Introduction to Deep Learning

0. Logistics

Fall 2022

Outline

- Introduction
- Objective and syllabus
- Course logistics
- Homeworks, quizzes, projects, grading, oh my!
- Prop, teamwork and mentoring
  - And cheating…
- Challenges

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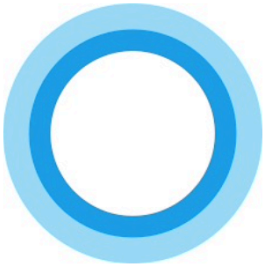
Neural Networks are taking over!

- Neural Networks have become one of the major thrust areas recently in various pattern recognition, prediction, and analysis problems
- Established state-of-the-art in many problems, often exceeding the previous benchmarks by large margins

Breakthrough with Neural Networks

- Audio and speech recognition: Siri, Alexa, Google Home, Cortana



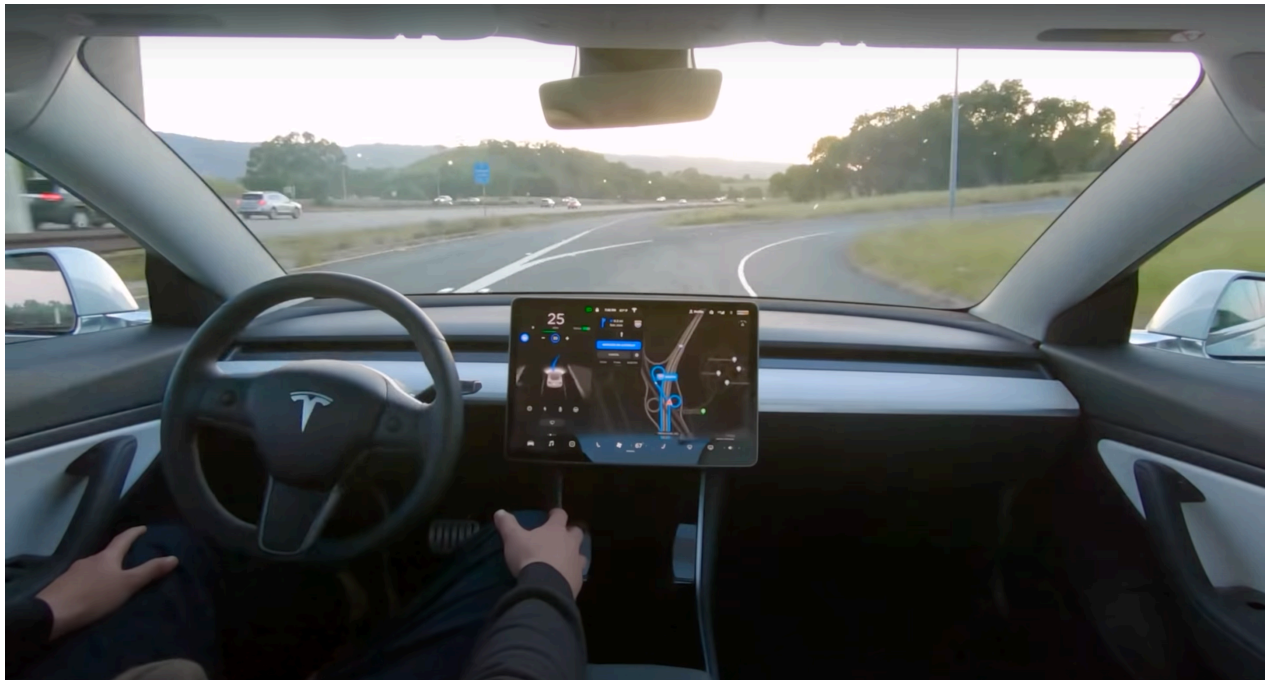
Breakthrough with Neural Networks

- Object Detection: Detectron2

https://github.com/facebookresearch/detectron2

Breakthrough with Neural Networks

- Self driving cars



https://youtu.be/tlThdr3O5Qo

Breakthrough with Neural Networks

- Music Generation: Jukebox

https://openai.com/blog/jukebox/

Breakthrough with Neural Networks

- DALL-E: Text to Image generator

https://huggingface.co/spaces/dalle-mini/dalle-mini

Input: guy standing on a flying car

Successes with Neural Networks

- And a variety of other problems:
  - From art to astronomy to healthcare...
  - and even predicting stock markets!

