Agenda

- Welcome!
- Introduction to Deep Learning
- About CS230
  - Course logistics
  - Prerequisites, & Workera Competency Models
  - CS230 vs. CS229 vs. CS229A
  - Overview of CS230 programming assignments
  - Examples of student projects
Welcome to CS230!

Stanford's Deep Learning Class (Fall 2022 Edition)
Introduction to Deep Learning
Why study Machine Learning / Deep Learning?

- Probabilistic Graphical Models
- Expert Systems
- Planning
- Knowledge Representation
- Search
- Deep Learning / Machine Learning
Research and development in ML/DL progresses rapidly.

2015
Modern Deep Learning Frameworks
Google's TensorFlow and Facebook's PyTorch taking the lead over frameworks like Lua, Torch, Caffe, Lasagna, and Chainer.

2016
Generative Adversarial Networks
Rapid adoption of GANS after the seminal paper from Goodfellow et al.

2017
Transformer Architecture
Attention is all you need and the rise of the transformer architecture improved the performance of state-of-the-art systems in various tasks.

2018
Responsible AI
Discussions on AI fairness, safety, reliability, transparency, and privacy become more prominent in the community.

2019
ML Ops Tools
Emergence of a set of tools and practices aiming to deploy and maintain ML models in production reliably and efficiently

2020
Data-Centric AI
Building AI systems with a focus on ensuring that the data clearly conveys what the AI must learn.

2021-22
Large Language Models & Latent Diffusion Models
Massive leaps forward in large language models and multimodal models that move between image and language.

[Non-exhaustive list!]

Source

Kian Katanforoosh
This affects ML as a discipline/job. Learning is the new norm.

How long is a skill useful?

The half-life of skills is 80% shorter than 40 years ago. (More: World Economic Forum)
AI is becoming a horizontal skill that applies to large portions of the workforce.

Centers of Excellence

These are highly qualified AI & Data practitioners, including machine learning engineers, data scientists, software engineers, data engineers, data analysts.

AI & Data+X individuals

Engineers or analysts who are experts in specific domains and want to grow their AI skills (e.g., medical experts)

AI & Data literate

Everyone else in the company

AI & Data fluent

People who have computational and analytical thinking, but aren't in the above category (e.g., product / project managers, recruiters, sellers, marketers, etc.)

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Let’s zoom on AI+X!
The Rise of AI+X practitioners
Combining subject matter expertise with AI skills

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Why AI+X practitioners have a critical advantage in projects

[Rajpurkar, Irvine et al. (2017): CheXNet]

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Let’s zoom on roles typically in the Center of Excellence!
Let’s look at Software teams as a proxy for AI teams

Roles in software teams are better understood than roles in AI teams. AI as a job category is still nascent!
AI is more than modeling.

Figure 1: Only a small fraction of real-world ML systems is composed of the ML code, as shown by the small black box in the middle. The required surrounding infrastructure is vast and complex.

[Source: Sculley et. al, *Hidden Technical Debt in Machine Learning Systems*]
AI roles and tasks are becoming clearer as the industry matures.
AI roles and tasks are becoming clearer as the industry matures.
In enterprises, AI & Data transformations are typically company-wide.

How ready is the workforce in terms of AI capabilities?
**Maturity 1:** Getting started (Laggards Curve)

Most companies are at this stage.
**Maturity 2: Emergence of Heroes**

A small % of accomplished practitioners emerge thanks to upskilling, hiring, and internal strategic initiatives. They have the ability to create value out of AI technologies.
Maturity 2: Emergence of Heroes

Workforce ordered from highest (left) to lowest (right) score

Workera Score

Workforce ordered from highest (left) to lowest (right) score
Exemplifying heroes and demonstrating the value of AI through projects (“Look, it works”) helps gain traction from the broader community, pushing people to develop more skills.

Maturity 3: Raising the bar for everyone (Investigators curve)

Still too few top experts and examples of successful experiment/project

Workforce ordered from highest (left) to lowest (right) score

- Accomplished: ~10%
- Developing: ~70%
- Beginning: ~20%
About CS230
Course Logistics

- **CS230 is composed of 5 “courses”**
  - C1: Neural Networks and Deep Learning
  - C2: Improving Deep Neural Networks
  - C3: Strategy for Machine Learning Projects
  - C4: Convolutional Neural Networks
  - C5: Sequence Models

- **Class Terminology & Websites**
  - Terminology: “C2M3” = “Course 2 Module 3”
  - The schedule is on [http://cs230.stanford.edu/syllabus/](http://cs230.stanford.edu/syllabus/)
  - We use Coursera: [www.coursera.org](www.coursera.org)
  - The class forum is on [Ed discussion](http://eddiscussion), which is accessible through Canvas under “Ed Discussion” tab.
A week in the life of a CS230 student

Watch videos on Coursera

≈1h

Solve quiz

≈20min

Complete programming assignments

≈1-2h

= 1 module

Assignments and quizzes are due every week before lecture

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Grading Formula

$$Grade = 0.02A + 0.08Q + 0.25Pa + 0.25M + 0.40Pr$$

A = Attendance
Q = Quizzes
Pa = (Programming) assignments
M = Midterm
Pr = Final-project

Active Ed participation = 1% bonus
Late Days

Example: For next Wednesday at 9.45am PDT you have to complete the following assignments:

● 2 Quizzes:
  ○ Introduction to deep learning
  ○ Neural Network Basics

● 2 Programming assignments:
  ○ Python Basics with Numpy
  ○ Logistic Regression with a neural network mindset

At 7am on Wednesday: you submit 1 quiz and the 1 PA.
At 3pm on Wednesday: you submit the second quiz.
At 2pm on Thursday: you submit the second PA.

