ME5406 Deep Learning for Robotics
Project 2: Build Your Own (Robotic) Project

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Proposal Due: 06/03/2023 (but earlier is better) Project Due: 21/04/2023

1 Goal

The goal of this assignment is to propose your own **robotically-inspired Reinforcement Learning (RL) project** that builds upon and puts in practice the concepts and tools discussed in class. Project will first be **proposed by students** early during part 2 of the module. Once validated, students will work on this project as a group of maximum 3 people, via independent learning. Projects will be graded based on the code submitted, video results (both common to a group), as well as a **short individual report** (10-page max) that explains the problem considered, the proposed solution and comparison with conventional baselines, and the **journey and lessons learned** throughout the project.

2 Assignment

2.1 Proposal (Due 06/03/2023, week 2 of part 2, but earlier is better)

This project allows you to make up your own problem statement, to then be solved by implementing and maybe even extending some of the tools/concepts discussed in class. Since the module is centred around robotics and deep learning (DL), the proposed project should of course combine concepts from these two areas.
The project proposal will be submitted as a single pdf document (2-3 pages max) via CANVAS by each student before the second Monday of class in part 2 (**March 06, 2023**). An acceptable project proposal needs to detail:

- The (robotic) motivation behind the specific problem considered (**WHY?**): why does this problem matter for real-world robotic applications/deployments?
- A brief discussion of the current (conventional) algorithms/methods that exist to solve this problem, highlighting their advantages and downsides. The idea here is to justify the use of ML/AI approaches, by explaining which downside they could address in current approaches.
- A clear problem statement (**WHAT?**), explaining what the agent(s)/robot(s) know about the system and how (e.g., sensing modalities, communications, etc.), what their goal/task is, as well as what their capabilities are (what do agents have control over).
- Following this problem statement, a cast of the problem into the reinforcement learning (RL) framework, detailing in as much detail as possible (at this stage) the proposed state space, action space, reward structure, and even neural network structure (**HOW?**).
- A short discussion about which RL algorithm(s) might be investigated to solve this problem, explaining why you have have chosen them for this specific task. What do you expect to achieve/obtain by using DL/RL for this specific problem (as opposed to conventional methods)?

Students will be notified upon proposal validation by the Professors/TAs. If a proposal is deemed incomplete or invalid, the group will then have one week to complete their initial proposal, or propose a new idea (meaning that they will will have less time to complete the project). **Please take the proposal step seriously to avoid wasting any time, and to get you started with your project as soon as possible!**

2.2 Final Project Submission (Due 21/04/2023, reading week of part 2; There will be absolutely no extension whatsoever)

The final project submission is due on **April 21, 2023**. **Each student of the class must individually submit as a single zip file directly on CANVAS, containing the files listed below**. The code and video file can be the same for all members of the same group, but the report is entirely individual and no copy-paste is allowed among students, **even among members of the same group**.

- Your group's **source code**, as a single zip document containing all necessary code files/libraries you wrote as well as the standard requirements for deep learning projects:
  - Your **complete training code**, as well as a simple **validation/testing code** that shows the functioning of the model, once trained.
  - At least one **fully-trained and functional model** of your proposed RL agent, to allow us to easily run your validation code.
  - A **requirement.txt** file defining an exact conda environment that can be created to directly run your training/validation code.
  - a **README.md** file that explains what your code does, what the main files are and how to use them, and what main **python libraries and/or other external software needed**, such as any simulation software, and their minimum/exact versions. See any good github repo for an example.
- Your **individual report**, as a single (10-pages max) pdf file, which details:
  - **Introduction/Summary**: details the problem you are considering and why it matters for real-world robotic applications (can be taken from a good proposal write-up), as well as a brief discussion of existing conventional (and even DL-based) approaches and their advantages/downsides.
  - All the **details of your proposed method**: full cast into the RL framework, details of the learning agent, neural network structure, training process, etc.
  - **Results** of your proposed approach, and which testing scenarios were used and why.
  - If possible (**Bonus points**): comparison of your approach with at least one state-of-the-art conventional alternative, highlighting the advantages/downsides of each method.
  - A discussion of the **advantages and limitations** of your approach.
  - A discussion of the **challenges encountered** during thr project, **lessons learned**, and potential **future works** to further develop the proposed method.
- Your group's **video file**, showing the performance of your method in an example scenario. Do not hesitate to include an example experiment using a conventional baseline, if you have one, to easily visually compare the performance of both methods.

Get creative, and try to go beyond the base requirements (bonus points)!

3 Use of Existing Code (e.g., from online resources)

We understand that a lot of codes are available online nowadays, and that part of any successful ML/AI project now entails scouting the internet and finding/using them. This is **perfectly acceptable** for this project, **provided the group still coded up a significant portion of the project's code from scratch (i.e.,) at least 50% of the total project's code base)**.
Therefore, you **will need to fully disclose** any code you have used for your project in your report, whether you have used that code directly or have used it as a starting point for further modifications. This year, we will be experimenting with the use of an anti-plagiarism software to detect how much of a project has been taken from online resources (or shared among groups), so be very careful and most of all, **be honest**.

Plagiarism measures will be taken if any piece of code can be found online that suspiciously resembles your code, without you disclosing such code in your report.