MIT Introduction to Deep Learning

Instructors: Alexander Amini, Ava Amini, Sadhana Lolla

Program Information

Summary

MIT's introductory program on deep learning methods with applications to computer vision, natural language processing, biology, and more! Students will gain foundational knowledge of deep learning algorithms and get practical experience in building neural networks in TensorFlow. Program concludes with a project proposal competition with feedback from staff and a panel of industry sponsors.

Prerequisites

We expect basic knowledge of calculus (e.g., taking derivatives), linear algebra (e.g., matrix multiplication), and probability (e.g., Bayes theorem) -- we'll try to explain everything else along the way! Experience in Python is helpful but not necessary. This program is taught during MIT's IAP term by deep learning researchers from MIT. Listeners are welcome!

Schedule

Monday Jan 9, 2023

- Lecture: Introduction to Deep Learning and NNs
- Lecture: Deep Sequence Modeling
- Lab: Lab 1A TensorFlow and building NNs from scratch
- Lab: Lab 1B Music Generation using RNNs

Tuesday Jan 10, 2023

- Lecture: Deep Computer Vision
- Lecture: Deep Generative Modeling
- Lab: Lab 2A Image classification and detection
- Lab: Lab 2B Facial recognition systems

Wednesday Jan 11, 2023

- Lecture: Deep Reinforcement Learning
- Lecture: Uncertainty and Bias, Sadhana Lolla, ThemisAI
- Lab: Lab 3 Debiasing facial recognition systems
- *Project signup due at 11:00pm ET!*

Thursday Jan 12, 2023

- Lecture: Limitations and New Frontiers
- Lecture: Ramin Hasani, Vanguard
- Lab: Work on labs + project pitch
- *Lab competition entries due at 11:00pm ET!*
- *Project slides due at 11:00pm ET!*

Friday Jan 13, 2023

- Lecture: Daniela Rus, Director of CSAIL and Professor at MIT
- Lecture: Dilip Krishnan, Google
- Lab: Project pitch competition; awards ceremony
- *Project pitch presentations!*

Lectures

Lectures will be held starting at **2:00pm ET from Jan 9 - Jan 13 2023**, Monday through Friday. Lectures will be given live in-person, in **MIT Stata Center 32-123**. We expect all program participants to respect MIT campus rules and COVID policies.

Lectures will be recorded and uploaded to the program website after the completion of the in-person program. This public edition of the program will only be made available after completion of the MIT program.

Labs, Project Proposals, Grading, and Prizes

The program is an efficient, high-intensity bootcamp designed to teach you the fundamentals of deep learning as quickly as possible. Participants will gain practical experience in building neural networks in TensorFlow through hands-on software labs. The program concludes with a project proposal competition with feedback from program staff.

In 2023, there are no official requirements for completion of the program, and the program does not count towards MIT's credit limit. For MIT students, employees, and affiliates, there is no notion of registered listeners for 2023. We expect participants to participate actively in the program with respect to lecture attendance.

Participants in the January 2023 offering will be eligible for prizes and awards as part of the program competitions. There will be two parts to the competitions: (1) software labs and (2) project proposals. More information is provided below. **Winners will be announced on the last day of the program, with thousands of dollars of prizes being given away!**

Software Labs

There are three TensorFlow software lab exercises for the program, designed as iPython notebooks hosted in Google Colab. Software labs can be found on GitHub: https://github.com/aamini/introtodeeplearning. These are self-paced exercises and are designed to help you gain practical experience implementing neural networks in TensorFlow.

Submission of lab materials is not necessary to get credit for the program.

There will be task-associated materials to submit (along with instructions) for **entry into the competitions, open to participants during the January 2023 offering**.

These instructions are provided at the end of each of the labs. Completing these tasks and submitting your materials will enter you into a per-lab competition. **Participants in the January 2023 offering will be eligible for prizes**; at the end of the program, prize-winners will be awarded with their prizes.

All competition submissions are due on January 15 at 11:59pm ET (deadline extended from Jan 12).

- **RNN Music (Lab 1) Submission Link: upload your RNN Music materials here**
- **Debiasing Faces (Lab 2+3) Submission Link: upload your Debiasing Faces materials here**

For the software lab competitions, submissions will be judged by a panel of judges, on the basis of the following criteria:

1. Strength and quality of final results (lab dependent)
2. Soundness of implementation and approach
3. Thoroughness and quality of provided descriptions and figures

Lab + Office Hour sessions

After each day's lecture, there will be open Office Hours + Lab Sessions. Office Hours will be held in MIT 32-123, in accordance with MIT COVID practices and visitor policies. Office Hours will begin immediately after the completion of the day's lectures and will conclude at 5pm ET.

