Carnegie Mellon University
School of Computer Science
Executive Education

Machine Learning: Fundamentals and Algorithms

Master the Most In-Demand Skills for Machine Learning and AI

Overview

Organizations today are chasing a competitive edge with machine learning and artificial intelligence. If you are an engineer, data scientist, or technical manager, your career depends on knowing advanced analytical and programming skills that deliver immense value.

Two of the top skillsets in demand today are Machine Learning and Python. In the Machine Learning: Fundamentals and Algorithms program from the Executive Education program from the School of Computer Science at Carnegie Mellon, you will dive deep into both, learning the mathematical underpinnings of core machine learning and artificial intelligence methods.

In this program, you will focus on the skills needed to work with decision trees, linear and logistic regression, and optimization. This program requires a significant amount of programming and blends concepts from linear algebra, probability, statistics, and calculus, which you will use to refine the inner workings of algorithms.

You will conduct your own analyses and also gain an understanding of when to apply the methods that would be most effective for a variety of problem types. This is what makes our program unique: it is designed to address both the how and the why of machine learning, providing you with technical knowledge that can be applied to any field where machine learning and AI are fast becoming essential.

Key takeaways

In this program, you will:

- Synthesize components of the machine learning pipeline to create functional tools for prediction of unseen data.
- Implement and analyze learning algorithms for classification, regression, and clustering.
- Use concepts from probability, statistics, linear algebra, calculus, and optimization to describe and refine the inner workings of machine learning algorithms.

Who Should Attend?

This program is designed for participants who have experience with programming—preferably with Python—and want to learn more about the underlying mathematics of machine learning algorithms. This program is most suitable for the following:

1. **Engineers** in IT products and services, healthcare, or banking and financial services who want hands-on instruction in the tools and techniques of machine learning.

   Representative roles include:

   - Software Engineer
   - Software Developer
   - Automation Engineer
   - Design Engineer

2. **Data Analytics Professionals** in the banking and financial services industry, or IT products and services, with responsibility for publishing reports, innovating, and working with analytics in a data-dense environment. This program will be especially relevant for analysts seeking to implement machine learning into projects or to upgrade from spreadsheet-based analysis to more powerful programmatic models of data analysis.

   Representative roles include:

   - Analyst
   - Business Analyst
   - Data Scientist
   - Data Analyst

3. **Technical Managers/Directors of Data Functions** leading a team of coders in banking and financial services, IT, healthcare, retail, logistics, or industrial goods who want to create enterprise value and gain hands-on skills in machine learning technology with the goal of solving business pain points.

   Representative roles include:

   - Tech Lead
   - Senior Engineer
   - Senior Developer
   - VP Engineering
   - VP Technology
   - Director of Business Systems & Information Technology
   - Director of Customer Experience
   - Data & Integration Director
   - Technology Director
   - VP Analytics

Program Curriculum

Structured as an online program, content is shared via recorded faculty videos and office hours with learning facilitators.

Module 1: **Decision Trees**

- Use a decision tree to make predictions.
- Given labeled training examples, learn a decision tree.

Module 2: **K-Nearest Neighbor**

- Use the k-NN algorithm to classify points given a simple dataset.
- Implement a full decision tree for learning and prediction.

Module 3: **Model Selection**

- Employ model selection techniques to select k for the k-NN algorithm.
- Implement a grid search to select multiple hyperparameters for a model.

Module 4: **Linear Regression**

- Adapt the k-NN algorithm and decision trees for classification to regression.
- Implement learning for linear regression using gradient descent.

Module 5: **Optimization**

- Determine how convexity affects optimization.
- Implement linear regression with optimization by stochastic gradient descent.

Module 6: **Binary Logistic Regression**

- Given i.i.d. data and parameters of a logistic regression distribution, compute the conditional likelihood.
- Implement stochastic gradient descent for binary logistic regression.

Module 7: **Regularization**

- Convert nonlinear dataset to a linear dataset in higher dimensions.
- Manipulate the hyperparameters of L1 and L2 regularization implementations and identify the effects on magnitude and sparsity of parameters.

Module 8: **Neural Networks**

- Combine simpler models as components to build up feed-forward neural network architectures.
- Write mathematical expressions in scalar form defining a feed-forward neural network.

Module 9: **Backward Propagation**

- Carry out the backpropagation algorithm on a simple computation graph over scalars.
- Instantiate the backpropagation algorithm for a neural network.

Module 10: **K-Means and Others Learning Paradigms**

- Implement the k-means algorithm.
- Recognize and explain challenges in selecting the number of clusters.

