Coordinating Human-Robot Teams in Uncertain Environments

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Uncertain, Critical Environments

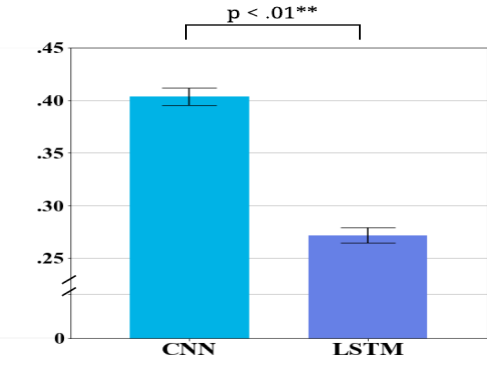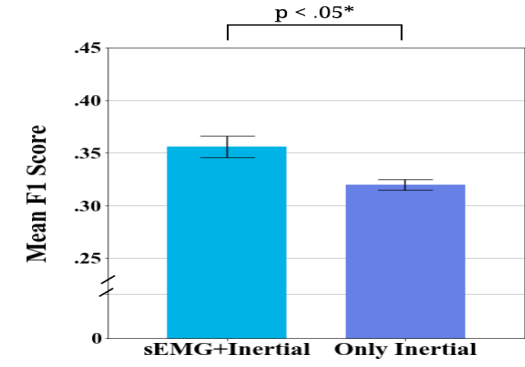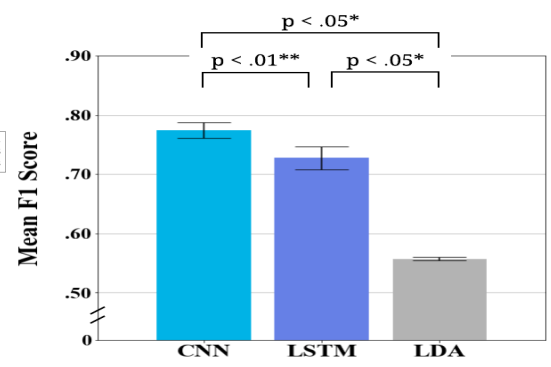"Coordinating Human Robot Teams in Uncertain Environments"– C. Amato (NEU) and L. Riek (UCSD)

Our goal: create and solve realistic models for coordinating teams of humans and robots in uncertain environments

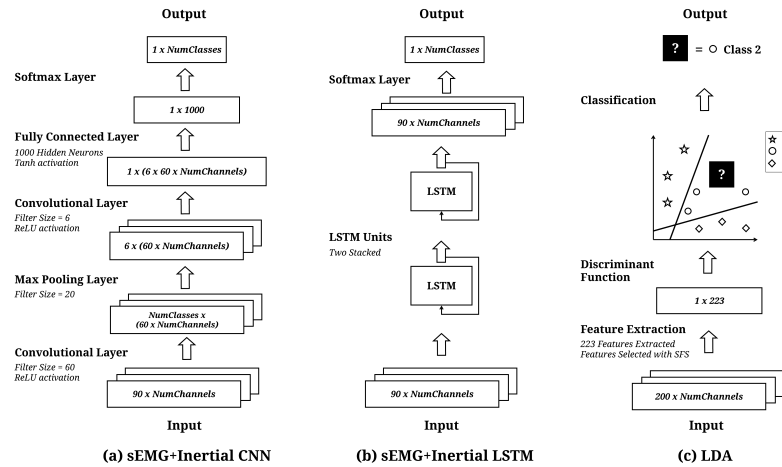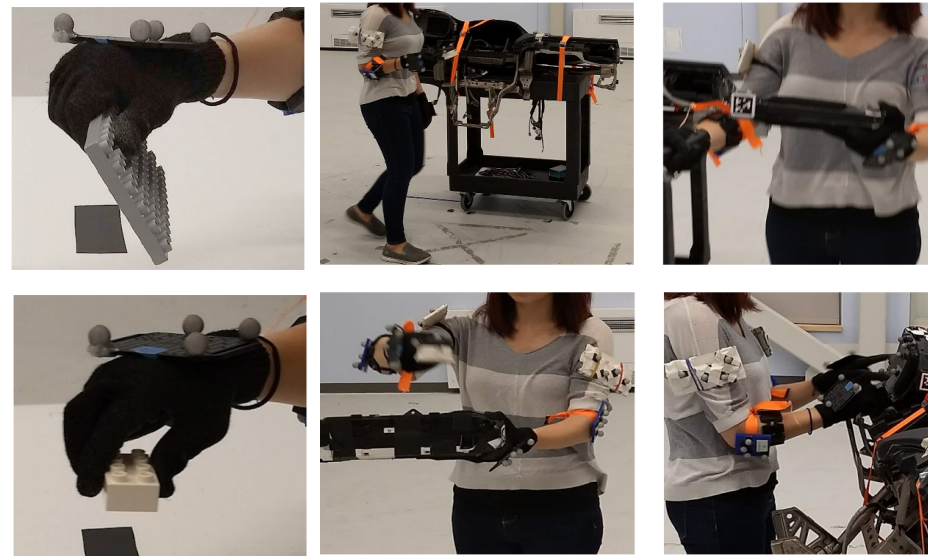"Coordinating Human Robot Teams in Uncertain Environments"– C. Amato (NEU) and L. Riek (UCSD)

Non-Visual Activity Modeling

(a) sEMG+Inertial CNN (b) sEMG+Inertial LSTM (c) LDA

Frank, Kubota, and Riek, IROS 2019.

