Menu

11-785 **Introduction to Deep Learning**

Spring 2023

Class Streaming Link (https://cmu.zoom.us/j/98857399276?pwd=ems3MzMvMjNQYkZzdTAyWGdVRGZSUT09)

In-Person Venue: Giant Eagle Auditorium, Baker Hall (A51)

Bulletin and Active Deadlines

Assignment	Deadline	Description	Links
HW3P1	Early Submission: 25th March, 11:59 PM Final Submission: 7th April, 11:59 PM	RNNs, GRUs and Search	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw3p1)
HW3P2	Early Submission: 25th March, 11:59 PM Final Submission: 7th April, 11:59 PM	Utterance to Phoneme Mapping	Kaggle (https://www.kaggle.com/competitions/11-785-s23-hw3p2) Writeup (./document/homework/HW3/11_785_hw3p2_S23-2.pdf)
HW4P1	Early Submission: 15th Apr, 11:59 PM Final Submission: 28th Apr, 11:59 PM	Language Modeling	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw4p1backup)
HW4P2	Early Submission (Mandatory) - Canvas Quiz : 10th Apr, 11:59 PM Early Submission Bonus (Optional) - Kaggle : 15th Apr, 11:59 PM Final Submission: 28th Apr, 11:59 PM	Automatic Speech Recognition using Attention-based Seq2Seq Models	Kaggle (https://www.kaggle.com/competitions/11-785-s23-hw4p2) Writeup (./document/homework/HW4/P2/HW4P2_S23.pdf)
Project Gallery (../shared/project.html)			
Here's an example of a successful project from Fall 2020. The team developed an AI Limmerick generator, and compiled a book from the AI Poet's creations.	**Project Report, (https://drive.google.com/file/d/1BORroctAKMLcZmmnmxDZjQwPFYDA8yJ2/view) Project Video, (https://www.youtube.com/watch?v=b16xOLpG_p0&feature=youtu.be) Book (Amazon) (https://www.amazon.com/dp/B08TV36KF7)**		
This piece is performed by the Chinese Music Institute at Peking University (PKU) together with PKU's Chinese orchestra. This is an adaptation of Beethoven: Serenade in D major, Op.25 - 1. Entrata (Allegro),for Chinese transverse flute (Dizi), clarinet and flute.	0:00 / 3:58		

Menu

The Course

"Deep Learning" systems, typified by deep neural networks, are increasingly taking over all the AI tasks, ranging from language understanding, speech and image recognition, to machine translation, planning, and even game playing and autonomous driving. As a result, expertise in deep learning is fast changing from an esoteric desirable to a mandatory prerequisite in many advanced academic settings, and a large advantage in the industrial job market.

In this course we will learn about the basics of deep neural networks, and their applications to various AI tasks. By the end of the course, it is expected that students will have significant familiarity with the subject, and be able to apply Deep Learning to a variety of tasks. They will also be positioned to understand much of the current literature on the topic and extend their knowledge through further study.

If you are only interested in the lectures, you can watch them on the YouTube channel (https://www.youtube.com/channel/UC8hYZGEkI2dDO8scT8C5UQA).

Course description from student point of view

The course is well rounded in terms of concepts. It helps us understand the fundamentals of Deep Learning. The course starts off gradually with MLPs and it progresses into the more complicated concepts such as attention and sequence-to-sequence models. We get a complete hands on with PyTorch which is very important to implement Deep Learning models. As a student, you will learn the tools required for building Deep Learning models. The homeworks usually have 2 components which is Autolab and Kaggle. The Kaggle components allow us to explore multiple architectures and understand how to fine-tune and continuously improve models. The task for all the homeworks were similar and it was interesting to learn how the same task can be solved using multiple Deep Learning approaches. Overall, at the end of this course you will be confident enough to build and tune Deep Learning models.

Prerequisites

1. We will be using Numpy and PyTorch in this class, so you will need to be able to program in python3.
2. You will need familiarity with basic calculus (differentiation, chain rule), linear algebra and basic probability.

Units

Courses 11-785 and 11-685 are equivalent 12-unit graduate courses, and have a final project and HW 5 respectively. Course 11-485 is the undergraduate version worth 9 units, the only difference being that there is no final project or HW 5.

Acknowledgments (../shared/TAs.html)

Your Supporters

Instructors:

- Bhiksha Raj : bhiksha@cs.cmu.edu
- Rita Singh : rsingh@cs.cmu.edu

TAs:

