Marginal MAP Estimation for Inverse RL under Occlusion with Observer Noise

NRI:FND:Robust Inverse Learning for Human-Robot Collaboration

Award: 1830421, 08/18/2018

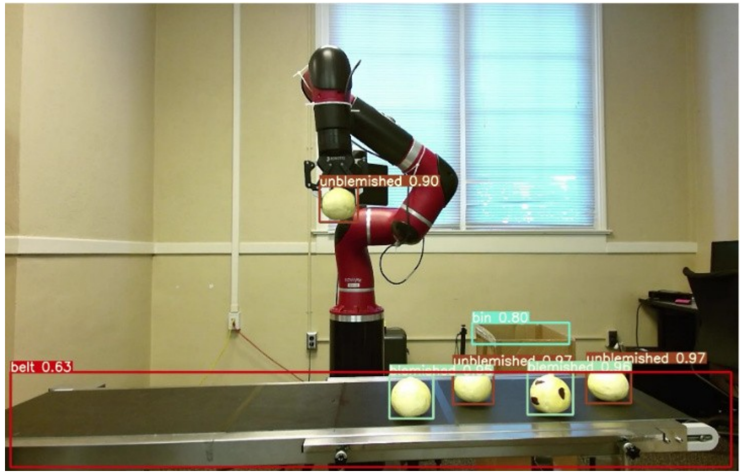
Prashant Doshi – University of Georgia, Kenneth Bogert – UNC Asheville

Challenge

- IRL with robotics often makes use of noisy sensors to estimate the expert’s state, causing learning error

Solution

- Extend MMAP - Bayesian IRL to occlusion and sensor noise
- Fast gradient computation with forward-backward optimization for occluded regions



Sawyer robot performing an onion sort with bounding boxes detected in real time by YOLO v5. These are used as uncertain measurements of the robot and environment state, which are input as observations into MMAP-BIRL. Our technique outperforms existing techniques with this noisy data.

Scientific Impact

- Considering noise in robot learning can help to extend the simulation experiments to the real-world ones without being worried about noisy sensors

Broader Impact

- Expedite task transfer from human to cobot and reduce the programming effort
- PI Doshi developed a new joint under-and-graduate course on RL, in which IRL is a core module

IRL with Partial Observations using the Principle of Uncertain Maximum Entropy

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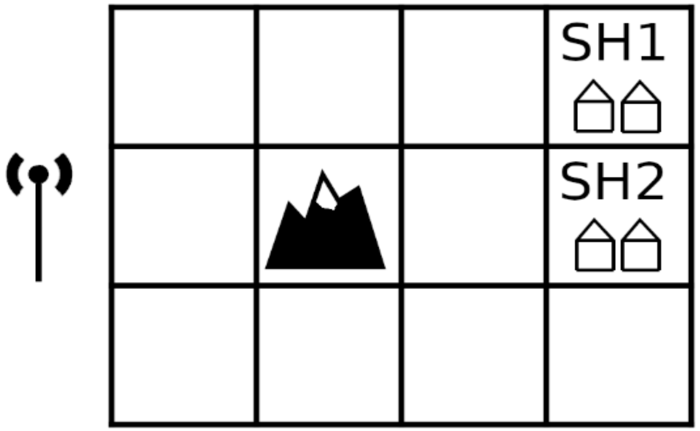
Challenge

- IRL with robotics often makes use of noisy sensors to estimate the expert's state, causing learning error

Solution

- Extend Principle of Maximum Entropy to uncertain measurements
- General EM-based solution developed, we show that uMaxEntIRL outperforms prior approaches



Example domain for uMaxEntIRL. A fugitive being tracked by a radio tower is attempting to reach Safe House 1. Due to noisy position measurements that degrade as the fugitive gets further from the tower or moves behind the mountain range, existing techniques fail to learn the fugitive's policy from provided noisy data, while uMaxEntIRL is much more robust.

Scientific Impact

- Formal method for employing MaxEnt models in domains with data from noisy sensors. Improve accuracy and applicability of MaxEntIRL.

Broader Impact

- Contribute to automating software for task transfer and deploying of cobots
- PI Bogert employing uMaxEntIRL in undergrad research projects at UNCA

MVSA-Net: Robust Multi-View State-Action Recognition Using Gated Networks and Deep Neural Networks

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Challenge

- During robotic LfO, single viewpoint cameras can provide incomplete expert information

Solution

- Use multiple cameras during demonstrations, input into multiple deep neural nets to output fused estimate of the expert's state and action
- Gated network increases accuracy by distributing the decision making over the views

Scientific Impact

- MVSA-NET is a general supervised technique to take advantage of multiple heterogeneous visual sensors; a similar approach can be applied to other problems with multiple sensory data

Broader Impact

- Increase deployment scenarios for robotic LfO, co-bot training, and tracking.