Program Experience

Office Hours with Learning Facilitators

Knowledge Checks

Dedicated Program Support Team

Healthcare Data

Python Coding Exercise in Each Module

Mobile Learning App

Bite-Sized Learning

Peer Discussion

Faculty Interaction

The Carnegie Mellon School of Computer Science Difference

Expertise

Instructors that are experts in their fields blend thought leadership with practical experience

Integration

Ability to develop a suite of interconnected learning modules that leverage resources from across Carnegie Mellon University School of Computer Science

Engagement

Program structured around small-group learning that allows for direct interaction with both instructors and peers

Reputation

Recognized worldwide as a leader in academic research

Program Faculty

Patrick Virtue

Assistant Teaching Professor, Computer Science and Machine Learning, Carnegie Mellon University

Pat Virtue is an Assistant Teaching Professor in the Computer Science and Machine Learning departments at Carnegie Mellon University. He focuses on teaching techniques for artificial intelligence, machine learning, and computer science.

His interests include active learning teaching methods, effective instruction for large classes, building inclusive learning environments, and AI/ML curriculum development. Pat completed his graduate work at UC Berkeley in Electrical Engineering and Computer Sciences, and his undergraduate at the University of Notre Dame. Prior to graduate school, he researched and developed volumetric medical image applications as a software engineer at GE Healthcare.

Matt Gormley

Assistant Teaching Professor, Computer Science and Machine Learning, Carnegie Mellon University

Matt Gormley is an Assistant Teaching Professor in the Machine Learning Department at Carnegie Mellon University. He regularly teaches Introduction to Machine Learning to over 400 students, one of the largest courses offered at CMU.

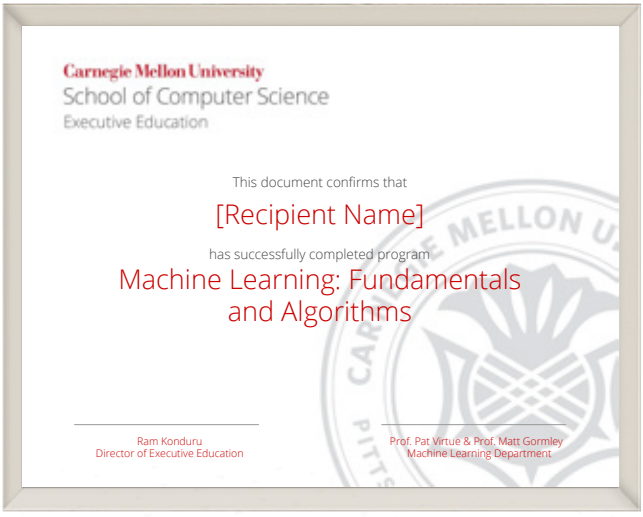
Matt obtained his Ph.D. in Computer Science at Johns Hopkins University. He holds a Bachelor's in Computer Science from CMU. Matt's research focuses on machine learning for natural language processing. His interests include global optimization, learning under approximations, hybrids of graphical models and neural networks, and applications where supervised resources are scarce.

Program Prerequisites

Prior to enrolling, we strongly encourage you to complete the provided self-assessment exercises designed to evaluate your competency with mathematics content, the Python programming language, and Jupyter notebooks. A passing score will indicate your readiness for the rigorous program material, but will not guarantee success. Should you not pass these self-assessments, we recommend you strengthen gaps and weaknesses in your core knowledge and programming skills until you achieve proficiency before program participation.

Certificate

Upon successful completion of the program, participants will receive a verified digital certificate of completion from Carnegie Mellon University School of Computer Science Executive Education.



Your digital certificate will be issued in your legal name and emailed to you at no additional cost, upon completion of the program, per the stipulated requirements. All certificate images are for illustrative purposes only and may be subject to change at the discretion of CMU School of Computer Science Exec Ed.

About Carnegie Mellon University's School of Computer Science

The School of Computer Science (SCS) at Carnegie Mellon University is recognized and respected internationally as a center for unparalleled research and education in computer science. A home to world-class faculty, SCS offers undergraduate and graduate education and research opportunities that are second to none, along with executive education programs designed for today's professionals who work in a variety of technical leadership roles. SCS is known for being at the forefront of – often setting the course for – advanced computer science disciplines including artificial intelligence, computational biology, human-computer interaction, language technologies, machine learning, robotics and software research.

About Emeritus

Carnegie Mellon University's School of Computer Science is collaborating with online education provider Emeritus to offer a portfolio of high-impact online programs. By working with Emeritus, we are able to broaden access beyond our on-campus offerings in a collaborative and engaging format that stays true to the quality people expect from CMU School of Computer Science Executive Education.

The Emeritus approach to learning is grounded in a cohort-based design to maximize peer-to-peer sharing and includes live teaching with world-class faculty and hands-on project-based learning. In the last year, more than 66,000 students from over 160 countries have benefited professionally from Emeritus courses.

DURATION
10 Weeks

FORMAT
Online

PROGRAM FEE
US$2,250

CONNECT WITH A PROGRAM ADVISOR

Email: CMUSCS@emeritus.org
Phone: +1 412-314-2432

Easily schedule a call with a program advisor to learn more

SCHEDULE A CALL

You can enroll in the program here

ENROLL