CS/ME 301: Introductory Robotics Laboratory

Assignment #3: Machine Learning

Code Due: Mar. 11th (3:29pm)   **Demo Due:** Mar. 13th (12:30pm)   **Report Due:** Mar. 16th (11:59pm)

This assignment will focus on robot learning. The format for this lab will be largely open: you will have the freedom to define *what* it is your robot will learn, *how* the robot will learn it, and *which* metrics will be used for assessment.

Instructions

I. Problem formulation

The first step in this lab is to identify what it is that you want your robot to learn, and what machine learning algorithm you will implement to learn it. For example, machine learning could be used to improve your walking and turning gaits from Assignment #1, or you could learn the cost map of Assignment #2 from environment exploration. Or you could learn an entirely new behavior, unrelated to any of the previous labs; for example, responding to a particular stimulus detected by your robot's sensors. You and your partner should brainstorm on this.

You must clear with the instructor your choice for each of the following:

   (i) what behavior the robot will learn

   (ii) the algorithm which will be used to learn this behavior (with details of its exact formulation)

   (iii) the procedure for training this algorithm (including dataset collection, if appropriate)

   (iv) the analysis of the performance of your learned behavior running on the robot (including data collection)

   (v) what your group will demo on Demo Day

The reason for this is to make sure your group is choosing a learning task that is sufficiently challenging, but also reasonable to achieve within the allotted time, and that your choice of algorithm can actually learn the task.

After receiving verbal approval for your approach, **you must email the instructor** with all of the above details. She will respond with a confirmation email that is your official approval, and will include guidelines for what you should be prepared to show in your demo.

Target completion: End of class, Thursday February 27th.

II. Implementation

Code it up, and test it thoroughly!

As you progress with the implementation, you might find that one of the above choices (i)-(v) needs modification. If so, **send an email to the instructor, to update your approval**. *You will be assessed on your most recent approval*, so this step is important.

Target completion, coding: Start of class Tuesday, March 4th

Target completion, training: End of class Thursday, March 6th

Make sure you leave enough time for the data collection needed for your analysis.

Target completion, analysis: End of class Tuesday, March 11[h]

III. Demo

The exact demo requirements will be unique to each group, according to their learning task, and must be cleared by the instructor in the confirmation email (above).

Additionally, on the demo day, **each group will give an oral presentation** about their learning approach. These presentations will be short (5 minutes), and the participation from each partner (in speaking, and answering questions) should be equal. Groups are free to write on the board; no other visual aids (e.g., slides) are expected. Presentations should essentially be a summary of what would go into Sections II and IV of the lab report; see below for more details on what this entails.

Report

Each group member is to submit their **own** report, in PDF format. While it is expected that the raw data for each student will match that of their partner, the presented figures, tables, and analyses must be performed by each student individually, and be their own work. (See the Syllabus for more about plagiarism/cheating.)

In addition to the guidelines set out in the Lab Report Guide, the following questions/considerations should be addressed in the Assignment #3 lab report:

I. INTRODUCTION:
Discuss machine learning for robots at a more general level than your specific implementation. (When is it used, why can it be helpful, what sort of techniques are employed... etc.)
Draw upon information presented in lecture, the book, and any additional resources you consulted for your implementation.

II. METHODS:
Make sure to provide a clear description, in sufficient detail, of the behavior your robot is meant to learn.
Make sure to provide a thorough description of your algorithm formulation. (What is the input? What is the output? What is assumed? What is unknown? How were parameters tuned? Etc.)
When describing the analysis and data collection will you perform, also provide motivation for why are they useful – what will they tell us, and why is this important?

III. RESULTS:

Report the results from the analysis and data collection described in Section II.

Be sure to describe any relevant initial conditions, measurement mechanisms, failures, etc.

Be creative in your reporting mechanisms; e.g. using plots when possible, rather than just data tables.

IV. DISCUSSION:

Identify any reasons for poor performance, challenges, sources of uncertainty, areas for improvement, any surprising results, and anything else you think merits discussion. Be generous!