Multimodal Contextualized Activity Recognition

	SVM			LDA			KNN		
	Vicon	Myo	Vicon+Myo	Vicon	Myo	Vicon+Myo	Vicon	Myo	Vicon+Myo
Automotive (Gross motion)	**.79**	.42	.43	**.76**	.48	.49	**.88**	.58	.59
Block (Fine-grained motion)	.09	**.37**	.36	.23	**.39**	.36	.32	**.43**	.43

Kubota, Iqbal, Shah, and Riek, ICRA 2019.

"Coordinating Human Robot Teams in Uncertain Environments"– C. Amato (NEU) and L. Riek (UCSD)

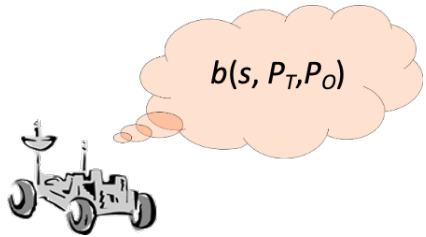# ED Workflow Characterization & Task Representation
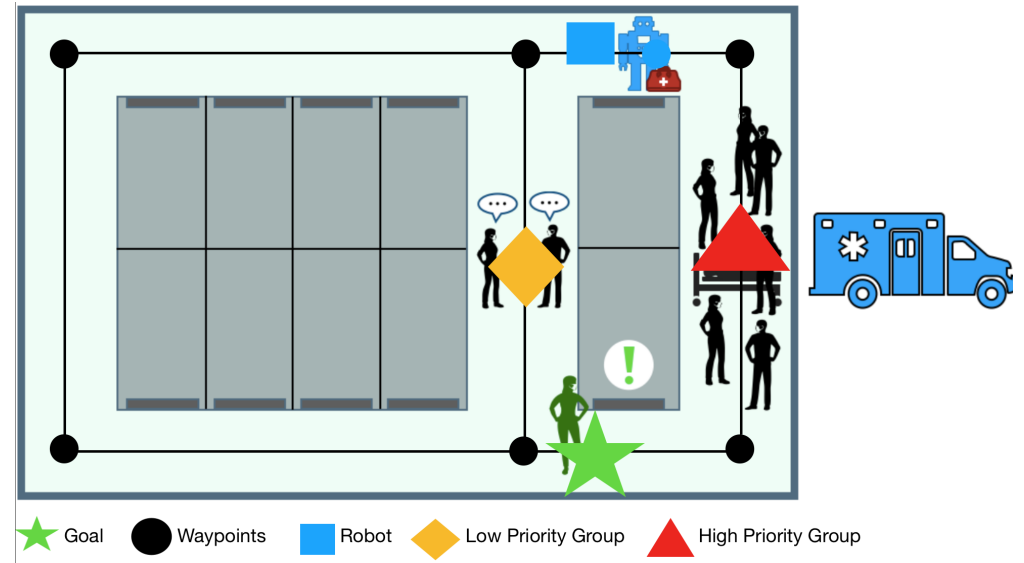
Taylor, Matsumoto, and Riek, AAAI 2020; Taylor, Matsumoto, Xiao, and Riek, In review

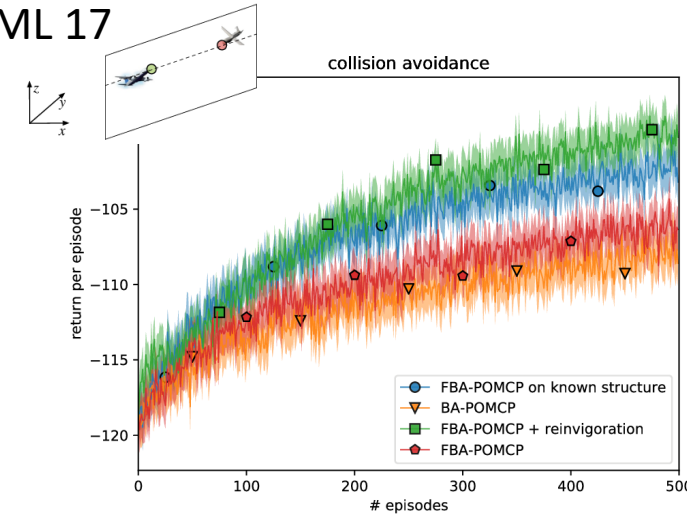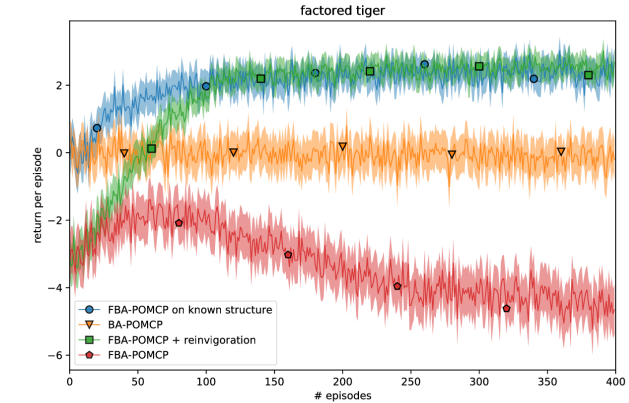"Coordinating Human Robot Teams in Uncertain Environments"– C. Amato (NEU) and L. Riek (UCSD)

