Deep Learning Team Mission

ASU Racing Team

Introduction

We are glad you want to join this team and hope you will learn much from this mission. In this document, you will find logistics, and technical requirements.

Preparation Guidelines

Not just to help you prepare for our projects, but also if you want a plan to study AI, we have divided the topics into three levels. Each level covers different aspects of machine learning and AI.

Level 1: Core Topics

- Topic 1: Linear Algebra
- Topic 2: Statistics
- Topic 3: Probability
- Topic 4: Optimization
- Topic 5: Fundamentals of Machine Learning
- Topic 6: Neural Networks as UAF (CNN, RNN, Attention)

Level 2: Deep Unsupervised Learning

- Topic 1: Autoregressive Models
- Topic 2: Flow Models
- Topic 3: Latent Variable Models
- Topic 4: GANs
- Topic 5: Energy Based Models

Level 3: Deep Reinforcement Learning

- Topic 1: Fundamentals (Intro, DP, MDP)
- Topic 2: Monte Carlo and Temporal Difference
- Topic 3: Policy Gradient
- Topic 4: PPO Optimization

These topics form the foundations of the Deep Learning in general. Reviewing these materials will not only help you in our projects, or in the mission but also provide a strong base for your future work in any projects, in any field. Consider taking a look at these great resources (from our point of view) here.

Projects

Projects you can work on

Signal Processing

- Medical Signal Processing in collaboration with Cairo University Faculty of Medicine (Positions Available: 5)
- Voice Conversion
- MIMO Channel Modeling

Control Systems

- Arm Control with Reinforcement Learning
- MyoSuite 24 Challenge
- Humanoid Locomotion with Reinforcement Learning

The only project that is opened currently is the medical one. If we see a lot of interested people in any other projects we will consider to open them as well and maybe we can prepare some session about Reinforcement Learning for specific projects or other topics that we could need for them.

Technical Mission

Technical Mission

- This online test is aiming to test your ability to search and self-study in technical topics that you may know or may not heard about. Feel free to get help from the internet, doctors, teaching assistants, textbooks, or whatever source you find available to you (but you can't work on this mission with others who are also planning to join this team).
- Please read all the following questions carefully and provide your answers in a single repo as will be explained. Aid your answers with figures, graphs, or sketches if needed.
- Please **don't be intimidated** if you find the questions hard. We expect you to solve all of them, but it's not necessary to get the best results just do your best; the goal is to expose you to some of the topics that may need to explain in greater depth while working on specific projects, this also aims to measure your research skills and your ability to understand advanced topics alone. Do your best and, more importantly, try to learn along the way.
- Submit your answers to this Google form here.
- The deadline for submission is 20/08/2024.
- If you have any inquiries about the questions below, submit them here

Questions

Question 1:

Problem Statement: Finger Angle Prediction from EMG Data

Here are all the papers that could help you to understand the problem, data and to define the problem correctly. PLEASE make sure you understand it. It's a crucial step to build the **right model** and the **right architecture** under the **right assumptions**. If you have any issue about it, please contact us.

- We will use the data on this website: ninapro, but for this mission you will use our prepared data from here
- **NOTE:** You may need to walk through the *EMG_report.pdf*
- **NOTE:** You don't need to walk through them all if you have any queries, just ask us. We just put them as a reference. If you find it difficult to understand the data, you may also need to walk through the *des_data.pdf*

Papers and materials for the problem

- EMG_report.pdf
- des_data.pdf
- Biomechanical Characteristics of Hand Coordination
- biorob2012.pdf
- fnbot-12-00057.pdf
- Muscle Synergy Based Planning and Neural Adaptive Control for a Prosthetic Arm
- PIIS2405844023034096.pdf
- s12984-019-0536-6.pdf
- s41598-020-65257-w.pdf
- sensors-20-04297-v3.pdf
- tnsre2012_submitted.pdf
- tnsre2013.pdf
- 6878.full.pdf

Steps

- Use the prepossessed data directly from here.
- you will need to build 5 models and train each with no more than 10 epochs.
    1. First model: use the tabular dataset to train a Linear based model (DNNs, Linear layers, fully connected layers).
    2. Second model: use the tabular dataset to train a CNN based model, convolve through the sensors (here you can use also Linear layers).
    3. Third model: use the sequential dataset to train CNN based model, convolve through the time with a suitable time window (here you can use also Linear layers).
    4. Fourth model: use the sequential dataset to train RNNs based model (here you can use also Linear layers, you can use any kind of Recurancy layers).
    5. Fifth model: use the sequential dataset to train CNN-LSTM based model (here you can use also Linear layers).
    6. Sixth model: Attention based model (bonus).
- Train your models for no more than 10 epochs.

  Note: You must illustrate with readme file the assumptions made and the bottlenecks for each model.

Question 2:

For the same problem above with the same data used how we can represent the data? write a code that compress the data or represent the data with low dimensional representation and plot it.

Question 3: (Bonus)

For this section, you will need to review this paper here and attempt to implement the described methodology to achieve the same results. The data required can be found here.

Submission Guidelines

- Create a GitHub repository named `$DLASU24_mission_<{your_name}>`.
- Organize your repository with the following structure:
  - For Questions 1 and 2, create a folder named **EMG**.
  - For Question 3, create a folder named **oral_disease_classification**.
- For Question 1:
  - In the **EMG** folder, create a `README.md` file that includes your insights, conclusions, and figures. Illustrate the assumptions for each model. You may create a separate README file for each model if necessary.
  - Create two subfolders: **models** and **plots**.
    - The **models** folder should contain `.py` files only, with each model in a separate file.
    - The **plots** folder should contain your plots.
- For Question 2, within the **EMG** folder, create another subfolder named **representational_learning** for your answer.
- For Question 3:
  - Compare your metrics with those presented in the paper.
  - Experiment with alternative approaches or Attention-based models using the provided data and compare the results.