

Welcome to SEAS Online at George Washington University

Class will begin shortly

Audio: To eliminate background noise, please be sure your audio is muted. To speak, please click the hand icon at the bottom of your screen (**Raise Hand**). When instructor calls on you, click microphone icon to unmute. When you've finished speaking, ***be sure to mute yourself again.***

Chat: Please type your questions in Chat.

Recordings: As part of the educational support for students, we provide downloadable recordings of each class session to be used exclusively by registered students in that particular class. **Releasing these recordings is strictly prohibited.**

SEAS 8520 – Lecture 1: Course Intro & Overview

Walid Hassan, M.B.A, D.Eng.

AI & Ethics

“ This potent technology will change the world to at least the same extent as electricity, the internal combustion engine, the transistor, or the internet. The potential benefits in healthcare, design, entertainment, transport, education, and almost every area of commerce are enormous. However, scientists and engineers are often unrealistically optimistic about the outcomes of their work, and the potential for harm is just as great.”

Src: Prince, S. J. (January 28, 2024). Understanding Deep Learning. MIT Press. <http://udlbook.com>

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Agenda

- Introduction
- Syllabus Walk-Thru
- Overview of Deep Learning
- Applications of Deep Learning
- Environment Setup

About Me



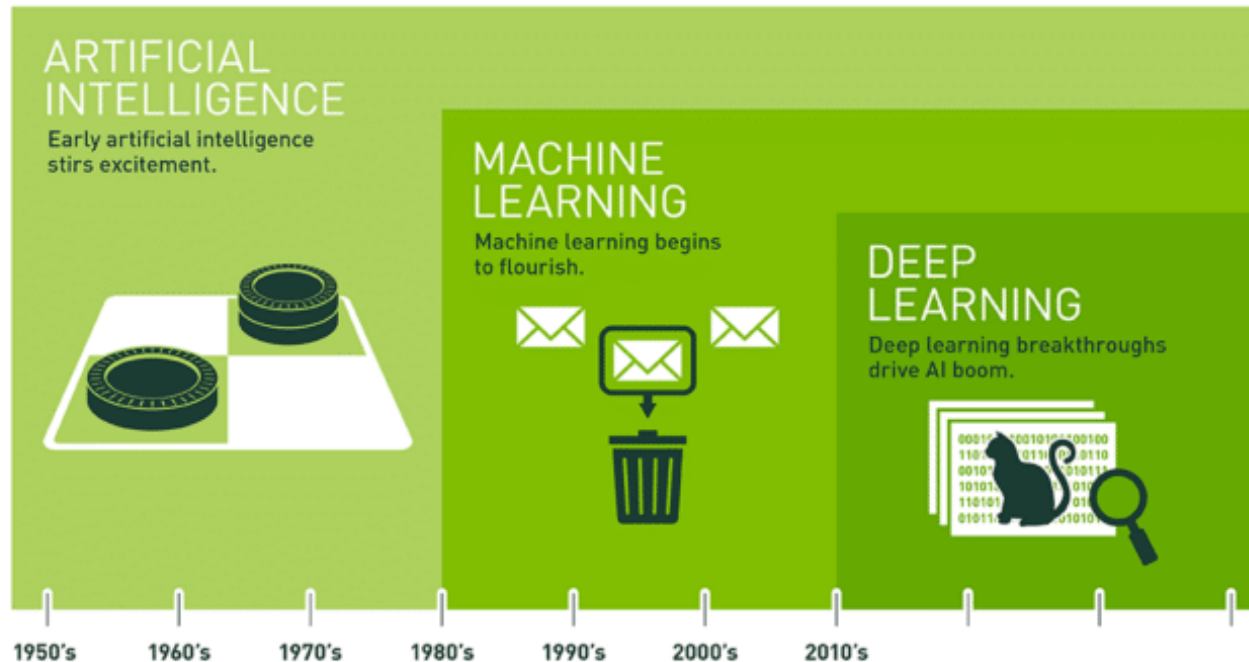
- BS in Computer Engineering – Beirut
 - MBA – Wharton School, UPenn
 - Doctorate in Engineering Management - GWU
-
- Email: wnhassan@gwu.edu
 - Typically, emails will be answered within 24 hours
-
- Office hours:
 - Wednesday, 6 – 7:30 pm Est
 - Friday 6 – 7:30 pm Est

About You

- Name:
- Education:
- Profession: If working/ worked
- Python programming proficiency?
- Hobbies/Interests
- Anything else worth sharing

Course Syllabus

Artificial Intelligence - Machine Learning - Deep Learning



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Source: <https://blogs.nvidia.com/blog/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/>

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Artificial Intelligence - Machine Learning - Deep Learning

- **Artificial Intelligence (1950s):** This period is characterized by an initial wave of excitement about the possibilities of creating machines that could simulate aspects of human intelligence. The models developed are rule-based.
- **Machine Learning (1970s):** The era when machine learning began to flourish. Machine learning is a subset of AI that focuses on the development of algorithms that can learn from and make predictions or decisions based on data.
- **Deep Learning (2010s):** The most recent development is deep learning, which began to cause significant disruption in the 2010s. Deep learning is a subset of machine learning that uses neural networks with many layers (hence "deep") to process data in a hierarchical manner, allowing machines to identify patterns and make decisions with minimal human intervention.

