BMES 547 Machine Learning in Biomedical Applications

Instructor: Ahmet Saçan <ahmetmsacan@gmail.com>

Course Description:
Machine Learning is a computational approach for construction of algorithms that can learn from and make predictions on data. The focus in the course is on delivering a practical approach that can help appropriate utilization of machine learning methods for relevant data exploration and prediction tasks in biomedical applications. Applications will be drawn from bioinformatics, neuro-engineering, and biomedical image analysis, with special emphasis given to feature extraction and representation strategies specific to the data types prevalent in these domains. The machine learning concepts and methods will include parameter density estimation, dimension reduction, supervised and unsupervised learning, neural networks, and support vector machines.

Course Objectives:
1. To gain practical knowledge in machine learning tasks and develop ability to utilize available tools in biomedical applications.
2. To learn the basic concepts and techniques of exploratory data analysis, pattern classification, and data clustering.
3. To gain experience in data representation and feature extraction strategies in biomedical applications.

Student Learning Outcomes:
1. Problem Solving Abilities 2 - Ability to seek an optimized solution of an engineering problem.
2. Technological Skills 3 - Ability to use computers and computer software for analyzing and solving problems and justify application of hardware and software selected.

Drexel Student Learning Priorities:
1. Technology Use. Make appropriate use of technologies to communicate, collaborate, solve problems, make decisions, and conduct research, as well as foster creativity and life-long learning.
2. Information Literacy. Possess the skills and knowledge to access, evaluate and use information effectively, competently, and creatively.

Prerequisites: Bmes546 or Bmes550 (or other programming course).

Recommended Textbooks:
1. R. O. Duda, P. E. Hart and D. G. Stork. *Pattern Classification* (2nd ed.). John Wiley, 2001.
2. Z.R. Yang, *Machine Learning Approaches to Bioinformatics*, World Scientific, 2010.

Recommended Readings:
3. C.M. Bishop. *Pattern Recognition and Machine Learning*. Springer, 2007.
4. S. Dua and P. Chowriappa. *Data Mining for Bioinformatics.* CRC Press, 2012.
5. S. Theodoridis and K. Koutroumbas. *Pattern Recognition*. Academic Press, 1999.
6. W. Härdle and L. Simar. *Applied Multivariate Statistical Analysis*. Springer, 2007.
7. A. Webb. *Statistical Pattern Recognition*. Wiley, 2002.
8. T. Mitchell. Machine Learning. Mcgraw-Hill, 1997.

Course Outline:
For each topic listed below, a theoretical introduction will be accompanied by applications from bioinformatics, neuroengineering, and biomedical image analysis.

	Theory	Application (tentative)
Week 1	Data representation, classification and analysis	Biomedical data types and feature representations
Week 2	Probability, Bayes Decision Theory	
Week 3	Dimension reduction, Principal Component Analysis, Linear Discriminant Analysis	Gene Expression
Week 4	Neural Networks	Protein Secondary Structure Prediction

Week 5	Support Vector Machines Midterm Exam	Hospital readmission rates
Week 6	Classification and Regression Trees	Protein Subcellular Localization
Week 7	Feature Selection	Prediction of Catalytic sites
Week 8	Hierarchical & k-means clustering	Cancer Metastasis in Lymph Node
Week 9	Nearest neighbor classification, KD-trees, Final Exam	
Week 10	Projects	

Tentative Grading:
Assignments/Quizzes: 40% (Breakdown of points for individual assignments available on course website)
Project: 20%
Midterm: 20%
Final: 20%

Graded assignments, assessments, and evaluations:

Task/activity	Type	Graded	Purpose	Value
Assignments	Written & Programming	Yes	Reinforce weekly content	High
Midterm	Written & Programming	Yes	Evaluate understanding of course concepts and ability to apply the methods	Moderate
Final	Written & Programming	Yes	Evaluate understanding of course concepts and ability to apply the methods	Moderate
Project	Written & Programming	Yes	Evaluate ability to apply the methods to a research problem	Moderate

Assignments: Online tests will be used to reinforce weekly material. Additional application problems that may require writing code in Python, Matlab, or other programming languages will be assigned.

