

Group Research Seminar Syllabus

1. Overview

Title	Machine Learning Essentials		
Mode	Online lectures and mentor sessions		
Prerequisites	High School Students	Required course/Knowledge	Linear Algebra
		Required course/Knowledge	Python programming

2. Program Introduction and Objectives

Course Objectives	Students will be exposed to real-world problems where sample data will be given and analyzed using a variety of tools from machine learning. Each meeting will include a practical problem, a theory relevant to the problem which will involve some mathematical concepts, and hands on where implementation of algorithms learned will be implemented in Python.
Software/Tools (if any)	The recommended software for the course is Python.

3. Program Schedule

Week	Lecture	Mentor Session (lab/case study, etc.)	Assignment	Reading Materials	
1	Topic	Review of Probability and Statistics	Probability examples	Basic Probability Statistical inference problems	Notes No 1
	Detail	Central Limit theorem and implications	Probability and Statistical inference		
2	Topic	Supervised Machine Learning	Labelled Datasets	PCA for denoising and data reduction. Classification of images.	Notes No 2
	Detail	PCA and data reduction and denoising. Classification techniques: SVM, kernel methods, application to digits classification, and face recognition. Decision trees and random forests.	Classification in python. Digits, Wine quality, Medical data.		
3	Topic	Unsupervised Machine Learning	Unlabeled datasets	Clustering and manifold learning	Notes no 3
	Detail	K-means, Hierarchical clustering, Manifold learning – MDS, tSNE	Unsupervised learning examples in python		
4	Topic	Introduction to Deep Learning using KERAS	Deep learning in python	Classification using deep learning	Notes no 4
	Detail	The basics of neural networks. Classification Problems.	Image classification, digits, images.		
5	Research Workshop Preparation Session Students will present their ideas about the final project and will get feedback. It is expected that the steps to carry out the project will be laid down in details. The Professor will help focus the project so that it level of difficulty is appropriate for the course.				
6	Research Workshop Preparation Session Here we expect student to show partial results, showing that they can complete the project. Feedback by the Professor will be given for successful completion of the project				
7	Final Written Reporting and Oral Presentation				

4. Problem Sets/Written Assignments/Quizzes

Total Number of Assignments	4
Submission Deadline	<u>7</u> Days after class
There will NOT be quizzes	

5. Final Oral and Written Project

Final project will be done in groups. Three students per group I recommended.

5.1 Final Oral Presentation

- **Oral Project Theme:** Each group will present the math if relevant, the numerical methods and the results using some visualization. The presentation slides are the written report.
- **Oral Project Requirements:** Power Point or any other presentation tool

5.2 Final Written Project

- **Written Project Requirements:** The slides of the presentation will be taken as the final report.

6. Suggested Future Research Fields/Direction/Topics

A natural continuation of the material presented here are advanced techniques in deep learning. Material for the continued study will be discussed.

7. Instructor Introduction

7.1 Instructor Title: Professor

7.2 Instructor Bio:

I have studied applied mathematics in Tel Aviv University, then did my M.Sc and Ph.D. at the Weizmann Institute of Science. I have then moved to the USA and worked at ICASE (Institute for Computer Application in Science and Engineering), which was at NASA Langley Research Center. I was a senior scientist at the Weizmann Institute for a few years. From 1994, I was a Professor at Carnegie Mellon University. In the early stages of my career, I worked on problems that originated in aerospace, this included solving the fluid dynamics equation as well as dealing with large scale optimization problems. When I moved to CMU, I started working on Materials Science and Immunology and Medicine. In recent years I added machine learning and AI to m activity.

7.3 Instructor Profile Photo:

