Robots that Learn to Communicate through Natural Human Dialog

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Our Goal

Develop a human-robot dialog system that communicates through natural language, and learns to become more capable from repeated user interactions
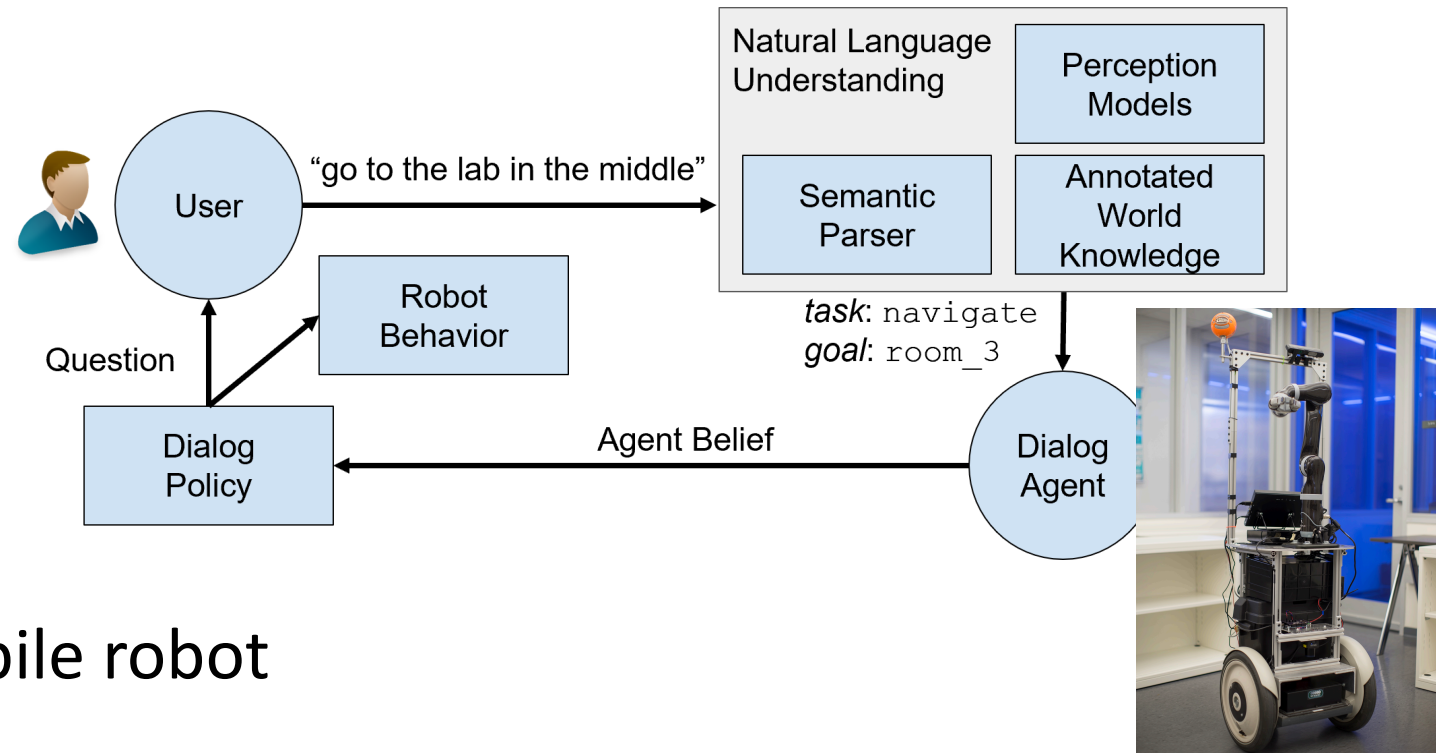

Robot, fetch me the green empty bottle

Method and Novelty

We integrate and adapt learning techniques from:

- Perceptual language grounding

- Semantic parsing

- Dialog management

- Active learning

And implement them on a mobile robot

Perceptual language grounding

Associating words and phrases in language to objects, properties and relations in the world as perceived by the robot's sensors

Vision - RGB(255,0,0)

"Get the red heavy mug!"