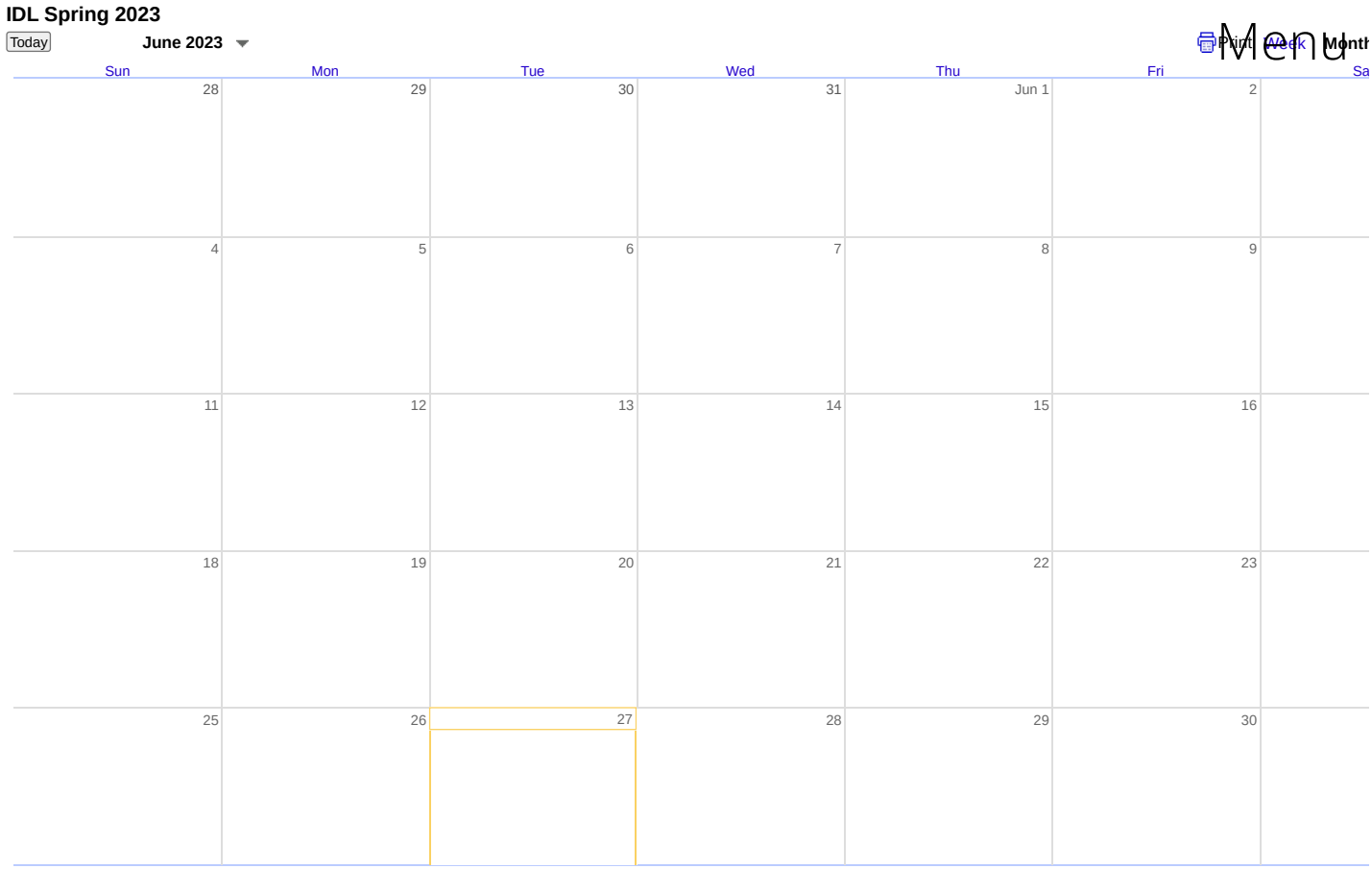
- Abuzar Khan: abuzark@andrew.cmu.edu
- Aparajith Srinivasan: aparajis@andrew.cmu.edu
- Arjun Chauhan: arjunc@andrew.cmu.edu
- Cedric Manouan: cmanoun@andrew.cmu.edu
- Eshani Agrawal: eshania@andrew.cmu.edu
- Harshith Kumar: harunkum@andrew.cmu.edu
- Joseph Konan: jkonans@andrew.cmu.edu
- Liangze "Josh" Li: liangzel@andrew.cmu.edu
- Miya Sylvester: nsylvest@andrew.cmu.edu
- Prakruthi Pradeep: prakruth@andrew.cmu.edu
- Qin Wang: qinw@andrew.cmu.edu
- Sarthak Bisht: sbisht@andrew.cmu.edu
- Shikhar Agnihotri: sagnihot@andrew.cmu.edu
- Swathi Jadav: sjadav@andrew.cmu.edu
- Varun Jain: vjain2@andrew.cmu.edu
- Vedant Bhasin: vedantb@andrew.cmu.edu
- Vishhvak Srinivasan: vishhvas@andrew.cmu.edu
- Yooni Choi: jungyoon@andrew.cmu.edu
- (SV) Ruimeng Chang: ruimengc@andrew.cmu.edu
- (Kigali) Yonas Chanie: ychanie@andrew.cmu.edu
- (Kigali) Paul Ewuzie: pewuzie@andrew.cmu.edu

Pittsburgh Schedule (Eastern Time)