- Neural Networks date back decades, so why the resurgence?

1. Big Data

- Larger Datasets
- Easier Collection & Storage

IMAGENET



Source: MIT

2. Hardware

- Graphics Processing Units (GPUs)
- Massively Parallelizable

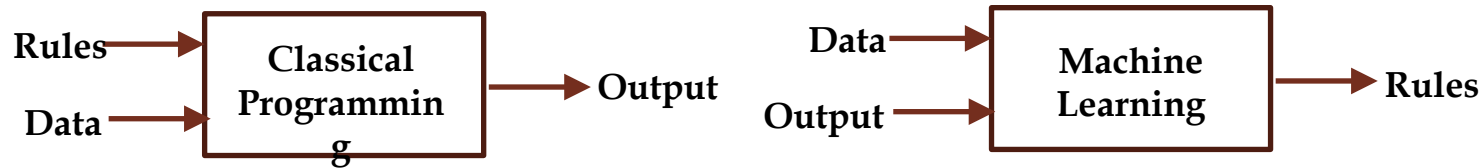


3. Software

- Improved Techniques
- New Models
- Toolboxes



What is Machine Learning (ML)?



- Machine Learning: Field of study that gives computers the ability to learn without being explicitly programmed
- The study of computer programs (algorithms) that can learn by example
- ML algorithms can generalize from existing examples of a task

Traditional Programming vs. Machine Learning - Example

Imagine creating a system to sort fruits based on their type.

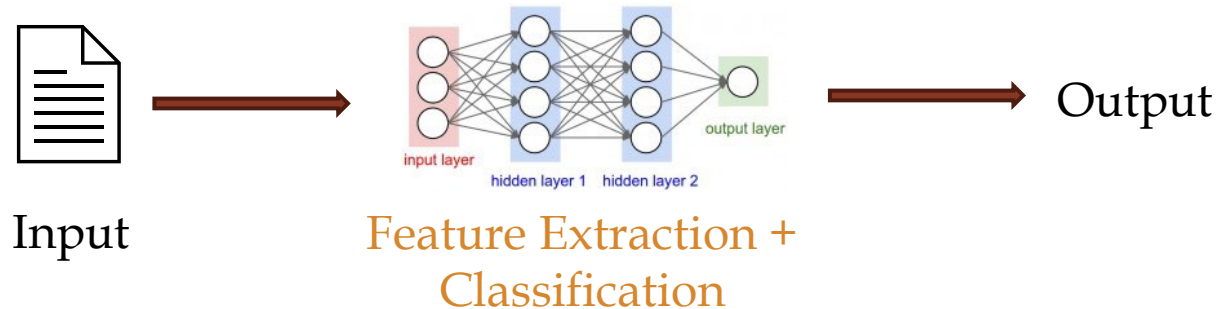
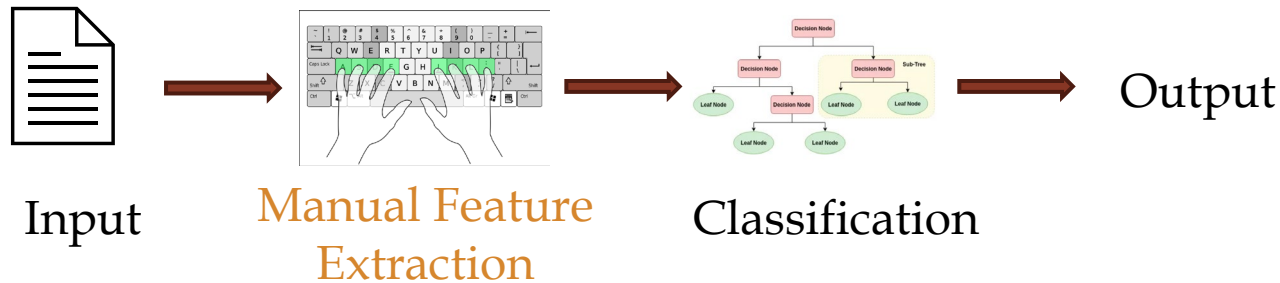
- **Traditional Approach:** You'd write rules like, "If the fruit is red and round, it's an apple." "If it's yellow and curved, it's a banana."
- **Machine Learning Approach:** We start by selecting specific characteristics, like color, size, and shape, from a large set of fruit images. This step is called feature extraction. After extracting these features, we input them into the machine learning system, which then learns to associate certain features with specific fruit types. Once trained, the model uses these patterns to identify and classify new fruit images. The key to a successful model is selecting the right features, which sometimes requires expert knowledge.