Haptic - joint torque

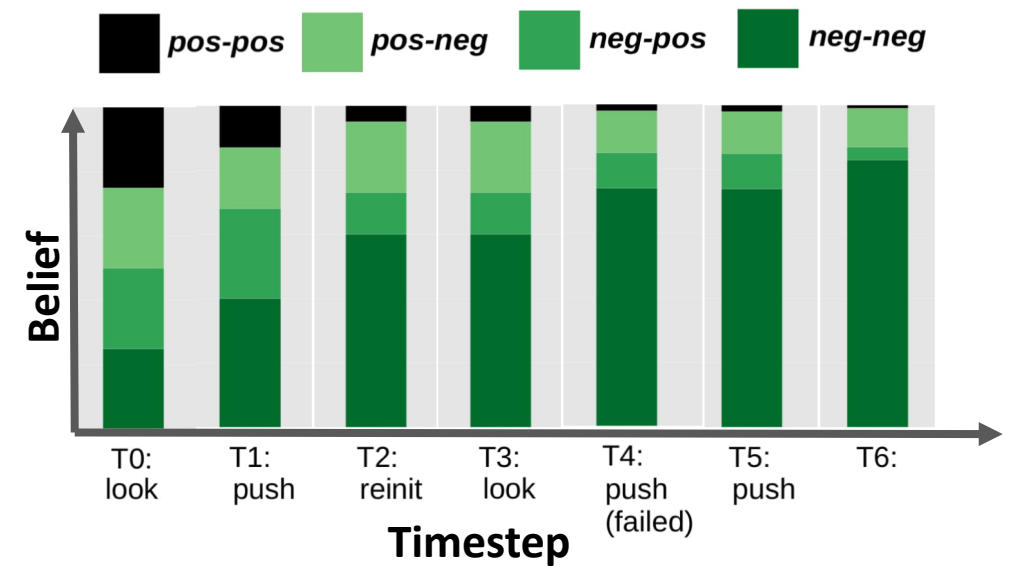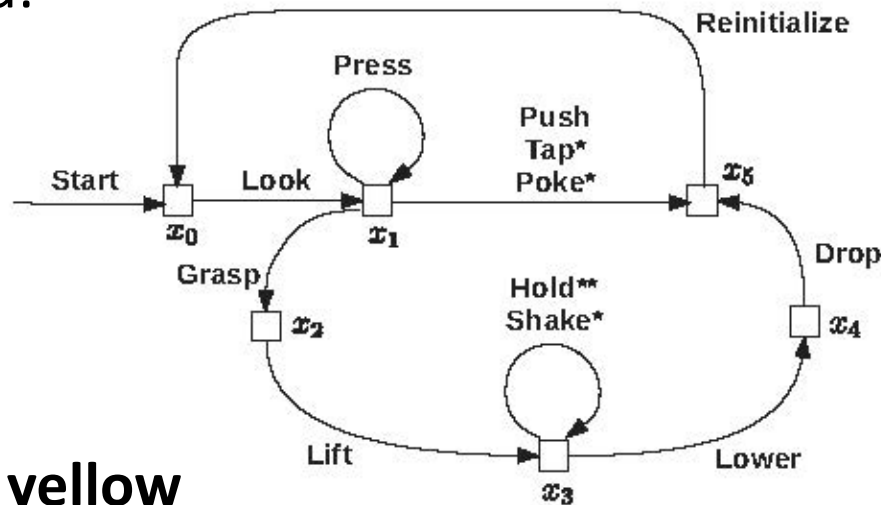Exploring objects for all possible sensorimotor contexts takes time

Multi-modal Predicate Identification using Dynamically Learned Robot Controllers , Amiri et al. **(IJCAI 2018)**