Neural Networks and the Job Market

This guy didn't know about neural networks (a.k.a deep learning)

This guy learned about neural networks (a.k.a deep learning)

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Course Objectives: High Level

- Understanding neural networks
- Comprehending the models that do the previously mentioned tasks
  - And maybe build them
- Familiarity with some of the terminology
  - What are these:
    - http://www.datasciencecentral.com/profiles/blogs/concise-visual-summary-of-deep-learning-architectures
- Fearlessly design, build and train networks for various tasks
- *You will not become an expert in one course*

Course Objectives: Mid Level

- Concepts
  - Some historical perspective
  - Types of neural networks and underlying ideas
  - Learning in neural networks
    - Training, concepts, practical issues
  - Architectures and applications
  - Will try to maintain balance between squiggles and concepts (concept >> squiggle)
- Practical
  - Familiarity with training
  - Implement various neural network architectures
  - Implement state-of-art solutions for some problems
- Overall: Set you up for further research/work in your research area

Course Objectives: Topics

- Basic network formalisms:
  - Multilayer Perceptrons
  - Convolutional Neural Networks
  - Recurrent Neural Networks
  - Boltzmann Machines
- Some advanced formalisms
  - Generative models: VAEs
  - Adversarial models: GANs
  - Graph Neural Networks
- Topics we will touch upon:
  - Computer vision: recognizing images
  - Text processing: modelling and generating language
  - Machine translation: Sequence to sequence modelling
  - Modelling distributions and generating data
  - Speech recognition
  - Wish list: Reinforcement learning and games

Reading Materials

- List of books on the course webpage
- Additional reading material will also appear on the course pages

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Instructor and TAs

- Instructor: Bhiksha Raj
  - bhiksha@cs.cmu.edu
- TAs:
  - List of TAs, with email ids on course page
  - We have TAs from the Pittsburgh, SV and Kigali Campuses
  - Remote and in-person OH offerings and times are subject to change
- Office hours: On webpage:

  https://deeplearning.cs.cmu.edu/

Lectures

- In-class lectures (unless rules change due to covid)
  - Live streaming for remote sections
  - Lectures will also be recorded and uploaded to the course website
- Important that you view the lectures
  - Even if you think you know the topic
  - Your marks depend on viewing lectures
  - We will monitor attendance (more on this later)

**In the event that the course is moved online due to covid, we will continue to deliver lectures via zoom. In the event that an instructor is unable to deliver a lecture in person, we will broadcast that lecture over zoom or, in extreme situations, expect you to view pre-recorded lectures from prior semesters. You will be notified through piazza should any of these eventualities arise.*

Additional Logistics

- Discussions: Piazza (please be updated with the recent threads)
- Compute Infrastructure:
  - Everyone gets Amazon tokens (AWS)
  - Initially a token for $50
  - Can get additional tokens of $50 up to a total of $150

Lecture Attendance

- You get marks for attendance
  - Our performance metrics over the semesters show a distinct correlation between attendance and course scores
  - We also note a distinct *inverse* correlation between attendance and the amount of help you require on piazza and during office hours
  - To encourage attendance, we assign 1 mark for attendance
    - 1% of your total grade for 11685/11785/18786
    - 1.3333% of your total grade for 11485
    - This can be the difference between a B and an A
- We will track lecture attendance
  - More on next slide

