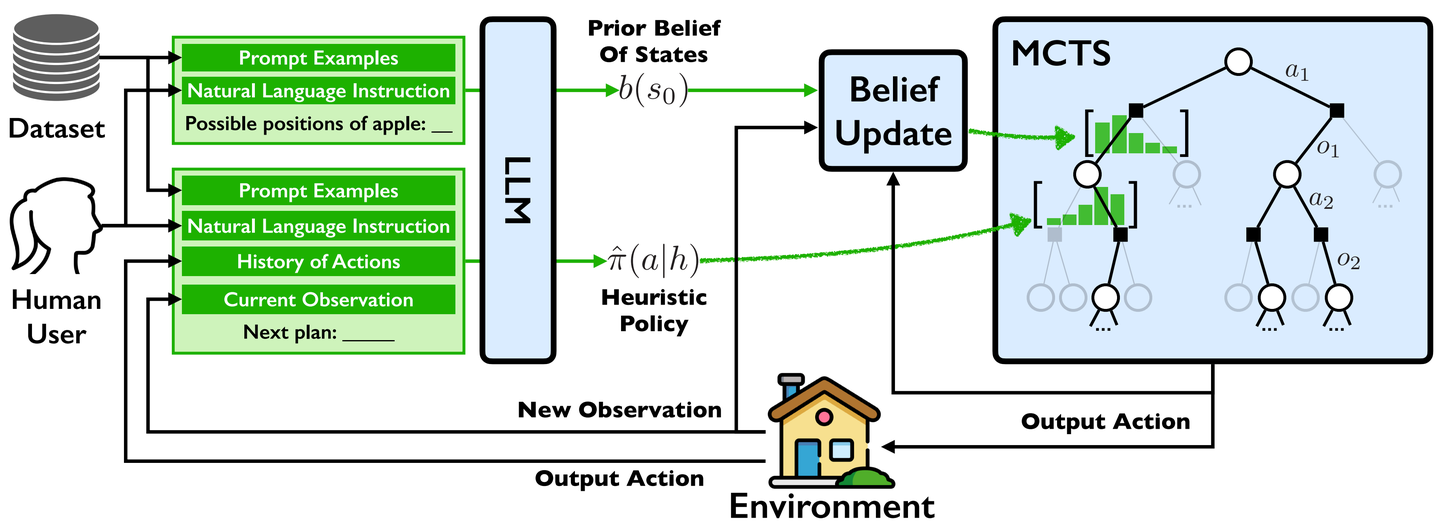


We aim to solve the task-planning problems at scale.

