

CSCI 599: Deep Learning and its Applications

Lecture 1

Fall 2017
Joseph J. Lim

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Welcome to CSCI 599!

For today, we need your attendance checked.

Please check in with TAs after the class.

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Welcome to CSCI 599!

This class will teach you

one of the most exciting developments in

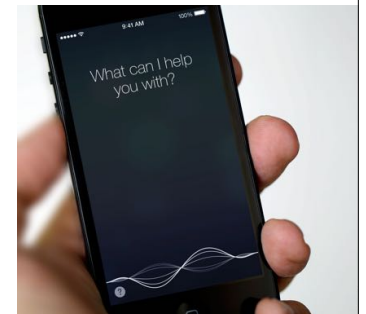
Machine Learning, Computer Vision, NLP, Robotics,
Other AI related fields

in the last decade!

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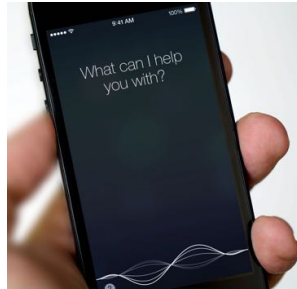
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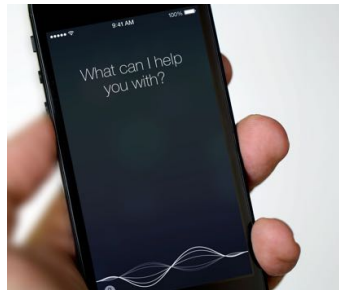
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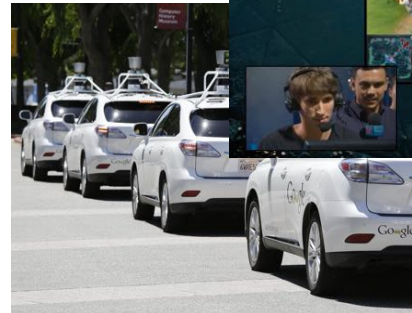
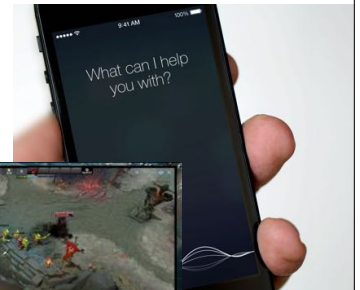


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Disclaimer

- This course is taught for the 1st time @ USC. This course is 599, and thus an **experimental** course.
- The syllabus, course policy, and grading details **may change** over the semester (**check website!**)
- If you prefer a well-structured course, this is **NOT** a course for you, and I encourage you to take the course next year. We really mean this.
- It will be fun but **demanding** and challenging!

Should be **already** familiar with Machine Learning

Do you know the following..?

- Probability and Statistical Learning
 - Density function, loss function, cross-validation

Should be **already** familiar with Machine Learning

Do you know the following..?

- Probability and Statistical Learning
 - Density function, loss function, cross-validation
- Supervised Learning
 - Nearest Neighbor, Kernels, Random Forest

Should be **already** familiar with Machine Learning

Do you know the following..?

- Probability and Statistical Learning
 - Density function, loss function, cross-validation
- Supervised Learning
 - Nearest Neighbor, Kernels, Random Forest
- Unsupervised Learning
 - Clustering, PCA, SVD

Should be **already** familiar with Machine Learning

- If not, please take other ML courses first!
 - For example, CSCI 567: Machine Learning

Today's agenda

- A brief introduction to Deep Learning
- Survey
- CSCI 599 overview

Today's agenda

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- Survey
- CSCI 599 overview

Deep Learning is impacting everywhere

- Machine Learning
- Computer Vision
- Natural Language Processing
- Robotics
- Medical Application
- Graphics
- Finance
- and many more