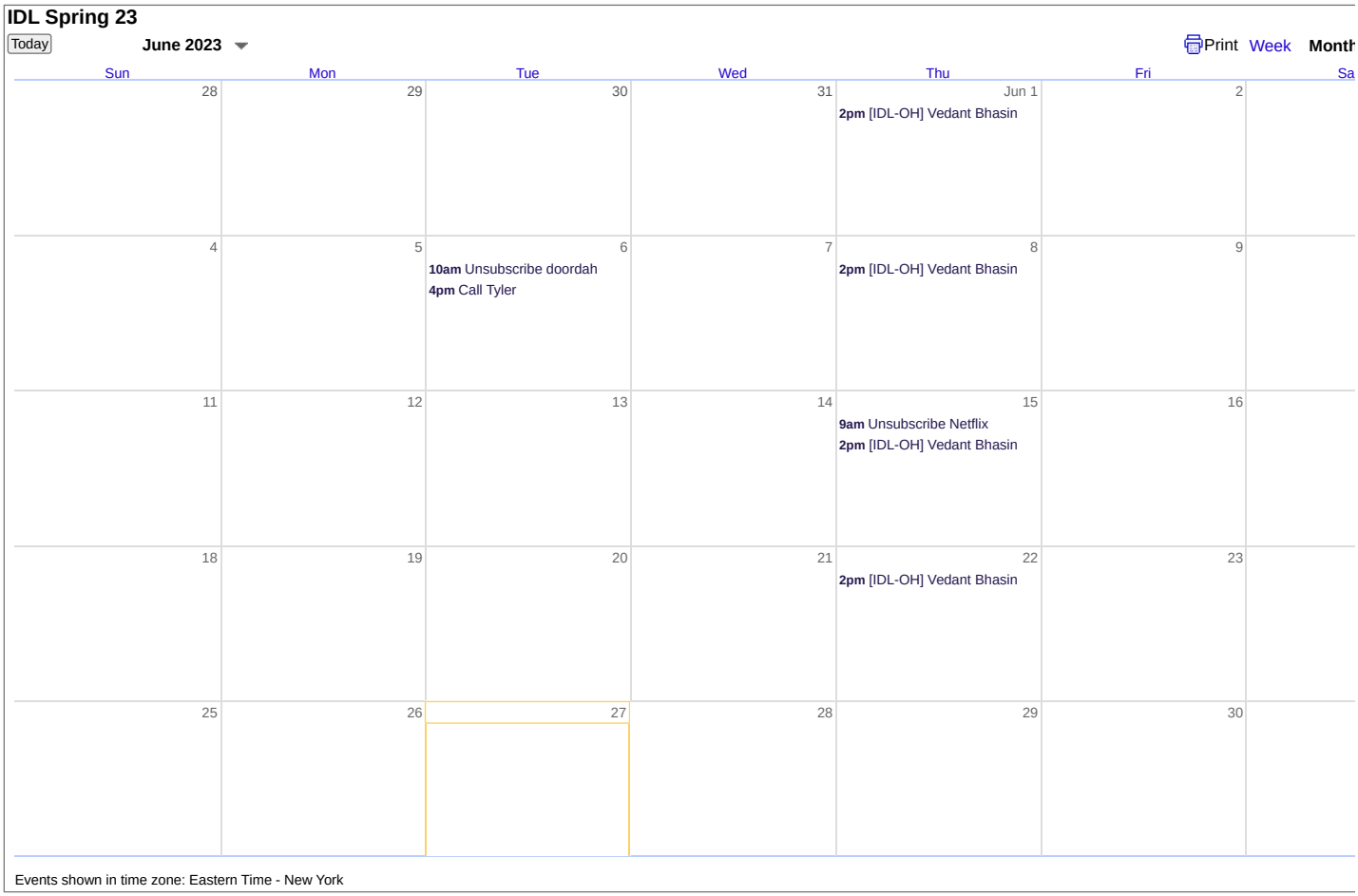
Lecture: Tuesday and Thursday, 12:30 p.m. - 1:50 p.m. - Good times :')

Recitation: Friday, 12:30 p.m. - 1:50 p.m.

Event Calendar: The Google Calendar below ideally contains all events and deadlines for student's convenience. Please feel free to add this calendar to your Google Calendar by clicking on the plus (+) button on the bottom right corner of the calendar below. Any adhoc changes to the schedule will be visible on the calendar first.



OH Calendar: The Google Calendar below contains the schedule for Office Hours. Please feel free to add this calendar to your Google Calendar by clicking on the plus (+) button on the bottom right corner of the calendar below. Any adhoc changes to the schedule, including extra OH, will be visible on the calendar first.



Office hours: This is the schedule for this semester. We will be using OHQueue (https://ohq.eberly.cmu.edu/#/ca)(11-785) for both zoom and in-person Office hours. Please refer the OH calendar/ Piazza for updated information on OH hours.

Menu

Day	Time (Eastern Time)	TA	Zoom/In Person
Monday	9:00AM to 10:00AM	Prakruthi Pradeep	Zoom
	11:00AM to 12:00PM	Arjun Chauhan	In-person
	2:00PM to 3:00PM	Eshani Agrawal	In-person
	8:00PM to 9:00PM	Swathi Jadav	Zoom
Tuesday	8:00AM to 9:00AM	Yooni Choi	Zoom (https://cmu.zoom.us/my/yoonichoi)
	9:30AM to 10:30AM	Liangze "Josh" Li	Zoom
	10:30AM to 11:30AM	Yonas Charlie	Zoom (https://cmu.zoom.us/my/yonas)
	3:00PM to 4:00PM	Qin Wang	In-person
	4:00PM to 6:00PM	Vish	In-person
	6:00PM to 7:00PM	Harshith Arun Kumar	In-person
Wednesday	8:00AM to 9:00AM	Yooni Choi	Zoom (https://cmu.zoom.us/my/yoonichoi)
	9:00AM to 10:00AM	Prakruthi Pradeep	Zoom
	11:00AM to 12:00PM	Arjun Chauhan	In-person
	12:00PM to 1:00PM	Abu	In-person
	2:00PM to 3:00PM	Eshani Agrawal	In-person
	6:30 PM to 7:30 PM	Swathi Jadav	In-person
Thursday	9:30AM to 10:30AM	Liangze "Josh" Li	Zoom
	11:00AM to 12:00PM	Abu	In-person
	2:00PM to 3:00PM	Vedant Bhasin	In-person
	3:00PM to 5:00PM	Varun Jain	Zoom (https://cmu.zoom.us/j/6293775343)
	6:00PM to 7:00PM	Harshith Arun Kumar	In-person
Friday	10:30AM to 11:30AM	Yonas Charlie	Zoom (https://cmu.zoom.us/my/yonas)
	11:30AM to 12:30PM	Paul Ewuzie	Zoom (https://cmu.zoom.us/j/9486705609)
	2:00PM to 3:00PM	Vedant Bhasin	In-person
	5:00PM to 7:00PM	Sarthak Bisht	In-person
Saturday	9:00AM to 10:00AM	Paul Ewuzie	Zoom (https://cmu.zoom.us/j/9486705609)
	10:00AM to 11:00AM	Shikhar Agnihotri	Zoom (https://cmu.zoom.us/my/shikhar)
	6:00PM to 7:00PM	Ruimeng Chang	Zoom (https://cmu.zoom.us/j/9952452727)
Sunday	9:00AM to 11:00AM	Shikhar Agnihotri	In-person
	12:00PM to 1:00PM	Ruimeng Chang	Zoom (https://cmu.zoom.us/j/9952452727)
	1:00PM to 2:00PM	Qin Wang	In-person
	6:00PM to 8:00PM	Aparajith Srinivasan	Zoom (https://cmu.zoom.us/j/96859426301?pwd=czJTRWlSb3p1QkZsWFFsT3N3S0pKZz09)

Homework Hackathon: During 'Homework Hackathons', students will be assisted with homework by the course staff. It is recommended to come as study groups.
Location: BH A36/A136
Time: Saturday 2-5 PM EST

Course Work

	Policy
Breakdown	

Grading will be based on weekly quizzes (24%), homeworks (50%) and a course project (25%). Note that 1% of your grade is assigned to Attendance.

