MIND MELD: Personalized Meta-Learning for Robot-Centric Imitation Learning

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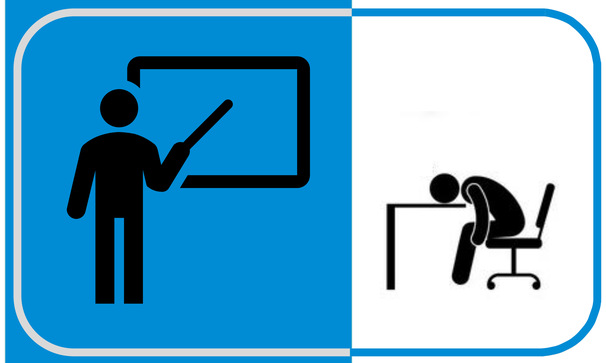
Motivation

Learning from Demonstration (LfD) allows users without programming expertise to teach robots novel tasks.

Humans are both suboptimal and heterogenous teachers [1, 2].

Difficult for robots to learn from human demonstrators.

Robots must account for suboptimality and heterogeneity when learning from humans.



Research Question

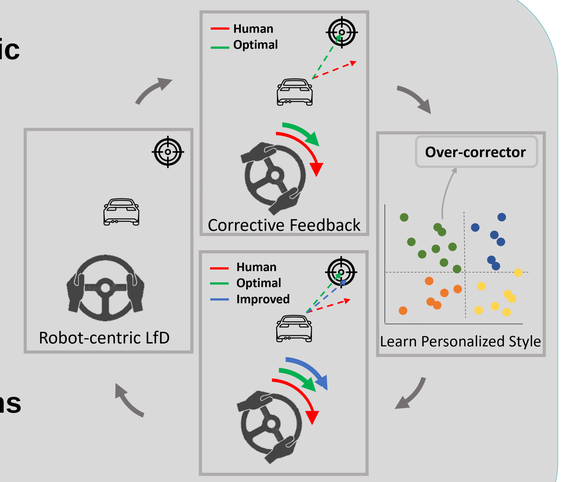
1) **Can we learn to map poor human demonstrations to better demonstrations to improve robot learning?**
2) **Can we learn an informative embedding describing an individual's teaching style?**

Approach

Improve upon robot-centric LfD via personalized embedding describing demonstration style.

Meta-learn embedding representing individual style via calibration tasks.

Utilize embedding to map suboptimal demonstrations to better demonstrations.



Demonstrate MIND MELD in driving simulator.

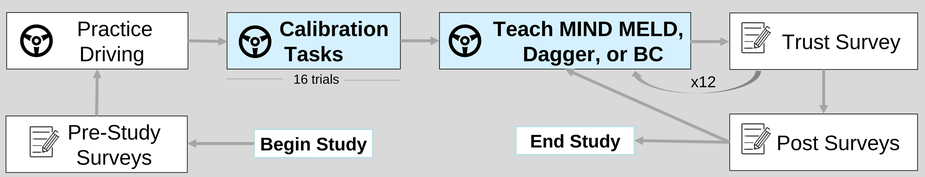
Study Conditions

MIND MELD: learn personalized embedding describing style. Use embedding to improve upon suboptimal corrective feedback. Teach robot with improved demonstrations.

DAgger: teach robot via robot-centric LfD. Teacher provides corrective feedback.

BC: teach robot via human-centric LfD. Teacher provides demonstrations.

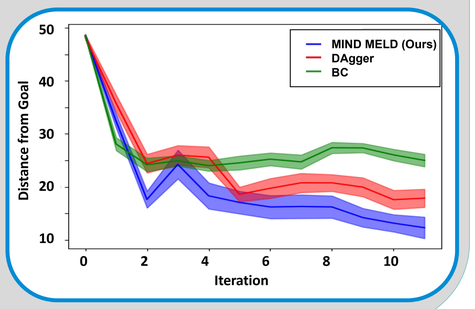
Procedure



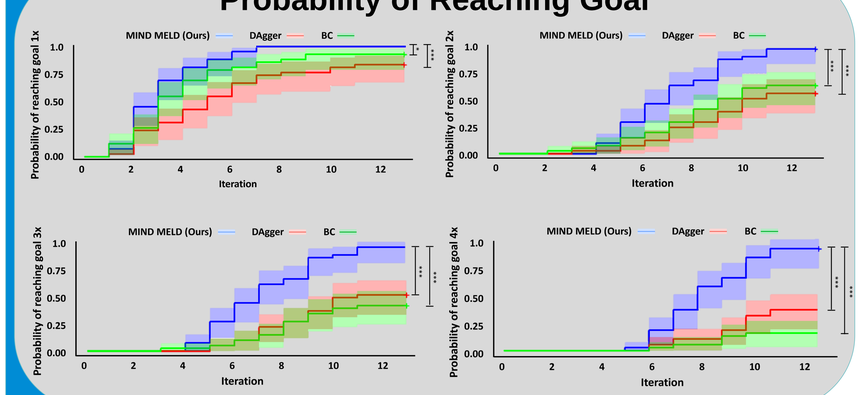
Results

- **MIND MELD outperforms baselines in terms of**
  - **Probability of reaching goal**
  - **Average distance to goal**
  - **Subjective metrics**

Metric	MELD-Dagger
Workload	-8.1 (2.8), p=.005
Likeability	1.1 (2.5), p=.004
Intelligence	1.2 (.32) p=.008
Trust	0.80 (.16), p<.001

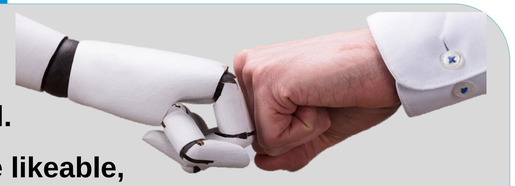


Probability of Reaching Goal



Conclusion

- **MIND MELD improves robot's ability to reach goal.**
- **MIND MELD is more likeable, trustworthy and intelligent.**



Utilizing personalized embeddings to describe suboptimal tendencies improves a robot's ability to learn from a human

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References

1. Sammut, C. 1992. Automatically Constructing Control Systems by Observing Human Behaviour. Second International Inductive Logic Programming Workshop (May).

2. Paleja, R.; and Gombolay, M. 2019. Inferring personalized bayesian embeddings for learning from heterogeneous demonstration. arXiv ISSN 23318422.

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