Machine Learning

Stanford University

About this Course

Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a

⌄ More

vastly improved understanding of the human genome. Machine learning is so pervasive today that you probably use it dozens of times a day without knowing it. Many researchers also think it is the best way to make progress towards human-level AI. In this class, you will learn about **Taught by:** Andrew Ng, CEO/Founder the most effective machine learning techniques, and gain Landing AI; Co-founder, Coursera; Adjunct practice implementing them and getting them to work for Professor, Stanford University; formerly yourself. More importantly, you'll learn about not only the Chief Scientist,Baidu and founding lead of theoretical underpinnings of learning, but also gain the Google Brain practical know-how needed to quickly and powerfully apply these techniques to new problems. Finally, you'll learn about some of Silicon Valley's best practices in innovation as it pertains to machine learning and AI.

Language English, **Subtitles:** Chinese (Simplified),
Hebrew, Spanish,
This course provides a broad introduction to machine Hindi, Japanese
learning, datamining, and statistical pattern recognition. Volunteer to
Topics include: (i) Supervised learning (parametric/non- translate subtitles
parametric algorithms, support vector machines, kernels, for this course
neural networks). (ii) Unsupervised learning (clustering,
dimensionality reduction, recommender systems, deep
learning). (iii) Best practices in machine learning **How To Pass** Pass all graded
(bias/variance theory; innovation process in machine assignments to
learning and AI). The course will also draw from complete the
numerous case studies and applications, so that you'll course.
also learn how to apply learning algorithms to building
smart robots (perception, control), text understanding
(web search, anti-spam), computer vision, medical **User Ratings** ★★★★★
informatics, audio, database mining, and other areas. Average User Rating
4.9

Syllabus

Introduction

Welcome to Machine Learning! In this module, we introduce the core idea of teaching a computer to learn concepts using data—without being explicitly programmed. The Course Wiki is under construction. Please visit the resources tab for the most complete and up-to-date information.

5 videos, 9 readings expand

1.   **Video:** Welcome to Machine Learning!
  Graded: Introduction
2.   **Reading:** Machine Learning Honor Code

3.   **Video:** Welcome

Linear Regression with One Variable
4.   **Video:** What is Machine Learning?

5.   **Reading:** What is Machine Learning?
Linear regression predicts a real-valued output based on an input value. We discuss the
6.   **Reading:** How to Use Discussion application of linear regression to housing price Forums prediction, present the notion of a cost
7.   **Video:** Supervised Learning function, and introduce the gradient descent
8.   **Reading:** Supervised Learning method for learning.

9.   **Video:** Unsupervised Learning
7 videos, 8 readings expand
10.   **Reading:** Unsupervised Learning
1.   **Video:** Model Representation
11. **Graded:** Who are Mentors? Linear Regression with One
1.   **Reading:** Model Representation Variable
12.   **Reading:** Get to Know Your Classmates
3.   **Video:** Cost Function
13.   **Reading:** Frequently Asked Questions
4.   **Reading:** Cost Function
14.   **Reading:** Lecture Slides

Linear Algebra Review
5.   **Video:** Cost Function - Intuition I
This optional module provides a refresher on

linear algebra. A good basic understanding of
linear algebra is necessary for the rest of the
course, especially as we begin to cover models
with multiple variables.

6. **Reading:** Cost Function

7. **Video:** Cost Function - Intuition II

8. **Reading:** Cost Function - Intuition II

9. **Video:** Gradient Descent

6 videos, 7 readings, 1 practice
quiz   expand

10. **Reading:** Gradient Descent

11. **Video:** Gradient Descent Intuition

   1. **Video:** Matrices and Vectors

12. **Reading:** Gradient Descent Intuition

   2. **Reading:** Matrices and Vectors

13. **Video:** Gradient Descent For Linear
Regression

   3. **Video:** Addition and Scalar
Multiplication

WEEK 2

14. **Reading:** Gradient Descent For Linear
Regression

   4. **Reading:** Addition and Scalar
Multiplication

Linear Regression with Multiple Variables

15. **Reading:** Lecture Slides

   5. **Video:** Matrix Vector Multiplication

What if your input has more than one value? In
this module, we show how linear regression can
be extended to accommodate multiple input
features. We also discuss best practices for
implementing linear regression.