Late Policy:
Late submissions after due date are not accepted for Blackboard Tests. See late submission penalties for programming assignments on Blackboard.
Late submissionsare not accepted for an assignment if its solution is already provided or presented in class or in web-conference (regardless of whether the student viewed the solution).
Late submissions of assignments are not accepted after the last day of classes.
Individual assignments may have a different late policy than stated here; any such differences in per-assignment late policy will be provided on Blackboard.
Exceptions to the late policy subject to medical excuse or other emergencies.

Grading Scale:

Score %:	<64	64	67	70	74	77	80	84	87	90	94	97
Letter Grade:	F	D	D+	C-	C	C+	B-	B	B+	A-	A	A+

The grading scale is subject to alterations depending on student performance in the class.

Course policies:
- I will communicate with you via email and Blackboard Discussion Board. You are responsible for reading your Drexel email account and check the discussion board on a daily basis to receive these announcements.
- All items in this syllabus are subject to change as the course progresses. You will be notified in class or via email of any changes in policies or content.

All students are expected to abide by Drexel University's policies. If an act of academic dishonesty is determined to have occurred, for a first offense, one of the following sanctions will be imposed, depending on the severity of the offense:

- Reduction of a course grade
- An "F" for the assignment or exam
- Failure for the entire course with the inability to withdraw.
- Other action deemed appropriate by the faculty member. Examples include, but are not limited to, requiring the student to re-take the exam, re-complete an assignment, or complete an assigned exercise. The decision of the faculty member and the department head shall be reported to the Office of Judicial Affairs, which is responsible for maintaining student conduct records. The incident will result in an official disciplinary record for the student(s).
- Any academic honesty infraction beyond a first offense is subject to the sanctions described above, as well as to disciplinary sanctions that may be imposed through the University judicial process, administered through the Division for Student Life and Administrative Services/Office of Judicial Affairs. These sanctions may include suspension or expulsion from the University.

Course and University Policies.
Course / Syllabus Changes: While the syllabus is intended to be as accurate as possible, the instructor retains the right to make changes to the content or schedule. Students will be notified in advance of any changes via announcements on the course website, e-mail, and in class.

Please refer to the following links regarding important University policies.

Academic Integrity:
Drexel University is committed to a learning environment that embraces academic honesty. In order to protect members of our community from results of dishonest conduct, the University has adopted policies to deal with cases of academic dishonesty. Please read, understand, and follow the "Academic Integrity Policy."
https://drexel.edu/provost/policies/academic-integrity/

Disability Accommodation:
If you have a disability for which you may be requesting an academic accommodation, you are encouraged to contact both your instructor and the access coordinator for your school to establish eligibility for academic accommodations.
http://drexel.edu/oed/disabilityResources/students/

Course Add/Drop and Withdrawal Policies:
https://drexel.edu/provost/policies/course-add-drop/
https://drexel.edu/provost/policies/course-withdrawal/

Appropriate Use and Intellectual Property of Course Materials:
It is important to recognize that some or all of the course materials provided to you may be the intellectual property of Drexel University, the course instructor, or others. Use of this intellectual property is governed by Drexel University policies, including the IT-1 policy found here: https://drexel.edu/it/about/policies/policies/01-Acceptable-Use/

Briefly, this policy states that course materials, including recordings, provided by the course instructor may not be copied, reproduced, distributed or re-posted. Doing so may be considered a breach of this policy and will be investigated and addressed as possible academic dishonesty, among other potential violations. Improper use of such materials may also constitute a violation of the University's Code of Conduct found here: https://drexel.edu/cpo/policies/cpo-1/ and will be investigated as such.