Green University of Bangladesh
Department of Computer Science and Engineering

Course Outline

1 General Information

Faculty	Faculty of Science and Engineering (FSE)
Department	Department of Computer Science and Engineering (CSE)
Programme	Bachelor of Science in Computer Science and Engineering
Semester	**Spring 2024**
Course Title	*Machine Learning*
Course Code	CSE 411
Course Credit	3.0 units
Contact Hours	2.5/week
Course Status	Optional Course
Prerequisite Course	None

2 Course Instructors

Section	Name	Office	Email
211 D1	Dr Muhammad Abul Hasan	F106	muhammad.hasan@cse.green.edu.bd

3 Class Hours

Section	Room	Weekday	Time	Weekday	Time
211 D1	L103	Tuesday	12:15 PM - 01:30 PM	Thursday	12:15 PM - 01:30 PM

4 Counseling Hours

Section	Weekday	Time	Weekday	Time
211 D1	Wednesday	11:00 AM - 12:15 PM	Friday	11:00 AM - 12:15 PM

5 Course Rationale

The science of getting computers to act without being explicitly programmed is known as machine learning. Machine learning has given us self-driving cars, practical speech recognition, efficient web search, and a vastly improved understanding of the human genome in the last decade. Machine learning is so common these days that you probably use it dozens of times a day without even realizing it. Many researchers believe it is the best way to advance toward human-level AI. In this class, you will learn about the most effective machine-learning techniques and practice putting them to use for yourself. More importantly, you will not only learn about the theoretical underpinnings of learning, but you will also gain the practical knowledge required to quickly and powerfully apply these techniques.

6 Course Description

The Machine Learning course provides a comprehensive exploration of the principles, algorithms, and applications that underpin the field of machine learning. The curriculum covers fundamental concepts such as supervised, unsupervised, and reinforcement learning, as well as advanced topics like deep learning and natural language processing. Through a combination of theoretical lectures, practical exercises, and hands-on projects, students will develop a deep understanding of various machine learning techniques and their real-world applications.

The course mainly emphasizes the theoretical foundations of machine learning algorithms. Students will learn how to preprocess data, select appropriate algorithms, and evaluate their performance. Throughout the course, students will also explore ethical considerations and challenges in machine learning, ensuring a well-rounded understanding of the field's implications. By the end of the course, students will have the knowledge and skills to design, implement, and deploy machine learning solutions in various domains, contributing to advancements in technology, business, healthcare, and more.

7 Teaching Methods

The teaching methods for a Machine Learning course encompass a range of strategies that engage students with both theoretical concepts and practical applications. Here are the key teaching methods for such a course:

- Lectures and Theoretical Foundations: Engage students through interactive lectures that introduce fundamental concepts in machine learning, data processing, neural networks, deep learning, and Data. Provide a solid theoretical foundation to build upon.
- Project-Based Learning: Assign projects that challenge students to design and implement Machine Learning solutions. Projects can include Model evaluation and selection and practical application.
- Discussion and Peer Learning: Facilitate class discussions where students can share their insights, ask questions, and discuss challenges they encounter while working on projects. Peer learning encourages collaboration and diverse viewpoints.

8 Course Outcomes

CO	CO Description	PO	Domain (Taxonomy)	Weight	WK	WP	EA	Assessment Methods
CO1	To understand and apply fundamental machine learning concepts, such as supervised, unsupervised, reinforcement learning, online learning, Bayesian rules, etc.	PO2	Cognitive (C3)	40%				Please refer to Section 9.
CO2	To acquire critical thinking and problem-solving ability via analyzing data, identifying patterns, and formulating effective ML models.	PO4	Cognitive (C4)	40%	WK1, WK3	WP1, WP3	EA2	
CO3	To be able to comprehend the understanding of the outputs of machine learning techniques, fostering a greater willingness to explore advanced topics in the field.	PO10	Affective (A4)	20%	WK5		EA3	

Legend:

CO: *Course Outcome*
WK: *Knowledge Profile* (Appendix: B)
EA: *Complex Engineering Activities* (Appendix: D)
PO: *Program Outcome* (Appendix: A)
WP: *Complex Problem Solving* (Appendix: C)

9 Assessment Methods of COs

Assessment Method	CO1	CO2	CO3	Total
Final Exam	20%	20%		40%
Midterm Exam	15%	15%		30%
Class Tests	5%	5%		10%
K/S/A Test 1			10%	10%
K/S/A Test 2			10%	10%
Total	40%	40%	20%	100%

10 Topic Outline

Lecture	Selected Topic	Article	Problems
(1)	Introduction	Class Notes	
(2-6)	Supervised Learning (Regression, Classification, Linear Regression, Logistic Regression, Importance of designing effective cost function, convex function, learning parameters and parameter optimization concepts)	Class Notes	Assignment 1
(7-10)	Bayesian Decision Theory (review of probability concepts, uncertainty modeling, likelihood, posterior probability, naive decision rules, sensitivity and specificity)	Class Notes	
(11-12)	Parametric and non-parametric Methods for density estimation	Class Notes	Quiz 1
(13-14)	Unsupervised Learning (Association rule, KMeans Clustering, etc.)	Class Notes	
	Midterm Exam		
(15-15)	Perceptron learning (basic architecture and limitations)	Class Notes	Call for a Group Project
(16-19)	Multilayer Perceptrons (importance of non-linearity, understanding artificial neural network architecture, cost function, understanding multivariate calculus and its role in Neural networks, Stochastic Gradient Descent optimization, hyperparameter tuning)	Class Notes	
(20-21)	Introduction to Graphical Models	Class Notes	Quiz 2
(22-25)	Time series modeling/online learning (Markov model, Hidden Markov Models, and their applications, Bayesian Networks)	Class Notes	
(26-28)	Reinforcement Learning (Markov decision processes and Q-learning)	Class Notes	
(29-30)	Design and Analysis of Machine Learning Experiments	Class Notes	
	Final Exam		

For the definitions of and **R** , Please refer to Section 11.