Art Creation



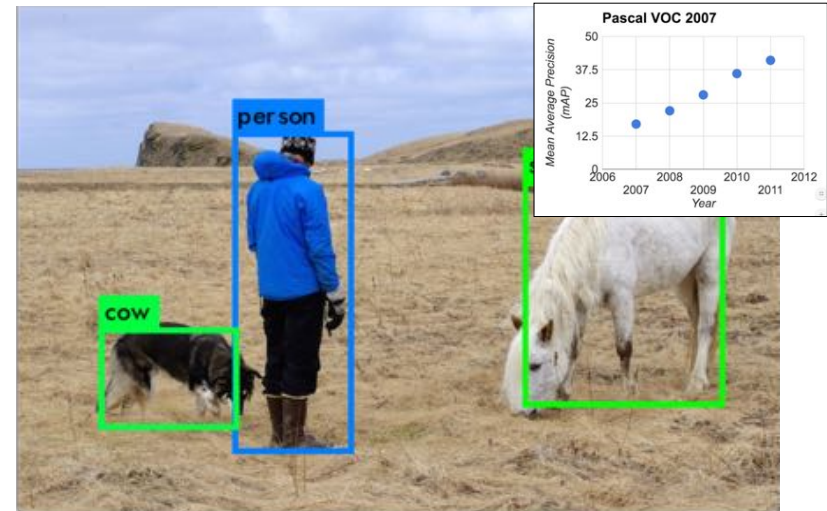
Elgammal, Ahmed, et. al. CAN: Creative Adversarial Networks, Generating "Art" by Learning About Styles and Deviating from Style Norms. arXiv 2016.

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Object Detection



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Object Detection in Video



J. Redmon and A. Farhadi. YOLO9000: Better, Faster, Stronger. CVPR 2017.

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Semantic Segmentation



K. He, etl. al. Mask R-CNN. arXiv 2017.

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3D Pose for Furniture



J. Lim, et. al. Parsing IKEA Objects: Fine Pose Estimation. ICCV 2013.

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Human Pose



Z. Cao, et. al. Realtime Multi-person 2D Pose Estimation using Part Affinity Fields. CVPR 2017.

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Image to Caption



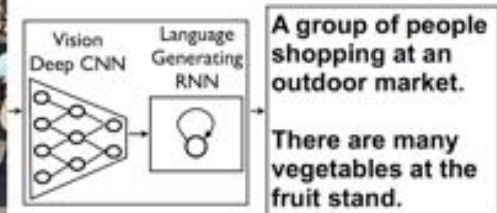
From <https://research.googleblog.com/2014/11/a-picture-is-worth-thousand-coherent.html>

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Image to Caption



From <https://research.googleblog.com/2014/11/a-picture-is-worth-thousand-coherent.html>

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Caption to image

Caption

the flower shown has yellow anther red pistil and bright red petals

this flower has petals that are yellow, white and purple and has dark lines

the petals on this flower are white with a yellow center

Reed, Scott, et. al. Generative Adversarial Text to Image Synthesis. ICML 2016.

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Caption to image

Caption

the flower shown has yellow anther red pistil and bright red petals

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the petals on this flower are white with a yellow center

Generated Images



Reed, Scott, et. al. Generative Adversarial Text to Image Synthesis. ICML 2016.

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Visual Question Answering (VQA)



Who is holding the kite?

Submit

From <http://www.visualqa.org/>

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Visual Question Answering (VQA)



Who is holding the kite?

Submit

Predicted top-5 answers with confidence:

man	39.354%
woman	17.491%
girl	14.872%
child	7.801%
boy	6.191%

From <http://www.visualqa.org/>

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Machine Translation

Google Translate interface showing the translation of the sentence "CS599 will be a fun class!" into multiple languages. The selected language is Korean, resulting in "CS599는 재미있는 수업이 될 것입니다!". Other visible translations include Spanish ("CS599 será una clase divertida!"), Chinese ("CS599将是一个有趣的课!"), German ("CS599 sera une classe amusante!"), and French ("CS599 sera une classe amusante!").

Google Translate

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Machine Translation

A screenshot of the Science magazine website. The main article is titled "How AI detectives are cracking open the black box of deep learning" by Paul Hozier. The article discusses how researchers are using a small group of labeled images to recognize objects in the world of an artificial intelligence. The text mentions that this is a significant step in understanding how deep learning models work, which have been a "black box" for some time.