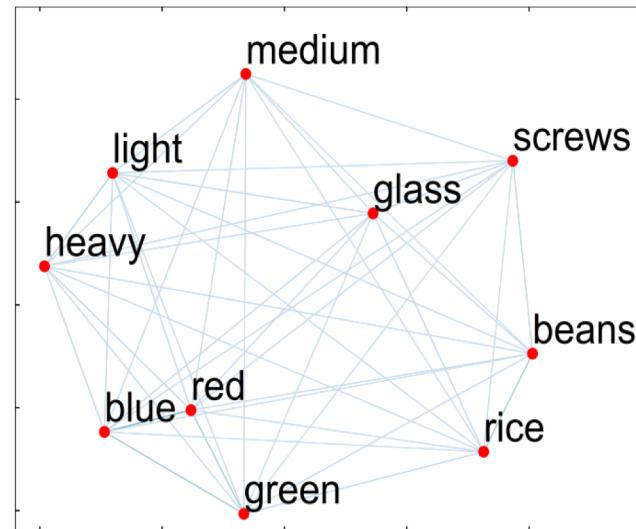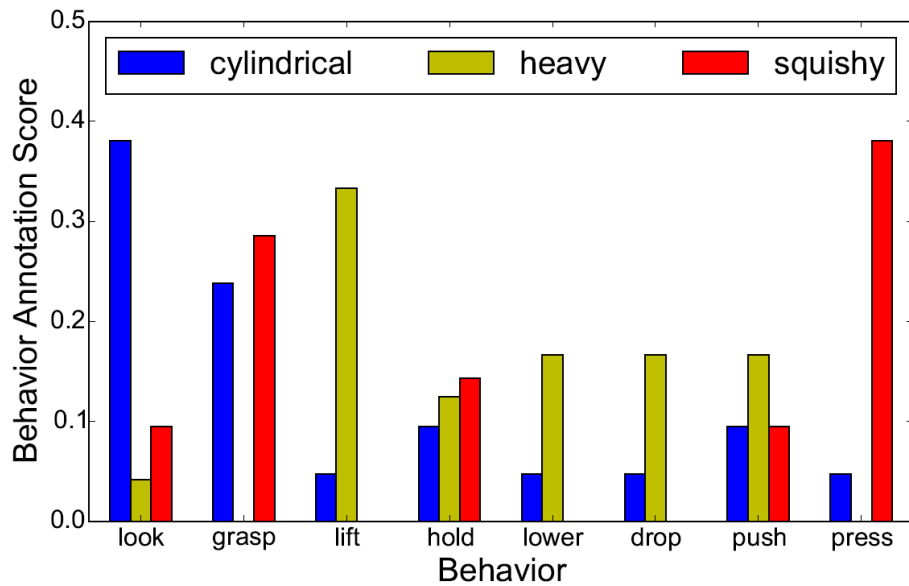Efficient exploratory behavior using MOMDP

Object selected:

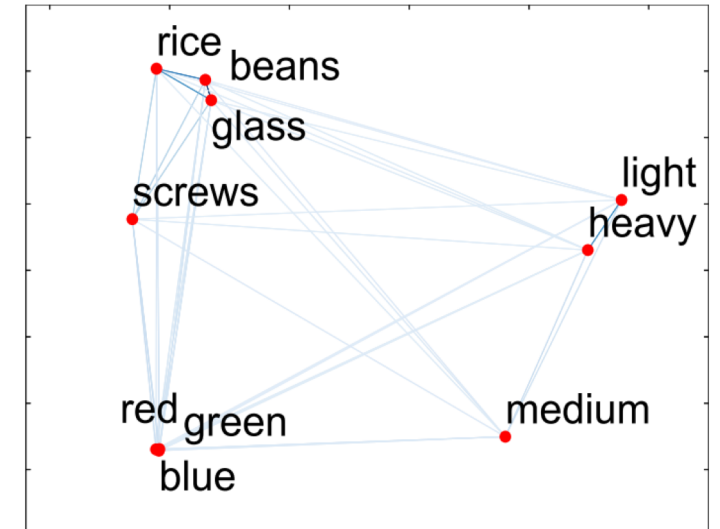Query: Is this a **yellow metallic** object?

Guiding exploratory behaviors for multi-modal grounding of linguistic descriptions. Thomason et al. **(AAAI 2018)**

Efficient exploratory behavior using linguistic closeness

Word embeddings   Sensorimotor embeddings

Opportunistic active learning for grounding natural language descriptions. Thomason et al. **(CoRL 2017)**

Asking off topic questions to improve **future** interactions in object retrieval tasks

Fetch me the **green** bottle

On Topic

Would you describe this object as **green**?

