CSCI 111 Web Programming and Problem Solving
Section 1
PART III Artificial Intelligence
Weeks [12 - 15]
Week-12-lecture-1: Machine Learning
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CONTENT

- Introduction
- Machine Learning example
- Deep Learning examples
- Machine Learning
- One more example of ML
- Terms
- Summary

There is no clear definition of "intelligence"

INTRODUCTION

programs use algorithms upon data and return result

data + algorithms = result

AI use data and their results to develop algorithms for another results

data + results = algorithms

INTRODUCTION. Some scary math

$$\sum_{i=1}^{5} = 1 + 2 + 3 + 4 + 5$$

INTRODUCTION. Some scary math

$$P(A|B) = 0.7$$

INTRODUCTION. Some scary math

Conditional probability.
The probability that an event A occurs given that another event B already occurs.

$$P(A|B) = 0.7$$

A - Snow
B - Live in Astana

The probability that it snows today given that we live in Astana is 70%

ML ⊂ AI

Artificial Intelligence (AI)

Machine Learning (ML)

- supervised
  - classification
  - regression
- unsupervised
- reinforcement

Neural Networks (NN)

Deep Learning (DL)
big data, strong AI

AI Examples

Artificial Intelligence (AI)

Machine Learning (ML)

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- reinforcement

Neural Networks (NN)

Deep Learning (DL)
big data, strong AI

ML Example. Buy a phone.

BUY A PHONE

Human. Logic and Reasoning.

Look carefully for features such as

```
brand, price, memory, display size, camera
```

etc.

Find the most optimal combination.

ML Example. Buy a phone.

BUY A PHONE

Human. Experience.

Ask friends `what phone` they have and what they `like` and `dislike` about it.

Form a list of information and use that list to `decide`.

ML Example. Buy a phone.

Human. Experience. ⟶ Machine Learning. Data.

Ask friends **what phone** they have and **what they like** and **dislike** about it.

Form a list of information **then** use that list to **decide**.

Remember ⟶ Formulate ⟶ Predict.

ML Example. Buy a phone.

Machine Learning use Data:

phone name	like	dislike
iphone 16 pro	photo camera	video camera
iphone 16	display size	price
Samsung s24	S Pen	weight
Huawei Mate X3	double screen	operating system

Decide:

best phone name

Deep Learning (DL $\subset$ ML)

Neurons - are the fundamental units of the brain and nervous system, the cells responsible for

- receiving sensory input from the external world,
- sending motor commands to our muscles,
- transforming and relaying the electrical signals at every step in between.

Approximately 86 billion neurons

form 100 trillion connections in human brain.

https://qbi.uq.edu.au/brain/brain-anatomy/what-neuron
https://hms.harvard.edu/news/new-field-neuroscience-aims-map-connections-brain
https://www.nature.com/scitable/blog/brain-metrics/are_there_really_as_many/
https://news.ucr.edu/articles/2020/07/24/neurons-are-genetically-programmed-have-long-lives

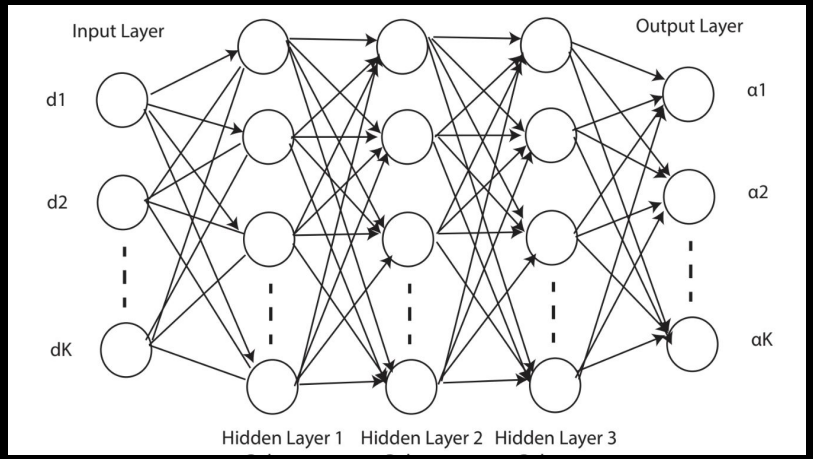
Deep Learning (DL $\subset$ ML)

(Artificial) Neural Networks (NN) are meant to mimic how the human brain operates.