Menu

Quizzes

There will be weekly quizzes.

- We will retain your best 12 out of the remaining 14 quizzes.
- Quizzes will generally (but not always) be released on Friday and due 48 hours later.
- Quizzes are scored by the number of correct answers.
- Quizzes will be worth 24% of your overall score.

Assignments

There will be five assignments in all. Assignments will include *autolab* components, where you must complete designated tasks, and a *kaggle* component where you compete with your colleagues.

- Autolab components are scored according to the number of correctly completed parts.
- We will post performance cutoffs for HIGH (90%), MEDIUM (70%), LOW (50%), and VERY LOW (30%) for Kaggle competitions. Scores will be interpolated linearly between these cutoffs.
- Assignments will have a "preliminary submission deadline", an "on-time submission deadline" and a "late-submission deadline."
  - Early submission deadline: You are required to make at least one submission to Kaggle by this deadline. People who miss this deadline will automatically lose 10% of subsequent marks they may get on the homework. This is intended to encourage students to begin working on their assignments early.
  - On-time deadline: People who submit by this deadline are eligible for up to five bonus points. These points will be computed by interpolation between the A cutoff and the highest performance obtained for the HW. The highest performance will get 105.
  - Late deadline: People who submit after the on-time deadline can still submit until the late deadline. There is a 10% penalty applied to your final score, for submitting late.
  - Slack days: Everyone gets up to 10 slack days, which they can distribute across all their homework P2s only. Once you use up your slack days you will fall into the late-submission category by default. Slack days are accumulated over *all* parts of *all* homeworks, except HW0, to which no slack applies.
  - Kaggle scoring: We will use *max(max(on-time score), max(slack-day score), .0.9*max(late-submission score))* as your final score for the HW. If this happens to be a slack-days submission, slack days corresponding to the selected submission will be counted.
- Assignments carry 50% of your total score. HW0 is not graded (but is mandatory), while each of the subsequent four are worth 12.5%.
- A fifth HW, HW5, will be released later in the course and will have the same weight as a course project. Please see Project section below for more details.

Project

- All students taking a graduate version of the course are required to do a course project. The project is worth 25% of your grade. These points are distributed as follows: 20% - Midterm Report; 35% - Project Video; 5% - Responding to comments on Piazza; 40% - Project report.
- Note that a Project is mandatory for 11-785/18-786 students. In the event of a catastrophe (remember Spring 2020), the Project may be substituted with HW5. 11-685 Students may choose to do a Project instead of HW5. Either your Project OR HW5 will be graded.

Attendance

- If you are in section A you are expected to attend in-person lectures. We will track attendance.
- If you are in any of the other (out-of-timezone) sections, you must watch lectures live on zoom. Real-time viewing is mandatory unless you are in inconvenient time zones. Others are required to obtain specific permission to watch the pre-recorded lectures (on MediaServices).
- If viewed on MediaServices, the lectures of each week must be viewed before 8AM of the Monday following the following week (Otherwise, it doesn't count)

- At the end of the semester, we will select a random subset of 50% of the lectures and tabulate attendance
- If you have attended at least 70% of these (randomly chosen) lectures, you get the attendance point

Final grade

The end-of-term grade is curved. Your overall grade will depend on your performance relative to your classmates.

Pass/Fail

Students registered for pass/fail must complete all quizzes, HWs and if they are in the graduate course, the project. A grade equivalent to B- is required to pass the course.

Auditing

Auditors are not required to complete the course project, but must complete all quizzes and homeworks. We encourage doing a course project regardless.

End Policy

Study groups

This semester we will be implementing study groups. It is highly recommended that you join a study group; Check piazza for further updates.

Piazza: Discussion Board

Piazza is what we use for discussions. You should be automatically signed up if you're enrolled at the start of the semester. If not, please sign up TBA. Also, please follow the Piazza Etiquette (etiquette.html) when you use the piazza.

AutoLab: Software Engineering

AutoLab is what we use to test your understand of low-level concepts, such as engineering your own libraries, implementing important algorithms, and developing optimization methods from scratch.

Menu

Kaggle: Data Science

Kaggle (https://kaggle.com/) is where we test your understanding and ability to extend neural network architectures discussed in lecture. Similar to how AutoLab shows scores, Kaggle also shows scores, so don't feel intimidated -- we're here to help. We work on hot AI topics, like speech recognition, face recognition, and neural machine translation.

MediaServices/YouTube: Lecture and Reciation Recordings

CMU students who are not in the live lectures should watch the uploaded lectures at **MediaServices (https://mediaservices.cmu.edu/channel/11785%2BIntroduction%2Bto%2BDeep%2BLearning%2B%2528Spring%2B2023%2529)** in order to get attendance credit. Links to individual videos will be posted as they are uploaded.

Our YouTube Channel (https://www.youtube.com/channel/UC8hYZGEkI2dDO8scT8C5UQA) is where non-CMU folks can view all lecture and recitation recordings. Videos marked "Old" are not current, so please be aware of the video title.

