Spring 2018
24-788 Artificial Intelligence and Machine Learning Project

Class	MW 11:30 AM – 1:20PM SH-214
Instructor	Levent Burak Kara lkara@cmu.edu , SH-411
Website	Carnegie Mellon University Canvas system

This is a semester-long project oriented course that provides an open-ended computational design experience for the students who have taken 24-787 Artificial Intelligence and Machine Learning for Engineering Design. This course will build upon the techniques taught in 24-787 and will enable student teams to design, develop and test data-driven computational algorithms.

The projects will target problems involving experimental, simulated or crowd-sourced data. Each project will aim to build an artificial intelligence or machine learning system that accomplishes one or more of the following: Identify patterns in data, establish a mathematical model for the input/output relationships, classify data into distinct categories, use existing data to synthesize new solutions to a synthesis problem. Team activities include various presentations and reports, team lectures, paper debates, and one final report in the form of an archival publication and deliverables.

Synopsis:

- Open-ended project experience for primarily ME graduate students.
- Provide experience in data sciences and data-driven methods for engineering.
- Advanced programming and computational system design experience.
- Project planning and management, project evaluation, teamwork, technical communication.

Specific Objectives:

- Learn how to define a problem using research, benchmarking, literature review, and brainstorming techniques.
- Learn how to establish key project requirements, a project plan, success criteria, assessment methods, and final deliverables.
- Gain experience in working in teams.
- Learn how to acquire and process real and large data sets. Develop computational techniques to learn from such data.
- Gain experience in data sciences and data-driven methods for engineering.
- Learn advanced programming and computational system design.
- Learn project planning and management, project evaluation, teamwork, technical communication.

Submission Procedures:

All submissions will be through Canvas > Team Pages.

Teams:

Each student will be assigned to a team. This is to provide a realistic project experience. There will be no more than four students per team.

Late Submission Policy:

For any late written assignment, a 30% compounding penalty will be applied per 24 hours. If you are late, but submit your assignment within 24 hours past the deadline, your grade will be 70% of the nominal grade. If you are late beyond 24 hours and within 48 hours, you grade will be 70%*70% = 49% of the nominal grade etc. Late submissions for any oral assignments will not be accepted. That is you will receive 0% of the nominal grade.

Project Ideas:

Students are encouraged to pursue projects related to their academic research, engineering field, or personal interests. The project you choose is up to you.

- Engineering Drawing Combination Composing Optimization
- Research on Topology Optimization using PCA
- Identifying the Face Value of Dollar Bills
- Interactive Genetic Algorithm to Help Witnesses Remember Criminals
- On a Step Ankle Push-Off Controller Design to Enhance Stability
- Automatic Gear Set Mechanism Design Based on Genetic Algorithm
- Character Recognition from Scan
- Morphing 2D Shapes using Free-Form Deformation
- Adaboost Face Detecting
- Gesture Recognition in Virtual Reality environments
- Data driven topology optimization
- IBM Watson Challenge
- Optimization of Robotic Manipulation using Gaussian Process
- Web-based TSP Solver using Genetic Algorithm
- Forecasting Solar Radiation in the Western United States
- 2D Object Packing
- Klotski Game
- Optimal Route Selection of Multiple Destinations using A* Search
- NFL Game Prediction
- Robot Leg Parameter Identification using Optimization
- 2D Shape Recognition and Path Planning
- Hand Gesture Recognition
- Solving the Rubik's Cube
- Brain Image Analysis and Choice Prediction
- A Robust Face-Detection Application using Machine Learning Methods
- Muse of Matrix
- Construction Zone Recognition
- An Image-based, Trainable Symbol Recognizer for Textual Mathematical Expressions
- American Sign Language Recognition System
- A Parametric Feature Study on Star-Galaxy Classification
- Predicting NBA Championships by Learning from History
- Comparison of Classification Algorithms on Robot Arm Execution Failures
- Detecting Whether a Password is Entered by an Authorized Person
- Online Anomaly Detection and Extraction from News Streams for Auto Updating News Articles

In addition, there are some interesting project ideas on https://www.kaggle.com, which uses the crowdsourcing model to solve challenging data mining problems. Finally, some of the lecture slides from 24787 may contain information that will help you during the brainstorming process.