Deep Learning is a field of ML which use NN.

DL popularity due to:

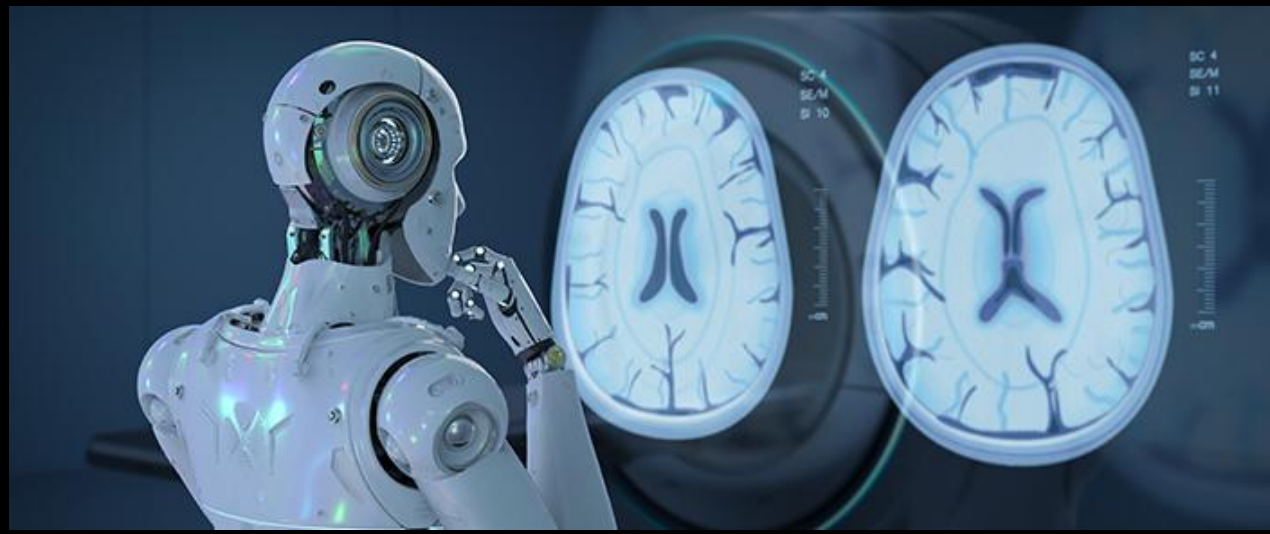
- Processors became fast enough
- Storage became large enough
- Training and tuning improved



https://link.springer.com/article/10.1007/s11277-022-09511-6

Deep Learning Application Examples

- Image recognition
  - Medical Diagnosis



https://blog.labtag.com/wp-content/uploads/2021/10/0139-Diagnostic-AI-700x290px.jpg

Deep Learning Application Examples

- Image recognition
  - Medical Diagnosis
  - Face Detection

https://itchronicles.com/wp-content/uploads/2023/07/face-recognition-1024x630.jpg

