NYU STERN

MS in Business Analytics and AI

Modern Artificial Intelligence
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COURSE DESCRIPTION

The field of AI will fundamentally transform many industries within the next few years. AI has experienced rapid growth over the last ten years because of major advances in its subfields of Deep Learning, Reinforcement Learning, Natural Language Processing, Computer Vision, and Robotics, among others. According to a recent World Economic Forum (WEF) report, AI will create 133 million new and displace 75 million old jobs worldwide (with the net creation of 58 million new jobs) within the next few years. PwC estimates that AI will contribute up to $15 trillion to the global GDP by 2030. Despite this, there is an acute AI skills shortage around the world: the demand for AI jobs is measured in millions, while there are currently about 300,000 AI professionals worldwide. Not surprisingly, AI-related jobs are among the fastest-growing and the most in-demand today.

The purpose of this course is to provide students with a systematic introduction to some of the recent developments in AI through coverage of fundamental AI concepts, practical business applications, and hands-on experiences with modern AI frameworks, particularly deep neural networks.

Upon completion of this course, students will:

1. Understand the fundamentals of AI, e.g., what it can do and cannot do, and the foundations of machine learning;

2. Gain deep knowledge of modern AI techniques, particularly deep learning, including various deep neural network (NN) architectures and state-of-the-art applications.

3. Be able to apply AI-based methods to solve real-world business problems, understanding considerations for the integration of AI into an existing business process

REQUIRED TEXTBOOK & READING MATERIALS

Textbooks

Required Textbook:

- Chollet, François. (2021). *Deep Learning with Python (2nd Edition)*. Manning Publications Co. **ISBN-13: 978-1617296864.** https://www.manning.com/books/deep-learning-with-python-second-edition

Optional Textbooks:

- *Artificial Intelligence: 101 Things You Must Know Today About Our Future.* Lasse Rouhiainen, CreateSpace Independent Publishing Platform, 2018.

- *Deep Learning.* Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016

Other Reading Materials:

These reading materials (extracted PDFs from websites) will be available on NYU Brightspace. You can either read PDF files or access the links provided below:

Pre-Module Readings (must read prior to class):

Note: your pre-module quiz will be based on the first reading (Chapters 1 and 2)

- You are required to read chapters 1 and 2 of the required textbook above in detail and try to implement the code in Chapter 2.

Optional Pre-module Reading:

- Neural Networks and Deep Learning (Chapter 1) by Michael Nielsen: http://neuralnetworksanddeeplearning.com/chap1.html

- A Complete History of AI: https://learn.g2.com/history-of-artificial-intelligence

Post-Module Readings:

Note: Chapters 5 and 6 of the required book will strengthen your understanding of some topics that we cover in class. You can also reference the reading materials below after the class has completed *if you have time and if you want to dive deeper into these topics*. *That said, if you feel that you have a solid understanding of fundamental machine learning, you could also read these prior to the class.*

- Convolutional Neural Networks (CNN) for Visual Recognition
  - https://cs231n.github.io/convolutional-networks/

- AI Transformation Playbook (see the uploaded PDF)

- Understanding LSTM networks – for your own interest
  - https://colah.github.io/posts/2015-08-Understanding-LSTMs/

- Tutorial on Generative Adversarial Networks (GANs) – for your own interest
  - https://medium.com/ai-society/gans-from-scratch-1-a-deep-introduction-with-code-in-pytorch-and-tensorflow-cb03cdcdba0f

SOFTWARE

We will use the Keras library in Python. To make use of the code examples and to follow along, you will need to create a Google Colab account https://colab.research.google.com/). Note that using Colab will be much easier than using your own computer because the virtual machines Colab provides access to provide GPUs, which will be important for fitting models on larger datasets.

For the Post module exercise, you should modify the Colab Notebooks provided in class to accomplish your task.

GRADING

Grading is based on the pre-module quiz on NYU Brightspace (25%) and the post-module assignment (75%). Below is the grading guideline defined by the Stern School:

- 30-35% of the grades will be A.
- 50-70% of the grades will be B.
- 5-15% of the grades will be C or lower.