Core Idea

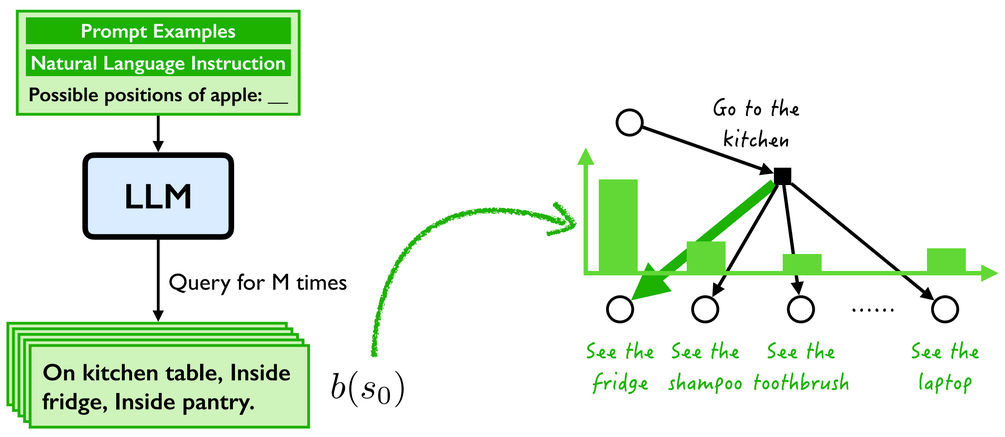


LLM-MCTS Overview

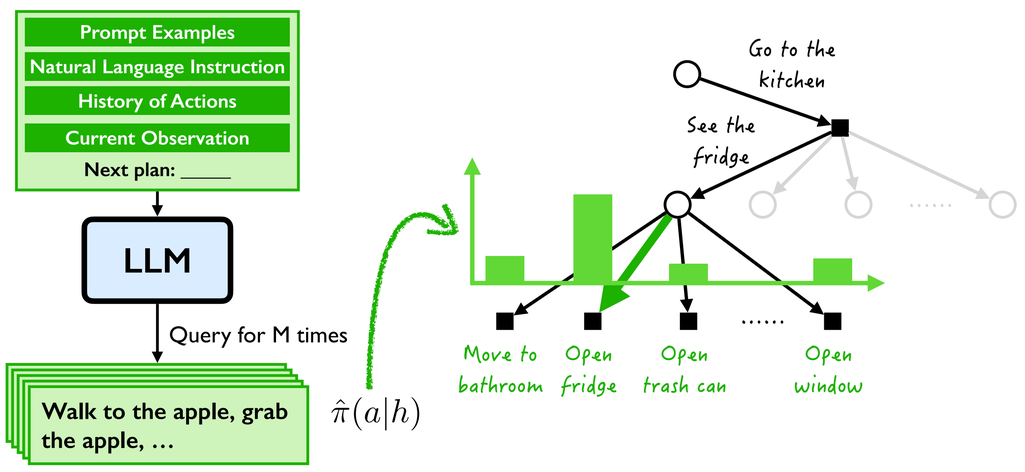


- LLM as **commonsense world model** and **heuristic policy** for MCTS
- MCTS helps LLMs
  - Algorithmic benefits for reasoned decision-making
  - Explore new combination of actions
  - Enabling exploitation of world knowledge in LLMs
- LLMs help MCTS
  - Reduce the search space
  - Accelerate the search by selecting actions biasedly

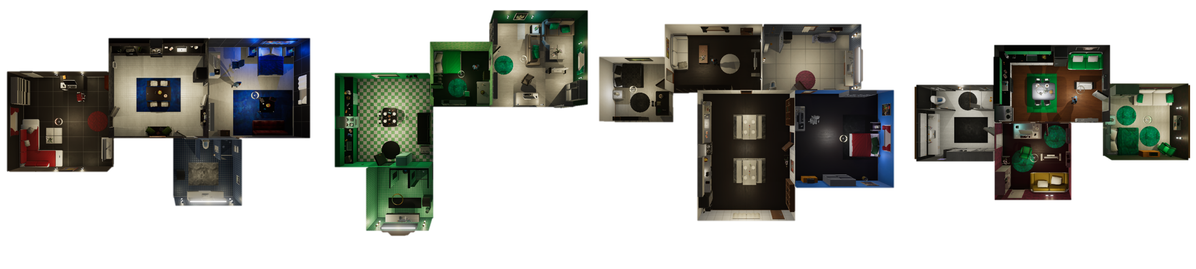
LLM as Commonsense World Model



LLM as Commonsense Heuristic Policy



Main Results



Environments in VirtualHome simulators.

TABLE I
SUCCESS RATE (%): MEAN ± STANDARD ERROR

Method	Seen Apartment				
	Simple	Comp.	NovelSimple	NovelComp.(2)	NovelComp.(3)
UCT	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
finetuned GPT2 policy	81.3±2.4	59.0±6.7	41.2±7.1	30.9±2.8	2.3±1.5
GPT3.5 Policy	83.4±6.8	47.0±7.8	74.3±4.0	48.2±8.8	5.4±2.0
GPT3.5-MCTS (Ours)	91.4±3.3	71.2±6.2	88.1±4.3	72.6±6.9	33.6±3.1
	Unseen Apartment				
Method	Simple	Comp.	NovelSimple	NovelComp.(2)	NovelComp.(3)
UCT	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
finetuned GPT2 policy	65.5±3.4	39.9±5.2	33.4±6.4	12.8±3.9	1.1±0.9
GPT3.5 Policy	74.3±5.0	43.3±4.0	67.8±4.9	54.0±3.0	6.9±2.1
GPT3.5-MCTS (Ours)	82.9±3.2	71.9±5.6	79.3±3.3	70.4±6.4	38.8±3.4

Discussion

- LLM's knowledge about modeling the world is potentially more complete than its knowledge about policy.
  - Assume n moveable objects, m containers, k rooms.
  - Description length for world model $O((m+n)\log(m+k))$
  - Description length for policy of tasks $O(mn\log(m+n+k))$
  - Policy for compositional tasks $O((mn)^N\log(m+n+k))$

Conclusion

- LLM-MCTS exploits LLM's knowledge regarding the world model and policy for reasoned and informed decision-making
- The runtime of our method is currently hindered by computational constraints, resulting in sluggish performance. Future advancements in edge computing devices may allow our method to be applied in robotic systems to enhance decision-making capabilities.
- Our analysis and empirical evidence suggest that, for some domains, the knowledge possessed by LLM in world modeling exhibits a higher degree of comprehensiveness than policies, owing to the significant discrepancy in their respective description complexities.