5CS037:
Concepts and Technologies of AI.

Faculty Meet : 01

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Module Overview

- In this module we aim to provide an overview regarding:
  - Basic Mathematics Required to further learn AI/ML.
  - Basic Concepts regarding learning Paradigm (Supervised and unsupervised):
    - Learning algorithms.(Supervised and Unsupervised).
    - Requirements for learning paradigm:
      - Error function, Generalize Error , Over and Underfitting, Train-Test Split etc.
    - How to improve the learning paradigm?
      - Regularization Cross-Validation, Feature Selection etc.
  - Implementation
    - Python Programming Language, Sickit Learn(Scratch), Google Colab(Recommended)

Module Assessment:

S.No	Assessment	Points	Start	Due
1	Data Wrangling, Data Transformation and Exploratory Data Analysis.	[10]	Week-2	Week-3/4
2	Mid-Term Examination	[20]	Week-8	-
3	Term-Paper[Essay-Ethics of AI]	[20]	Week-7	Week-9
4	Weekly Workshop Assessment	[10]	Weekly	
5	Final Portfolio [Regression and Classification]	[40]	Week-10	Week-12

Week-01: Linear Algebra Review.

- Lecture:
  - Focuses mostly on vector, Basic Vector Operation (Vector Space, Vector independence, Norm, Angle of Vector) Matrix, Basic Matrix Operations(Matrix Multiplication, Special Matrices, Inverse and Determinant of Matrices).
- Tutorial:
  - Problem and Solution related to content from Lecture.
- Workshop:
  - Introduction of Google Colab and its feature (Drive Mount)
  - Review of Python, Vector and Matrix operation with Numpy.

Week-02: Data and Descriptive Statistics.

- Lecture:
  - Introduction to Data and Descriptive Statistics.
  - Graphical:
    - Histogram.
      - Frequency, interval data
    - Bar Chart, Pie Chart etc.
    - Box-Plot
  - Numerical:
    - Central Tendency
    - Measurement of Dispersion
    - Measurement of Position(Percentile)
- Tutorial:
  - Problem and Solution related to content from Lecture.
- Workshop:
  - Introduction of Google Colab and its feature (Drive Mount)
  - Use of Pandas for Data Manipulation.
  - Exploratory Data Analysis with Matplotlib.

Week-03: Introduction to Probability.

- Lecture:
  - Introduction to Probability.
  - Define Probability.
    - Axioms of Probability.
  - Finding the Probability.
    - Counting Techniques.
  - Events and Experiments:
    - Mutually Exclusive Events.
    - Independent Events.
    - Conditional Events.
  - (Bayes Law).
- Tutorial:
  - Problem and Solution related to content from Lecture.
- Workshop:
  - Extend the workshop from Week-1 and Week-2.
  - (Further Exercises)

Week-04: Probability-II.

- Lecture:
  - Random Variable ad Discrete Distributions.
    - Random Variable:
      - Random Experiment.
      - Discrete Random Variable.
        - Expectation and Variance.
      - Continuous Random Variable
      - Probability Distribution Function.
        - PMF
        - CDF
  - Discrete Distributions
  - Bernoulli/Binomial/ Multinomial
  - Poisson Distribution
- Tutorial:
  - Problem and Solution related to content from Lecture.
- Workshop:
  - Submission of Assessment-1
  - (Further/New Exercises)

Week-05: Review of Calculus.

- Lecture:
  - Calculus (Derivative and Integration).
    - Derivative:
      - Examples for rule of Derivatives
    - Integration:
      - Type and Example of Integration Problems.

- Tutorial:
  - Problem and Solution related to content from Lecture.
- Workshop:
  - Further Exercises on Python and Data Analysis.(Class Test -Python)

Week-06: Probability-III.

- Lecture:
  - Continuous Discrete Distributions.
    - Random Variable:
      - Random Experiment-Review.
      - Continuous Random Variable
      - Expectation and Variance
      - Probability Distribution Function.
        - PDF
        - CDF
  - Continuous Distributions
    - Uniform Distribution
      - Discrete Vs. Continuous Case
    - Normal Distribution:
      - Standard Normal Distribution and Z-score.

- Tutorial:
  - Problem and Solution related to content from Lecture.
- Workshop:
  - Review Exercises (Class Test - Math).

Week-07: Introduction to AI.

- Lecture:
- Introduction to AI and Machine Learning.
- History of AI.
- Definition of AI.
- ML Vs. DL Vs. Data Science.
- Learning and Need for Learning Paradigm.
- Elements of Learning.
- Supervised Vs. Unsupervised Learning.
- Ethical and Social Aspects of AI.

- Tutorial:
  - Review of Lecture.
  - Focus on Term Paper.
  - Ask each group to present on AI and there understanding in Workshop.
  - (Allow some time to work on the presentation.)
- Workshop:
  - Presentation and Feedback.

Week-09: Regression.

- Lecture:
  - Introduction to Regression.
    - Regression Vs. Classification.
  - Regression with Linear Regression.
    - Simple/Multiple/Polynomial Regression.
    - Analytical method to solve Regression.
      - OLS.
    - Cost/Loss Function.
    - Evaluation Metrics.
  - Optimization with Gradient Descent.
    - Gradient Descent Algorithm.
    - Impact of Learning Rate and Initialization on Gradient Descent.
- Tutorial:
  - Review of Lecture.
  - Exercise on Gradient Descent.
- Workshop:
  - Implementation of Linear Regression from scratch.
  - Review of Sickit Learn.

Week-10: Classification.

- Lecture:
  - Introduction to Classification.
    - Regression Vs. Classification.
  - Classification with Logistic Regression.
    - Logistic Regression (Binary Example).
    - Sigmoid Function.
    - Cost/Loss Function
    - Evaluation Metrics.
  - Optimization with Gradient Descent (Review).
  - Extending the idea to Multiple Regression.
    - Softmax Regression.
- Tutorial:
  - Review of Lecture.
  - Generalization Error/ Over and Under Fitting.
  - Regularization
- Workshop:
  - Implementation of Logistic Regression from scratch.
  - Review of Sickit Learn.
  - Linear and Logistic (Regularized) with sickit Learn.

Week-11: Unsupervised Learning.

- Lecture:
  - Introduction to Unsupervised Learning.
    - Supervised vs. Unsupervised Learning.
  - Tasks in Unsupervised Learning.
    - Clustering.
    - Association.
    - Dimensionality Reduction.
  - Clustering.
    - K-means Clustering.
    - Distortion (WCSS)
    - Elbow methods.
- Tutorial:
  - Review of Lecture.
  - Feedback on Portfolio Project.
- Workshop:
  - Implementation of clustering from scratch.

Week-12: Wrap-Up.

- Lecture:
  - Office Hours
- Tutorial:
  - Portfolio Presentation and Viva.
- Workshop:
  - Portfolio Presentation and Viva.

Challenges:

- Number of Students(24-25 Groups)
- Logistic Management:
  - Workshop Tracking.
  - Dedicated Office Hours.
- Regarding Leave.
  - Leave shall be granted only in the case of emergency.

Reference:

- Mathematics for Machine Learning:
- https://mml-book.github.io/book/mml-book.pdf
- Mathematical Statistics by Wackerly et. al
- Exercises:
  - HSEB mathematics Book.
  - Probability for Engineers