# BA865: Advanced Topics
# (Introduction to Neural Networks)
Spring 2023

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## Instructional Staff


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**Office Hours:** By appointment

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## Course Description & Learning Goals

This course will introduce you to neural networks in the Python programming language. The course will begin with a brief review of relevant concepts in Python and mathematics, before covering theory and implementation of (Deep) Neural Networks to address prediction problems. Students will learn various architectures, including multimodal networks, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) and attention-based models, employing various types of data (images, text, audio). Implementation will be conducted using TensorFlow and Keras, and course material will be presented through a combination of lecture slides and Jupyter notebooks (e.g., Google Colab). By the end of this course, you should be able to demonstrate a conceptual understanding of the various concepts covered in the course, both in written and verbal form, e.g., explaining the difference between CNNs and RNNs, how backpropagation works, or when to apply a particular neural network architecture. You will also be able to implement various neural network architectures in Python, employing Keras and TensorFlow.

## Course Meeting Times & Location

*Section A1:* Tuesdays & Thursdays: 3:30pm – 6:15pm; HAR 240
*Section B1:* Tuesdays & Thursdays: 6:30pm – 9:15pm; HAR 220

Course assignments and announcements will be posted to the course Blackboard site. Assignments are to be submitted via Blackboard. An up-to-date course schedule can also be viewed on Blackboard: https://learn.bu.edu/ultra/courses/_92163_1/outline

# Course Materials & Readings

*Textbook:* This course has one required text. We will closely follow the material in the latest release of François Chollet's Deep Learning with Python. The book is available in both digital and physical formats from the publisher, Manning (or from Amazon).

- 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

# Grading Distribution & Scale

| | |
|---|---|
| **(1) Participation** | 15% |
| **(2) Individual Assignment** | 15% |
| **(3) Quizzes (In-class; Paper & Pencil)** | 10% |
| **(4) Final Exam** | 30% |
| **(5) Group Project** | 30% |
| **Total:** | 100% |

**Attendance & Participation:** Participation in this course will contribute 15% toward your final grade. I expect all students to attend each class and to actively participate in class discussions and exercises. I try to foster an informal, hands-on approach to learning. Much of what will be presented and discussed in class will be available only, or primarily, in class. To help assess participation, you will complete an online form during each class, wherein you will self-assess your own engagement in that lecture, and where you will also have the opportunity (optionally) to indicate the name of another student who made a comment / raised a question that helped you to better understand the material. Your self-assessments and appearance in peer mentions will determine your participation grade.

**Individual Assignment:** There is one individual homework assignment, worth 15% of your final grade. The assignment is to be completed individually. You may discuss with other students, but **you cannot / should not copy/share code or collaborate directly with other students**. The assignment is due by 11:59pm on the due date indicated in the course schedule. You are required to submit a Python notebook as a standalone file, including module installation statement at the outset of your script, such that the script can be executed by myself or the TA within a clean Google Colab environment, without error or modification.

**Quizzes:** I will conduct 5 in-class quizzes, which are collectively worth 10% of your final grade. These quizzes will not be announced ahead of time. I will allocate about 15 minutes for each quiz, followed by 10-15 minutes for review of answers.

**Group Project:** The final project is worth 30% of your grade in the course. The project will evaluate your practical and conceptual understanding of the course material. You will work on this project in groups of no more than 3 students (your choice).

Pick a real-world topic that interests you and/or is relevant to your career, where *neural network-based predictions can be applied to add real value.* The problem domain you identify and the dataset you work with will ideally involve some form of text-, audio or image data, to make the application of neural network methods most relevant. You are expected to conduct in-depth research on the topic / problem, to motivate your project. You will need to meet a few milestones along the way:

- Submit a 1-page proposal outlining your project topic (5% of project grade). You have the first 2 weeks of class to complete this deliverable.
- Attend a mid-point check-in with me to ensure you are on track (5% of project grade). Sign-up for a 15-min in-person meeting with me during regular class time on April 4th. When you are not meeting with me, you can be collaborating with your group members to make progress on the project.
- Submit a final deliverable that summarizes everything you have learned / completed on the topic (40% of project grade). This deliverable will take the form of a blog post, explaining your project background / motivation, data, your neural network architecture, and the performance of your model, employing in-line code samples or visuals along the way to clarify points. Note that I am not asking you to publish a post to Medium; this is merely a point of reference for style / formatting purposes.
- Deliver a 15–20-minute presentation on the date indicated on the course schedule (50% of project grade). This component is weighted particularly heavily, because the expectation is that you will motivate the research by covering background on the topic, you will explain your dataset, you will introduce your neural network and its architecture, and you will explain your evaluation of your model's performance. All group members are expected to participate in the presentation unless otherwise approved by the instructor.

Make this project useful for YOU. By the end of this assignment, ideally, you should have become a decent expert on the topic, and the report you produce should be readily convertible into a high-quality blog post, e.g., on Medium.

**Final Exam:** A final exam will be conducted on the last day of regular class, worth 30% of your final grade in the course. The exam will be paper and pencil and will be closed book. The exam will cover your conceptual understanding of the topics covered in this course.

## Course Guidelines & Academic Policies

**Online Submissions:** All homework assignments will require online submission via the course Blackboard page. Online submission provides several advantages to the course staff and students, including date/time stamps and confirmation/verification of your submission. If you are not familiar with the online submission process, please plan to make your first few submissions early, so that you can address any issues. For a variety of reasons, you should not email assignments to the instructor or TA unless specifically requested to do so.