COURSE SCHEDULE

Pre-Module

1. Complete all the pre-module reading materials (see Reading Materials Section above)

2. Complete the pre-module quiz, which is based on the required pre-module readings (Chapters 1 and 2 of the text).

3. Make sure you are comfortable with the material from the Data Mining in R class (concepts such as Training/Test Sets, Logistic Regression, model error). I will provide no more than a quick review of these pre-requisite materials during class.

4. Create a google account and make sure you can access Google Colab. I recommend that you purchase a Google Colab Pro subscription. You can do this via the settings menu in Google Colab (click the gear icon, then choose Colab Pro).

In Class Module

DAY 1

Session 1: Overview of AI & Review of Traditional Machine Learning Concepts

1. What is AI? History and evolution of AI.

Session 2: Introduction to Artificial Neural Networks (ANNs)

1. The building blocks of a Neural Network.
2. Gradient tape (auto differentiation), optimizers, and the Keras APIs
3. Training a Neural Network: a) Forward pass; b) Loss; c) Back propagation

Session 3: Working Through Several Examples

1. Examples of prediction using neural networks (detecting fake reviews, predicting home price)

Session 4: Working with Image Data

1. Anatomy of an image or video
2. Convolutional Neural Networks (CNNs) – Components and architecture (e.g., convolution, stride, etc.)
3. Transfer learning (using pre-trained models)

DAY 2

Session 5: Working with Sequence Data

1. Working with sequence data (e.g., text, audio).
2. Recurrent Neural Networks (RNNs) – GRU, LSTM, Bidirectional LSTM
3. Creating and Working with Embeddings
4. Introduction to attention mechanisms

Session 6: Dissecting Neural Networks

1. Shapley Values (SHAP) and Locally Interpretable Model-agnostic Explanations (LIME) for neural networks.

Session 7: Deploying AI in Practice – How to Get Started

1. Understanding the strengths and weaknesses of deep nets.

Post Module Exercise

First, read the post-module reading materials (see **Reading Materials** Section). Then, complete the following two post-module assignment items:

(1) The first part of the assignment is to be done ***independently***. Discussion is allowed, but each student needs to submit his/her own individual write-up. Please submit a single edited .ipynb file (with your name and ID in the file name). (40% of final grade).

(2) The second part is an open-ended (group) project; you can do it either independently or collaborate with up to two other students (maximum of three students in each group). Please submit a separate single WORD/PDF file with all group members' names and IDs. (35% of final grade)

INSTRUCTOR'S BIOGRAPHICAL PROFILE

Dr. Gordon Burtch is Professor of Information Systems and Fellow of the Digital Business Institute at Boston University's Questrom School of Business. His research focuses on the economic evaluation of information systems employing a variety of empirical methods, including econometrics, field experimentation and machine learning techniques, to identify and quantify the drivers of individual participation in online social contexts. Gordon's work has been published in various leading peer-reviewed academic journals, including Management Science, Information Systems Research, MIS Quarterly, Manufacturing & Service Operations Management, Organization Science, Production and Operations Management, the Journal of Law, Economics & Organization, and the Journal of Consumer Psychology.

Gordon is a recipient of Early Career Awards from the Association for Information Systems (2017) and the Information Systems Society (ISS) of the Institute for Operations Research and Management Science (INFORMS) (2017). Gordon's research has been supported by more than $2 million in grants from various corporate, non-profit and government organizations, including the NSF, Ewing Marion Kauffman Foundation, the 3M Foundation, Adobe, Meta Research, and the European Commission. His work and opinions have been cited by numerous outlets in the popular press, including the Wall Street Journal, NPR, Time Magazine, Forbes, Vice, Wired, the LA Times, Pacific Standard and PC Magazine. Gordon presently serves as an Associate Editor for two journals: Management Science and ISR, and he has previously served as Associate Editor for Service Science.