Lecture Attendance: Rules

- You must either attend the lectures in person, or the streamed video
  - With some exceptions: see below
  - **Weget attendance stats from your participation in in-class polls**
  - Polls will be conducted via Piazza. It is recommended to use the Piazza app available both on Android and iOS. You can also use Piazza in browser if you are attending via Zoom.
  - Use of electronic devices during in-person lectures is not permitted except during polls.
- Students in SV, and those stuck in bad timezones (i.e. if your local time is before 8am or after 5pm for the class) may alternately watch recorded lectures on mediatech instead
  - Mediatech records who watched and for how long. You must watch at least 70 mins of the lecture
  - If viewed on mediatech, 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 **(Subject to change)**

Lecture Schedule

- On website
  - The schedule for the latter half of the semester may vary a bit
    - Guest lecturer schedules are fuzzy..
- Guest lectures:
  - TBD
    - One or more of: Scott Fahlman, Shinji Watanabe, Gerald Friedland, Graham Neubig

Recitations

- 14 recitations (Excluding HW Bootcamps)
- Every Friday of the semester
- Will cover implementation details and basic exercises
  - Very important if you wish to get the maximum out of the course
- Topic list on the course schedule

- *Strongly recommend attending all recitations*
  - *Even if you think you know everything*

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Evaluation

- Scores are evaluated based on 3 types of tests:
  - Weekly Quizzes
  - Home works
  - Team Project (Not for 11485)

Weekly Quizzes

- 10 multiple-choice questions (3 attempts)
- Related to topics covered that week
  - On both slides and in lecture
  - Released Friday, closed Sunday night
  - This may occasionally shift, don't panic!
- There will be 14 total quizzes
  - We will consider the best 12
  - This is expected to account for any circumstance- based inability to work on quizzes
    - You could skip up to 2

Weekly Quizzes

- Slides often contain a lot more information than is presented in class
- *Quizzes will contain questions from topics that are on the slides, but not presented in class*
- *Will also include topics covered in class, but not on online slides!*
- There will be questions based on latest research papers in the quiz – the links to the papers will be provided

Homework

- There will be one early homework (released before the start of the semester) and four in-term homeworks
  - Homework 0: Preparatory material for the course
  - Homeworks 1-4: Actual neural-net exercises

- Homeworks 1-4 all have two parts:
  - Part 1: Autograded problems with deterministic solutions
    - You must upload them to autolab
  - Part 2: Open problems posted on Kaggle

- Bonus HWs:
  - There will be 3 bonus homeworks corresponding to HW1-3 and 4 separate autograd bonus homeworks
  - These marks will not contribute to final grading curves but give you the chance to make up for marks missed elsewhere

Homework: Part 1

- Part 1 of the homeworks evaluate your ability to code neural nets on your own from scratch
  - If you implement all mandatory and bonus questions of part 1 of all homeworks, you will, hopefully, have all components necessary to construct a little neural network toolkit of your own
    - "mytorch" ☺
- The homeworks are autograded
  - Be careful about following instructions carefully
    - The autograder is setup on a computer with specific versions of various packages
    - Your code must conform to their restrictions
  - If not the autograder will often fail and give you errors or 0 marks, even if your code is functional on your own computer
  - Note: Submission before ESD (early submission deadline) will get you an early submission bonus

Homework: Part 2

- Part 2 of every homework tests your ability to solve complex problems on real-world data sets
  - The early submission deadline (ESD) is required and worth 10/100 points
  - The remaining 90/100 points are determined by your final score relative to the cutoffs

Homework: Part 2

- The standard cutoffs are (After 10pts ESD)
  - High cutoff : 90pts
  - Medium cutoff : 70pts
  - Low cutoff : 50pts
  - Very Low cutoff : 30pts
  - No submission : 0pts
- Your score is linearly interpolated between cutoffs. Ex, if an 85% accuracy model is for the high cutoff and 75% model is for the medium, a model with 80% accuracy will get 80/90pts
- There is a 5th bonus cutoff for extra credits (10pts) determined by the highest scoring student
  - Ex. If the highest accuracy is 92%, the scoring student will get 110/100 and anyone between 85% to 92% will get 100+/100 (considering they have the 10pts from ESD)

