Course Name: BME1560 Artificial Intelligence for Biomedical Engineering (Fall 2022)

Course Description: This course provides an opportunity to graduate students with both the breadth and depth in the area of machine learning and deep learning applied to biomedical applications. The course firstly introduces basic machine learning algorithms, including supervised learning (e.g., logistic regression, naïve bayes, decision trees, etc.) and unsupervised learning (k-means, hierarchical clustering). It will be followed by describing other fundamental concepts, such as classifier evaluation and statistical testing to compare classifiers. The next part is the study of different deep learning models (in seminar style) for various biomedical applications that deals with multiple types of data, including and not limited to biosignals, physiological data, environmental data, speech, text, images, and videos. Different types of supervised and unsupervised frameworks for sequential and non-sequential data will be discussed, including Feed-forward neural network, Convolution neural networks, Autoencoders, Long Short-Term Memory, Temporal Convolution Network. In the last part, advanced deep learning architectures applied to biomedical application will be discussed, including Generative Adversarial Network and Contrastive Learning. The course will comprise of programming assignment (2), paper critiques and a group project (team of 1-3 persons).

Course Lecturer / Instructor: Dr. Shehroz Khan

Contact : shehroz.khan@utoronto.ca. Please add 'BME1560' anywhere in your subject line, so your email is delivered to a dedicated folder and response time is faster.

Course Format: This course is a participatory course and has two components – taught lectures and seminar style paper reading. Each week on Quercus, pre-reading material will be posted for the upcoming class.

Learning Outcomes:

- Develop the research intuition to use and develop machine / deep learning approaches pertaining to specific biomedical engineering problem.
- Learn deep learning strategies to work with different data types, including images, videos, sensors, text and speech.
- An in-depth understanding of supervised, unsupervised, and self-supervised deep learning methods.
- Prepare constructive paper critiques that is clear and concise by identifying the strengths of the research papers and highlighting their potential shortcomings.
- Improve upon the methodology, experimental design and rigorous evaluation of various deep learning methods.
- Enhance programming abilities by implementation in python and PyTorch framework.
- Formulate research questions, work collaboratively on a group project, prepare an academic style written report, and give a presentatio to the class.

Grading:

Participation: 15%

Assignments: 15%

Paper Critiques: 20%

Course Project: 50%

Total: 100%

Please note the course requires the completion of all components listed in the grading breakdown.

Participation: This course has a strong participation component; therefore, attendance and participation will be marked. The topic for each week's class will be defined and students (or a group) will take turns to lead paper discussions, the rest will take active part in discussion and constructive feedback. The paper discussion can be either (i) Old school paper reading where the group reads from the printed research paper or on a laptop, or (ii) In the form of a presentation. The students will not be graded for leading paper discussion; however, it will count as a mark for their participation in the class. The papers (or relevant study material) will be provided on Quercus, so all the students are expected to have read the paper(s) before coming to the class. Failure to notify the instructor within 48 hours of a class absence related to illness, internet connectivity or personal circumstance will result in loss of class participation mark for that day.

Paper Critiques: Each week students will submit constructive paper critique of the paper to be read via Quercus by 12pm (noon) on the day of the class, that is before the class. This activity will help students to improve critical assessment of scientific literature, provide constructive feedback highlighting strengths and potential shortcomings. We are hoping seven paper critiques for the duration of the course. However, the top five marked will be considered in the final grade. Therefore, a student has to submit at least five (or maximum seven) paper critiques.

Assignments: There will be two programming assignments in the course both carrying equal marks – one at the beginning of the semester and another around the mid-term. These assignments will deal with implementing baseline machine learning and deep learning classifiers in python and/or PyTorch. The grading will depend on the methodology, evaluation, and the output results.

Course Project: This is the most important component of the course. It will be focused on three aspects – formulating a research problem, implementing and developing the code, and writing the report in an academic style format (e.g., IEEE double column). The students are expected to form groups of up to 3 individuals, each group members will be graded the same. A single person can also lead a project. The students will send a half-page project summary to the instructor in the first few weeks of the course. Based on initial feedback from the instructor, the group will proceed with the project. There will be a mid-point check with instructor/TA to assess the progress and direction of the project. Towards, the end of the term, groups will present their projects to the entire team. The groups will not be marked for the presentation, and it will be counted towards their participation. Finally, a project report will be submitted via Quercus / email towards the end of the semester.

Notice on Recording and Sharing: The classes will be delivered in person. However, your project presentation may be recorded on video for quality and internal evaluation purposes (not for grading). Course materials belong to the instructor or as copyrighted by the University.

Academic Integrity: All suspected cases of academic dishonesty will be investigated following procedure outlined in the *Code of Behaviour on Academic Matters*. Plagiarism will be dealt with strictly. You can find more information on U. of Toronto guide on Academic Integrity. Please reach out to the instructor shall you have any questions or concerns.

Equity, Diversity, and Inclusion: The U. of Toronto is committed to equity, diversity and inclusivity of all individuals. All members of the class should strive to create an environment of mutual respect where all members of our community can express their ideas, opinions, engage with each other, and respect each others' differences. The university does not condone discrimination or harassment against any individual or communities.

I hope that this class will be a great learning experience for you to achieve your goals.

(Dr. Shehroz Khan)