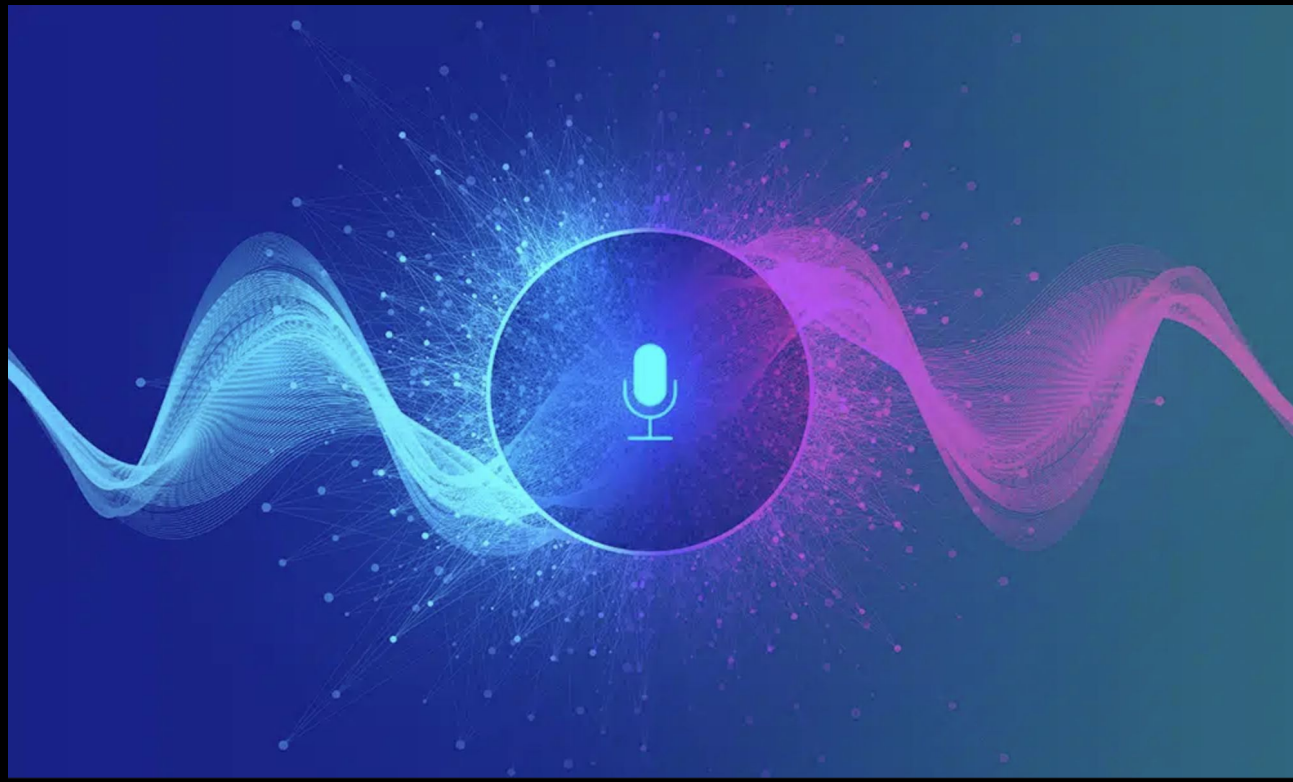
Deep Learning Application Examples

- Image recognition
  - Medical Diagnosis
  - Face Detection
  - Self-driving cars

https://static01.nyt.com/images/2024/05/22/multimedia/22sf-driverless-cars-tvqz/22sf-driverless-cars-tvqz-mediumSquareAt3X.jpg

