CSCI 599: Deep Learning and its Applications

Lecture 1

Spring 2019
Joseph J. Lim

Welcome to CSCI 599!

For today, we need your attendance checked.

Please check in with TAs after the class.

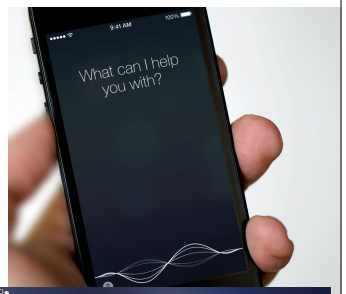
Welcome to CSCI 599!

This class will teach you

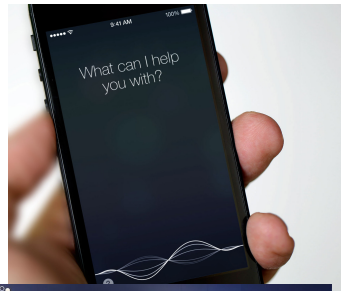
one of the most exciting developments in

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

in the last decade!


What can I help you with?

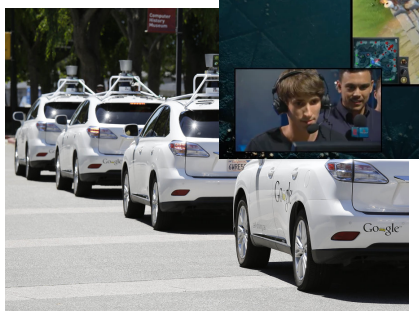

Google DeepMind
Challenge Match
AlphaGo
Lee Sedol


What can I help you with?


Google DeepMind
Challenge Match
AlphaGo
Lee Sedol

What can I help you with?

Google DeepMind
Challenge Match
AlphaGo
Lee Sedol



What can I help you with?

Google DeepMind
Challenge Match
AlphaGo
Lee Sedol

Disclaimer

- This course is taught for the 2nd 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.
- It will be fun but 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

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

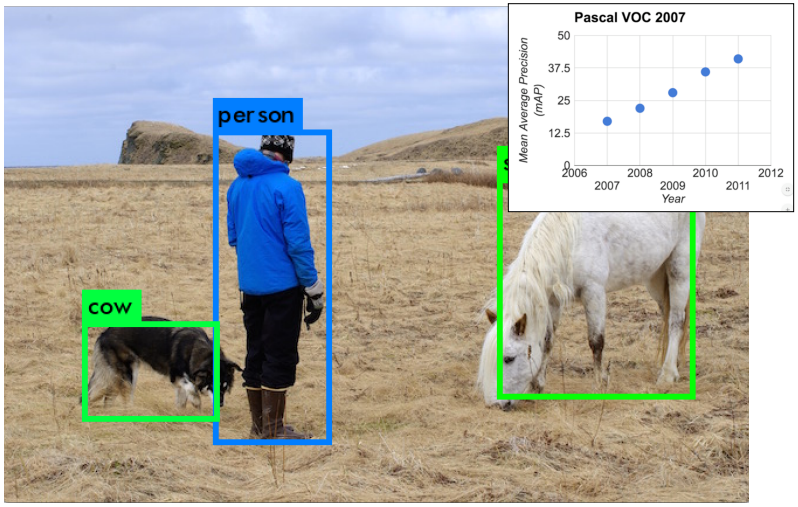
Deep Learning is impacting everywhere

- 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.