   6. **Reading:** Matrix Vector Multiplication

   7. **Video:** Matrix Matrix Multiplication

   8. **Reading:** Matrix Matrix Multiplication

   9. **Video:** Matrix Multiplication Properties

8 videos, 16 readings   expand

10. **Reading:** Matrix Multiplication
Properties

11. **Video:** Inverse and Transpose

   1. **Reading:** Setting Up Your Programming
    Assignment Environment

   Graded: Linear Regression with Multiple
   Variables

12. **Reading:** Inverse and Transpose

   2. **Reading:** Access MATLAB Online and
    Upload the Exercise Files

13. **Reading:** Lecture Slides

   3. **Reading:** Installing Octave on Windows

14. **Practice Quiz:** Linear Algebra

Octave/Matlab Tutorial

   4. **Reading:** Installing Octave on Mac OS X
    (10.10 Yosemite and 10.9 Mavericks and
    later)

This course includes programming assignments
designed to help you understand how to
implement the learning algorithms in practice.
To complete the programming assignments,
you will need to use Octave or MATLAB. This
module introduces Octave/Matlab and shows
you how to submit an assignment.

   5. **Reading:** Installing Octave on Mac OS X
    (10.8 Mountain Lion and Earlier)

   6. **Reading:** Installing Octave on
    GNU/Linux

6 videos, 1 reading   expand

   7. **Reading:** More Octave/MATLAB
    resources

   1. **Video:** Basic Operations

   Graded: Octave/Matlab Tutorial

   8. **Video:** Multiple Features

   2. **Video:** Moving Data Around

9. **Reading:** Multiple Features

10. **Video:** Gradient Descent for Multiple Variables

5. **Video:** Control Statements: for, while, if

11. **Reading:** Gradient Descent For Multiple Variables

6. **Video:** Vectorization

Logistic Regression

7. **Reading:** Lecture Slides

12. **Video:** Gradient Descent in Practice I - Feature Scaling

8. **Programming:** Linear Regression

Logistic regression is a method for classifying data into discrete outcomes. For example, we might use logistic regression to classify an email as spam or not spam. In this module, we introduce the notion of classification, the cost function for logistic regression, and the application of logistic regression to multi-class classification.

13. **Reading:** Gradient Descent in Practice I - Feature Scaling

14. **Video:** Gradient Descent in Practice II - Learning Rate

15. **Reading:** Gradient Descent in Practice II - Learning Rate

7 videos, 8 readings　expand

16. **Video:** Features and Polynomial Regression

1. **Video:** Classification

17. **Reading:** Features and Polynomial Regression

2. **Reading:** Classification

Graded: Logistic Regression

18. **Video:** Normal Equation

3. **Video:** Hypothesis Representation

19. **Reading:** Normal Equation

Regularization

4. **Reading:** Hypothesis Representation

20. **Video:** Decision Boundary / Normal Equation Noninvertibility

Machine learning models need to generalize well to new examples that the model has not seen in practice. In this module, we introduce regularization, which helps prevent models from overfitting the training data.

21. **Reading:** Normal Equation Noninvertibility

7. **Video:** Cost Function

22. **Video:** Working on and Submitting Programming Assignments

8. **Reading:** Cost Function

4 videos, 5 readings　expand

9. **Video:** Simplified Cost Function and Gradient Descent

23. **Reading:** Programming tips from Mentors

1. **Video:** The Problem of Overfitting

Graded: Regularization

10. **Reading:** Simplified Cost Function and Gradient Descent

24. **Reading:** Lecture Slides

2. **Reading:** The Problem of Overfitting

3. **Video:** Cost Function

11. **Video:** Advanced Optimization

4. **Reading:** Cost Function

Reading: Advanced Optimization

5. **Video:** Regularized Linear Regression

13. **Video:** Multiclass Classification: One-vs-all

6. **Reading:** Regularized Linear Regression

Neural Networks: Representation

14. **Video:** Multiclass Classification: One-vs-all

Video: Regularized Logistic Regression

Neural Networks is a model inspired by how the

8. **Reading:** Regularized Logistic

brain. Regression widely used today in many applications: when your phone interprets and understand your voice commands, it is likely that a neural network is helping to understand your speech; when you cash a check, the machines that automatically read the digits also use neural networks.

15. **Reading:** Lecture Slides

9. **Reading:** Lecture Slides

10. **Programming:** Logistic Regression

7 videos, 6 readings expand

1. **Video:** Non-linear Hypotheses

Graded: Neural Networks: Representation

2. **Video:** Neurons and the Brain

3. **Video:** Model Representation I

4. **Reading:** Model Representation I

WEEK 5

5. **Video:** Model Representation II

6. **Reading:** Model Representation II

Neural Networks: Learning

7. **Video:** Examples and Intuitions I

In this module, we introduce the backpropagation algorithm that is used to help learn parameters for a neural network. At the end of this module, you will be implementing your own neural network for digit recognition.