Off Topic

Would you describe this object as **red**?
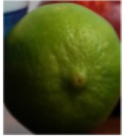
The inquisitive agent achieved **better accuracy** and was rated as **more fun** to interact with

Learning a Policy for Opportunistic Active Learning Padmakumar et al. **(EMNLP 2018)**

Using **reinforcement learning** to learn a policy for opportunistic active learning using the Visual Genome dataset


The agent needs to identify which object is best described by a given phrase

Policy	Success rate	Average Dialog Length
Learned	**0.44**	**12.95**
Static	0.29	16

The learned policy proved **more accurate** than the static policy with a **shorter dialog** length

Jointly improving parsing and perception for natural language commands through human-robot dialog. **(RSS 2018)**

Integration on a mobile robot + Demo
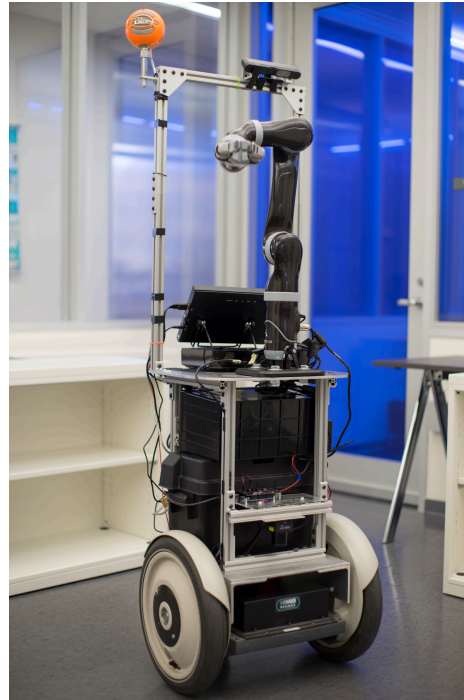
Contributions

- A human robot dialog system that **learns to ground new predicates**

- Object exploration as an **MDP** and by modeling **linguistic closeness**

- RL-based **opportunistic active learning** to improve parsing and perception

- Fully **integrated** on a **mobile robot**
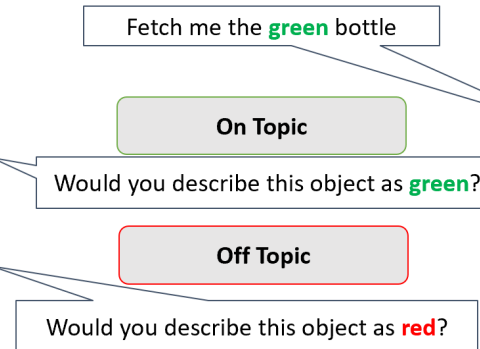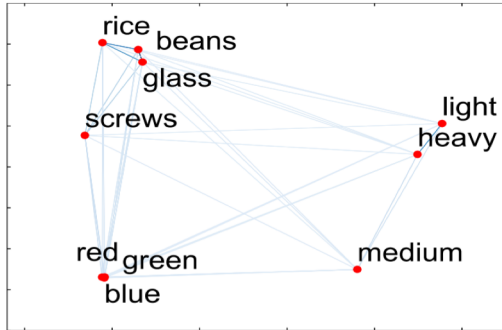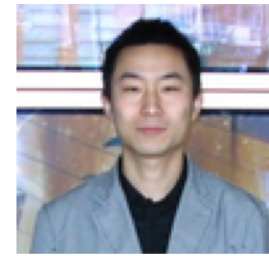
Acknowledgements

Ray Mooney

Peter Stone

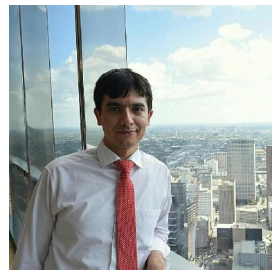Jesse Thomason

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Nick Walker

Yuqian Jiang

Saeid Amiri

Suhua Wei

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