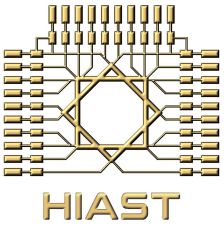
Syrian Arab Republic

Higher Institute for Applied Sciences and Technology



Course Specification Document

Title	Machine Learning

Credits	5 ECTS

Aims	This course aims to provide the student with the fundamental concepts of machine learning, enabling him to effectively use machine learning techniques to solve real-world problems in the field of artificial intelligence. The course also helps the student understands the general structure of machine learning systems, acquires knowledge of key supervised learning methods, and grasps the mechanisms of training and testing necessary for developing stable and useful trained models in practical applications. Additionally, the course introduces the student to the fundamental concepts of deep learning, the most well known architectures in deep learning, their applications, and effective training methods.

Intended learning outcomes

On successful completion of this course, the student will be able to:

- Understand the general structure of machine learning systems.
- Familiarize himself with the key supervised learning methods.
- Grasp the features and drawbacks of machine learning techniques.
- Understand the challenges of training and fine-tuning machine learning methods.
- Get acquainted with deep networks, their training mechanisms, and applications.
- Handle machine learning frameworks within Python to implement ML approaches.
- Implement machine learning system based on deep networks and evaluate its performance.

Syllabus

- **Introduction to machine learning:** Basic concepts, general structure of a machine learning system, machine learning types, applications, examples of simple learning methods.
- **Learning using decision trees:** The structure of decision trees, ID3 algorithm, derived decision boundary and the nature of compatible problems.
- **Training strategies and evaluation criteria for learned models**.
- **Feature engineering:** Various tasks of feature engineering, popular methods for feature selection.
- **Naïve Bayes based learning:** Optimal Bayes classifier, NB working principle, NB approximation, training mechanism, detailed parameters and their impact, strengths, weaknesses and use cases.
- **Learning using KNN:** KNN working principle and approximation, impact of basic KNN

parameters, training mechanism, strengths, weaknesses and use cases.

- **Learning using SVM:** SVM working principle, types of SVM and their advantages and disadvantages, kernel concept.
- **Training and tuning challenges:** Overfitting or underfitting issues, concepts of Variance and Bias.
- **Ensemble Methods:** Random forest, types of ensemble learning (Bagging, Random Subspace Method, Boosting), comparison of different types, when to use ensemble methods.
- **Introduction to deep neural networks:** Neural networks, basic concepts in deep networks, strategies for training deep networks.
- **Advanced concepts in deep network training:** Mini-batch Gradient Descent, Gradient Descent with Momentum, Nesterov Accelerated Momentum, Adaptive Moment, Learning Rate Scheduling, Gradient Vanishing Problem, Weight Decay, Dropout, Early Stopping, Batch Normalization.
- **CNN networks:** Working principle: using Convolution concept for feature extraction, CNN structure, learning mechanism, and comparison with fully connected networks, overview of different configurations and structures of CNN networks.
- **RNN networks:** Structure of RNN and its working principle, comparison between HMM and RNN, and their use cases, different configurations and structures of RNN networks, LSTM Structure and Comparison with RNN.
- **Advanced structures in deep learning:** Hybrid Models, Encoder-Decoder Networks, Attention Mechanism concept, Transformers concept, overview of Transfer Learning concept.