Object Detection



Object Detection in Video

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

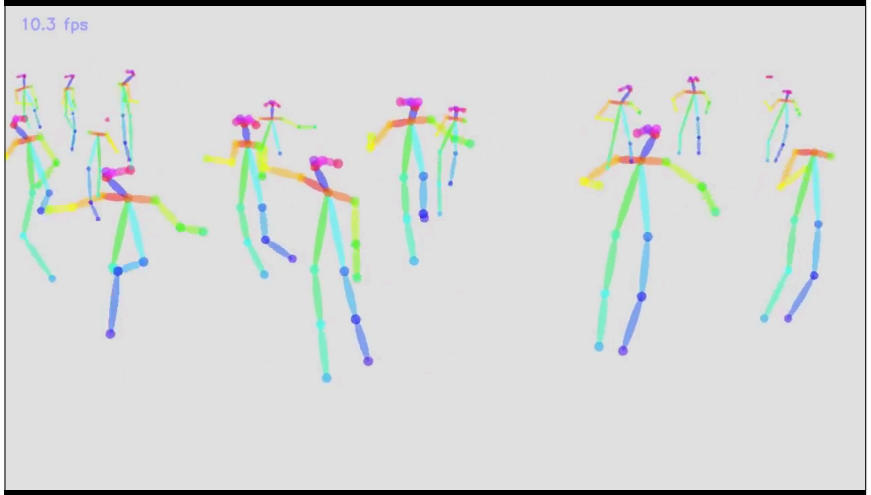
Semantic Segmentation

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

3D Pose for Furniture

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

Human Pose

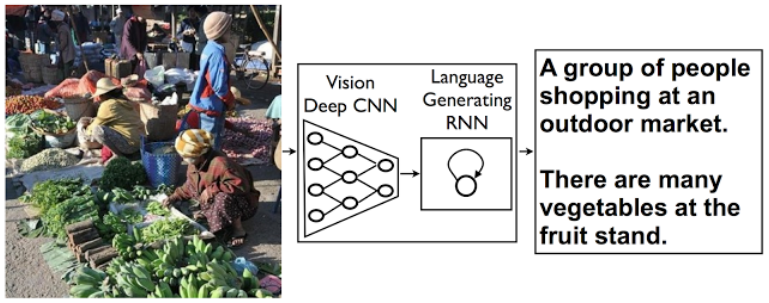


Z. Cao, et. al. Realtime Multi-person 2D Pose Estimation using Part Affinity Fields. CVPR 2017.

Image to Caption

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

Image to Caption



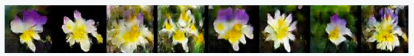
From https://research.googleblog.com/2014/11/a-picture-is-worth-thousand-coherent.html

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.

Caption to image

Caption	Generated Images
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.

Visual Question Answering (VQA)

Who is holding the kite? Submit

From http://www.visualqa.org/

Visual Question Answering (VQA)

Who is holding the kite? Submit

Predicted top-5 answers with confidence:

