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| Machine Learning | | | |
| Course Code: | CSE-804 | **Semester:** | 3rd |
| Credit Hours: | 3 | **Prerequisite Codes:** | Basic knowledge of Linear Algebra, Partial Derivatives, and Matlab/Python |
| Instructor: | Dr. Ali Hassan | **Class:** | MS |
| Office: | DCE-17 | **Telephone:** | -- |
| Lecture Days: | Tue | **E-mail:** | alihassan@ceme.nust.edu.pk |
| Class Room: | CRC-11 | **Consulting Hours:** | TUE Before Class or Email |
| Lab Engineer: | NA | **Lab Engineer Email:** | NA |

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| Course Objectives: | |
|  | This course has been designed to introduce the graduate students to a very active area of research in Machine Learning. In this course the students are introduced with the mathematical background of the tools available that can be used to implement any pattern recognition system. |

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| Grading | Distribution |
| Mid Term | 30% |
| Final | 40% |
| Assignments 4-6 | 10% |
| Quizzes 4-6 | 10% |
| Project | 10% |
| Total | 100% |

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| Books: | |
| Text Book: | 1. Machine Learning A Probabilistic Perspective by Kevin Murphy |
| Reference Books: | 1. Pattern Classification (2nd Edition) by Riachard Duda, Peter Hart and David Stork 2. Pattern Recognition and Machine Learning by Christopher Bishop 3. Lecture notes 4. Online Material Shared in the class |

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| Topics to be Covered: |
| Background Knowledge |
| History of Machine Learning |
| Introduction to linear algebra |
| * Matrix manipulation |
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| * Eigen Values and Eigen vectors |
| * Partial Derivatives |
| Optimsation |
| * Gradient Descent |
| * Lagrange Multipliers |
| Handling Data |
| * Types of Data |
| * Cross validation |
| * PCA |
| Machine Learning Algorithms |
| * Linear Regressions |
| * Logistic Regression |
| * Neural networks |
| * Support Vector Machines |
| Learning Theory |
| * Generalisation |
| * Regularisation |
| * Bayes Learning |
| Applications of Machine Learning |
| * Anomaly Detection |
| * Collaborative Filtering |
| * Big Data Applications |
| * Deep Learning |

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| Lecture Breakdown: | | |
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| Week No. | **Topics** | **Assessments** |
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| 1 | * Introduction to the course * Topics to be covered |  |
| 2 | * Types of Pattern Recognition (PR) * A PR system design cycle * Supervised vs Unsupervised Learning * Background to mathematics and calculus |  |
| 3 | * Linear Regression with One Variable * Gradient Descent |  |
| 4 | * Linear Regression with Multiple Variables   + Polynomial Regression * Linear Regression -- Normal Equations |  |
| 5 | * Regularisation   + Linear Regression   + Logistic Regression |  |
| 6 | * Neural Networks   + Introduction   + Cost function   + Cost function Minimisation   + NO Back Propagation |  |
| 7 | * Pre-Processing * Generalisation Error |  |
| 8 | * Multi-class Classification * Feature Selection * Dimensionality Reduction |  |
|  | **MID TERM EXAM** |  |
| 9 | * Un-Supervised Learning   + Clustering   + K-mean Clustering   + DBSCAN   + AutoEncoders |  |
| 10 | * Texture Recognition * Local Binary Patterns * Homogeneous Texture |  |
| 11 | * Support Vector Machines SVMs   + Linear SVMS |  |
| 12 | * Support Vector Machines   + Separable Linear   + Non-Separable Linear   + Separable Non-Linear   + Non-Separable Non-Linear   + *Kernel* Trick |  |
| 13 | * Ensemble Methods * Combining classifiers   + Bagging   + Boosting   + Ada-Boosting |  |
| 14 | * Genetic Algorithms |  |
| 15 | * Deep Learning |  |
| 16 | * Collaborative Filtering for Recommender Systems 2x Lectures |  |
| 17 | * Big Data Applications |  |
| ESE | | |
| Total Lectures: | | |

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| Assignments | |
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| Assign 01: | …… |
| Assign 02: | …… |
| Assign 03: | …… |
| Assign 04: | …… |
| Assign 05: | …… |
| Assign 06: | …… |

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| Grading Policy: | |
| Quiz Policy: | The quizzes will be unannounced and normally last for five-ten minutes. The question framed is to test the concepts involved in last few lectures. Number of quizzes that will be used for evaluation is at the instructor’s discretion. Grading for quizzes will be on a fixed scale of 0 to 5. A score of 5 indicates an exceptional attempt towards the answer and a score of 1 indicates your answer is entirely wrong but you made a reasonable effort towards the solution. Scores in between indicate very good (4), good (3), satisfactory (2), and poor (1) attempt. Failure to make a reasonable effort to answer a question scores a 0. |
| Assignment Policy: | In order to develop comprehensive understanding of the subject, assignments will be given. Late assignments will not be accepted / graded. All assignments will count towards the total (No ‘best-of’ policy). The students are advised to do the assignment themselves. Copying of assignments is highly discouraged and violations will be dealt with severely by referring any occurrences to the disciplinary committee. The questions in the assignment are meant to be challenging to give students confidence and extensive knowledge about the subject matter and enable them to prepare for the exams. |
| Plagiarism: | NUST CEME maintains a zero tolerance policy towards plagiarism. While collaboration in this course is highly encouraged, you must ensure that you do not claim other people’s work/ ideas as your own. Plagiarism occurs when the words, ideas, assertions, theories, figures, images, programming codes of others are presented as your own work. You must cite and acknowledge all sources of information in your assignments. Failing to comply with the NUST CEME plagiarism policy will lead to strict penalties including zero marks in assignments and referral to the academic coordination office for disciplinary action. |

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| Tools / Software Requirement: | |
|  | * Python |

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| Suggested Topics to be Added: |
| Unsupervised Learning |
| * Block Chains |
| * Recommender Systems |
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