Project synopsis

Project title:
Self-Supervised Keypoint Learning

Motivation:
Deep reinforcement learning using only image pixels as input often suffer from suboptimal generalization and poor sample efficiency due to the high dimensionality of images. One solution to this problem is to utilize methods which can create low-complexity feature spaces from data which can then be used for training instead of the original high dimensionality data. The main issue with this is that such methods often require human supervision to be accurate. In this project we will implement a self-supervised keypoint learning network for detecting keypoints in images. These keypoints will be used as input to a pre-implemented RL network to determine how effective self-supervised keypoints can be compared to images – both in terms of performance and learning. The DeepMind Control Suite will be used to test the pre-implemented RL network with and without the self-supervised keypoints.

Background:
The background for this project is primarily Paper: Unsupervised Learning of Object Landmarks through Conditional Image Generation which describes a self-supervised keypoint learning network for detecting keypoints in images. Our keypoint learning network will be based heavily on their implementation. We will also use Code: Public SAC+AE implementation in PyTorch on GitHub as our pre-implemented RL network which is based on Paper: Improving Sample Efficiency in Model-Free Reinforcement Learning from Images. Furthermore, we will use code from Nicklas Hansen (supervisor) as reference.

Milestones:

1. Implement self-supervised keypoint learning network and test implementation using single images
2. Make the keypoint learning work in a multi-frame setting
3. Integrate the keypoints in the RL network code s.t. the RL network can use keypoints as input
4. Compare performance of the RL network with and without the keypoints as input

References:

Book: Reinforcement Learning: An Introduction (Sutton & Barto)

Lectures: CS285 Deep Reinforcement Learning @ UC Berkeley

Code: Public SAC+AE implementation in PyTorch on GitHub

Paper: Unsupervised Learning of Object Keypoints for Perception and Control

Paper: Unsupervised Learning of Object Landmarks through Conditional Image Generation

Paper: KETO: Learning Keypoint Representations for Tool Manipulation

Paper: kPAM: KeyPoint Affordances for Category-Level Robotic Manipulation

Paper: DeepMind Control Suite

Paper: Improving Sample Efficiency in Model-Free Reinforcement Learning from Images