English

Google Translate

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Machine Translation

A screenshot of the Science magazine website, identical to the one in the previous slide. A large black arrow points from this screenshot towards the right, indicating a transition or a comparison with the next slide.

English

Google Translate

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Machine Translation

A screenshot of the Science magazine website, identical to the one in the previous slide. A large black arrow points from this screenshot towards the right, indicating a transition or a comparison with the next slide.

English

French

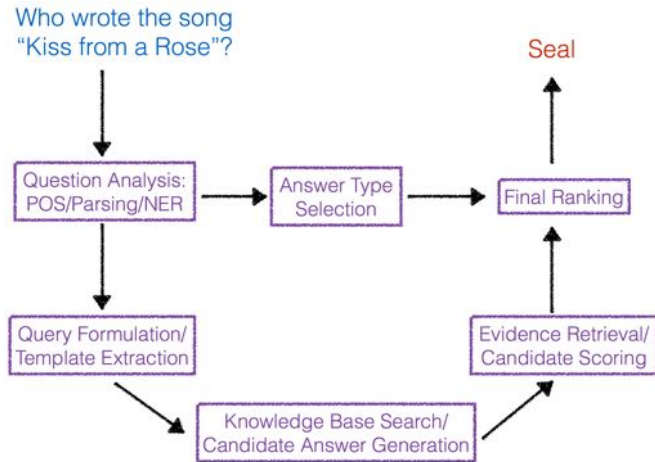
Google Translate

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Question Answering



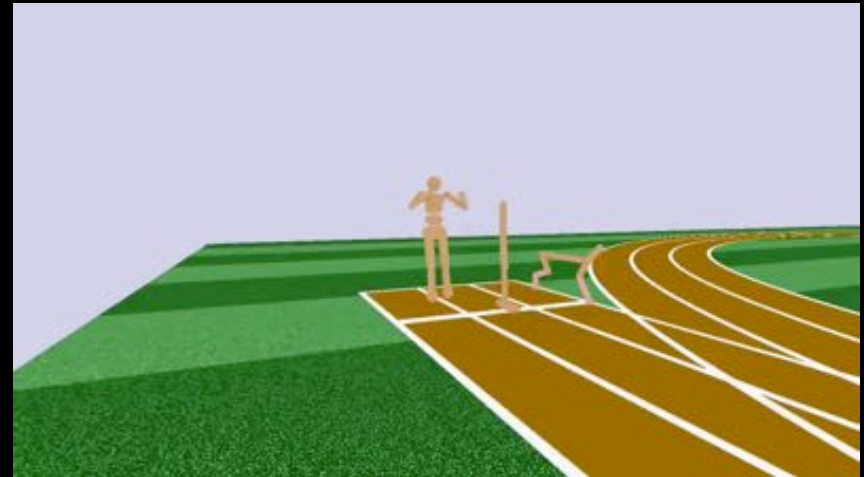
Kumar, Ankit, et. al. "Ask me anything: Dynamic memory networks for natural language processing." ICML 2016.

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Learning to Walk



From <https://blog.openai.com/roboschool/>

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Object Picking Robot



S. Levine, et. al. Learning Hand-Eye Coordination for Robotic Grasping with Deep Learning and Large-Scale Data Collection. IJRR 2017.

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Navigation Robot



Y. Zhu, et. al. Target-driven Visual Navigation in Indoor Scenes using Deep Reinforcement Learning. ICRA 2017.

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Autonomous Driving



From AutoX

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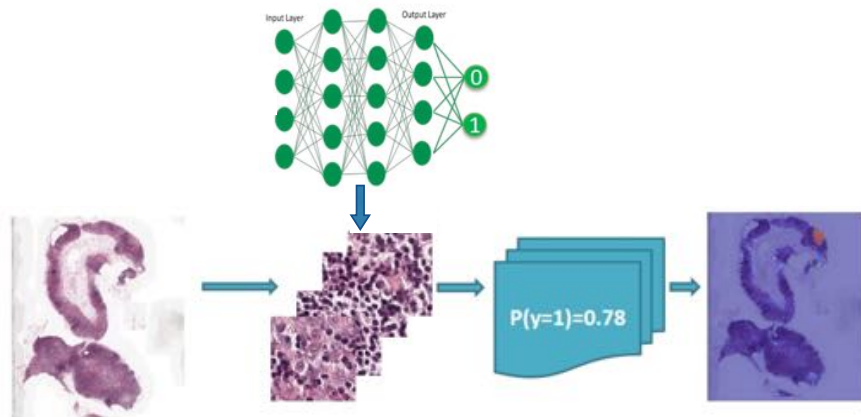


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Cancer Metastases Detection



From PathAI's submission to CAMELYON16.

