# Course Syllabus

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NOTE: Some links in this syllabus page may only be accessible to currently enrolled students.

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## Syllabus

You can download the **full PDF version** (https://canvas.oregonstate.edu/courses/2025514/files/111067912?wrap=1) of this syllabus.

**Course Name**: Applied Machine Learning

**Course Number**: CS 513

**Credits**: 4 Credits

**Instructor name**: Yong Bakos

**Instructor email**: yong.bakos@oregonstate.edu (mailto:yong.bakos@oregonstate.edu) (mailto:yong.bakos@oregonstate.edu) (mailto:chaudhrn@oregonstate.edu)

## Course Description

Explores machine learning basics (variance and bias, underfitting and overfitting, etc). Reviews linear algebra and numpy. Examines k-nearest neighbors, linear classification (perceptron and online learning), and linear and non-linear regression. Explores applications in housing price prediction (Kaggle contest) and text classification (sentiment analysis). This course is for Department of Statistics graduate students enrolled in **MS and PhD degrees in Statistics** (https://stat.oregonstate.edu/content/graduate-major-programs) .

## Communication

Please post all course-related questions in the Ed Discussion forum so that all students may benefit from our conversation. Please contact me privately for matters of a personal nature. I will attempt to reply to course-related questions within 48 business hours. I will strive to return your assignments and grades for course activities to you within three days of the due date.

## Course Credits

On average this course combines approximately 150 hours of instruction, online activities and assignments for 4 credits. The majority of the time will be spent completing the activities and assignments. Assignments can be challenging, start early and if you have questions ask them on the Ed Discussion board. Waiting until the last minute is not an effective strategy.

## Measurable Student Learning Outcomes

1. Formulate the components of a machine learning algorithm
2. Contrast training, test and generalization errors to identify and interpret underfitting and overfitting, and to use methods to cope with underfitting and overfitting.
3. Formulate and implement a k-NN classifier.
4. Formulate and implement the average perceptron classifier.
5. Interpret and extend the perceptron convergence proof.
6. Use linear regression in a real-world prediction task.
7. Use support vector machines and kernels in a real-world classification task.
8. Use linear classifiers in real-world text classification and sentiment analysis tasks.

## Learning Resources

There is no required course textbook, and we provide all learning materials within the Canvas modules of this course. Each exploration and assignment provides additional external learning resources.

## Evaluation of Student Performance

- Homework 30%
- Quizzes 10%
- Midterm Exam 30%
- Final Exam 30%

## Module Availability

Each module will generally be available at 8 am on Monday. We limit module availability to keep students focused on the similar topics and work each week of the course. We will provide access to the following week's module approximately one week in advance.

## Letter Grade

| Grade | Percent Range |
|---|---|
| A | 93 |
| A- | 90 |
| B+ | 87 |
| B | 83 |
| B- | 80 |
| C+ | 73 |
| C | 73 |
| C- | 70 |
| D+ | 67 |
| D | 63 |
| D- | 60 |
| F | 0 |

## Course Content

| Week | Topic | Learning Materials | Assessed Work |
|---|---|---|---|
| 1 | Introduction to Machine Learning | Explorations<br>• What is Machine Learning? (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512048)<br>• The Machine Learning Process (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512049)<br>• Introduction to Jupyter Notebooks (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512050) | Quiz 1 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512052)<br>Notebook 1 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512051) |
| 2 | Data Pre-Processing | Explorations<br>• Data Types, Quality & Preprocessing (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512055)<br>• Similarity Metrics (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512056) | Quiz 2 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512058)<br>Notebook 2 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512057) |
| 3 | Classification with k-Nearest Neighbors | Explorations<br>• Classification (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512061)<br>• k-Nearest Neighbors (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512062)<br>• Applying k-Nearest Neighbors (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512063) | Quiz 3 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512065)<br>Notebook 3 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512064) |

| Week | Topic | Learning Materials | Assessed Work |
|---|---|---|---|
| 4 | Classification with Perceptrons | Explorations<br>• Perceptrons (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512068)<br>• Applying Perceptrons (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512069) | Quiz 4 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512071)<br>Notebook 4 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512070) |
| 5 | Midterm, Survey of Deep Learning | Explorations<br>• Artificial Neural Networks (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512074)<br>• Deep Learning (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512075) | Quiz 5 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512076)<br>Practice Midterm Exam (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512080)<br>Midterm Exam (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512081) |
| 6 | Linear Regression with Gradient Descent | Explorations<br>• Linear Regression (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512083)<br>• Gradient Descent (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512084)<br>• Applying Linear Regression with Gradient Descent (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512085) | Quiz 6 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512087)<br>Notebook 6 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512086) |
| 7 | Classification with Logistic Regression | Explorations<br>• Logistic Regression (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512090)<br>• Applying Logistic Regression (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512091) | Quiz 7 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512093)<br>Notebook 7 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512092) |
| 8 | Classification with Support Vector Machines | Explorations<br>• Support Vector Machines (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512096)<br>• Applying Support Vector Machines (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512097) | Quiz 8 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512099)<br>Notebook 8 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512098) |
| 9 | Text Classification & Sentiment Analysis | Explorations<br>• Natural Language Processing (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512102)<br>• Sentiment Analysis (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512103)<br>• Applying Classifiers for Sentiment Analysis (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512104) | Quiz 9 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512106)<br>Notebook 9 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512105) |
| 10 | Reflection & Further Learning | Explorations<br>• Review (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512109)<br>• Learning More About Machine Learning (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512110) | Quiz 10 (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512111) |
| 11 | Final Exam | | Practice Final Exam (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512114)<br>Final Exam (https://canvas.oregonstate.edu/courses/2025514/modules/items/25512115) |

## Assessed Work

After completing the learning materials for each module, we will complete a quiz, to demonstrate our knowledge and understanding, and a Notebook, to demonstrate an application of knowledge and skill. There is both a midterm exam and a final exam in this course.