man 39.354%

woman 17.493%

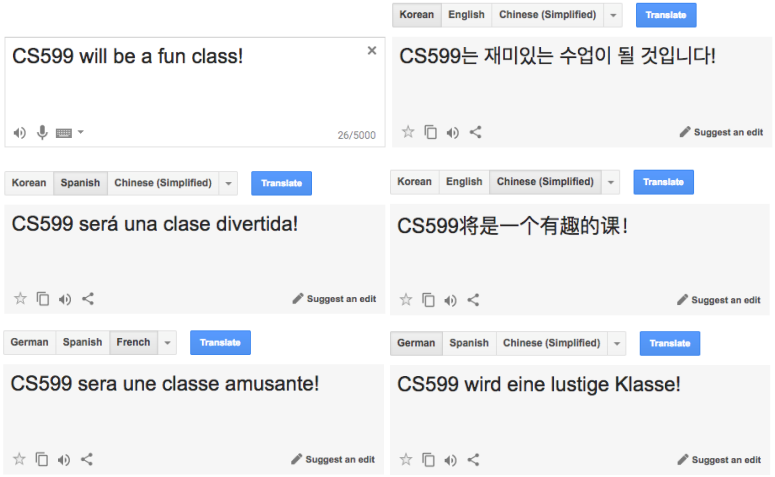
girl 14.672%

child 7.824%

boy 6.150%

From http://www.visualqa.org/

Machine Translation



Google Translate

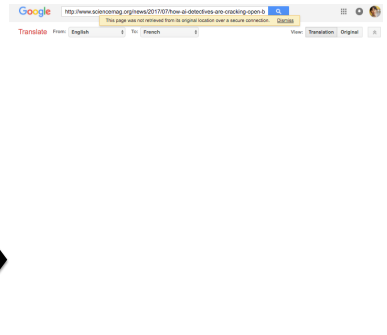
Machine Translation

English

Google Translate

Machine Translation

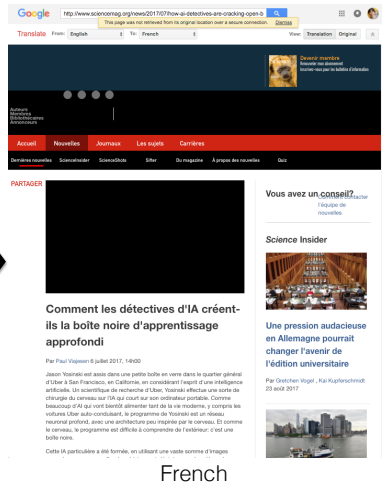
English



Google Translate

Machine Translation

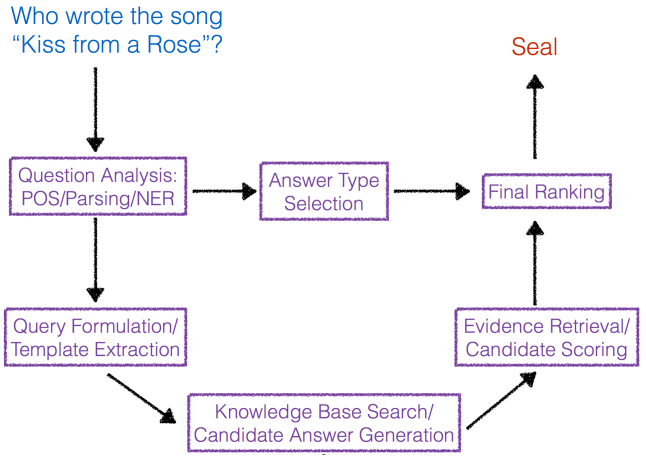
English



French

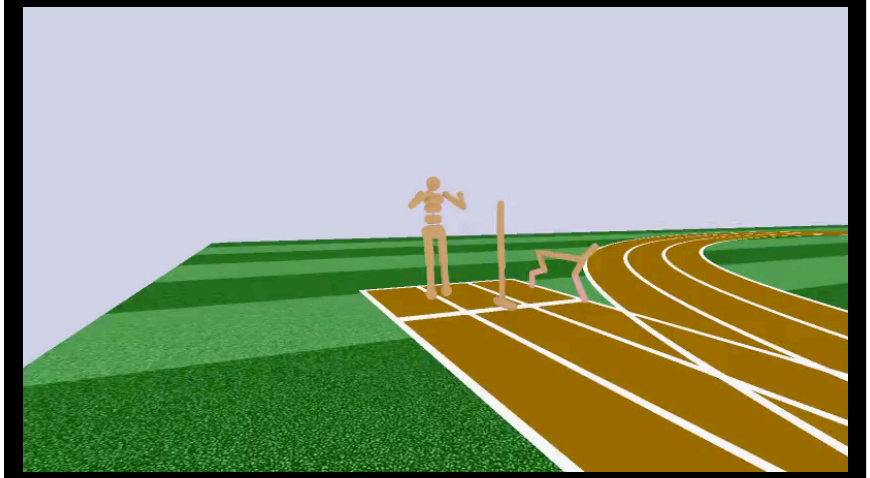
Google Translate

Question Answering



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