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Deep Learning is impacting everywhere

- Machine Learning
- Computer Vision
- Natural Language Processing
- Robotics
- Medical Application
- Graphics
- Finance
- and many more

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Why is DL so powerful?

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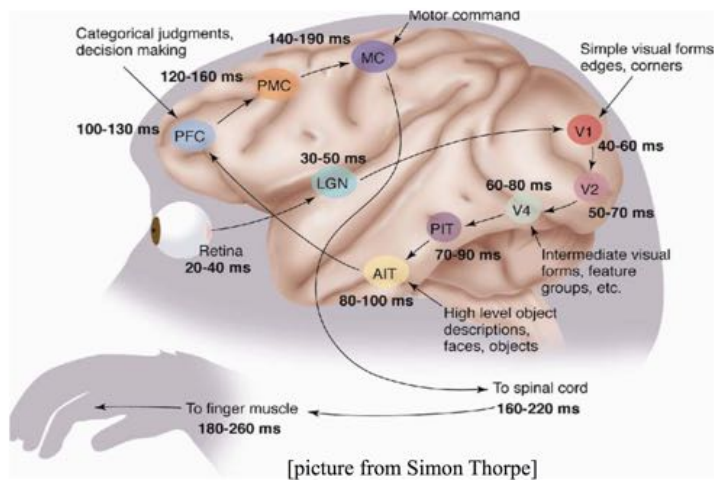
Deep Learning is motivated by ?

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Deep Learning is motivated by human brain



Slide credit: Marc'Aurelio Ranzato, Yann LeCun

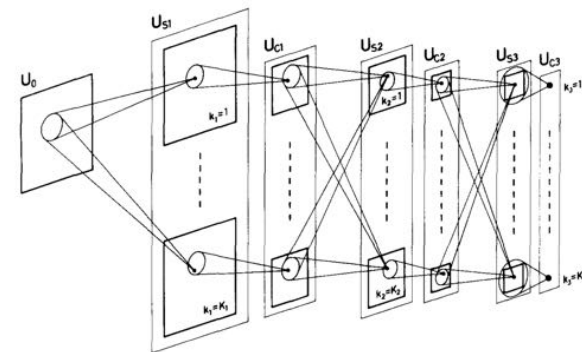
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History of DL in 3 slides

First idea



Fukushima, Kunihiko. Neocognitron: A self-organizing neural network model for a mechanism of visual pattern recognition. Competition and cooperation in neural nets 1982.

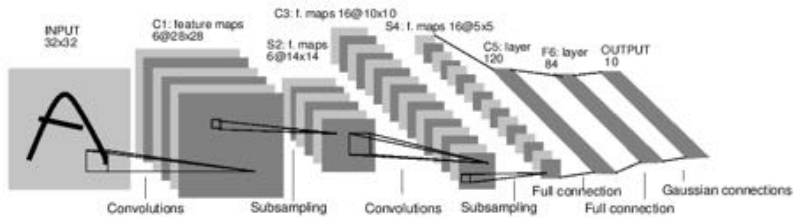
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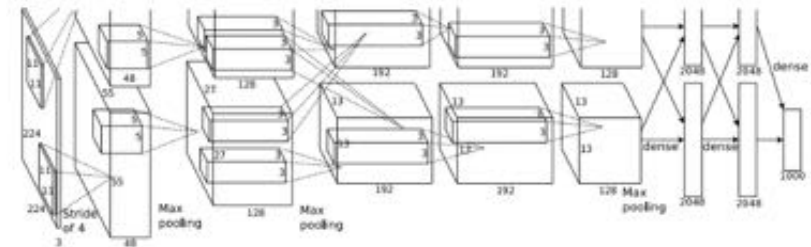
History of DL in 3 slides

Backpropagation for training



Y. LeCun, et. al. Handwritten digit recognition with a back-propagation network. NIPS 1989.

Large-scale data (& GPU)



A Krizhevsky, et. al. ImageNet Classification with Deep Convolutional Neural Networks. NIPS 2012.

