# fundamentals of machine learning – Syllabus

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\*\*Course Title:\*\* Fundamentals of Machine Learning  
  
\*\*Course Objectives:\*\* Upon successful completion of this course, students will be able to:  
  
\* Understand the fundamental concepts of machine learning.  
\* Implement common machine learning algorithms.  
\* Evaluate the performance of machine learning models.  
\* Critically analyze and interpret results from machine learning models.  
\* Apply machine learning techniques to solve real-world problems.  
  
  
\*\*Syllabus (15 Weeks)\*\*  
  
\*\*Week 1: Introduction to Machine Learning\*\*  
  
\* Main Topic: What is Machine Learning? Types of Machine Learning.  
\* Subtopics: Supervised, Unsupervised, Reinforcement Learning. Applications of ML. Ethical Considerations.  
\* Activity: Introductory Quiz on basic concepts.  
  
\*\*Week 2: Supervised Learning I: Regression\*\*  
  
\* Main Topic: Linear Regression. Model Evaluation Metrics.  
\* Subtopics: Simple Linear Regression, Multiple Linear Regression, Ordinary Least Squares. R-squared, MSE, RMSE.  
\* Activity: Lab - Implementing Linear Regression using a dataset (e.g., housing prices).  
  
\*\*Week 3: Supervised Learning II: Classification\*\*  
  
\* Main Topic: Logistic Regression. Performance Metrics for Classification.  
\* Subtopics: Logistic Regression, Accuracy, Precision, Recall, F1-score, ROC Curve, AUC.  
\* Activity: Lab - Implementing Logistic Regression using a classification dataset (e.g., spam detection).  
  
\*\*Week 4: Model Evaluation and Selection\*\*  
  
\* Main Topic: Bias-Variance Tradeoff. Cross-Validation. Hyperparameter Tuning.  
\* Subtopics: Overfitting, Underfitting, K-fold cross-validation, Grid Search, Random Search.  
\* Activity: Case Study – Analyzing a model’s performance and improving it through hyperparameter tuning.  
  
\*\*Week 5: Decision Trees and Ensemble Methods I\*\*  
  
\* Main Topic: Decision Trees.  
\* Subtopics: Building Decision Trees, Decision Tree Visualization, ID3, CART algorithms. Pros and Cons.  
\* Activity: Lab - Implementing Decision Trees and visualizing the resulting tree.  
  
\*\*Week 6: Ensemble Methods II\*\*  
  
\* Main Topic: Bagging and Boosting.  
\* Subtopics: Random Forests, AdaBoost, Gradient Boosting Machines (GBM).  
\* Activity: Lab – Comparing the performance of different ensemble methods.  
  
\*\*Week 7: Support Vector Machines (SVM)\*\*  
  
\* Main Topic: Support Vector Machines. Kernel Trick.  
\* Subtopics: Linear SVM, Non-linear SVM, Kernel Functions (linear, polynomial, RBF).  
\* Activity: Lab - Implementing SVM with different kernels.  
  
\*\*Week 8: Midterm Exam\*\*  
  
\* Main Topic: Comprehensive assessment of Weeks 1-7.  
\* Subtopics: All topics covered in previous weeks.  
\* Activity: Midterm Exam covering all concepts and practical applications.  
  
\*\*Week 9: Unsupervised Learning I: Clustering\*\*  
  
\* Main Topic: K-means Clustering.  
\* Subtopics: K-means algorithm, Determining optimal k, Limitations of K-means.  
\* Activity: Lab – Implementing K-means clustering and evaluating the results.  
  
\*\*Week 10: Unsupervised Learning II: Dimensionality Reduction\*\*  
  
\* Main Topic: Principal Component Analysis (PCA).  
\* Subtopics: PCA algorithm, Variance explained, Data visualization with PCA.  
\* Activity: Lab - Applying PCA to reduce dimensionality of a high-dimensional dataset.  
  
\*\*Week 11: Introduction to Neural Networks\*\*  
  
\* Main Topic: Perceptrons and Multilayer Perceptrons (MLP).  
\* Subtopics: Activation functions (sigmoid, ReLU), Forward and backward propagation.  
\* Activity: Lab – Implementing a simple neural network using a library (e.g., TensorFlow/Keras).  
  
\*\*Week 12: Deep Learning Fundamentals\*\*  
  
\* Main Topic: Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs).  
\* Subtopics: CNN architecture, RNN architecture, Applications of CNNs and RNNs.  
\* Activity: Case Study – Exploring pre-trained CNN models for image classification.  
  
\*\*Week 13: Regularization and Optimization\*\*  
  
\* Main Topic: Techniques for improving model generalization and training efficiency.  
\* Subtopics: L1 and L2 regularization, Gradient Descent, Stochastic Gradient Descent (SGD), Adam optimizer.  
\* Activity: Lab – Experimenting with different optimization algorithms and regularization techniques.  
  
\*\*Week 14: Introduction to Deep Learning Frameworks\*\*  
  
\* Main Topic: TensorFlow/Keras or PyTorch.  
\* Subtopics: Basic functionalities, Building and training models.  
\* Activity: Lab – Building and training a model using chosen framework.  
  
  
\*\*Week 15: Final Project Presentations and Wrap-up\*\*  
  
\* Main Topic: Student presentations of final projects. Course summary and review.  
\* Subtopics: Discussion of project results, Future directions in machine learning.  
\* Activity: Final Project Presentations and Q&A.

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