Gordon has previously worked as a research contractor for Microsoft Research. He currently works as a contract researcher for Meta, as part of their Core Data Science group. Prior to entering academia, Gordon was employed as an information systems auditor, a hardware design engineer, and a technology consultant with Accenture Canada in Toronto. Gordon teaches graduate courses on data analytics, machine learning, and digital business strategy. He holds a Bachelor of Engineering and Master of Business Administration from McMaster University, and he received his PhD in Business Administration from Temple University's Fox School of Business.

GENERAL CONDUCT & BEHAVIOR

Students are also expected to maintain and abide by the highest standards of professional conduct and behavior. Please familiarize yourself with Stern's Policy in Regard to In-Class Behavior & Expectations (https://www.stern.nyu.edu/portal-partners/registrar/policies-procedures/general-policies/code-

conduct) (http://www.stern.nyu.edu/portal-partners/current-students/undergraduate/resources-policies /academic-policies/index.htm) and the NYU Student Conduct Policy (https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/university-student-conduct-policy.html).

STUDENT ACCESSIBILITY

If you will require academic accommodation of any kind during this course, you must notify me at the beginning of the course and provide a letter from the Moses Center for Student Accessibility (212-998-4980, mosescsa@nyu.edu) verifying your registration and outlining the accommodations they recommend. If you will need to take an exam at the Moses Center for Student Accessibility, you must submit a completed Exam Accommodations Form to them at least one week prior to the scheduled exam time to be guaranteed accommodation. For more information, visit the CSA website: https://www.nyu.edu/students/communities-and-groups/student-accessibility.html

STUDENT WELLNESS

Our aim is for students to be as successful academically as they can, and to help them overcome any impediments to that. Bookmark the NYU Stern Well-being Resource Hub (https://www.stern.nyu.edu/wellbeing) for existing services at NYU and Stern covering a wide variety of topics including financial well-being, relationship well-being, mental well-being, and more. Any student who may be struggling and believes this may affect their performance in this course is urged to contact the Moses Center for Student Accessibility (see also the Student Accessibility section of this syllabus) at 212-998-4980 to discuss academic accommodations. If mental health assistance is needed, call the NYU's 24/7 Wellness Exchange hotline 212-443-9999. Furthermore, please approach me if you feel comfortable doing so. This will enable me to provide relevant resources or referrals. There are also drop in hours and appointments. Find out more at http://www.nyu.edu/students/health-and-wellness/counseling-services.html

NAME PRONUNCIATION AND PRONOUNS

NYU Stern students now can include their pronouns and name pronunciation in Albert. I encourage you to share your name pronunciation and preferred pronouns this way. Please utilize this link for additional information: Pronouns & Name Pronunciation

RELIGIOUS OBSERVANCES AND OTHER ABSENCES

NYU's Calendar Policy on Religious Holidays states that members of any religious group may, without penalty, absent themselves from classes when required in compliance with their religious obligations. You must notify me in advance of religious holidays or observances that might coincide with exams, assignments, or class times to schedule mutually acceptable alternatives. Students may also contact religiousaccommodations@nyu.edu for assistance.

Except for religious observances or other absences that may be required in compliance with nondiscrimination law, this class otherwise requires attendance and participation and cannot accommodate conflicts. Please review all class dates at the start of the semester and review all course

requirements to identify any foreseeable conflicts with exams, course assignments, projects, or other items required for participation and attendance. If you are aware of a potential conflict, it is strongly recommended that you do not take this class.

LAPTOPS, CELL PHONES & OTHER ELECTRONIC DEVICES

The use of electronic devices (e.g., tablets or laptops), for the purpose of notetaking and in-class exercises, is permitted. However, students should make every effort to avoid distracting their classmates or disrupting the class, including arriving early and choosing a seat that is less distracting for peers.

INCLUSION STATEMENT

This course strives to support and cultivate diversity of thought, perspectives, and experiences. The intent is to present materials and activities that will challenge your current perspectives with a goal of understanding how others might see situations differently. By participating in this course, it is the expectation that everyone commits to making this an inclusive learning environment for all.