Deep Learning Application Examples

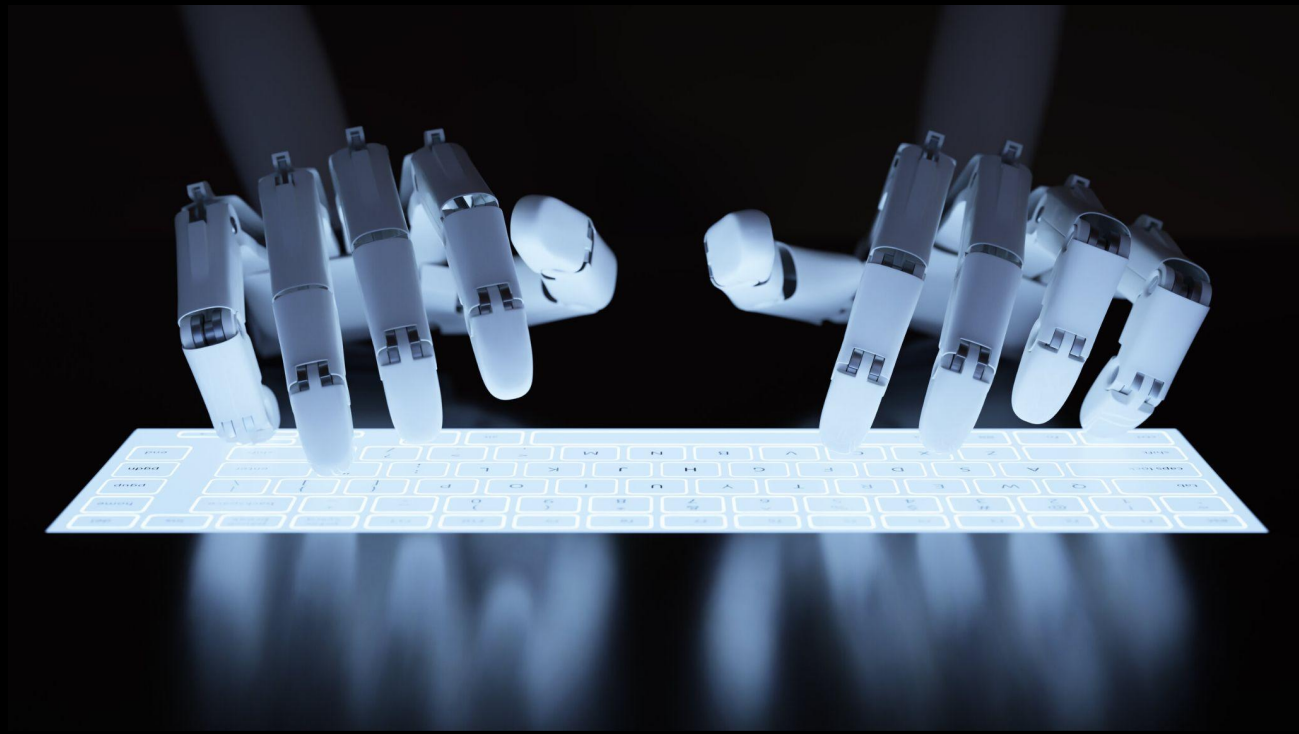
- Image recognition
  - Medical Diagnosis
  - Face Detection
  - Self-driving cars
- Voice Recognition



https://www.shaip.com/wp-content/uploads/2022/12/Blog_Difference-Between-Speech-Voice-Recognition.jpg

Deep Learning Application Examples

- Image recognition
  - Medical Diagnosis
  - Face Detection
  - Self-driving cars
- Voice Recognition
- Text generation



https://images.squarespace-cdn.com/content/v1/57462f541bbee075320514a9/1624462944359-1UDIFWK5V8FZATQNKVXY/shutterstock_403937386.jpg

Machine Learning

Teach computer to

- REMEMBER data
- *FORMULATE ~~rule~~ model*
- PREDICT the result

Machine Learning

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Model - is a set of rules that represent our data and can be used to make predictions

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Algorithm - is a set of steps to solve a problem. In ML to build a model.

Machine Learning

Teach computer to

- REMEMBER data
- *FORMULATE ~~rule~~ model*
- PREDICT the result

Model - is a set of rules that represent our data and can be used to make predictions

Algorithm - is a set of steps to ~~solve a problem~~ build a model.

SPAM from Friend. Model 1.

Our friend Kenes often sends us messages.

Looking at the last 10 messages we recognize that mostly they are not urgent:

There are 6 spam messages and 4 not spam

When new message is received we may roughly conclude that it is spam.

SPAM from Friend. Model 2.

We start to look at emails and pay attention to days of the week:

Monday: Meaningful
Tuesday: Meaningful
Saturday: Spam
Sunday: Spam
Sunday: Spam
Wednesday: Meaningful
Friday: Meaningful
Saturday: Spam
Tuesday: Meaningful
Thursday: Meaningful

When new message is received on weekends we may roughly conclude that it is spam.

SPAM from Friend. Model 3.

Once we meet Kenes and he asks why have I missed his birthday last Sunday.

SPAM from Friend. Model 3.

Once we meet Kenes and he asks why have I missed his birthday last Sunday.

We need to look at data again:

1 KB: Meaningful
2 KB: Meaningful
16 KB: Spam
20 KB: Spam
18 KB: Spam
3 KB: Meaningful
5 KB: Meaningful
25 KB: Spam
1 KB: Meaningful
3 KB: Meaningful

Any email of size 10 KB or larger is spam, and any email of size less than 10 KB is meaningful.

