Advanced Academic Programs

Zanvyl Kreiger School of Arts and Sciences

Johns Hopkins University

Machine Learning and Neural Networks – AS.470.667.81

Spring 2020

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**Office Hours:** By appointment via Zoom

COURSE DESCRIPTION

Machine learning and, more broadly, artificial intelligence, has recently had a series of unprecedented successes in performing tasks such as image recognition and autonomously playing video games at a higher level of accuracy and performance than humans. These successes are driven by accelerated developments in machine learning, notably neural networks.

This course will cover a variety of machine learning algorithms from linear regression to nonlinear neural networks. Students will learn to implement these algorithms and understand how they work. Further, students will learn how to select and implement an appropriate algorithm depending on the type of dataset they have, and will be able to use the algorithm to generate predictions.

REQUIRED TEXTS

Introduction to Statistical Learning (free PDF) - http://www-bcf.usc.edu/~gareth/ISL/

Deep Learning (Free Online) – http://www.deeplearningbook.com

REQUIRED SOFTWARE

Please download and install Anaconda, a free and full packaged distribution of Python, for Windows and Mac

RECOMMENDED TEXTS

Elements of Statistical Learning (free PDF) http://statweb.stanford.edu/~tibs/ElemStatLearn/

Pattern Recognition – Christopher Bishop

Data Science from Scratch – Joel Grus

GOALS & OBJECTIVES

By the end of this course, students will be able to:

Analyze a problem scope and data sets to determine if Machine Learning is an appropriate tool for the problem.

Determine which Machine Learning Algorithm is appropriate for the problem scope

Develop basic ML algorithms from scratch for Linear Regression and SVM

Train ML Algorithms on data to build models

Test and describe performance metrics of ML models developed

COURSE SCHEDULE

1. Introduction | Software Installation | Basic Introduction to Python
2. Python + Pandas + Numpy in Jupyter Notebooks
3. Linear Regression + Loss/Cost Function
4. Linear Regression Continued
5. Classification + Feature Extraction
6. Feature Extraction + Evaluating Models + Decision Trees
7. Decision Trees cont’d + Logistic Regression
8. Unsupervised Learning
9. Natural Language Processing: Working with Text; SpaCy
10. Neural Networks: Introduction
11. Neural Networks: MNIST Handwriting images recognition
12. Neural Networks: Convolutional Networks
13. Neural Networks: Auto-Encoders

Chapter Sections in Introduction to Statistical Learning are indicated below

1. Introduction | Software Installation | Basic Introduction to Python
2. Python + Pandas + Numpy in Jupyter Notebooks
3. Linear Regression + Loss/Cost Function 3.1, 3.2
   1. How does Linear Regression work? Answer: With a Loss function
   2. Optional – if you want to brush up on your Calculus
      1. Stewart - Calculus 2.1, 2.2, 2.3, 2.5
      2. ISL Chapter 1 Introduction (focus on Linear Algebra)
      3. Ch. 1 https://www.math.ucdavis.edu/~linear/linear-guest.pdf
      4. Watch Andrew Ng Lecture on Matrix and Linear Algebra
4. Linear Regression Continued
   1. Linear Regression with Time Series
   2. Reducing Overfitting
   3. Model Evaluation for Linear Regression
5. Classification + Model Evaluation
   1. Introduction to Classification 4.1
   2. Model Evaluation with Classification
6. Feature Extraction + Decision Trees
   1. Feature Extraction
   2. Decision Trees 8.1
   3. Random Forest 8.2
   4. Gradient Boosted Model 8.2
7. Logistic Regression
   1. Logistic Regression ISL 4.3
8. Unsupervised Learning 10.1
   1. Principal Component Analysis 10.2
   2. Clustering 10.3
9. Neural Networks: Introduction
10. Neural Networks: MNIST Handwriting images recognition
11. Neural Networks: Convolutional Networks
12. Neural Networks: Auto Encoders
13. Natural Language Processing: Working with Text; SpaCy

ASSIGNMENTS

All Assignments are worth 10 points each. PDF + Notebook must be submitted.

Instructions are listed in the *Assignment Guidelines* document.

Honestly attempting all the problems in each assignment will earn you half the points (5).

Partial credit will be liberally given in assignments, so give it a solid effort.

Install and Verify 10 Points

Python + Pandas 10 Points

Linear Regression 10 Points

Linear Regression 10 Points

Classification 10 Points

Features + Model Eval 10 Points

Decision Trees + Logistic Reg 10 Points

Unsupervised Learning 10 Points

NLP 10 Points

Neural Network: Intro 10 Points

Neural Nets: Handwriting 10 Points

Neural Nets: Application 10 Points

Neural Nets: Autoencoders 10 Points

Late Policy

All late assignments are still accepted with a penalty of:

10% (less than 1 week late)

20% (less than 2 weeks late)

40% (any assignment past 2 weeks late)

Feedback

I will provide feedback up to 1 week after assignment submission.

GRADING POLICY

Letter Grade Percentage

A+ 98% to 100% if grade>=98

A 94% and less than 98% if grade>=94 and grade <98

A- 90% and less than 94% if grade>=90 and grade <94

B+ 88% and less than 90% if grade>=88 and grade <90

B 84% and less than 88% if grade>=84 and grade <88

B- 80% and less than 84% if grade>=80 and grade <94

C 70% and less than 80% if grade>=70 and grade <80

F 0% and less than 70% if grade <70

COURSE COMMUNICATION POLICY & PROTOCOLS

Contacting the Instructor

For questions about course content, assignments, etc. that would be of interest to other students, please post your questions on the *Syllabus and Assignment Question* forum.

