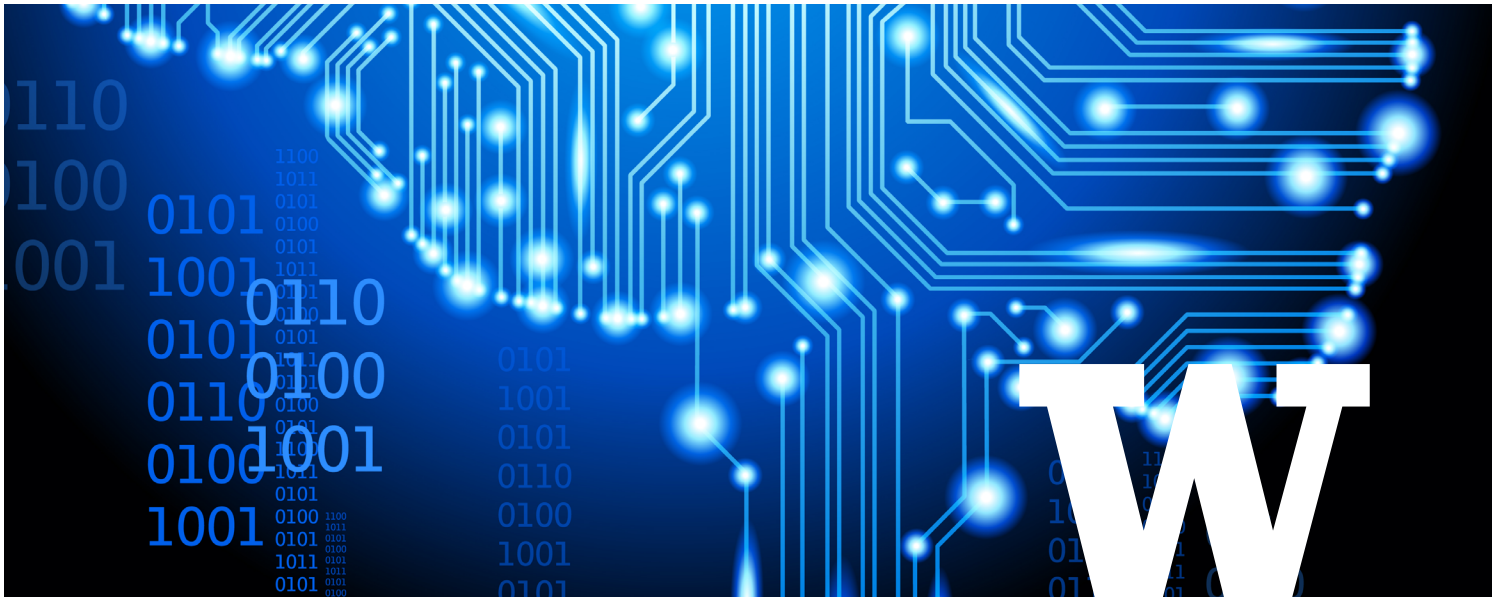
PROFESSIONAL &
CONTINUING EDUCATION
UNIVERSITY of WASHINGTON

KEEPLEARNING.UW.EDU

CERTIFICATE IN

MACHINE LEARNING

Program Syllabus



About This Program

Machine learning is changing our world in profound and fundamental ways. We can already see the results in innovations such as customized online recommendations, speech recognition, predictive policing and fraud detection. Future applications are limited only by the imagination.

In this three-course certificate program, we'll examine all aspects of machine learning. You'll study the probability concepts and statistical methods that are at the core of machine learning algorithms. We'll also practice ways to apply these techniques, using open-source tools — along with your developing judgment and intuition — to address actual business needs and real-world challenges.

PLEASE NOTE: This document is a general outline of the curriculum, which may vary depending on the instructor. For dates and costs, **visit us online**.

DESIGNED FOR

Software programmers, statisticians, experienced applied mathematicians and data scientists who want to become machine learning specialists.

WHAT YOU'LL LEARN

- Essential concepts of statistical analyses, probability and mathematical modeling
- Optimization techniques
- Supervised and unsupervised learning models for tasks such as forecasting, predicting and outlier detection
- Advanced machine learning applications, including recommendation systems and natural language processing
- Deep learning concepts and applications
- How to identify, source and prepare raw data for analysis and modeling

GET HANDS-ON EXPERIENCE

- Work with open source tools such as scikit-learn, TensorFlow and Keras
- Develop solutions to real-world machine learning problems

COURSE 1

Introduction to Machine Learning

Machine learning is the branch of artificial intelligence that entails learning from data. This course introduces the terminology and core concepts from the field of machine learning. Students will gain hands-on experience with linear models for both classification and regression, including data preprocessing, dimensionality reduction, feature selection, model construction, regularization and model selection. Models will be constructed using data from a variety of application domains.