How many late days did you use?

3 late days

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(Soft) Prerequisites

Students are expected to have the following background, and are invited to take the Workera technical assessments prior to the class to self-assess themselves prior to taking the class:

- Knowledge of **basic computer science principles and skills**, at a level sufficient to write a reasonably non-trivial computer program. This corresponds to a Developing level (or badge) in the “Algorithmic Coding” section on Workera.
- Familiarity with the **probability theory** (CS 109 or STATS 116), which students can assess by taking the “Data Science” section on Workera.
- Familiarity with **linear algebra** (MATH 51), which students can assess by taking the “Mathematics” section on Workera.

(Recommended) Take the Workera assessment ([https://workera.ai/for-individuals/](https://workera.ai/for-individuals/)) prior to starting the class, you’ll take it again at the end of the class to measure your progress!

Take Workera assessments (DLE) at the end of the class. We recommend (at least) the domains:

- **Deep Learning** on Workera, try to reach the Accomplished level at the end of the class
- **Tensorflow (or Pytorch)** on Workera, try to reach Developing level at the end of the class
- **AWS** on Workera, try to reach Developing level at the end of the class

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Workera competency models

- Understanding Machine Learning Models
- Structuring Machine Learning Projects
- Understanding Methods to Train Machine Learning Models
- Loss Function
- Regularization
- Optimization
- Initialization
- Hyperparameter Tuning
- End-to-end Learning
- Transfer Learning
- Batch Size
- Learning Rate
- Model Selection
- Implementing a learning rate decay

Machine Learning

Domain

Sub-domain

Topic

Sub-topic

100's of skills
CS230 Projects Overview

A sneak peak at what you’ll work on!
I. Overview of CS230 programming assignments

II. Examples of student projects
Projects: SIGN language image classification

\[ y = 0 \]
\[
\begin{bmatrix}
1 \\
0 \\
0 \\
0 \\
0
\end{bmatrix}
\]

\[ y = 1 \]
\[
\begin{bmatrix}
0 \\
1 \\
0 \\
0 \\
0
\end{bmatrix}
\]

\[ y = 2 \]
\[
\begin{bmatrix}
0 \\
0 \\
1 \\
0 \\
0
\end{bmatrix}
\]

\[ y = 3 \]
\[
\begin{bmatrix}
0 \\
0 \\
0 \\
1 \\
0
\end{bmatrix}
\]

\[ y = 4 \]
\[
\begin{bmatrix}
0 \\
0 \\
0 \\
0 \\
1
\end{bmatrix}
\]

\[ y = 5 \]
\[
\begin{bmatrix}
0 \\
0 \\
0 \\
0 \\
1
\end{bmatrix}
\]
Projects: others

- Optimal goalkeeper shoot prediction
- Car detection
- Face recognition
- Art generation
- Music generation
- Text generation
- Emojifier
- Machine translation
- Trigger word detection

And many more…
Assignment: Car detection for autonomous driving
Projects: others

- Optimal goalkeeper shoot prediction
- Car detection
- Face recognition
- Art generation
- Music generation
- Text generation
- "I love you"
- Emojifier
- Machine translation
- Trigger word detection

And many more…
In the style of Claude Monet

In the style of Yayoi Kusama

In the style of Piet Mondrian

In the style of Pablo Picasso

[L. Gatys et al.: Image Style Transfer Using Convolutional Neural Networks, 2015]
In the style of Hilma af Klint

In the style of Jamini Roy

In the style of Eiichiro Oda

In the style of Salvador Dali

[L. Gatys et al.: Image Style Transfer Using Convolutional Neural Networks, 2015]
I. Overview of CS230 programming assignments

II. Examples of student projects
LeafNet: A Deep Learning Solution to Tree Species Identification

Predicting price of an object from a picture

[Steven Chen: Fall 2017]
Detect cards from real-time video of tournaments to improve viewer understanding and accessibility.

Figure 2: Predicted objects on a single frame from Dataset 1 produced by my model (left) and the YOLOv3 baseline (right).
**font-gen**: Deep Models for Inferring Alternate Language Sets from Fonts

**Figures 5-6**: Convolution; predicting Japanese sets.
NBA 2k19 DeepBaller: A NN-Controlled Real-Time video game AI

Image-to-Image translation with Conditional-GAN

Figure 3: Generated map images of different architecture and hyperparameters. From left to right are source aerial images, baseline, U-Net, U-Net with ImageGAN, ResNet-6, ResNet-9, ResNet-50, and ground truth map images.