8. **Reading:** Examples and Intuitions I

9. **Video:** Examples and Intuitions II

10. **Reading:** Examples and Intuitions II

11. **Video:** Multiclass Classification

28 videos, 8 readings expand

12. **Reading:** Multiclass Classification

1. **Video:** Cost Function

13. **Reading:** Lecture Slides

Graded: Neural Networks: Learning

14. **Programming:** Multi-class Classification and Neural Networks

2. **Reading:** Cost Function

3. **Video:** Backpropagation Algorithm

4. **Reading:** Backpropagation Algorithm

WEEK 6

5. **Video:** Backpropagation Intuition

6. **Reading:** Backpropagation Intuition

Advice for Applying Machine Learning

7. **Video:** Implementation Note: Unrolling Parameters

Applying machine learning in practice is not always straightforward. In this module, we share best practices for applying machine learning in practice, and discuss the best ways

8. **Reading:** Implementation Note: Unrolling Parameters

9. **Video:** Gradient Checking

to evaluate your learned models.

Reading: Gradient Checking

7 videos, 7 readings expand

11. **Video:** Random Initialization

12. **Reading:** Random Initialization

1. **Video:** Deciding What to Try Next

13. **Video:** Putting It Together

Graded: Advice for Applying Machine Learning

2. **Video:** Evaluating a Hypothesis

14. **Reading:** Putting It Together

3. **Reading:** Evaluating a Hypothesis

15. **Video:** Autonomous Driving

4. **Video:** Model Selection and Train/Validation/Test Sets

16. **Reading:** Lecture Slides

Machine Learning System Design

5. **Reading:** Model Selection and Train/Validation/Test Sets

To optimize a machine learning algorithm, you'll need to first understand where the biggest improvements can be made. In this module, we discuss how to understand the performance of a machine learning system with multiple parts,

6. **Video:** Diagnosing Bias vs. Variance

7. **Reading:** Diagnosing Bias vs. Variance

and also how to deal with skewed data.

8. **Video:** Regularization and Bias/Variance

5 videos, 3 readings expand

9. **Reading:** Regularization and Bias/Variance

1. **Video:** Prioritizing What to Work On

Graded: Machine Learning System Design

10. **Video:** Learning Curves

2. **Reading:** Prioritizing What to Work On

11. **Reading:** Learning Curves

3. **Video:** Error Analysis

12. **Video:** Deciding What to Do Next Revisited

4. **Reading:** Error Analysis

Revisited

5. **Video:** Error Metrics for Skewed Classes

13. **Reading:** Deciding What to do Next Revisited

6. **Video:** Trading Off Precision and Recall

Support Vector Machines

7. **Video:** Data For Machine Learning

14. **Reading:** Lecture Slides

Support Vector Machines (SVMs) is a machine learning algorithm for classification. We introduce the idea and intuitions behind SVMs and discuss how to use it in practice.

8. **Reading:** Lecture Slides

15. **Programming:** Regularized Linear Regression and Bias/Variance

6 videos, 1 reading expand

1. **Video:** Optimization Objective

Graded: Support Vector Machines

2. **Video:** Large Margin Intuition

3. **Video:** Mathematics Behind Large Margin Classification

4. **Video:** Kernels I

5. **Video:** Kernels II

6.   **Video:** Using An SVM

7.   **Reading:** Lecture Slides

Unsupervised Learning

8.   **Programming:** Support Vector
      Machines

We use unsupervised learning to build models
that help us understand our data better. We
discuss the k-Means algorithm for clustering
that enable us to learn groupings of unlabeled
data points.

📄 5 videos, 1 reading expand

1.   **Video:** Unsupervised Learning:
👤 **Graded:** Unsupervised Learning
      Introduction

2.   **Video:** K-Means Algorithm

Dimensionality Reduction

3.   **Video:** Optimization Objective

In this module, we introduce Principal
4.   **Video:** Random Initialization
Components Analysis, and show how it can be
5.   **Video:** Choosing the Number of Clusters
used for data compression to speed up
learning algorithms as well as for visualizations
6.   **Reading:** Lecture Slides
of complex datasets.