### Quizzes

Quizzes are taken online within Canvas, and are timed, so once you begin, be prepared to complete the quiz in one sitting. You may take each quiz twice. These are not a huge part of your grade, so do not stress out over them. Rather use the quizzes to assess your knowledge and understanding of the course material. Please ask questions about any incorrect answers or confusing topics in the quiz.

### Notebooks

Data scientists and machine learning practitioners often employ Jupyter Notebooks to craft interactive, runnable machine learning experiments on data. Each notebook in this course provides some boilerplate code, a problem statement, a mix of text and code, and room for you to implement and demonstrate your solution. See the *Tools* tab in the syllabus for more information.

Each Notebook assignment has a rubric with the criteria we use for assessment.

**You are encouraged to complete your notebooks before the assignment deadline**, and post a comment in Canvas to request an early review of your work. That way, you can incorporate feedback into a revision, and resubmit prior to the deadline for additional credit, if any was missed.

### Exams

There is a midterm in this course in Module 5. The midterm is an unproctored, timed, online quiz within Canvas. A practice midterm exam is available. You may take the midterm exam any time before its due date. You may only take the midterm exam once.

There is a final exam in this course during Final Exam Week. The final exam is an unproctored, timed, online quiz within Canvas. A practice final exam is available. You must take the final exam before its due date.

## Expectations: Programming and Mathematics

This course is for data science students who have completed CS 511 or have equivalent experience in Python programming. In addition, students *should* have completed CS 512 prior to this course, but it is not mandatory. **You are expected to write programs in Python without guidance on basic syntax**. The emphasis of this course is on solving applied problems in machine learning through programming - the course does not teach you how to program.

In addition, this course expects students to have at least an undergraduate-level mathematics background in statistics, algebra, geometry, and trigonometry. Intimacy with linear algebra and basic calculus is helpful, but not mandatory.

## Difference with On Campus Courses

In an on campus course about ½ to ⅓ of the class time would consist of instructor-led lecture. The rest of the time would be used to do in-class examples and work in small groups. This is where you would test your understanding of the topics and ask your group mates for help. It is also where you would help your fellow students. If you were totally stuck, the instructor would help.

In principle, online learning should be about the same. But instead of a classroom, you have a discussion board. You should be active on the discussion board to help and get help from your classmates. When everyone gets stuck the instructor can help get the class unstuck. But the value of the course comes in your ability to get help from other people learning the same thing at the same time and having an instructor to help guide that learning. If you are not active on the discussion board you will get much less out of the course. **Ask lots of questions.**

(https://canvas.oregonstate.edu/courses/2025514/modules)

# Course Summary:

| Date | Details | Due |
|---|---|---|
| Sun Apr 6, 2025 | Notebook 1: Introduction to Jupyter Notebooks (w1) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065698) | due by 11:59pm |
| | Quiz 1: Machine Learning Concepts & Vocabulary (w1) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065688) | due by 11:59pm |
| | Quiz: Syllabus and 'Start Here' (https://canvas.oregonstate.edu/courses/2025514/assignments/10065694) | due by 11:59pm |
| Sun Apr 13, 2025 | Quiz 2: Data Types, Preprocessing & Similarity Metrics (w2) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065693) | due by 11:59pm |
| | Notebook 2: Data Exploration, Preprocessing & Similarity Metrics (w2) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065699) | due by 11:59pm |
| Sun Apr 20, 2025 | Quiz 3: k-Nearest Neighbors (w3) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065686) | due by 11:59pm |
| | Notebook 3: Classification with k-Nearest Neighbors (w3) | due by 11:59pm |

| Date | Details | Due |
|---|---|---|
| | (https://canvas.oregonstate.edu/courses/2025514/assignments/10065700) | |
| Sun Apr 27, 2025 | Quiz 4: Perceptrons (w4) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065690) | due by 11:59pm |
| | Notebook 4: Classification with Perceptrons (w4) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065701) | due by 11:59pm |
| Sun May 4, 2025 | Midterm Exam (w5) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065696) | due by 11:59pm |
| | Quiz 5: Deep Learning (w5) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065695) | due by 11:59pm |
| Sun May 11, 2025 | Quiz 6: Linear Regression & Gradient Descent (w6) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065692) | due by 11:59pm |
| | Notebook 6: Predicting Housing Prices with Linear Regression (w6) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065702) | due by 11:59pm |
| Sun May 18, 2025 | Quiz 7: Logistic Regression (w7) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065691) | due by 11:59pm |
| | Notebook 7: Classification with Logistic Regression (w7) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065703) | due by 11:59pm |
| Sun May 25, 2025 | Quiz 8: Support Vector Machines (w8) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065687) | due by 11:59pm |
| | Notebook 8: Classification with Support Vector Machines (w8) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065704) | due by 11:59pm |
| Sun Jun 1, 2025 | Quiz 9: Text Classification & Sentiment Analysis (w9) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065685) | due by 11:59pm |
| | Notebook 9: Text Classification & Sentiment Analysis (w9) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065705) | due by 11:59pm |
| Fri Jun 6, 2025 | Quiz 10: Reflection on Machine Learning (w10) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065689) | due by 11:59pm |
| Thu Jun 12, 2025 | Final Exam (w11) (https://canvas.oregonstate.edu/courses/2025514/assignments/10065697) | due by 11:59pm |