Bayesian Reinforcement Learning for POMDPs

$b(s, P_T, P_O)$

- Sample efficient RL for POMDPs

- Our method

  - Scalable method that learns the factorization to generalize more quickly

  - Novel sampling and particle reinvigoration method for estimating belief over states and models

- Significantly outperforms previous methods and scales to larger domains
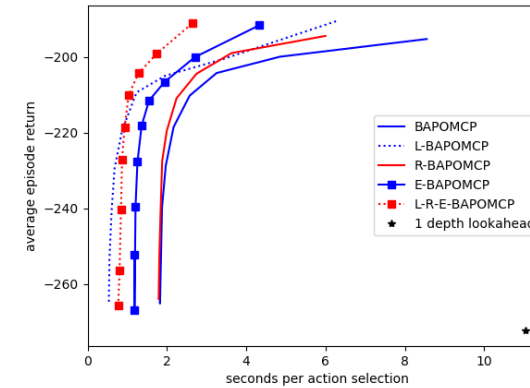
Katt, Oliehoek and Amato - ICML 17

Katt, Oliehoek and Amato - AAMAS 19

Deep (Non-Bayesian) Hierarchical RL for POMDPs

- Problems decompose into subtasks, which we call *macro-actions*

- Allows for asynchronous decision-making

- Current deep multi-agent reinforcement learning can't incorporate asynchronous (macro-)actions

- Developed

  - Methods for centralized and decentralized learning Xiao, Hoffman and Amato – CoRL 19

  - As well as centralized learning for decentralized execution Xiao, Hoffman, Xia and Amato – ICRA 20
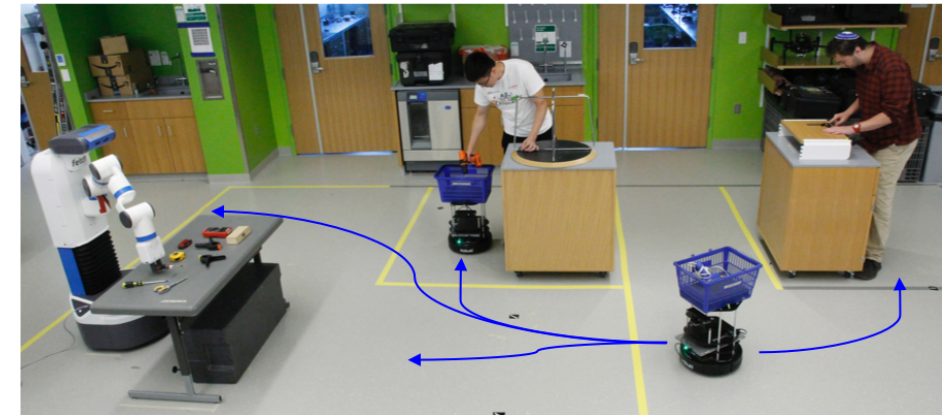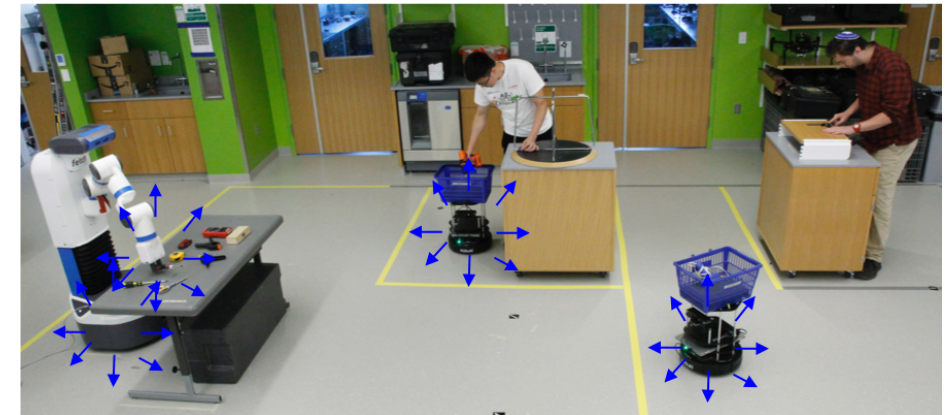
Deep (Non-Bayesian) Hierarchical RL for POMDPs

Xiao, Hoffman, Xia and Amato – ICRA 20

Future work

- More scalable and sample-efficient learning
- Better integration between learning human models and robot policies
- Evaluate models with human robot teams at the UCSD Medical Simulation and Training Center