### Discrete reasoning in natural language processing

<table>
<thead>
<tr>
<th>Reasoning</th>
<th>Passage (some parts shortened)</th>
<th>Question</th>
<th>Answer</th>
<th>BiDAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtraction (28.8%)</td>
<td>That year, his <strong>Untitled (1981)</strong>, a painting of a haloed, black-headed man with a bright red skeletal body, depicted amid the artists signature scrawls, was <strong>sold by Robert Lehrman for $16.3 million</strong>, well above its $12 million high estimate.</td>
<td>How many more dollars was the Untitled (1981) painting sold for than the 12 million dollar estimation?</td>
<td>4300000</td>
<td>$16.3 million</td>
</tr>
<tr>
<td>Comparison (18.2%)</td>
<td>In 1517, the seventeen-year-old King sailed to Castile. There, his Flemish court . . . In May 1518, Charles traveled to Barcelona in Aragon.</td>
<td>Where did Charles travel to first, Castile or Barcelona?</td>
<td>Castile</td>
<td>Aragon</td>
</tr>
<tr>
<td>Selection (19.4%)</td>
<td>In 1970, to commemorate the 100th anniversary of the founding of Baldwin City, <strong>Baker University professor and playwright Don Mueller and Phyllis E. Braun, Business Manager, produced a musical play entitled The Ballad Of Black Jack</strong> to tell the story of the events that led up to the battle.</td>
<td>Who was the University professor that helped produce The Ballad Of Black Jack, Ivan Boyd or Don Mueller?</td>
<td>Don Mueller</td>
<td>Baker</td>
</tr>
<tr>
<td>Addition (11.7%)</td>
<td>Before the UNPROFOR fully deployed, the HV clashed with an armed force of the RSK in the village of Nos Kalik, located in a pink zone near Šibenik, and captured the village at 4:45 p.m. on <strong>2 March 1992</strong>. The JNA formed a battlegroup to counterattack the next day.</td>
<td>What date did the JNA form a battlegroup to counterattack after the village of Nos Kalik was captured?</td>
<td>3 March 1992</td>
<td>2 March 1992</td>
</tr>
<tr>
<td>Count (16.5%) and Sort (11.7%)</td>
<td>Denver would retake the lead with kicker <strong>Matt Prater nailing a 43-yard field goal</strong>, yet Carolina answered as kicker <strong>John Kasay ties the game with a 39-yard field goal</strong> . . . Carolina closed out the half with Kasay nailing a 44-yard field goal. . . In the fourth quarter, Carolina sealed the win with <strong>Kasay’s 42-yard field goal</strong>.</td>
<td>Which kicker kicked the most field goals?</td>
<td>John Kasay</td>
<td>Matt Prater</td>
</tr>
</tbody>
</table>

• Roy, Quill, and Tuchman from Material Science & Engineering predicted the melting point and viscosity of ionic liquids based on the component anion and cation chemical structures (report poster).
• Buechler from Mechanical Engineering developed a deep learning framework to approximate the outputs from a power flow simulation, and evaluate performance for a variety of power network characteristics (report poster).
• Sokol and Aguirre from the Biomedical Informatics Training Program leveraged deep learning to estimate the ancestral composition of a genomic sequence at high resolution (report poster).
• Peng, Zhao, Yu from Computer Science, Civil Engineering, and Biomedical Engineering used deep learning to classify gestures from divers communicating with an autonomous robot companion in dangerous underwater environments (report poster).
• O’Day, Seagers, and Lee from Bioengineering and Mechanical Engineering studied neural signals of patients with Parkinson’s disease while walking to predict freezing behaviors (report poster).
And many more...

Predicting atom energy based on atomic-structure

Visual Question Answering

Cancer/Parkinson/Alzheimer detection

Activity recognition in video

Music genre classification / Music Compression

Accent transfer in a speech

Generating images based on a given legend

Detecting earthquake precursor signals

...

Check out past projects: http://cs230.stanford.edu/past-projects/
To sum up

1. You will learn about wide range of deep learning topics
2. The course is very applied, you will code these applications
3. You have access to mentorship to build an outstanding project in 10 weeks

For next week:
- Create Coursera account and join the private session using the invitation
- Finish C1M1 & C1M2
- 2 Quizzes:
  - Introduction to deep learning
  - Neural Network Basics
- 2 Programming assignments:
  - Python Basics with Numpy
  - Logistic Regression with a neural network mindset
- Find project team-mates and fill-in the Google form that will be posted on Ed soon.
- The GPU credit registration form will be posted with instructions on Ed soon. Upon forming a team, students should sign up for GPU credits.
- The teaching staff will create an open thread on Ed so that students can use it to find project teammates as we are all remote and this can prove cumbersome as compared to normal times.

This Friday: TA section “Getting Started with Your Project”

Download your iPython notebooks after you finished them!

You can find all deadlines on the website Syllabus