LEARNING OUTCOMES

After successfully completing this course, you'll be able to:

- Use foundational concepts from calculus, linear algebra, probability, statistics and the Python programming language to solve problems
- Define and use core concepts and terminology from the field of machine learning
- Construct linear models for regression and classification
- Construct nearest neighbor models for regression and classification
- Construct graphical models, including naïve Bayes and Bayesian network models
- Construct generalized additive models, including regression splines and local regression
- Select features to improve model performance
- Regularize models
- Preprocess data, including normalization and dimensionality reduction
- Tune models and evaluate model performance

COURSEWORK

Each lesson is accompanied by a knowledge check and a lab assignment, as well as a discussion forum where you will share your experiences and insights in the assignment. The knowledge checks are designed to help you know if you have mastered the core concepts and are ready to move on to the labs. The lab assignments are an opportunity for you to demonstrate that you're able to complete the exercises and analysis independently.

LESSONS

Introduction to Statistical Learning

Linear Regression

Classification

Model Building, Part 1

Model Building, Part 2

Resampling Methods

Linear Model Selection and Regularization

Moving Beyond Linearity

Bayesian Analysis

Dimensionality Reduction

TIME COMMITMENT

You should plan to spend 10–12 hours per lesson in this course. Your time commitment will vary depending on your level of experience.

COURSE 2

Advanced Machine Learning

In this course, we'll cover advanced methods in machine learning. While linear models remain popular in industry, modern machine learning methods take advantage of increased complexity to provide improved performance. You'll discover advanced applications that require specialized algorithms to model them, and learn where basic techniques would result in suboptimal solutions. We'll also explore more techniques used to improve model performance.

LEARNING OUTCOMES

After successfully completing this course, you'll be able to:

- Construct classification and regression trees
- Use bootstrap aggregation (bagging) to improve performance
- Use gradient boosting to improve model performance
- Handle missing values
- Construct support vector machines
- Use stacking and blending to improve performance
- Identify frequent item sets and constructing association rules
- Cluster data using k-means and hierarchical clustering
- Apply machine learning to real-world tasks including Natural Language Processing and Recommendation Systems
- Construct forecasting models, based on past and present data

COURSEWORK

Most lessons are accompanied by a lab exercise and a lab assignment, as well as a discussion forum where you will share your experiences and insights in the assignment (Lesson 7 includes questions and a lab problem). The lab assignments are an opportunity for you to demonstrate that you're able to complete the exercises and analysis independently.

LESSONS

- Inputs and Outputs
- Classification SVM, ANN
- Decision Tree/Ensemble Methods
- Ensemble (cont'd) and Missing Values
- Clustering, Instance-Based Learning, Unsupervised Algorithms
- Frequent Itemset Mining
- Markov Chains, Q-Learning and Intro to Reinforcement Learning
- Mining Unstructured Data
- Recommendation Systems
- Forecasting

TIME COMMITMENT

You should plan to spend 10–12 hours per lesson in this course. Your time commitment will vary depending on your level of experience.

COURSE 3
Deep Learning

Deep learning is a subfield of artificial intelligence that is inspired by how the human brain works, a concept often referred to as neural networks. In the last decade we've seen significant development of deep learning methods that enable state-of-the-art performance for many tasks, including image, audio and video classification. In this course, you'll gain both a theoretical understanding of deep learning and hands-on experience with emerging use cases.

LEARNING OUTCOMES

After successfully completing this course, you'll be able to:

- Describe the history of neural networks
- Derive the backpropagation algorithm
- Implement a basic neural network from scratch
- Use Keras and Tensorflow to rapidly build and train deep neural networks
- Understand and apply modern deep learning techniques such as dropout and batch normalization
- Know how to select appropriate loss functions, optimizers and activation functions
- Build computer vision models using convolutional networks
- Build your own machine translation system using recurrent networks
- Build an automatic game-playing agent using deep reinforcement learning

COURSEWORK

Most lessons are accompanied by a set of questions from the text and/or a task to complete using datasets and notebooks from Kaggle.com, as well as a discussion forum where you will share your experiences and insights in the assignment.

LESSONS

- Introduction and History of Neural Networks
- Neural Network Fundamentals
- CNNs
- Applications of CNNs: Going Deeper
- Recurrent Neural Networks
- RNNs (cont'd)
- Variational Auto Encoders
- Generative Adversarial Networks (GANs)
- Reinforcement Learning
- Recent Topics in Deep Learning

TIME COMMITMENT

You should plan to spend 10–12 hours per lesson in this course. Your time commitment will vary depending on your level of experience.