Books and Other Resources

The course will not follow a specific book, but will draw from a number of sources. We list relevant books at the end of this page. We will also put up links to relevant reading material for each class. Students are expected to familiarize themselves with the material before the class. The readings will sometimes be arcane and difficult to understand; if so, do not worry, we will present simpler explanations in class.

You can also find a nice catalog of models that are current in the literature here (http://www.datasciencecentral.com/profiles/blogs/concise-visual-summary-of-deep-learning-architectures). We expect that you will be in a position to interpret, if not fully understand many of the architectures on the wiki and the catalog by the end of the course.

Academic Integrity

You are expected to comply with the University Policy on Academic Integrity and Plagiarism (https://www.cmu.edu/policies/student-and-student-life/academic-integrity.html).

- You are allowed to talk with and work with other students on homework assignments.
- You can share ideas but not code. You should submit your own code.

Your course instructor reserves the right to determine an appropriate penalty based on the violation of academic dishonesty that occurs. Violations of the university policy can result in severe penalties including failing this course and possible expulsion from Carnegie Mellon University. If you have any questions about this policy and any work you are doing in the course, please feel free to contact your instructor for help.

Class Notes

A book containing class notes is being developed in tandem with this course; check it out (http://mlsp.cs.cmu.edu/people/rsingh/IDLbook.html).

Schedule of Lectures

You can watch the recorded lectures on MediaServices (https://mediaservices.cmu.edu/channel/11785%2BIntroduction%2Bto%2BDeep%2BLearning%2B%2528Spring%2B2023%2529).

Lecture	Date	Topics	Slides and Video	Additional Materials
0	-	• Course Logistics • Learning Objectives • Grading • Deadlines	Slides (*.pdf) (./document/slides/lec0.logistics.pdf) Video (YT) (https://youtu.be/IMXmJoD0jjw)	
1	Tuesday, 17 Jan	• Introduction	Slides (*.pdf) (./document/slides/lec1.intro.pdf) Video (YT) (https://youtu.be/Q3qCfSiRmQY)	The New Connectionism (1988) (docume On Alan Turing's Anticipation of Connect McCullogh and Pitts paper (https://www Rosenblatt: The perceptron (document/ Bain: Mind and body (document/reading Hebb: The Organization Of Behaviour (https://pure.mpg.de/pubman/item/item
2	Thursday, 19 Jan	• Neural Nets As Universal Approximators	Slides (*.pdf) (./document/slides/lec2.universal.pdf) Video (YT) (https://youtu.be/RnFpV1W3_XY) (F22 in-person lecture link)	Shannon (1949) (document/readings/Sh Boolean Circuits (document/readings/bc On the Bias-Variance Tradeoff (https://w

Menu

Lecture	Date	Topics	Slides and Video	Additional Materials
3	Tuesday, 24 Jan	• The problem of learning, Empirical Risk Minimization	Slides (*.pdf) (./document/slides/lec3.learning.pdf)Video (YT) (https://youtu.be/RpH6DsN7ZZM)	Widrow and Lehr (1992) (document/rea Adaline and Madaline (document/readir Convergence of perceptron algorithm (h Threshold Logic (https://www.tutorialspo TC (Complexity) (https://en.wikipedia.org AC (Complexity) (https://en.wikipedia.org
4	Thursday, 26 Jan	• Empirical risk minimization and gradient descent • Training the network: Setting up the problem	Slides (*.pdf) (./document/slides/lec4.learning.pdf) Video (YT) (https://youtu.be/adS_Dv2pOqo)	Werbos (1990) (http://axon.cs.byu.edu/D Rumelhart, Hinton and Williams (1986) (
5	Tuesday, 31 Jan	• Backpropagation • Calculus of Backpropagation	Slides (*.pdf) (./document/slides/lec5.learning.pdf) Video (YT) (https://youtu.be/N2CUiCwwcyU)	Werbos (1990) (http://axon.cs.byu.edu/D Rumelhart, Hinton and Williams (1986) (
5.5	Wednesday, 1 Feb	• Backpropagation (Extra Lecture) • Calculus of Backpropagation	Video (YT) Extra Lecture (https://www.youtube.com/watch?v=_YWxXj4G0Sk&list=PLp-0K3kfddPwgBSCbDtT6NaVOd-gIHVMW&index=6&t=31s)	
6	Thursday, 2 Feb	• Convergence issues • Loss Surfaces • Momentum	Slides (*.pdf) (./document/slides/lec6.pdf) Video (YT) (https://youtu.be/N-rAA7SvyF0)	Backprop fails to separate, where perce Why Momentum Really Works (https://d
7	Tuesday, 7 Feb	• Optimization • Batch Size, SGD, Mini-batch, second-order methods	Slides (*.pdf) (./document/slides/lec7.stochastic_gradient.pdf) Video (YT) (https://youtu.be/2VpMupDorqk)	Momentum, Polyak (1964) (https://www. Nestorov (1983) (http://www.mathnet.ru Derivatives and Influences (document/re

8	Thursday, 9 Feb	• Optimizers and Regularizers
		  ◦ Choosing a divergence (loss) function
		  ◦ Batch normalization
		  ◦ Dropout
			Slides (*.pdf) (./document/slides/lec8.optimizersandregularizers.pdf)Video (YT) (https://www.youtube.com/watch?v=XAq0X-qYwKY)	Derivatives and Influence Diagrams (./dc
				ADAGRAD, Duchi, Hazan and Singer (20
				Adam: A method for stochastic optimiza