Also known as, **AlexNet**

DL trend in arXiv



By Andrej Karpathy

DL trend in arXiv



By Andrej Karpathy

Deep Learning is impacting everywhere

- Machine Learning
- Computer Vision
- Natural Language Processing
- Robotics
- Medical Application
- Graphics
- Finance
- and many more

Is Artificial Intelligence solved?

What is Artificial Intelligence?

What is Artificial Intelligence?

- Artificial intelligence (AI, also machine intelligence, MI) is **intelligence exhibited by machines**, rather than humans or other animals (natural intelligence, NI).

AI is **intelligence exhibited by machines**

- Object Detection
- Visual Question Answering
- Question Answering
- Autonomous Driving
- ...

Is AI solved (by deep learning)?!

AI is **intelligence exhibited by machines**

- Object Detection
- Visual Question Answering
- Question Answering
- Autonomous Driving
- ...

Is AI solved (by deep learning)?!

- **No!** There are many domains of problems that we don't even know how to tackle.

Is AI solved (by deep learning)?!

- Supervised Learning
- Unsupervised Learning
- Reinforcement Learning

Is AI solved (by deep learning)?!

- Supervised Learning

We are quite good

- Unsupervised Learning
- Reinforcement Learning

Is AI solved (by deep learning)?!

- Supervised Learning

We are quite good

- Unsupervised Learning
- Reinforcement Learning

Yet to explore more

Is AI solved (by deep learning)?!

- Supervised Learning

We are quite good

- Unsupervised Learning
- Reinforcement Learning

Yet to explore more

Specific AI vs General AI

Is AI solved (by deep learning)?!

- Supervised Learning

We are quite good

- Unsupervised Learning
- Reinforcement Learning

Yet to explore more

Specific AI vs General AI

ok..

Is AI solved (by deep learning)?!

- Supervised Learning

We are quite good

- Unsupervised Learning

Yet to explore more

- Reinforcement Learning

Specific AI

vs

General AI

ok..

Yet to explore more

Today's agenda

- A brief introduction to Deep Learning
- Survey
- CSCI 599 overview

Degree Level

1. Undergraduate
2. Master's
3. PhD

Department

1. Computer Science
2. Electrical Engineering
3. Science / Engineering
4. Medical
5. Business
6. Others

Background in Programming

1. Python Guru
2. Python Proficient
3. Python Intermediate
4. Python Beginner
5. Proficient in other languages
6. Others

Background in Deep Learning

1. Know all state-of-the-art topics (e.g. memory networks, relation networks, and A3C)
2. Worked on 1-2 projects
3. Heard about it
4. None of the above

Background in Machine Learning

1. Research experience in ML
2. Took some relevant courses
3. None of the above

Research experience?

1. Multiple projects in AI
2. Worked on at least 1 project in AI
3. Research experience in CS/EE
4. Research experience in Engineering
5. Research experience in others
6. No experience

When to eat dinner?

1. Before
2. After
3. During

Today's agenda

- A brief introduction to Deep Learning
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- CSCI 599 overview

Our Goal

- Creating and tackling challenging yet interesting **deep learning projects**
- Teaching **practical deep learning** knowledge

Topics

- Basic ML
- Convolutional Neural Networks (CNNs)
- Recurrent Neural Networks (RNNs)
- Generative Models
- Deep Reinforcement Learning
- Advanced Deep Learning (e.g. memory networks)

Course Staff



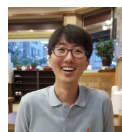
Prof. Joseph Lim



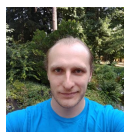
Hexiang Hu



Zeng Huang



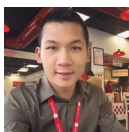
Youngwoon Lee



Artem Molchanov



Shunsuke Saito



Shao-Hua Sun



Te-Lin Wu



Sitao Xiang

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Office Hours

- Instructor OH @ SAL 214
 - Wednesday 2-3pm
 - This is NOT for homework related questions.
- TA OH @ SAL 125
 - Tuesday 1-5pm