📄 7 videos, 1 reading expand

1.   **Video:** Motivation I: Data Compression
👤 **Graded:** Principal Component Analysis
2.   **Video:** Motivation II: Visualization

3.   **Video:** Principal Component Analysis
      Problem Formulation

4.   **Video:** Principal Component Analysis
      Algorithm

5.   **Video:** Reconstruction from
Anomaly Detection
      Compressed Representation

Given a large number of data points, we may
6.   **Video:** Choosing the Number of
sometimes want to figure out which ones vary
      Principal Components
significantly from the average. For example, in
7.   **Video:** Advice for Applying PCA
manufacturing, we may want to detect defects
or anomalies. We show how a dataset can be
8.   **Reading:** Lecture Slides
modeled using a Gaussian distribution, and
9.   **Programming:** K-Means Clustering and
how the model can be used for anomaly
      PCA
detection.

8 videos, 1 reading expand

1. **Video:** Problem Motivation

Graded: Anomaly Detection

2. **Video:** Gaussian Distribution

3. **Video:** Algorithm

Recommender Systems

4. **Video:** Developing and Evaluating an

When you buy a product online, most websites Anomaly Detection System

automatically recommend other products that

you may like. Recommender systems look at 5. **Video:** Anomaly Detection vs.

patterns of activities between different users Supervised Learning

and different products to produce these 6. **Video:** Choosing What Features to Use

recommendations. In this module, we

introduce recommender algorithms such as the 7. **Video:** Multivariate Gaussian

collaborative filtering algorithm and low-rank Distribution

matrix factorization. 8. **Video:** Anomaly Detection using the

Multivariate Gaussian Distribution

6 videos, 1 reading expand

9. **Reading:** Lecture Slides

1. **Video:** Problem Formulation

Graded: Recommender Systems

2. **Video:** Content Based

Recommendations

3. **Video:** Collaborative Filtering

WEEK 10 4. **Video:** Collaborative Filtering Algorithm

5. **Video:** Vectorization: Low Rank Matrix

Factorization

Large Scale Machine Learning

6. **Video:** Implementational Detail: Mean

Machine learning works best when there is an Normalization

abundance of data to leverage for training. In

this module, we discuss how to apply the 7. **Reading:** Lecture Slides

machine learning algorithms with large

datasets. 8. **Programming:** Anomaly Detection and

Recommender Systems

6 videos, 1 reading expand

1. **Video:** Learning With Large Datasets

Graded: Large Scale Machine Learning

2. **Video:** Stochastic Gradient Descent

3. **Video:** Mini-Batch Gradient Descent

4. **Video:** Stochastic Gradient Descent

WEEK 11 Convergence

5.   **Video:** Online Learning

6.   **Video:** Map Reduce and Data Parallelism

Application Example: Photo OCR

Identifying and recognizing objects, words, and digits in an image is a challenging task. We discuss how a pipeline can be built to tackle this problem and how to analyze and improve the performance of such a system.

7.   **Reading:** Lecture Slides

📋 5 videos, 1 reading expand

1.   **Video:** Problem Description and Pipeline

👤 **Graded:** Application: Photo OCR

2.   **Video:** Sliding Windows

View Less

3.   **Video:** Getting Lots of Data and Artificial Data

4.   **Video:** Ceiling Analysis: What Part of the Pipeline to Work on Next

How It Works

5.   **Reading:** Lecture Slides

6.   **Video:** Summary and Thank You

GENERAL

How do I pass the course?

To earn your Course Certificate, you'll need to earn a passing grade on each of the required assignments—these can be quizzes, peer-graded assignments, or programming assignments. Videos, readings, and practice exercises are there to help you prepare for the graded assignments.

∨ More

What do start dates and end dates mean?

Most courses have sessions that run multiple times a year — each with a specific start and end date. Once you enroll, you'll have access to all videos, readings, quizzes, and programming assignments (if applicable). Peer-graded assignments can only be submitted and reviewed once your session has begun. If you choose to explore the course without purchasing, you may not be able to access certain assignments. If you don't finish all graded assignments before the end of the session, you can

PROGRAMMING ASSIGNMENTS

Programming assignments require you to write and run a computer program to solve a problem.

What are programming assignments?

Programming assignments include both assignment instructions and assignment parts. Instructions may include a link to a downloadable starter package that includes starter code, detailed guidelines, and

∨ More

View More

Related Courses

Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization

deeplearning.ai

Structuring Machine Learning Projects

deeplearning.ai

Convolutional Neural Networks

deeplearning.ai

Neural Networks and Deep Learning

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Sequence Models

deeplearning.ai