SPAM from Friend. Model 4.

Monday: Meaningful	1 KB: Meaningful
Tuesday: Meaningful	2 KB: Meaningful
Saturday: Spam	16 KB: Spam
Sunday: Spam	20 KB: Spam
Sunday: Spam	18 KB: Spam
Wednesday: Meaningful	3 KB: Meaningful
Friday: Meaningful	5 KB: Meaningful
Saturday: Spam	25 KB: Spam
Tuesday: Meaningful	1 KB: Meaningful
Thursday: Meaningful	3 KB: Meaningful

days of the week and size are features

If an email is larger than 10 KB or it is sent on the weekend, then it is classified as spam. Otherwise, it is classified as meaningful.

SPAM from Friend. More Models.

Monday: Meaningful	1 KB: Meaningful
Tuesday: Meaningful	2 KB: Meaningful
Saturday: Spam	16 KB: Spam
Sunday: Spam	20 KB: Spam
Sunday: Spam	18 KB: Spam
Wednesday: Meaningful	3 KB: Meaningful
Friday: Meaningful	5 KB: Meaningful
Saturday: Spam	25 KB: Spam
Tuesday: Meaningful	1 KB: Meaningful
Thursday: Meaningful	3 KB: Meaningful

If the email is sent during the week,
then it must be larger than 15 KB
to be classified as spam.

If the email is sent during the weekend,
then it must be larger than 5 KB
to be classified as spam.

Otherwise, it is classified as meaningful.

SPAM from Friend. More Models.

Monday: Meaningful	1 KB: Meaningful
Tuesday: Meaningful	2 KB: Meaningful
Saturday: Spam	16 KB: Spam
Sunday: Spam	20 KB: Spam
Sunday: Spam	18 KB: Spam
Wednesday: Meaningful	3 KB: Meaningful
Friday: Meaningful	5 KB: Meaningful
Saturday: Spam	25 KB: Spam
Tuesday: Meaningful	1 KB: Meaningful
Thursday: Meaningful	3 KB: Meaningful

Consider the number of the day, where
Monday is 0,
Tuesday is 1,
Wednesday is 2,
Thursday is 3,
Friday is 4,
Saturday is 5,
Sunday is 6.
If we add the number of the day and the size of the email (in KB), and the result is 12 or more, then the email is classified as spam. Otherwise, it is classified as meaningful.

Machine Learning

REMEMBER: Look at a huge table of data.

FORMULATE MODEL: Go through many rules and formulas, and check which model fits the data best.

PREDICT: Use the model to make predictions about future data.

SPAM from Friend. Some More Features.

- If the email has two or more spelling mistakes, then it is classified as spam.
- If it has an attachment larger than 10 KB, it is classified as spam.
- If the sender is not in our contact list, it is classified as spam.
- If it has the words buy and win, it is classified as spam.
- Otherwise, it is classified as meaningful.

if (size) > 10

and

if (number of spelling mistakes) + (number of appearances of the word “buy”) > 10

then we classify the message as spam.

Otherwise, we classify it as meaningful.

Terms

"Machine Learning - is a common sense done by a computer."

Grokking Machine Learning, Luis Serrano 2021

"Machine Learning is a subfield of computer science that gives computers the ability to learn without being programmed"

Arthur Samuel, IBM Journal of Research and Development, Vol. 3, 1959

"Artificial intelligence refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions."

Investopedia 2022

"Artificial Intelligence is the set of all tasks in which a computer can make decisions"

Grokking Machine Learning, Luis Serrano 2021

Summary

Machine Learning is …

- not difficult to start
- applied in science, social problems, medicine etc.
- common sense, done by a computer. It mimics the ways humans think to make decisions quickly and accurately.
- make decisions based on previous data by computers like humans make decisions on experience.

Self work

https://www.w3schools.com/ai/default.asp

https://www.w3schools.com/ai/ai_history_brain.asp

Serrano, L., 2021. *Grokking machine learning*. Simon and Schuster. Chapter 1