9	Tuesday, 14 Feb	• Shift invariance and Convolutional Neural Networks	Slides (*.pdf) (./document/slides/lec9.CNN1.pdf) Video (YT) (https://youtu.be/gKVfy8sAX5s)	
10	Thursday, 16 Feb	• Models of vision, Convolutional Neural Networks	Slides (*.pdf) (./document/slides/lec10.CNN2.pdf) Video (YT) (https://youtu.be/vAVtALDVmUc)	
11	Tuesday, 21 Feb	• Learning in Convolutional Neural Networks	Slides (*.pdf) (./document/slides/lec11.CNN3.pdf) Video (YT) (https://youtu.be/sjQe3X4BM8Q)	CNN Explainer (https://poloclub.github.i
12	Thursday, 23 Feb	• Learning in CNNs • Transpose Convolution • CNN Stories	Slides (*.pdf) (./document/slides/lec12.CNN4.pdf) Video (YT) (https://youtu.be/5omQcU8vHhM)	
13	Tuesday, 28 Feb	• Time Series and Recurrent Networks	Slides (*.pdf) (./document/slides/lec13.recurrent.pdf) Video (YT) (https://youtu.be/75skj-hdsV8)	Fahlman and Lebiere (1990) (https://pap How to compute a derivative, extra help
14	Thursday, 2 Mar	• Stability and Memory, LSTMs	Slides (*.pdf) (./document/slides/lec14.recurrent.pdf) Video (YT) (https://youtu.be/Be6NjkwTA-g)	Bidirectional Recurrent Neural Networks

Menu

Lecture	Date	Topics	Slides and Video	Additional Materials
-	Tuesday, 7 Mar	• No Class - Spring Break	-	
-	Thursday, 9 Mar	• No Class - Spring Break	-	
15	Tuesday, 14 Mar	• Sequence Prediction • Alignments and Decoding	Slides (*.pdf) (./document/slides/lec15.recurrent.pdf) Video (YT) (https://youtu.be/tLfOD883haM)	LSTM (document/readings/LSTM.pdf)
16	Thursday, 16 Mar	• Sequence prediction • Connectionist Temporal Classification (CTC) - Blanks and Beam-search	Slides (*.pdf) (./document/slides/lec16.recurrent.pdf) Video (YT) (https://youtu.be/xwdBvlpZvXU)	
17	Tuesday, 21 Mar	• Language Models • Sequence To Sequence Prediction	Slides (*.pdf) (./document/slides/lec17.recurrent.pdf) Slides (*.pdf) (./document/slides/lec17.recurrent.pdf) Video (YT) (https://youtu.be/mXPSlqmg5x4)	Labelling Unsegmented Sequence Data
18	Thursday, 23 Mar	• Sequence To Sequence Methods • Attention	Slides (*.pdf) (./document/slides/lec18.attention.pdf) Video (YT) (https://youtu.be/XuFIj2Giey4)	Attention Is All You Need (https://arxiv.o The Annotated Transformer - Attention (http://nlp.seas.harvard.edu/annotated-t
19	Tuesday, 28 Mar	• Transformers and GNNs	Slides (*.pdf) (./document/slides/lec19.transformer_GNN.pdf) Video (YT) (https://youtu.be/hPPg1jLj57M)	A comprehensive Survey on Graph Neur
20	Thursday, 30 Mar	• Learning Representations • AutoEncoders	Slides (*.pdf) (./document/slides/lec20.representations.pdf) Video (YT) (https://youtu.be/TkergiVs_5Y)	
21	Tuesday, 4 Apr	• Variational Auto Encoders	Slides (*.pdf) (./document/slides/lec21.VAE_1.pdf) Video (YT) (https://youtu.be/YmUwDxnCoMs)	Tutorial on VAEs (Doersch) (https://arxiv Autoencoding variational Bayes (Kingma
22	Thursday, 6 Apr	• Variational Auto Encoders II	Slides (*.pdf) (./document/slides/lec21.VAE_2.pdf) Video (YT) (https://youtu.be/uXk0DzZlwMQ)	
23	Tuesday, 11 Apr	• Generative Adversarial Networks, 1	Slides (*.pdf) (./document/slides/lec23.GAN1.pdf)	
-	Thursday, 13 Apr	• No Class - Spring Carnival	-	-
24	Tuesday, 18 Apr	• Generative Adversarial Networks, 2	TBA	
25	Thursday, 20 Apr	• Hopfield Nets and Auto Associators	TBA	
26	Tuesday, 25 Apr	• Hopfield Nets and Boltzmann Machines	TBA	
27	Thursday, 27 Apr	• Boltzmann Machines	TBA	