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Pre-requisite

- Proficiency in Python
- College calculus, linear algebra
- Probability and statistics
- Equivalent knowledge of CSCI 567 (Machine Learning)
 - Online course may or may not be sufficient
- (Ideally) experience with cloud services

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Entrance Exam

- You need to pass both
 - Take-home coding assignment (due next Wednesday 5pm)
 - In-class exam (next Wednesday)
Last name starts with
 - A-L: 5-6:30pm
 - M-Z: 6:45-8:15pm

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Entrance Exam: In-class exam

- Background Knowledge
 - Calculus
 - Linear algebra
 - Probability and statistics
 - Machine Learning
- Open-ended questions (1 paragraph each):
 - Why are you taking this course?
 - Which project(s) are you excited about?

Entrance Exam: Take-home

- Individual assignment - **Do NOT collaborate**
- Python programming skills
 - Data manipulation
 - Basic ML algorithms
- Due by 5pm on Aug 30th
 - Submit your code online

Grading

Entry	% of grade
Assignment #1	15
Assignment #2	15
Midterm	25
Course project	45
TOTAL	100

Important Dates

- Assignment 1: week 6
- Assignment 2: week 11
- Project meeting with Instructor #1: week 8 (M-W)
- Project meeting with Instructor #2: week 11 (M-W)
- Project meeting with TA: 3 times (arranged later)
- Final presentation:
 - week 15 (5-9:30pm) **4.5 hours**

Subject to change!

Course Project

- Team-based project (3-4 students per team)
- Each team will have at least 1 dedicated TA
 - Mandatory meeting with TA at least once every 3 weeks
- Create your own problems (extra points)
 - **Talk and discuss** with your TAs and me!
 - In the worst case, we will give a project idea
 - Less fun, Less points!

Course Project

- Computational resource (**be conservative!**):
 - \$150 Google Cloud credit per student
 - \$125 Amazon AWS credit per student
- Tentative Schedule for Project
 - Week 4: Course Project Team
 - Week 8: Course Project Proposal
 - Week 12: Mid-report
 - Week 15: **Project Presentation** (5-9pm) + Report

Subject to change!

Collaboration Policy

Entry	Ok to discuss?
Entrance Take-home Exam	NO
Assignment #1	Yes
Assignment #2	Yes
Course project	Yes

Please list all names of people whom you had discussions with!

Other Policy

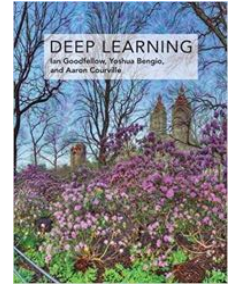
- Regrading: **within 1 week** after we hand out grades
- Late days: 5 days for the entire semester (no exception).
 - **No late day** for the final project presentation and report!

Communication

- Please use **Piazza** for any general communication including questions
<https://piazza.com/usc/fall2017/csci599/home>
- Use e-mail ONLY when it is necessary. Seriously I don't know when...
But, the staff e-mail address is: deeplearning-staff-l@usc.edu
- Any non-necessary e-mail will be ignored. Period.

Course material

- Deep Learning (MIT Press)
Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- Free online version is available at
<http://www.deeplearningbook.org/>



Course website

- <https://csci599-dl.github.io/>

Syllabus

- Syllabus is on the course website.
- This will keep changing.

Disclaimer

- This course is taught for the 1st time @ USC. This course is 599, and thus an **experimental** course.
- The syllabus, course policy, and grading details **may change** over the semester (**check website!**)
- If you prefer a well-structured course, this is **NOT** a course for you, and I encourage you to take the course next year. We really mean this.
- It will be fun but **demanding** and challenging!

Thanks for generous support!



Google Cloud Platform



Questions?

Todo

- Check in before you leave with TAs
- Take-home assignment
- Next week: In-class exam

Welcome to CSCI 599!