11 Text and Reference Materials

T Textbook:

- *Christopher M. Bishop*, **Pattern Recognition and Machine Learning**, First Edition, Springer, 2006.

R References:

- *Richard O. Duda, Peter E. Hart, & David G. Stork*, **Pattern Classification**, Second Edition, Wiley-Interscience, 2000.

12 Grading Policy

Marks Obtained	Letter Grade	Numerical Evaluation	Definition
80% and above	A+	4.00	Excellent
75% <80%	A	3.75	Excellent
70% <75%	A-	3.50	Very Good
65% <70%	B+	3.25	Good
60% <65%	B	3.00	Good
55% <60%	B-	2.75	Good
50% <55%	C+	2.50	Average
45% <50%	C	2.25	Average
40% <45%	D	2.00	Below Average
below 40%	F	0.00	Failing

13 Additional Course Policies

1. **Equipment and Aids**: Bring your own materials such as a calculator, notebook, and pen to participate effectively in classroom activities. You are NOT allowed to borrow from others inside the classroom which may potentially create distractions for your classmates.

2. **Assignments**: There will be a number of assignments for formative assessment purposes. The average of the assignment marks will be used for computing the final grade. Late submission of homework will carry a zero mark.

3. **Class Tests**: There will be at least three Class Tests taken during the semester and the best two will be counted for final grading. A class test can be taken with/without prior announcement.

4. **Examinations**: The midterm and final examinations will be a closed book, closed notes. Mobile phones are strictly prohibited in the exam hall. Please bring your own watch (non-smart) and synchronize at the beginning of the examination.

5. **Test Policy**: In case of missing a test without prior notice to the respected faculty member, a zero mark will be given. No makeup tests will be taken as the best two test scores will be considered for grading out of three tests.

6. **Mobile Devices Policy**: Empirical evidence of using multitasking devices such as laptops and smartphones in the classroom hinders the learning experience. Thus, the use of multitasking devices is strictly discouraged. Switch off your laptop/mobile devices during class activities.

14 Additional Information

Please click or scan:

Academic Calendar Spring, 2024:

Academic Information and Policies:

Proctorial Rules:

Grading and Performance Evaluation:

Dr. Muhammad Abul Hasan
Course Coordinator, CSE 411
February 15, 2024

Dr. Muhammad Aminur Rahaman
Chairman, Department of CSE
February 15, 2024

Appendix A : Program Outcomes

POs	Category	Program Outcomes
PO1	Engineering Knowledge	Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO2	Problem Analysis	Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.
PO3	Design/Development of Solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.
PO4	Investigations	Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
PO5	Modern tool usage	Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO7	Environment and sustainability	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics	Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice.
PO9	Individual work and teamwork	Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.
PO10	Communication	Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.
PO11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments.
PO12	Life Long Learning	Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

Appendix B : Knowledge Profile

Knowledge Profile	Attribute
WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
WK2	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
WK5	Knowledge that supports engineering design in a practice area
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
WK7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability

WK8	Engagement with selected knowledge in the research literature of the discipline

Appendix C : Range of Complex Engineering Problem Solving

Attribute	Identity	Complex Engineering Problem Description
Depth of knowledge required	WP1	Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach
Range of conflicting requirements	WP2	Involve wide-ranging or conflicting technical, engineering and other issues
Depth of analysis required	WP3	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	WP4	Involve infrequently encountered issues
Extent of applicable codes	WP5	Are outside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder involvement and conflicting requirements	WP6	Involve diverse groups of stakeholders with widely varying needs
Interdependence	WP7	Are high-level problems including many component parts or sub-problems

Note: Complex Engineering Problems have IDENTITY P1 AND SOME OR ALL OF P2 TO P7.

Appendix D : Range of Complex Engineering Activities

Attribute	Identity	Activity Description
Range of resources	EA1	Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies)
Level of interaction	EA2	Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	EA3	Involve creative use of engineering principles and researchbased knowledge in novel ways
Consequences for society and the environment	EA4	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	EA5	Can extend beyond previous experiences by applying principles-based approaches

Note: Complex activities means (engineering) activities or projects that have SOME OR ALL OF THE ABOVE ACTIVITIES.

Appendix E : Domain and Level of Bloom's Taxonomy

Cognitive Domain		Psychomotor Domain		Affective Domain	
C1	Remembering	P1	Perception	A1	Receive
C2	Understanding	P2	Set	A2	Respond
C3	Applying	P3	Guided Response	A3	Value
C4	Analyzing	P4	Mechanism	A4	Organize
C5	Evaluating	P5	Complex Overt Response	A5	Internalize
C6	Creating/ Designing	P6	Adaption		
		P7	Origination		