Learning to Walk

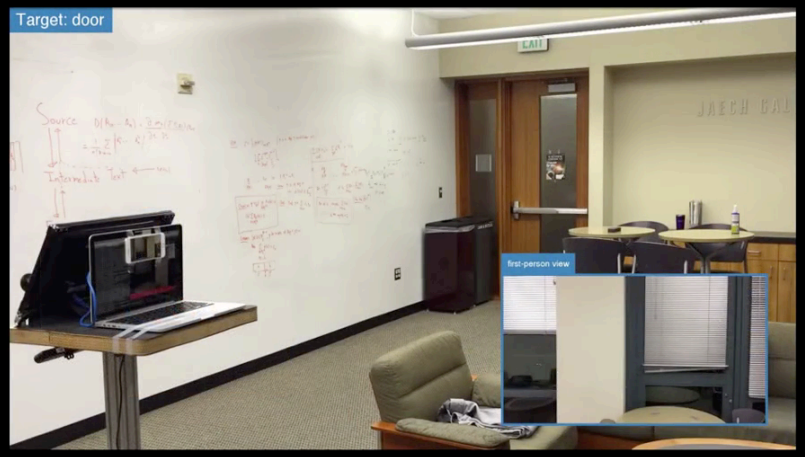


From https://blog.openai.com/roboschool/

Object Picking Robot

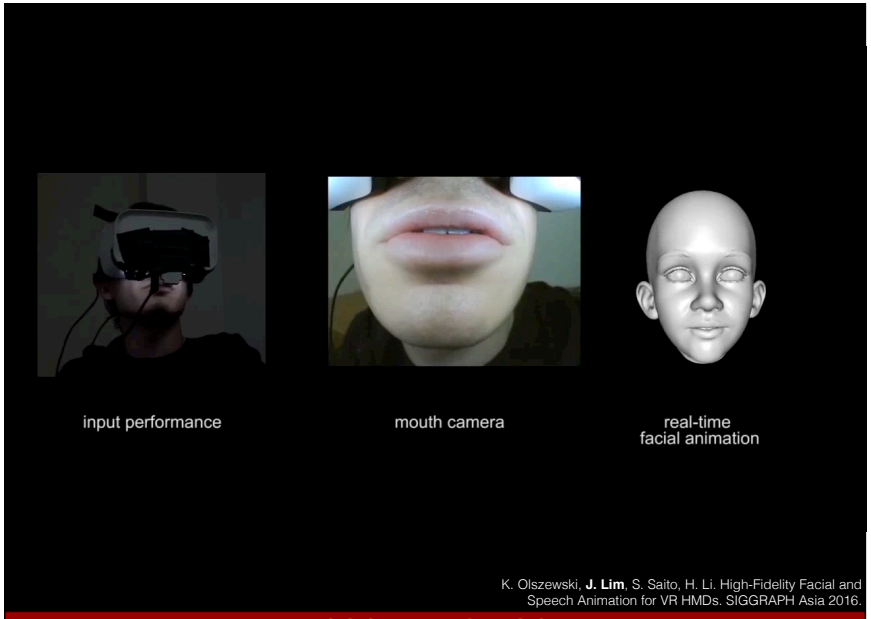
S. Levine, et. al. Learning Hand-Eye Coordination for Robotic Grasping with Deep Learning and Large-Scale Data Collection.. IJRR 2017.

Navigation Robot

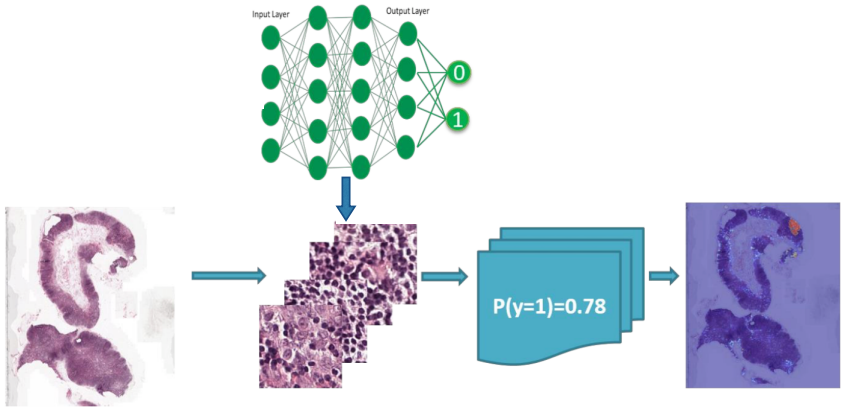


Y. Zhu, et. al. Target-driven Visual Navigation in Indoor Scenes using Deep Reinforcement Learning. ICRA 2017.

Autonomous Driving



Cancer Metastases Detection



From PathAI's submission to CAMELYON16.

