DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
KATHMANDU UNIVERSITY

Subject: Machine Learning **Course Code: COMP 484**
Credit: 3 **F.M: 100**
Type: Elective

Course Description:

This course introduces the students in the undergraduate level to the primary approaches of machine learning and the study of computer algorithms which improve automatically through experience. Students would be introduced to basic concepts from statistics, artificial intelligence, information theory and other disciplines with a balanced coverage of theory and practice. As part of the course, students would not only get the exposure to theoretical and practical know-how about building machine learning systems on real-world problems but also would be developing their own prototypes or proof-of-concepts in the form of project assignments.

Prerequisites:

It is expected that students have taken prior courses like Statistics and Probability, Discrete Mathematics, Artificial Intelligence, Programming and Data Structures. For the understanding and implementation of the algorithms, it is essential that the students have a fairly good command of some of the high level programming languages like C, C++, Python or Java.

EVALUATION:
Internal: 50
External: 50

Unit 1: Introduction to Machine Learning [5 hrs]

1.1.The essence of Machine Learning
1.2. Well-defined Learning Problem
1.3. Concept Learning
1.4. Learning from Examples

1.5. General to Specific Ordering over Hypotheses
1.6. Version Spaces and Candidate Elimination Algorithm
1.7. Picking New Example
1.8. The need for Inductive Bias

Unit 2: Decision Tree Learning [4 hrs]

2.1. Decision Tree Representation
2.2. The Basic Decision Tree Learning Algorithm
2.2. ID3 Learning Algorithm
2.3. Entropy
2.4. Information Gain
2.5. Overfitting

Unit 3: Artificial Neural Networks [4 hrs]

3.1. Neural Network Representations
3.2. Perceptrons
3.3. Threshold units
3.4. The Perceptron Training Rule
3.5. Gradient descent
3.3. Multilayer networks
3.4. Backpropagation
3.5. Hidden layer representations
3.6. Example: Face Recognition
3.7. Advanced Topics

Unit 4: Evaluating Hypotheses and Bayesian Learning [**4 hrs**]

4.1. Sample error
4.2. True error
4.3. Confidence intervals for observed hypothesis error
4.4. Estimators
4.5. Binomial distribution
4.6. Normal Distribution
4.7. Central Limit Theorem
4.8. Paired t tests
4.9. Comparing Learning Methods

Unit 5: Bayesian Learning [5 hrs]

5.1. Bayesian Learning Bayes Theorem
5.2. MAP
5.2.1. ML hypotheses
5.2.2. MAP learners
5.3. Minimum description length principle
5.4. Bayes optimal classifier
5.5. Naïve Bayes learner
5.6. Example: Learning over text data
5.7. Bayesian belief networks
5.8. Expectation Maximization algorithm

Unit 6: Computational Learning Theory [**4 hrs**]

6.1. Computational Learning Theory
6.2. Probably Approximately Correct (PAC) Learning
6.3. Vapnik-Chervonenkis Dimension
6.4. Mistake Bounds

Unit 7: Instance Based Learning [**3 hrs**]

7.1. K-Nearest Neighbor
7.2. Locally Weighted Regression
7.3. Radial Basis Functions
7.4. Case-based Reasoning
7.5. Lazy and Eager Learning

Unit 8. Unsupervised Learning [4 hrs]

8.1. Issues with Unsupervised Learning
8.2. Parametric and Non-Parametric Unsupervised Learning
8.3. Use Cases of Unsupervised Learning
8.4. Clustering Algorithms
8.4.1. K-Means Clustering
8.4.2. Hierarchical Clustering Algorithms

Unit 9. Genetic Algorithms [4 hrs]

9.1. Genetic Algorithms Evolutionary computation
9.2. Prototypical GA,
9.2.1 An example: GABIL
9.3. Genetic Programming
9.4. Individual learning and population evolution

Unit 10. Reinforcement Learning [5 hrs]

10.1. Learning task
10.2. Q Learning
10.3. Nondeterministic Rewards and Actions
10.4. Temporal Difference Learning
10.5. Generalizing from Examples
10.6. Relationship to Dynamic Programming

11. Machine Learning Applications [3 hrs]

Text book:

Machine Learning. Tom M. Mitchell. McGraw-Hill International Editions. Computer Science Series, 1997.

Reference books:

1. Master Machine Learning Algorithms, Jason Brownlee, 2016
2. Machine Learning – A Probabilistic Perspective, Kevin P. Murphy. The MIT Press, Cambridge, Massachusetts. London, England. 2012.
3. Introduction to Machine Learning. Ethem Alpaydin. The MIT Press. Cambridge, Massachusetts. London, England. 2004
4. Data Mining. Practical Machine Learning Tools and Techniques. Third Edition. Ian H. Witten, Eibe Frank, Mark A. Hall. Elsevier Inc., 2011.
5. Building Machine Learning Systems Using Python, Second Edition, Luis Pedro Coelho, Willi Richart, Packt Publishing, 2015.
6. Mastering Machine Learning with Python in Six Steps – A Practical Implementation Guide to Predictive Data Analytics Using Python, Manohar Swamynathan, Apress, 2017.
7. Artificial Intelligence with Python – Build real-world Artificial Intelligence Applications with Python to intelligently interact with the world around you. Prateek Joshi, Packt Publishing, 2017.

8. Hands-On Machine Learning with Scikit-Learn and TensorFlow. Aurelien Geron, O'Reilly Media, Inc., 2017.