Homework Deadlines

- Multiple deadlines
- Separate deadline for Autograded deterministic component
- Kaggle component has multiple deadlines
  - *Early Submission D*eadline: Worth 10% of P2 and affirms you have started the assignment
  - *On-time Submission Deadline:* Your final submission must occur before this deadline to be eligible for full marks (of your cutoff)
  - *Late/Slack Deadline:* Submissions after the On-time Submission Deadline will receive a penealty, and you can use slack days to avoid a penalty (but not to get bonus)
- Homeworks: Late policy
  - Everyone gets up to 10 total slack days **(does not apply to initial submission or part 1 of the HWs)**
- You can distribute them as you want across your HWs
  - You become ineligible for "A+" bonus if you're using your grace days for Kaggle
- Once you use up your slack days, all subsequent late submissions will accrue a 10% penalty (on top of any other penalties)
- There will be no more submissions after the drop-dead deadline (Late/Slack)
- Kaggle: Kaggle leaderboards stop showing updates on full-submission deadline
  - But will continue to accept submissions until drop-dead deadline (using another Late kaggle)
- ***Please see course webpage for complete set of policies***

Course Project

- If you're taking 11-785, you will be required to do a course project
  - 11-685 students will be assigned a fifth HW that is equivalent to a project

- Projects are done by teams of students
  - Ideal team size is 4
  - 11-685 teams are ideally 2-person teams
  - You are encouraged to form your teams early

- Projects are intended to exercise your ability to comprehend and implement ideas beyond those covered by the HWs

- Projects can range from
  - Implementing and evaluating cutting-edge ideas from recent papers
    - *Verifying* results from "hot" published work
  - "Researchy" problems that might lead to publication if completed well
  - Proposing new models/learning algorithms/techniques, with proper evaluation
  - Etc.

Course Project

- Think about forming project teams as soon as possible. More details on website.
  - If you don't form your own teams, we will team you up
- Each team must:
  - Submit a project proposal by the deadline listed on the website
  - Submit a mid-way report 3⁄4 way through the semester
  - Submit a preliminary full report three days **before the presentation due date**
  - Make a **5 min** video presentation of the project at the end of the semester
    - Can be presented by one, some, or all team members
    - Will be evaluated by the instructor, TAs, and your classmates
    - Ensure you explain the problem, proposed solution, and the evaluation clearly
    - Allocate enough time to make the presentation, it is not as easy as you think
    - Poor presentation can significantly affect your project score :)
  - Submit a final full report at the end of the semester
  - Defend your project in front of peers and TAs
  - Templates for proposals and reports will be posted
- *Each team will be assigned a mentor from among the TAs, who will monitor your progress and assist you if possible.*
- **More details on project evaluations will be posted towards the end of the sem**
- **The project is often the most fun portion of the course**

Grading

Weekly Quizzes		**24**
14 Quizzes, bottom two dropped		24
Assignments		**50**
HW1 – Basic MLPs	(AL + Kaggle)	12.5
HW2 – CNNs	(AL + Kaggle)	12.5
HW3 – RNNs	(AL + Kaggle)	12.5
HW4 – Sequence to Sequence Modelling	(AL + Kaggle)	12.5
Team Project (Not for 11-485)		**25**
Proposal		-
Mid-term Report		5
Preliminary Full Report		-
Project Presentation		10
Peer Reviewing		binary multiplier
Final report		10

*** Note: There is 1 mark for attendance**

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Preparation for the course

- Course is implementation heavy
  - A lot of coding and experimenting
  - Will work with some large datasets
- Language of choice: Python
- Toolkit of choice: Pytorch
  - You are welcome to use other languages/toolkits, but the TAs will not be able to help with coding/homework
    - Some support for TensorFlow
- We hope you have gone through
  - Recitation zero
  - HW zero
    - Carries no marks

