Graph-Structured Visual Imitation

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Visual Imitation Learning

Learn policy from visual input so that the robot's actions create the same effect on the environment as the human

Problem Statement

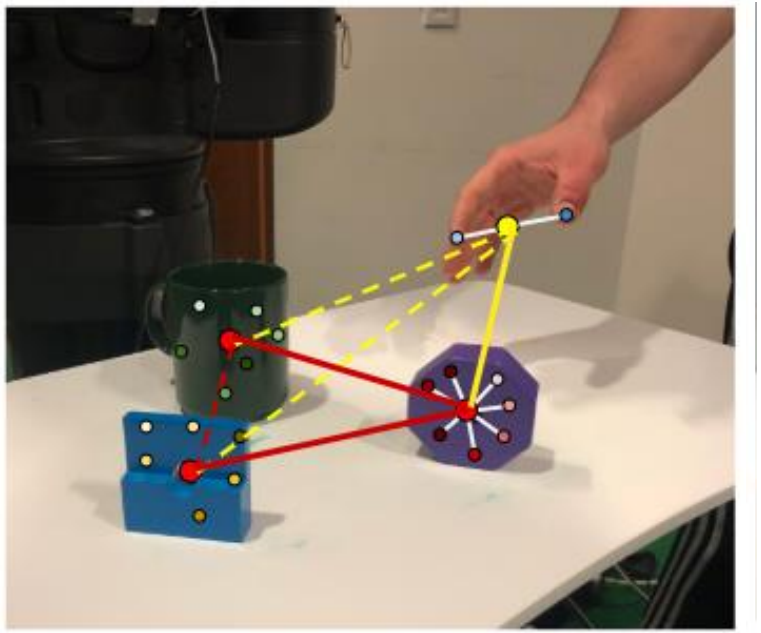
Focus of this work:

Find interpretable state representation that allows

for sample-efficient visual imitation learning from

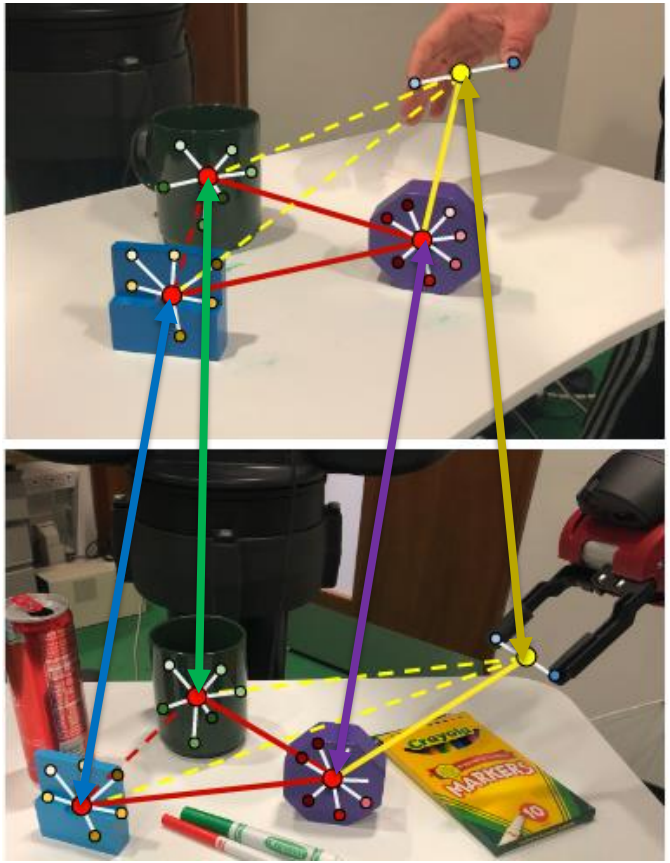
single demonstration

Visual Entity Graphs for Visual Imitation



1. Detect **object** and **hand entities** in image
2. Detect object-level **pixel entities**
3. Establish **geometric relations** between the entities
4. Place **attention** on “important” edges