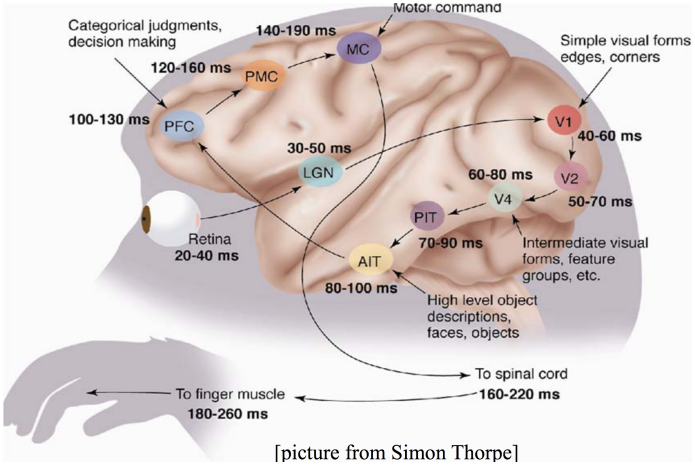
Deep Learning is impacting everywhere

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

Why is DL so powerful?

Deep Learning is motivated by ?

Deep Learning is motivated by human brain

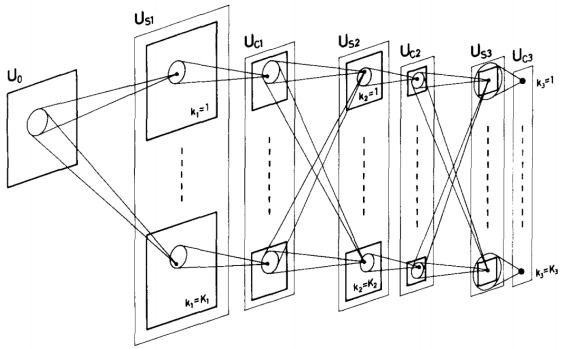


[picture from Simon Thorpe]

