NRI: INT: COLLAB: Collaborative Task Planning and Learning through Language Communication in a Human-Robot Team

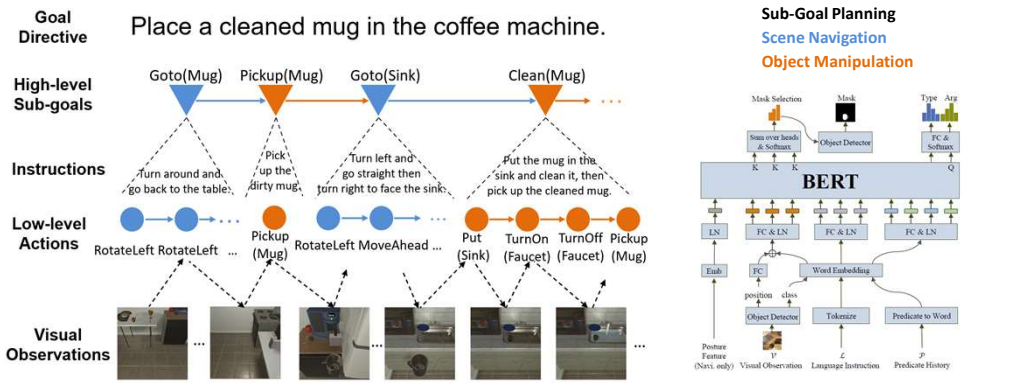
Joyce Chai (University of Michigan) and Julie Shah (Massachusetts Institute of Technology)
https://sled-group.eecs.umich.edu/nri-int-collab/

Objective: Connect language and dialogue processing with the robot's underlying planning system to support collaborative task planning and learning.

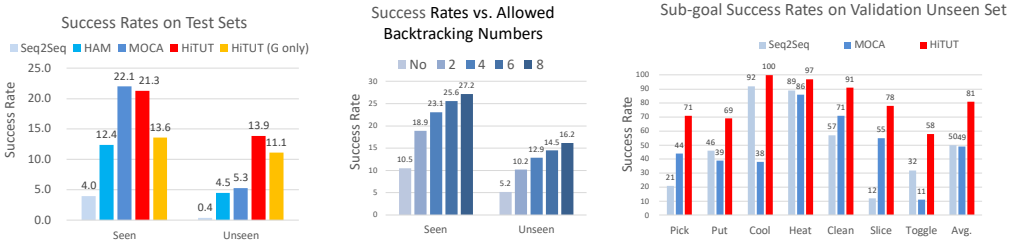
Task Learning through Language Instructions

Hierarchical task learning with unified transformers and self monitoring (HiTUT)

- An unified transformer model for the three sub-problems
- Dynamically adjust the plan to cope with failures during execution via backtracking.
- An explainable model achieving the new state-of-the-art performance
- A decomposable platform to support in-depth evaluation and analysis



Results: Over 160% gain of unseen success rate (SR); backtracking improves SR

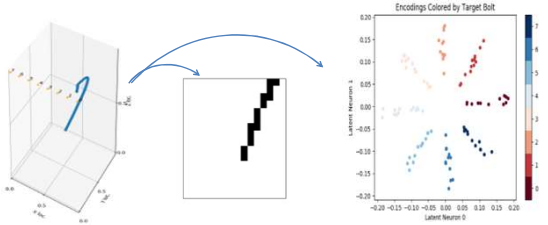


Latent Space Alignment Using Adversarially Guided Self-Play

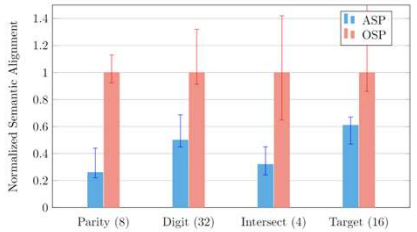
Neural nets often learn efficient but uninterpretable representations, limiting their ability to share information with other agents or humans. We develop a new technique for aligning representation spaces:

- A small amount of paired data from a partner to mimic
- A large corpus of unpaired data for acceptable representations
- Self-play for task-specific optimization

Partnering with humans on AMT showed improved information transfer and trust calibration, depending upon the representation format used



Partnering with other agents with only 8 or 32 examples outperforms prior art



Task	*ASP dig.*	*ASP par.*	*OSP dig.*	*OSP par.*	*PAE*
Parity	0.63 (200)	**0.82** (150)	_	0.70 (280)	0.75 (140)
Digit	**0.52**** (50)	0.30 (90)	0.33 (80)	_	0.24 (70)
	ASP 2D	*ASP sketch*	*OSP 2D*	*OSP sketch*	*PAE*
Inter.	**0.68*** (40)	0.61 (110)	0.62 (50)	0.53 (40)	0.56 (60)
Target	**0.53*** (130)	0.36 (110)	0.11 (90)	0.33 (130)	0.34 (150)

Classification accuracy of humans, given encodings

Our technique enabled efficient learning of representations schemes, which we found supported better human-agent team performance and improved trust calibration compared to prior art.

Broader Impact:

- Towards enabling human-robot team that can adapt to new and changing environments and tasks, which will benefit many applications such as manufacturing, service, assistive technology, and search and rescue.
- Provide new exciting training and education opportunities for a diverse body of students through research mentoring, curriculum development, and outreach.

2021 NRI & FRR Principal Investigators' Meeting
March 10-12, 2021

IIS 1949634, IIS 1830282