**Late Submission:** 10% will be deducted from a deliverable grade for each midnight that passes following the deadline indicated in the course schedule, until a deduction of 30% has been reached, beyond which a grade of 0 will be assigned.

**Grading Appeals:** If you disagree with any assignment score for a specific item, you should feel free to discuss or get feedback from the teaching assistant or myself about the question. Note that any grading check request must be raised within 1 week of the grade's posting. Late requests to review a score will not receive attention.

**Academic Misconduct / Individual Work:** The university's policies on academic integrity govern the class. These policies are available at: http://questromworld.bu.edu/acc/. Any clear evidence of an honor code violation on an assignment, project, or test will be brought to the Academic Conduct Committee. The Boston University Questrom School of Business defines academic misconduct as

"Conduct by which a student misrepresents his or her academic accomplishments or impedes other students' chances of being judged fairly for their academic work."

This includes, but is not limited to, cheating on assignments or examinations, plagiarizing, i.e., misrepresenting as one's own work any work done by another (here, I am counting ChatGPT or Bing), submitting the same project or substantially similar projects, to meet the requirements of more than one course without the approval and consent of the instructors concerned, or sabotaging another's work. Students found guilty of academic misconduct face penalties ranging from lowering of the course grade to suspension from the University.

**Accommodations for Students with Special Needs:** In keeping with university policy, any student with a disability who needs or thinks they need academic accommodations must call the Office of Disability Services at 353-3658 or stop by 19 Deerfield Street to arrange a confidential appointment with a Disability Services staff member. Accommodation letters must be delivered to me in a timely fashion (within two weeks of the date on the letter and not later than two weeks before any major examination). Please note that accommodations will not be made without an official letter of accommodation.

**Mental Health and Wellness:** Life at college can get complicated and it is easy to feel overwhelmed, lost, anxious, or depressed. If you find yourself struggling with your mental or physical health this semester, please feel free to approach me. I will try to be flexible and accommodating, within reason. But I am not a professional and there is no shame in getting help. Help for managing stress and your mental wellbeing can be found at Student Health Services. There you can find short term therapy, groups, and workshops, 24/7 on-call service (617-353-3569), referrals, and more resources. If you are feeling stressed and having trouble making choices around alcohol consumption the Collegiate Recovery Program may offer help.

**Financial Insecurity:** We learn as whole people. It can be challenging to do your best in school when you are worried about meeting basic needs like safe shelter, sleep, and nutrition. If financial insecurity is an obstacle to learning for you I urge you to contact Terrier Meal Share, Boston University Financial Assistance, or the Dean of Students Office.

**Diversity and Inclusion Statement:** In this course, I try to be thoughtful about how identity and culture impact the course content. I invite you to share your personal experiences and perspective related to the course content. If there are topics or conversations that you feel would benefit from incorporation of social context or a differing perspective, please let me know. I will explore resources and opportunities for us to engage a wide variety of perspectives in our classroom.

**Classroom Conduct**

- *Professionalism:* Students are expected to conduct themselves with a sense of respect and professionalism and can expect the same treatment from others. A part of the training in this program is learning what is expected in a workplace, and we try to enforce those standards throughout the program.

- *Punctuality:* Students are expected to arrive at the classes and scheduled meetings on time.

- *Name Tents:* Students are expected to keep the name tents in front of them during the class. This helps peers and faculty know them faster.

- *Cell Phones:* Students cannot use their cell phone during class or exams unless specifically instructed. If you need to take an urgent call, simply leave the classroom, and return as soon as possible.

- *Activities Unrelated to Class:* Activities that are unrelated to the class are not allowed during the class. These include, but are not limited to, use of social media, news sites, online video sites, gaming, email checking and/or writing, unless explicitly asked by the instructor for the purpose of the class.

- *Absence Policy:* If you need to miss a class, notify your instructor before the class.

*A Complete Schedule Follows on the Next Page*

**COURSE SCHEDULE**
**(*Subject to Revision Depending on Progress*)**

| Week | Date | Topic | Assignments | Lecture Block | Readings |
|---|---|---|---|---|---|
| 1 | 3/21 (Tu)<br>3/23 (Th) | **Course Intro & Setup**<br>**The Math of NNs** | -- | A<br>B | Chapter 1<br>Chapter 2 |
| 2 | 3/28 (Tu)<br>3/30 (Th) | **Introduction to Keras and TensorFlow**<br>**Neural Nets for Classification & Regression** | --<br>-- | B<br>B | Chapter 3<br>Chapter 4 |
| 3 | 4/4 (Tu)<br>4/6 (Th) | **Model Tuning + Deep Dive on Keras**<br>**Mid-Point Project Check-in** | Individual Assignment Posted<br>Project Proposal Due | C | Chapters 5 & 7<br>Chapter 6 |
| 4 | 4/11 (Tu)<br>4/13 (Th) | **Intro to CNNs**<br>***No Class: Work on Project!*** | Individual Assignment Due<br>-- | D | Chapter 8<br>-- |
| 5 | 4/18 (Tu)<br>4/20 (Th) | **Advanced CNNs**<br>**Intro to RNNs** | --<br>-- | D<br>E | Chapter 9<br>Chapter 10 |
| 6 | 4/25 (Tu)<br>4/27 (Th) | **Advanced RNNs, Attention & SHAP / LIME**<br>**Final Project Presentations** | --<br>-- | F | Chapter 11<br>-- |
| 7 | 5/2 (Tu) | **Final Exam** | Final Project Deliverables Due | | |