Correspondence of Visual Entity Graphs



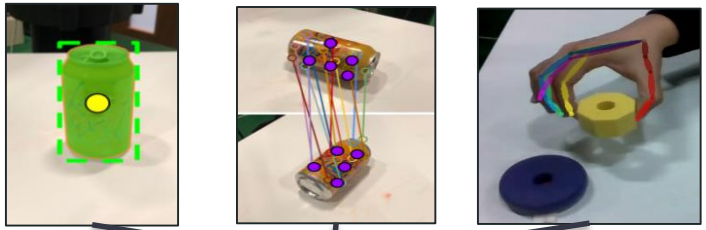
Establish correspondence between demonstration and imitation

From Visual Entity Graphs to Policy Learning

Object entities

Pixel entities

Hand entities



Visual Entity Graph Encoding $\mathcal{G}$

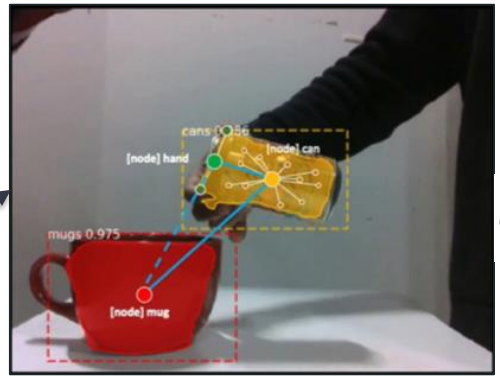
Demonstration

Encode

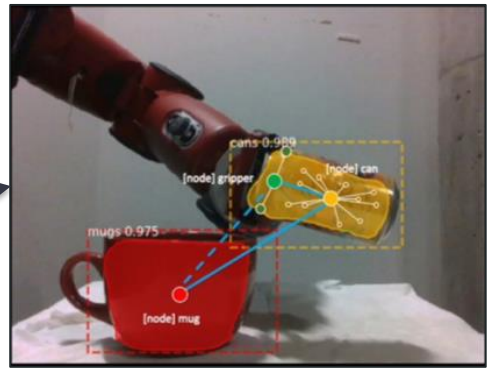
Imitation

Encode

$$\mathcal{C}(\mathcal{G}_D^t, \mathcal{G}_I^t) = \sum_{i,j,i<j} w(\mathcal{E}^{t,(i,j)}) \cdot \mathrm{att}(\mathcal{E}^{t,(i,j)}) \cdot \left\| \left(\mathbf{x}_D^{t,i} - \mathbf{x}_D^{t,j}\right) - \left(\mathbf{x}_I^{t,i} - \mathbf{x}_I^{t,j}\right) \right\|$$

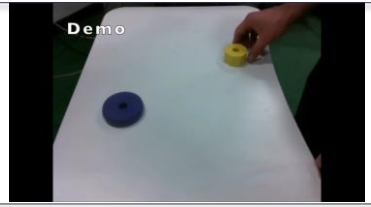
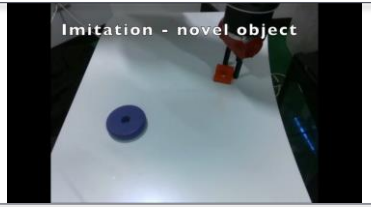
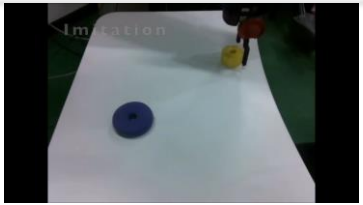
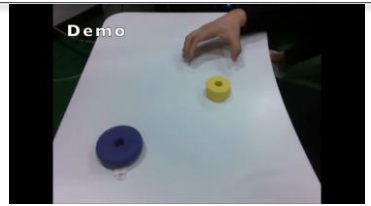


$\mathcal{G}_D^t$



$\mathcal{G}_I^t$

$\mathrm{Cost}\left(\mathcal{G}_D^t, \mathcal{G}_I^t\right)$ → **Policy Learning**

	Demonstration	Imitation	Imitation different object instance
Pushing			
Pushing – Direction Change			
Stacking			
Pouring