Syllabus for EM 626
Applied AI & Machine Learning for Systems and Enterprises

Instructor:

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Course Time:

See Canvas

Purpose:

This syllabus provides the student with information about the details and guidance necessary to complete EM 626.

Texts:

1. Lecture Notes and Handouts
2. Building Intelligent Systems: A Guide to Machine Learning Engineering; Geoff Hulten; Apress; 2018

Additional and recommended texts:

1. Thinking in Systems; Donella H. Meadows; Chelsea Green Publishing; 2008
2. Introduction to Machine Learning with Python - A Guide for Data Scientists; Sarah Guido, Andreas Müller; O'Reilly Media; 2016
3. Machine Learning with Python Cookbook - Practical Solutions from Preprocessing to Deep Learning; Chris Albon; O'Reilly Media; 2018
4. Natural Language Processing with Python Cookbook; Pratap Dangeti, Krishna Bhavsar, Naresh Kumar; O'Reilly Media; 2017
5. John W. Foreman, Data Smart: Using Data Science to Transform Information into Insight, 2014.
6. Cole Nussbaumer Knaflic, Storytelling with Data: A Data Visualization Guide for Business Professionals, 2015
7. Paul Scharre, Army of None: Autonomous Weapons and the Future of War, 2019

Course Description:

The aim of this course is to provide an all-around practical education on how to leverage on Machine Learning to better address key needs of Systems and Enterprises.

This is an advanced application course and even if it is focused on applications rather than theoretical components, it requires students to have a good mathematical, statistical and coding background. Course is using Python and its main Machine Learning libraries.

Course Objectives:

This course aims to:

- Provide the student with practical approaches to leverage on data and text using Machine Learning to approach applications for Enterprise Science and Systems Engineering
- Develop and modify Machine Learning prototypes using advanced tools as Python for Machine/Deep Learning
- Help the student to understand the basic principles and the current applications of text processing using both traditional Natural Language Processing techniques and more recent vector-based approaches
- Determine how to leverage on text to get actionable insights on developing and managing Systems and Enterprises applications
- Bridging text and data to provide students with an integrated view of the possible sources
- Develop and modify hybrid man/machine systems for decision-intensive problems
- Provide the student with a software toolkit to apply advanced models and techniques to decision taking problems
- Make the students work on Enterprise Science and Systems Engineering applications, such as Marketing/Entrepreneurship, Politics, Healthcare, Planning, Risk management.

Course Outcomes

- Understanding
  - Ability to understand the information embedded in data and text via the most appropriate algorithms and techniques to define the conditions for proper implementation strategies
- Analyzing and Evaluating
  - Ability of analyze, evaluate and extract information in large sets of data and text with a pragmatic and solution-oriented attitude
- Applying
  - Using selected tools and methods to design and prototype data/text-driven systems addressing domain-specific needs.

Grading Percentages:

- Homework   30%
- Midterm Exam   30%
- Project   40%

Midterm Exam will be performed in class with a 2.5 hours duration. Students will work on a Machine Learning application using the software presented during the classes. Students can use notes and books. Project will be a take home assignment student will develop individually.

Homework will be done using the software presented during the classes.

Final Exam will be a project students will prepare individually at home and submit on Canvas. A selection of projects will be presented in class.

If part of an assignment is not original and not from a cited source, the case will be considered as "cheating"/plagiarism. Cheating of any kind will result in a zero grade for the assignment.

Cheating of any kind – including "code sharing" between students - will result in a zero grade for the assignment and could also be subject to other Stevens academic penalties.

All code must be your original creation. Any non-original code must be clearly marked as such (use comments). Submissions are subject to screening by plagiarism detection software. Plagiarism is considered cheating and will result in a zero grade.

Students may use online resources, such as StackOverflow. If students use parts of code from those online sites, the exact link to the page with the source that has been used must be added to the code as comment.

Prerequisites:

- EM 624 or equivalent: a complex data exploration level of knowledge of Python is required.

Modules:

	Topic(s)	Reading(s)	HW
Week 1	Introduction to Machine Learning and Data Mining for Systems applications	Lecture Notes and Handouts	
Week 2	Assessing the value of data for systems and enterprises: understanding, cleaning and transforming	Lecture Notes and Handouts; Data Smart; Thinking in Systems	**HW1**: Students will be provided with a dataset to be assessed, using primarily Excel
Week 3	Python refresh and Machine Learning specific libraries	Lecture Notes and Handouts; Introduction to Machine Learning with Python	**HW2**: Students will be asked to 1.: redo HW1 with Python and 2.: create a Python script to address an application problem
Week 4	Key Machine Learning and Data Mining Algorithms for Systems and Enterprises	Lecture Notes and Handouts	
Week 5	Introduction to advanced methods and algorithms - such as deep neural networks - for Systems and Enterprises	Lecture Notes and Handouts	**HW3**: Students will be asked to apply data mining and machine learning methods to address a system application problem
Week 6	Using advanced methods and algorithms - such as deep neural networks - for Complex Systems	Lecture Notes and Handouts; Building Intelligent Systems	**HW4**: Students will be asked to apply machine learning and deep NN in particular to address a system application problem
Week 7	Using key ML libraries for complex tasks (e.g.:TensorFlow and Keras)	Lecture Notes and Handouts; Hands-On Machine Learning with Scikit-Learn and TensorFlow	**HW5**: Students will be asked to use the different methods they learned so far and compare the results in terms of better functional coverage for a given application problem
Week 8	Midterm exam		**Midterm**: This is an in-class assignment. Students will receive an application problem and a related dataset, and they need to apply the

Week	Topic	Materials	Assignment
			most appropriate techniques and methods, providing a human-readable report, supported by code they will develop
Week 9	Text mining as key element in measuring and address key enterprises need: introduction, techniques and applications to systems analyses	Lecture Notes and Handouts; Natural Language Processing with Python	**HW6**: Students will receive a text to be cleaned and analyzed, generating a short human-readable report addressing a system application
Week 10	Creating systems risk analysis support systems using Natural Language Processing via text vectorization	Lecture Notes and Handouts	**HW7**: Students will receive a text as in HW6, apply text vectorization, extract metrics and create a basic risk decision support system
Week 11	Data & text fusion: extracting metrics from text and integrating them with data to better understand and use systems behavior	Lecture Notes and Handouts	**HW8**: Students will receive different text and data representing a given system, extract metrics from both, integrate them and generating a basic risk decision support system
Week 12	Using data & text fusion for decision taking in complex systems - Introduction to the Final project	Lecture Notes and Handouts	**Project**: This is an individual take home assignment. Students will select a domain/system, a problem they want to address within the domain, text/dataset to be used and they will generate a comprehensive human-readable report and related prototypal system. Instructor has to pre-approve the project
Week 13	Systemic view of Machine Learning - Humans in the loop for decision-intensive tasks	Lecture Notes and Handouts; Army of None	
Week 14	Final projects presentation and discussion		