Project Proposal Presentation

Keyword: proposal

This is a 1 week bootcamp program so we do not require results or working implementations! However, to win the top prizes, nice, clear results and implementations will demonstrate feasibility of your proposal which is something we look for!

Logistics -- please read!

- **You must sign up to present before 11:00pm Eastern Time (ET) on Wednesday Jan 11, 2023. SIGN UP HERE**
- **Slides must be in a Google Slide before 11:00pm Eastern Time (ET) on Thursday Jan 12, 2023. ADD SLIDES HERE**
- **Project groups can be between 1 and 5 people**
- **Each participant will only be allowed to be in one group and present one project pitch**
- **Attendance on Jan 13, 2023 is required to make the project pitch!!!**
- **3 min presentation on your idea (we will be very strict with the time limits)**
- **Prizes! (see below)**

Sign up to Present here: by 11:00pm ET on Wednesday Jan 11 2023.

Once you sign up, make your slides in the following Google Slides; submit by 11:00pm ET on Thursday Jan 12. Please specify the project group # on your slides!!!

Things to Consider

1) This **doesn't** have to be a new deep learning method. It can just be an interesting application that you apply some existing deep learning method to.
2) What problem are you solving? Are there use cases/applications?
3) Why do you think deep learning methods might be suited to this task?
4) How have people done it before? Is it a new task? If so, what are similar tasks that people have worked on? In what aspects have they succeeded or failed?
5) What is your method of solving this problem? What type of model + architecture would you use? Why?

6) What is the data for this task? Do you need to make a dataset or is there one publicly available? What are the characteristics of the data? Is it sparse, messy, imbalanced? How would you deal with that?

Project Proposal Scoring Rubric

Project proposals will be evaluated by a panel of judges on the basis of the following three criteria: 1) novelty and impact; 2) technical soundness, feasibility, and organization, including quality of any presented results; 3) clarity and presentation. Each judge will award a score from 1 (lowest) to 5 (highest) for each of the criteria; the average score from each judge across these criteria will then be averaged with that of the other judges to provide the final score. The proposals with the highest final scores will be selected for prizes.

Here are the guidelines for the criteria:

1. **Novelty and impact**: encompasses the potential impact of the project idea, its novelty with respect to existing approaches. Why does the proposed work matter? What problem(s) does it solve? Why are these problems important?
2. **Technical soundness, feasibility, and organization**: encompasses all technical aspects of the proposal. Do the proposed methodology and architecture make sense? Is the architecture the best suited for the proposed problem? Is deep learning the best approach for the problem? How realistic is it to implement the idea? Was there any implementation of the method? If results and data are presented, we will evaluate the strength of the results/data.
3. **Clarity and presentation:** encompasses the delivery and quality of the presentation itself. Is the talk well organized? Are the slides aesthetically compelling? Is there a clear, well-delivered narrative? Are the problem and proposed method clearly presented?

Past Project Proposal Ideas

Recipe Generation with RNNs
Can we compress videos with CNN + RNN?
Music Generation with RNNs
Style Transfer Applied to X
GAN's on a new modality
Summarizing text/news articles
Combining news articles about similar events
Code or spec generation
Multimodal speech → handwriting
Generate handwriting based on keywords (i.e. cursive, slanted, neat)
Predicting stock market trends
Show language learners articles or videos at their level
Transfer of writing style
Chemical Synthesis with Recurrent Neural networks

Transfer learning to learn something in a domain for which it's hard or risky to gather data or do training
RNNs to model some type of time series data
Computer vision to coach sports players
Computer vision system for safety brakes or warnings
Use IBM Watson API to get the sentiment of your Facebook newsfeed
Deep learning webcam to give wifi-access to friends or improve video chat in some way
Domain-specific chatbot to help you perform a specific task
Detect whether a signature is fraudulent

Awards + Categories

Software Lab Awards:

- Headphones/earbuds or speaker (RNN Music Lab)
- $1000 value Gold, $750 value Silver, $500 value Bronze (Debiasing Faces Lab)

Project Proposal Awards:

- NVIDIA 3070
- Smartwatch
- HD Display Monitor

Important Links and Emails

Program website: http://introtodeeplearning.com
Program staff: introtodeeplearning-staff@mit.edu
Piazza forum (MIT only): https://piazza.com/mit/spring2023/6s191
Software lab repository: https://github.com/aamini/introtodeeplearning