What is Deep Learning?

- **Definition:** Deep learning is an advanced AI technique that uses multi-layered neural networks to mimic human brain functions.
- **Data-Driven Approach:** Trains on large data sets, learning directly from the data without manual feature extraction.
- **Applications:** Powers modern AI applications like voice recognition, image processing, and autonomous vehicles.
- **Challenges:** Requires substantial data and computing power and faces issues like interpretability and ethical considerations.

Deep Learning Vs. Machine Learning Approach

Machine Learning



DL vs. ML – Feature Extraction

Traditional Machine Learning:

- **Manual Feature Extraction:** Before training a model, domain experts typically have to identify the right features (or variables) that will be useful in predicting the outcome. This involves domain-specific knowledge and manual effort.

Deep Learning:

- **Automated Feature Extraction:** In deep learning, the neural networks are designed to automatically learn the best features from raw data during the training process.
- **Classification (or Prediction):** After automatically extracting features, the later layers of the neural network are responsible for making predictions or classifications based on those features.

DL vs. ML – Example

Imagine you're trying to grade essays.

In the traditional ML approach: You might manually design a rubric, deciding to grade based on grammar, use of vocabulary, clarity of argument, length of essay, and number of references cited.

In the deep learning approach: You feed numerous examples of essays directly into a neural network, along with their grades. The network learns on its own which aspects of an essay correlate with higher or lower grades. Note that while deep learning can automatically extract features, it doesn't mean it always understands them in the way humans do. The features learned by deep learning models are often abstract and not easily interpretable by humans.

Applications of Deep Learning



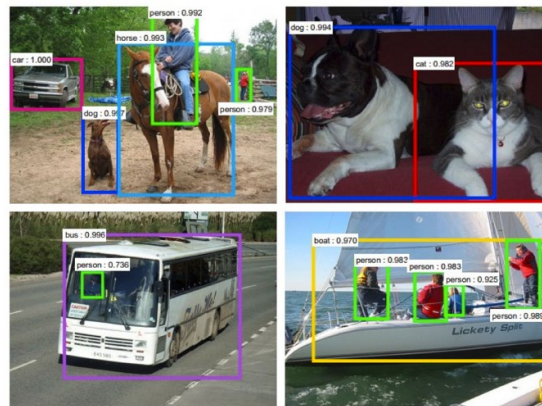
Source: <https://www.interviewbit.com/blog/applications-of-deep-learning/>

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Image & Video Recognition

Apps like Snapchat and Instagram use deep learning for their filters, which can detect faces and apply fun modifications in real-time.

Technologies such as Google Photos can categorize and tag photos without manual input, identifying objects, locations, and even people.



<https://proceedings.neurips.cc/paper/2015/file/14bfa6bb14875e45bba028a21ed38046-Paper.pdf>

Game Playing & AI

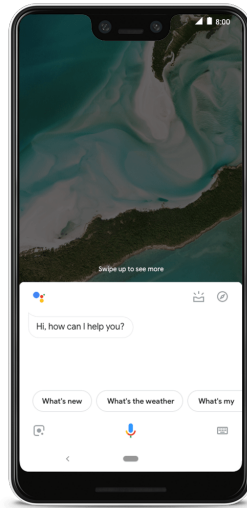
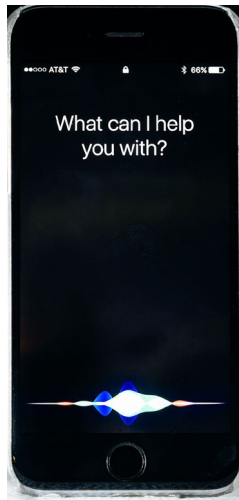
AlphaGo by DeepMind, a subsidiary of Alphabet Inc. (Google's parent company), defeated the world champion Go player, a feat previously thought to be decades away due to the game's complexity.