Schedule of Recitations

Menu

Recitation	Date	Topics	Materials
0A	Friday, 13th Jan	Python & OOP Fundamentals	Notebook (*.zip) (./document/recitation/Recitation0/Recitation0a.zip)
0B	Friday, 13th Jan	Fundamentals of NumPy	Notebook (*.zip) (./document/recitation/Recitation0/Recitation0b.zip)
0C	Friday, 13th Jan	PyTorch Tensor Fundamentals	Notebook + Slides + Cheatsheet (*.zip) (./document/recitation/Recitation0/Recitation0c.zip)
0D	Friday, 13th Jan	Dataset & DataLoaders	Notebook + Slides (*.zip) (./document/recitation/Recitation0/Recitation0d.zip)
0E	Friday, 13th Jan	Introduction to Google Colab	Notebook (*.zip) (./document/recitation/Recitation0/Recitation0e.zip)
0F	Friday, 13th Jan	AWS Fundamentals	Slides (*.zip) (./document/recitation/Recitation0/Recitation0f.zip)
0G	Friday, 13th Jan	Debugging, Monitoring	Notebook + Slides (*.zip) (./document/recitation/Recitation0/Recitation0g.zip)
0H	Friday, 13th Jan	Basics of Git	Colab Notebook (https://colab.research.google.com/drive/15mk3OTEx14CuJmdwc_PqBh4RQjiLQLxU?usp=sharing)
0I	Friday, 13th Jan	Wandb	
0J	Friday, 13th Jan	What to do if you're struggling	Slides (*.zip) (./document/recitation/Recitation0/Recitation0i.zip)
0K	Friday, 13th Jan	Data Preprocessing	Notebook + Slides (*.zip) (./document/recitation/Recitation0/Recitation0j.zip)
0L	Friday, 13th Jan	Google Cloud	
0M	Friday, 13th Jan	Workflow of a Deeplearning Homework	Notebook + Slides (*.zip) (./document/recitation/Recitation0/Recitation0l.zip)
1	Friday, 20th Jan	Your first MLP Code	Slides (*.pdf) (./document/recitation/Recitation1/Your First MLP - S23.pdf), Notebook 1a (https://colab.research.google.com/drive/1gSjoUsmPxRjH3bzEkkmCZYYhPG_M_rMp?authuser=1#scrollTo=DsNhXR25mCmq), Notebook 1b (https://colab.research.google.com/drive/1h5gWHIFups_ZV0FEhYJj0J-e7uZ1jYip#scrollTo=gwz0u5NKn1n6), Notebook 1c (https://colab.research.google.com/drive/1kAOgTsIOoizTMXZDh3xVL2_8FN5UZx8X#scrollTo=ZgDp_Mm7xOV
2	Friday, 27th Jan	Network Optimization, Hyperparameter Tuning	Slides (*.pdf) (./document/recitation/Recitation2/11785-NetworkOptimization-Spring23.pdf)
HW1 Bootcamp	Saturday, 28th Jan	How to get started with HW1	Slides (*.zip) (./document/bootcamp/S23_Bootcamp 1_HW1P2.pdf)
3	Friday, 3rd Feb	Computing Derivatives & Autograd	Slides (*.pdf) (./document/recitation/Recitation3/s23_Recitation_3_AutoDiff__Backprop.pdf) Notebook (*.ipynb) (./document/recitation/Recitation3/s23_Simple_Grad.ipynb)
HW1 Hackathon	Saturday, 4th Feb	Tips with HW1	Slides (*.zip) (./document/bootcamp/s23_hw1_hackathon.pdf)

Menu

Recitation	Date	Topics	Materials
4	Friday, 10th Feb	Paper Writing Workshop	Slides (*.pdf) (./document/recitation/Recitation4/Paper_Writing_Workshop.pdf)
HW1 Hackathon	Saturday, 11th Feb	Tips with HW1P2	Slides (*.zip) (./document/bootcamp/s23_hw1_hackathon2.pdf)
5	Friday, 17th Feb	CNN: Basics & Backprop	Slides (*.pdf) (./document/recitation/Recitation5/S23_IDL_ Recitation 5.pdf) Colab Notebook (https://colab.research.google.com/drive/1US-Bi-INfSkM-wW3Vxxvty7Q04j__Hvc?authuser=1#scrollTo=utWAViW7LA_A)
6	Friday, 24th Feb	CNNs: Classification & Verification	Slides(*.pdf) (./document/recitation/Recitation6/IDL S'23 Recitation 6_CNN Classification.pdf)
HW2 Bootcamp	Saturday, 25th Feb	How to get started with HW2	Resources (*.zip) (./document/bootcamp/hw2_bootcamp.zip)
7	Friday, 3rd Mar	CNNs: Verification, Code	Slides (*.pdf) (./document/recitation/Recitation7/IDL_S23_Recitation_7_CNN_Verification.pdf)
8	Friday, 10th Mar	RNN Basics (Pre-recorded)	Slides (*.pdf) (./document/recitation/Recitation8/IDL_S23_Recitation_8__RNN_Basics.pdf) Code (*.ipynb) (./document/recitation/Recitation8/language_model-2.ipynb)
9	Friday, 17th Mar	CTC, Beam Search	CTC Slides (*.pdf) (./document/recitation/Recitation9/Recitation 9 (CTC Decoding and Beam Search).pdf) Beam-search Slides (*.pdf) (https://drive.google.com/file/d/1jW32YLlOeh3cFC04siYiD8W4y1iBbH-p/view?usp=sharing)
HW3 Bootcamp	Saturday, 18th Mar	How to get started with HW3	HW3P1 Slides (*.pdf) (./document/bootcamp/hw3p1_bootcamp_s23.pdf) HW3P2 Slides (*.pdf) (./document/bootcamp/hw3p2_bootcamp_s23.pdf)
10	Friday, 24th Mar	Attention, MT, LAS	Slides (./document/recitation/Recitation10/Recitation_10_s23.pdf)
11	Friday, 31st Mar	Transformers	Slides (./document/recitation/recitation11/IDL_recitation_transformers.pdf) Colab Notebook (https://colab.research.google.com/drive/1NXKxOXk80fiXNaWRYoVNGDDhf-CekAbC?usp=sharing)
12	Friday, 7th Apr	Graph Neural Networks	Slides (*.ipynb) (./document/recitation/Recitation12/recitation12-slides.pdf)
HW4 Bootcamp	Wednesday, 12th Apr	How to get started with HW4	
13	Friday, 21st Apr	Autoencoders and VAEs	
14	Friday, 28th Apr	Deep Reinforcement Learning	
HW5 Bootcamp		GANs and How to get started with HW5	