Other sources may include published data sets. Here is a good repository of classical data sets for your reference: https://en.m.wikipedia.org/wiki/List_of_datasets_for_machine_learning_research

Grading:

Project Proposals v1, v2	0 (Mandatory)
Phase I Paper	10
Phase I Presentation	6
Phase II Paper	12
Phase II Presentation	10
Phase III Paper	15
Phase III Presentation	15
Team Lecture (1 lecture / team)	13
Participation and Attendance	8
Results of Peer Evaluations	7
Submission of Peer Evaluations	3
Faculty Course Evaluation	1
Total	**100%**

Grading Scale and Description:
85%-100% = A
75%-85% = B
65%-75% = C
55%-65% = D
0%-60% = R

A
Superior performance. All requirements are met in a timely and thoughtful manner. Creativity and rigor are demonstrated. All communications are clear, with no flaws. Diligence and intellectual effort clearly demonstrated. Solution is exciting and meaningful.

B
Acceptable performance. All requirements are met in a complete and timely manner. All communications are clear with no flaws. However, the work lacks excitement and sufficient justification to indicate potential success. Or, the student did not demonstrate sufficient contribution to project at a superior level.

C
Below average performance. While the requirements may have been met, there is one or more flaws such as technical feasibility and quality; clarity, breadth and depth of solution or process; insufficient assumptions; insufficient phase results; overall completeness. Or, the student did not demonstrate sufficient contribution to project at an acceptable level.

D
Performance well below average. The work is not representative of a Carnegie Mellon Graduate Mechanical Engineering student. Inadequate planning, work distribution, and a lack of motivation and commitment will likely result in such outcome.

R
Very poor performance: Student clearly lacked sufficient participation in course, team and/or project to justify graduation and passing course.

		Date	Topics	Student Due Dates	From Teaching Staff
	W1	**15-Jan** **17-Jan**	*No class – MLK day* Intro, Team assignment		
Phase 1	**W2**	**22-Jan** **24-Jan**	LBK_Lecture Team Meetings: A&B (in SH-411)		Proposal 1 guidelines out Team lecture assignments out, guidelines out
	W3	**29-Jan** **31-Jan**	Proposal 1: A&B Team Meetings: A&B (in SH-411)		Proposal 2 guidelines out, Peer Evals out
	W4	**5- Feb** **7- Feb**	Proposal 2: A&B Team Meetings: A&B (in SH-411)		Phase 1 paper / presentation guidelines out
	W5	**12- Feb** **14- Feb**	LBK_Lecture, Team Meetings: A&B		
	W6	**19- Feb** **21- Feb**			
Phase 2	**W7**	**26- Feb** **28- Feb**	Phase I presentations: A Phase I presentations: B		
	W8	**5- Mar** **7- Mar**	LBK_Lecture, Team Meetings: A&B (in SH-411)	7-Mar: Phase 1 papers. Peer evals 1	Phase 2 paper / presentation guidelines out
	W9	**12- Mar** **14- Mar**	*No class – Spring break* *No class – Spring break*		
	W10	**19- Mar** **21- Mar**	LBK_Lecture, Team Lecture: A3-CNNs, Team Lecture: A4- Recurrent NNs Oral Presentation Workshop (SH-214). Team Meetings: A&B (in SH-411)		
	W11	**26- Mar** **28- Mar**	Written communication workshop (SH-214). Phase II presentations: A1, A2, A3 Phase II presentations: A4, B1, B2, B3		
Phase 3	**W12**	**2- Apr** **4- Apr**	Team Lecture: B2-Feature selection, Team Lecture: A2- Reinforcement Learning. Team Meetings: A&B (in SH-411)	7-Apr: Phase 2 paper. Peer evals 2	Phase 3 paper / presentation guidelines out
	W13	**9- Apr** **11- Apr**	LBK_Lecture, Team Lecture: B3-Ensembles, Bagging, Bootstrapping, AdaBoost Team Meetings: A&B (in SH-411)		
	W14	**16- Apr** **18- Apr**	LBK_Lecture, Team Lecture: B1-Random Forest Regression Team Meetings: A&B (in SH-411)		
	W15	**23- Apr** **25- Apr**	Team Lecture: A1-GANs Team Meetings: A&B (in SH-411)c		
	W16	**30- Apr** **2- May**	Phase III presentations: A Phase III presentations: B	5-May: Phase 3 paper. Peer evals 3	

Teams and Ideas: https://docs.google.com/spreadsheets/d/14bCOUV6p4A3BlhBDa3CQdj5SA2VG2PJB809NsCOUXGM/edit?usp=sharing