Final Project

(You may work in a group up to 2 persons.)

Task

Your task is to develop a controller for a robotic arm to lift an object. Such control is not difficult if the accurate location of the object is known. However, in real world scenarios, we often have noise in measurement and thus the controller won't have precise location information. Using reinforcement learning, you will develop a controller that has access to both noise perturbed location information and camera images. The controller can use the images to adjust the location information to complete the lift task.

Robotic Simulation

The robotic simulation class and functions are in the "utils.py" file.

The notebook ("Robosuite Demo.ipynb") shows how to use the simulation environment and gives a waypoint-based controller. The controller can complete the task if noise is turned off. But it often fails when noise is present.

Objective

Design a reinforcement learning process to train a neural network that can be used to adjust the control code in the example so that the arm can lift the object with noisy location information.

Your design must meet the following requirements:

1. The neural network adjustment must be trained using reinforcement learning, not supervised learning.
2. The true location information is available in the simulation code. But **you cannot use the true location information in any part of training or testing process**. This further prevents approaches such as training a neural network to predict the accurate location by supervised learning because you cannot use the true location information as your training target.
3. Each time you create a new simulation environment, the location of the object and the amount of noise perturbation are different. Your neural network and adjustment should work for any object location and noise perturbation.

You are free to use any neural network architecture and any reinforcement learning algorithm.

To test your neural network and control algorithm, create 10 simulation environments (each with random object location and noise). Run your control algorithm trained by reinforcement learning in each of the environment. Calculate the success rate (i.e., # of environment among the 10 in which your control can successfully complete the task.

Record videos for one environment in which your controller gives the best result.

Submission

Code and model: organize your code in a directory named “src”. It should include:

1) Your controller code together with the neural network for making the adjustment. The code should allow downloading your trained model (you may borrow the downloading implementation from your hw2) so that we can run the controller in a new environment without training.
2) Code implementing the reinforcement training scheme you designed.
3) A README file providing:
    a. A short description of the codebase
    b. Instruction for running your code to conduct reinforcement learning and instruction for using your trained controller
    c. The links that can be used to download your saved trained models. You should save your saved trained model in an online drive. **Do not submit the saved model in moodle**.

Vidoe:

1) A demo video showing the best attempt by your controller

Writeup: write a 4-page report on what you did, including

1) the reinforcement learning scheme you designed and a justification on why you think it may work;
2) the success rate of the trained model;
3) the information on the true object location and the noisy object location for the environments in your example video;
4) Analysis of the reason behind the result and any lesson learned.

(Your method may not train a successful policy/controller, but it needs to make sense in a theoretical way. Innovative solution, theoretically soundness and proper validation are the main considerations for grading.)

Save the writing in a pdf file.

Put the pdf file, the video and the “src” directory in a directory named “robot”. Zip the “robot” directory and submit the zip file in moodle. **If you work as a group (up to 2 persons), one group only needs to make one submission. Put the names of the group members on the PDF writeup.**