For other questions or to set up an appointment for office hours, contact the instructor via email. You will receive a response within 24-48 hours.

All email messages will be sent to you via your JHU email account, so you should be in the habit of checking that account every day or you should ensure that your JHU email account forwards messages to another account.

Network Etiquette (i.e. “Netiquette”)

In this course, online discussion will be primarily take place in our online discussion board. In all textual online communication it’s important to follow proper rules of netiquette. What is netiquette? Simply stated, it's network etiquette -- that is, the etiquette of cyberspace. And "etiquette" means the social and cultural norms of communicating with others in a proper and respectful way. In other words, netiquette is a set of rules for behaving and interacting properly online.

[The Netiquette “Core Rules” are a set of general guidelines for cyberspace behavior](http://www.albion.com/netiquette/corerules.html). They probably won't cover all situations, but they should give you some basic principles to use in communicating online.

Course Protocols

*How will I know about changes to the course?*

Frequently, you will find new announcements posted in the Announcements, which contain information about current course activities that you are working on and any changes to the course. Please check announcements every time that you log into your online course.

*How should I communicate with others in this course?*

You should communicate often with your classmates and with your instructor. The majority of communication will take place within the Discussion forums. When you have a question about an assignment or a question about the course, please contact your instructor, or post your question in the course’s “Syllabus & Assignment Question” forum.

*Are there any requirements for sending e-mail messages?*

When you send an e-mail message to the instructor or to another participant in the course, please observe the following guidelines:

Include the title of the course in the subject field.

Keep messages concise, and check spelling and grammar.

Send longer messages as attachments.

Sign your full name (the sender’s email is not always obvious).

Specific Technology Requirements & Skills for this Course

This course requires the use of a computer that complies with the following hardware specifications. For specifics, please see the [recommendations of the Information Technology Office at Johns Hopkins](http://www.it.johnshopkins.edu/gettingstarted.html).

Learning online requires some basic knowledge of computer technology. At a minimum, you need to be able to:

Navigate in and use Blackboard; the Blackboard Student Orientation course on your “My Institution” page

Create and save MS Word documents; see [MS Word training and tutorials](https://support.office.com/en-au/article/Word-2013-training-courses-videos-and-tutorials-14807f76-d2b5-44d6-af11-9c880c44e551?ui=en-US&rs=en-AU&ad=AU) for PC users (all versions); [Word Help](http://www.microsoft.com/mac/help.mspx?product=Word&app=4) for Mac users

Find basic resources on the Internet; Create and organize files & folders on your computer; Send, receive, and manage email

UNIVERSITY POLICIES

General

This course adheres to all University policies described in the academic catalog. Please pay close attention to the following policies:

Students with Disabilities

Johns Hopkins University is committed to providing reasonable and appropriate accommodations to students with disabilities. Students with documented disabilities should contact the coordinator listed on the [Disability Accommodations](http://advanced.jhu.edu/current-students/current-students-resources/disability-accommodations/) page. Further information and a link to the Student Request for Accommodation form can also be found on the [Disability Accommodations](http://advanced.jhu.edu/current-students/current-students-resources/disability-accommodations/) page.

Ethics & Plagiarism

JHU Ethics Statement: The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructor.

Read and adhere to JHU’s [Notice on Plagiarism](http://advanced.jhu.edu/current-students/policies-2/notice-on-plagiarism-2/).

Dropping the Course

You are responsible for understanding the university’s policies and procedures regarding withdrawing from courses found in the current catalog. You should be aware of the current deadlines according to the [Academic Calendar](http://advanced.jhu.edu/current-students/academic-calendar/).

Getting Help

You have a variety of methods to get help. Please consult the help listed in the "Blackboard Help" link in the online classroom for important information. **If you encounter technical difficulty in completing or submitting any online assessment, please immediately contact the designated help desk listed on the** [**AAP online support page**](http://advanced.jhu.edu/academics/online-programs/support/). Also, contact your instructor at the email address listed atop this syllabus.

Copyright Policy:

All course materials are the property of JHU and are to be used for the student's individual academic purpose only. Any dissemination, copying, reproducing, modification, displaying, or transmitting of any course material content for any other purpose is prohibited, will be considered misconduct under the [JHU Copyright Compliance Policy](https://www.jhu.edu/assets/uploads/2016/11/compliance_policy.pdf), and may be cause for disciplinary action. In addition, encouraging academic dishonesty or cheating by distributing information about course materials or assignments which would give an unfair advantage to others may violate AAP’s [Code of Conduct](http://advanced.jhu.edu/wp-content/uploads/2013/01/AAP1101_CodeofConduct.pdf) and the University’s [Student Conduct Code](http://studentaffairs.jhu.edu/policies/student-code/). Specifically, recordings, course materials, and lecture notes may not be exchanged or distributed for commercial purposes, for compensation, or for any purpose other than use by students enrolled in the class. Other distributions of such materials by students may be deemed to violate the above University policies and be subject to disciplinary action.