Assignments

∑ Ongoing, ∏ Upcoming

Assignment	Release Date (EST)	Due Date (EST)	Related Materials / Links Menu
HW0P1	Friday, 13th Jan, 11:59 PM	Final: 30th Jan, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw0p1), Handout (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw0p1/attachments/4322) (see recitation 0s)
HW0P2	Friday, 13th Jan, 11:59 PM	Final: 30th Jan, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw0p2), Handout (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw0p2/attachments/4313) (see recitation 0s)
HW1P1	Sunday, 22nd Jan, 11:59 PM	Early Submission: 11th Feb, 11:59 PM Final: 17th Feb, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw1p1), Writeup (pdf) (./document/homework/HW1/HW1P1_S23.pdf), Handout (.tar) (./document/homework/HW1/hw1p1_handout.tar)
HW1P2	Sunday, 22nd Jan, 11:59 PM	Early Submission: 11th Feb, 11:59 PM Final: 17th Feb, 11:59 PM	Kaggle (https://www.kaggle.com/competitions/11-785-s23-hw1p2), Writeup (pdf) (./document/homework/HW1/HW1P2_S23.pdf), Starter Notebook (https://colab.research.google.com/drive/1KPvkpxELmLfjxBHrwOg1CApQW2t8Hv3c?usp=sharing8), MCQ (https://canvas.cmu.edu/courses/32813/quizzes/98455)
HW1 Bonus	Sunday, 22nd Jan, 12:00 AM	Friday, 10th Mar, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw1p1bonus)
HW1 Autograd	Sunday, 22nd Jan, 12:00 AM	Wednesday, 3rd May, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw1p1bonusautograd), Writeup (pdf) (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw1p1bonusautograd/attachments/4347), Handout (.tar) (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw1p1bonusautograd/attachments/4362)
Project Proposal	Monday, 27th Feb, 11:59 PM		
HW5	Monday, 20th Feb, 11:59 PM	Thursday, 27th Apr, 11:59 PM EST	
HW2P1	Friday, 17th Feb, 11:59 PM	Early Submission: 4th Mar, 11:59 PM Final: 17th Mar, 11:59 PM	Writeup (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw2p1/attachments/4379), Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw2p1)
HW2P2	Friday, 17th Feb, 11:59 PM	Early Submission: 4th Mar, 11:59 PM Final: 17th Mar, 11:59 PM	Face Classification: Kaggle, (http://www.kaggle.com/c/11-785-s23-hw2p2-classification) Face Verification: Kaggle, (https://www.kaggle.com/c/11-785-s23-hw2p2-verification) Writeup (*.pdf), (./document/homework/HW2/11_785_HW2P2_S23_v2.pdf) Starter Notebook (./document/homework/HW2/HW2P2_Starter_S23.ipynb)
HW2 Bonus	Friday, 17th Feb, 11:59 PM	Friday, 31st March, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw2p1bonus),
HW2 Autograd	Friday, 5th March, 11:59 PM	Wednesday, 28th April, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/autogradcnn)
Project Midterm Report	-	Friday, 31st March, 11:59 PM	

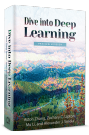
Assignment	Release Date (EST)	Due Date (EST)	Related Materials / Links
HW3P1	Friday, 10th Mar, 11:59 PM	Early Submission: 26th Mar, 11:59 PM Final: 7th Apr, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw3p1), Writeup (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw3p1/attachments/4418)
HW3P2	Friday, 17th Mar, 11:59 PM	Early Submission: 26th Mar, 11:59 PM Final: 7th Apr, 11:59 PM	Kaggle (https://www.kaggle.com/competitions/11-785-s23-hw3p2), Canvas Quiz (https://canvas.cmu.edu/courses/32813/quizzes/98457), Writeup (*.pdf) (./document/homework/HW3/11_785_hw3p2_S23-2.pdf)
HW2 Autograd	Friday, 5th Mar, 11:59 PM	Wednesday, 28th April, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/autogradcnn)
HW4P1	Friday, 31st Mar, 11:59 PM	Early Submission Bonus: 15th Apr, 11:59 PM Final: 28th Apr, 11:59 PM	Autolab (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw4p1backup), Writeup (*.pdf) (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw4p1backup/attachments/4434), Handout (*.zip) (https://autolab.andrew.cmu.edu/courses/11785-s23/assessments/hw4p1backup/attachments/4437)
HW4P2	Friday, 4th Apr, 11:59 PM	Early Submission Canvas Quiz (Mandatory): 10th Apr, 11:59PM Kaggle Cutoff Bonus (Optional): 15th Apr, 11:59 PM Final: 28th Apr, 11:59 PM	Kaggle (https://www.kaggle.com/competitions/11-785-s23-hw4p2), Writeup(*pdf) (./document/homework/HW4/P2/HW4P2_S23.pdf)
HW5	Friday, 1st Apr, 11:59 PM	Early: 18th Apr, 11:59 PM Final: 1st May, 11:59 PM	Kaggle (https://www.kaggle.com/competitions/11-685-s23-hw5/), Writeup(*pdf) (https://piazza.com/class_profile/get_resource/lbz3z9om43h2n3/lfyyrmqplki7ll), Handout (https://piazza.com/class_profile/get_resource/lbz3z9om43h2n3/lfyys8tlz2kot)
Final Project Video Presentation & Preiliminary Project Report	-	27th Apr, 11:59 PM	
Project Peer reviews			-
Final Project Report Submission	-	3rd May, 11:59 PM	

Menu

Documentation and Tools

Textbooks

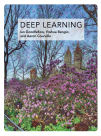
This is a selection of optional textbooks you may find useful



Dive Into Deep Learning (http://d2l.ai)
By Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola
PDF, 2020

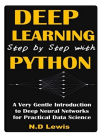
Deep Learning (https://www.deeplearningbook.org/)
By Ian Goodfellow, Yoshua Bengio, Aaron Courville

Menu



Online book, 2017

Neural Networks and Deep Learning (http://neuralnetworksanddeeplearning.com/)
By Michael Nielsen
Online book, 2016



Deep Learning Step by Step with Python: A Very Gentle Introduction to Deep Neural Networks for Practical Data Science (https://www.amazon.com/Deep-Learning-Step-Python-Introduction/dp/1535410264)
By N. D. Lewis

Parallel Distributed Processing, Volume 1 (https://mitpress.mit.edu/books/parallel-distributed-processing-volume-1)
By Rumelhart and McClelland

Parallel Distributed Processing, Volume 2 (https://mitpress.mit.edu/books/parallel-distributed-processing-volume-2)
By Rumelhart and McClelland