Teamwork

- Learning happens best together
  - You will learn more from each other than you will from us
- *We encourage teamwork*
  - But there are strict rules…

Study groups

- Please form study groups
- If you do not have a study group of your own, we will form one for you
  - Please register on the forms posted on Piazza
- *Everyone must be part of a study group*
- ***Each study group will be assigned a TA mentor for help throughout the course***

Study groups

- What study groups may do:
  - Discuss homework problems and solutions
  - Discuss papers
  - Discuss class work
  - Discuss quizzes
- We encourage you to meet regularly to discuss IDL work
- Study groups may also go on to form project teams
- So what are the caveats? What may you *not* do?

Study groups vs. Cheating

- Every student must solve their quizzes by themselves
  - You may discuss the questions with your study groups/friends, but when you solve the quiz**, isolate yourself and do it alone**
- Every student must solve every homework by themselves
  - You may discuss the homeworks with your friends, and even help them debug their code, but when you finally solve it, every line of your code (except libraries that have been okayed by course staff) must be written by you
  - Your solution must be yours
- Plagiarizing code from the web or your friends constitutes cheating
  - And submitting solutions not obtained by you constitutes cheating

Cheating

- You are here to learn DL yourself, not to demonstrate how well your friend, or that guy on the web has learned DL

- You are at CMU – which means you are among the brightest and best students in the *world*
  - You probably were among the top students in your peer group all your life, before you came here
  - It will be an insult to yourself and everything you ever stood for in your life to lower yourself from your own standards and start cheating
    - **So don't!!!**

- If you are unsure whether something you're doing constitutes cheating or not, check with us

Mentoring

- Every study group will be assigned a TA mentor
  - We will track your progress and reach out to you if you appear to be in trouble
- If in trouble, reach out to your TA mentor and/or the instructor
  - If you feel you're falling behind, reach out
  - If you feel you are struggling, reach out
  - If you feel pressured/unable to cope, reach out
  - We will try our best to help you
  - *Please watch Recitation 0I if you are stuck or feeling overwhelmed*
- We aim to make this a successful course for all of you
  - In our ID(ea)L world, everyone performs well enough to get an A
  - *Without lowering our standards* – i.e. we would like to bring *you* all up to where we believe you deserve an A
  - Everything about this course is geared to that objective

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This course is not easy

- A lot of work!

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This course is not easy

- A lot of work!
- A lot of work!!
- A lot of work!!!

This course is not easy

- A lot of work!
- A lot of work!!
- A lot of work!!!
- **A LOT OF WORK!!!!**

Not for chicken!

This course is not easy

- A lot of work!
- A lot of work!!
- A lot of work!!!
- **A LOT OF WORK!!!!**

- But a lot of fun :)

This course is not easy

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- **A LOT OF WORK!!!!**

- But a lot of fun :)

And somewhat calibrated (over the years) to ensure it is doable

Over 60% of students got some flavor of A each of the past three semesters and they deserved it

This course is not easy

- A lot of work!
- A lot of work!!
- A lot of work!!!
- **A LOT OF WORK!!!!**
- *Mastery-based* evaluation
  - Quizzes to test your understanding of topics covered in the lectures
  - HWs to teach you to implement complex networks
    - And optimize them to high degree
  - Projects to expose you to real world DL problems
  - **Target: Anyone who gets an "A" in the course is technically ready for a deep learning job**

HW0/Recitation0

- Please, please, please, please, please go through the videos for recitation 0, and complete HW0.
  - These are essential for you to gain comfort with the coding require in the following homeworks

- HW1 part 1 also has many components intended to help you *later* in the course
  - So if it seems a bit dense, please bear with it, its worth it
- HW1 is the easiest HW!

Questions?

- Please post on piazza

Thank you for deciding to take this journey of Deep Learning with us

- Prof. Bhiksha and TAs