Slide credit: Marc'Aurelio Ranzato, Yann LeCun

History of DL in 3 slides

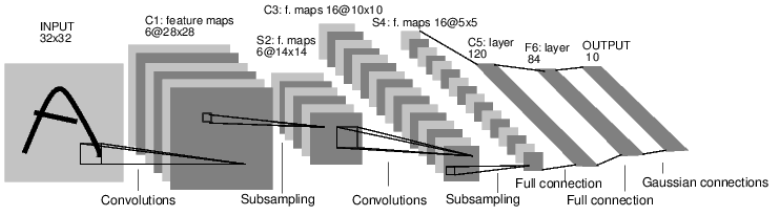
First idea



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

History of DL in 3 slides

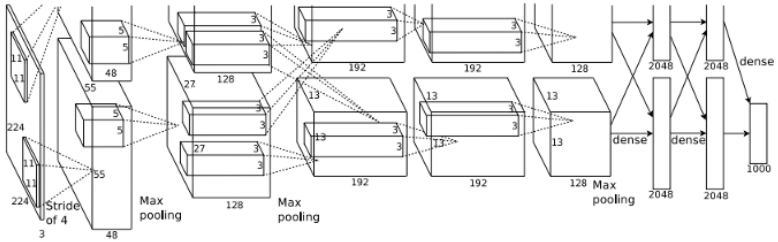
Backpropagation for training



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

History of DL in 3 slides

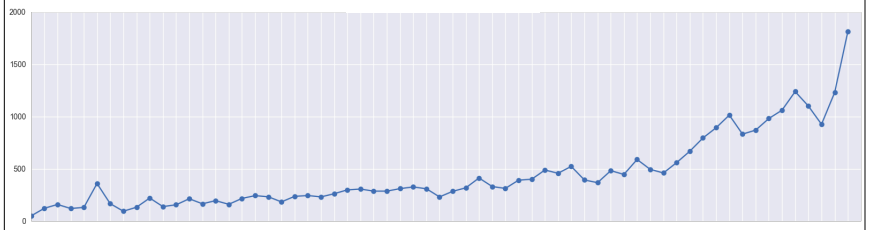
Large-scale data (& GPU)



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

Also known as, **AlexNet**

DL trend in arXiv

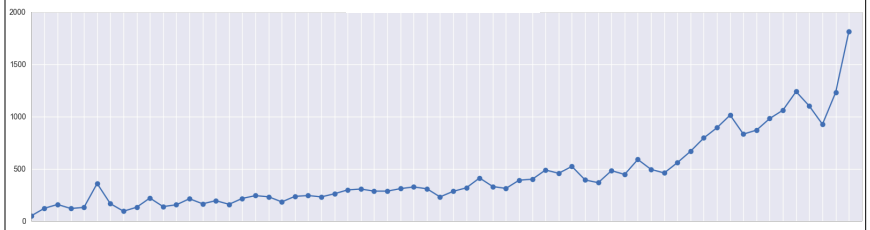


2012 2017

AlexNet

By Andrej Karpathy

DL trend in arXiv



2012 2017

AlexNet **3 magnitude!!!**

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).

From wikipedia

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 — Yet to explore more
- Reinforcement Learning

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

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..

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.. 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
- Survey
- CSCI 599 overview

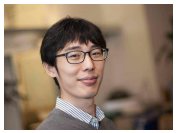
Our Goal

- 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)

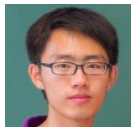
Course Staff


Joseph Lim


Ayush Jain


Karl Pertsch


Youngwoon Lee


Hanpeng Luo


Shao-Hua Sun


Te-Lin Wu

Office Hours

- Instructor OH @ RTH 402
  - Tuesday 2-3:30pm
  - This is NOT for homework related questions.
- TA OH @ SAL 125
  - TBD

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

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?

Grading

Entry	% of grade
Participation	5
Assignment #1	15
Assignment #2	15
Midterm	25
Course project	40
TOTAL	**100**

Important Dates

- Entrance exam: 1/15
- Assignment 1: 2/19
- Midterm: 3/5
- Project meeting with Instructor #1: 3/6 — 3/8
- Assignment 2: 3/26
- Project meeting with Instructor #2: 4/1 — 4/3
- Project meeting with TA: 3 times (arranged later)
- Final presentation: 4/23 5-9:00pm **4 hours**

Subject to change!

Course Project

- Team-based project (3-5 students per team)
- Each team will have at least 1 dedicated TA
  - 2 Mandatory meetings with TA
  - 2 meetings with me
- 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 5 (2/5): Course Project Team
  - Week 8 (2/26): Course Project Proposal
  - Week 13 (4/2): Mid-report
  - Week 16 (4/23): **Project Presentation** (5-9pm) + Report

Subject to change!

Collaboration Policy

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

No code sharing

Other Policy

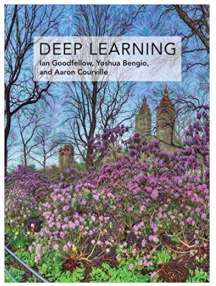
- Regrading: **within 1 week** after we hand out grades
- Late days: 5 days for the entire semester (no exception).
  - **No late day** for the final project presentation and report!

Communication

- Please use **Piazza** for any course related communication
  https://piazza.com/usc/spring2019/csci599
- 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 2nd 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.
- It will be fun but challenging!

Questions?

Todo

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

Welcome to CSCI 599!