Source: <https://intellipaat.com/blog/power-of-deep-learning-alphago-vs-lee-sedol-case-study/?US>

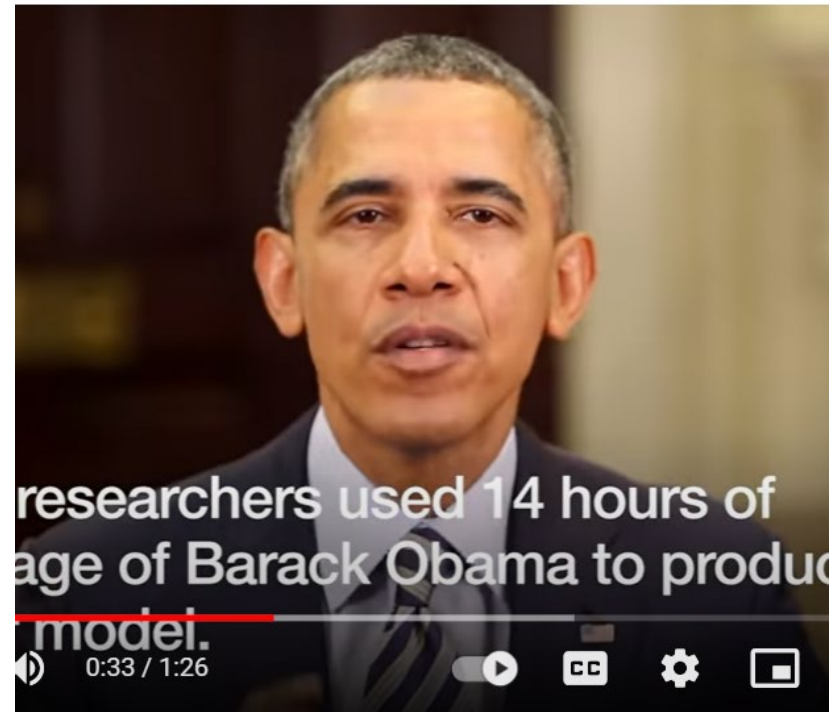
NLP & ChatBots

Virtual assistants like Siri, Alexa, and Google Assistant rely on deep learning to understand voice commands and produce human-like responses. They can answer questions, play music, set reminders, and even tell jokes.



Deepfake Creation & Detection

Deep learning can be used to create deepfakes: highly realistic but entirely fake content. This tech can swap faces in videos, mimic voices, or even generate entirely new content.



<https://www.youtube.com/watch?v=AmUC4m6w1wo>

Turning the Day into Night



<https://www.youtube.com/watch?v=N7KbfWodXJE>

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Autonomous Vehicles

Companies like Tesla and Waymo are developing self-driving cars using deep learning. These vehicles can recognize obstacles, read traffic signs, and make driving decisions on the fly.



<https://www.youtube.com/watch?v=URmxzxYlmtg&t=390s>

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Reasoning Tasks

Prompt :

If tomatoes are technically a fruit, then is ketchup a smoothie?

ChatGPT's Response:

Well, while tomatoes are botanically classified as a fruit, culinary usage often treats them as a vegetable due to their savory flavor. Ketchup, which is primarily made from tomatoes, is further flavored with vinegar, sugar, and other spices. So even though you might argue it's a "fruit sauce," calling ketchup a smoothie would be a stretch. Besides, I wouldn't recommend drinking it for breakfast!

Reasoning Tasks

Prompt:

If Cinderella's shoe fit perfectly, why did it fall off in the first place?

ChatGPT's Response:

That's a classic "fairy tale logic" question! Perhaps Cinderella's shoes were the magical kind that fit perfectly but didn't have the best grip. Or maybe she was just in such a hurry that she didn't notice it slipping off. But, without that little shoe mishap, Prince Charming wouldn't have had a reason to search the kingdom, and the story wouldn't be as enchanting. So, let's just chalk it up to the magic of storytelling!

Reasoning Tasks

Prompt:

If a tree falls in a forest and no one's around to hear it, does it still make a sound?

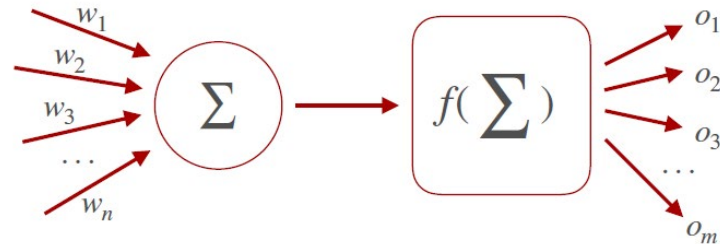
ChatGPT's Response:

Ah, the age-old philosophical question! Scientifically, when a tree falls, it creates vibrations in the air which we perceive as sound. So yes, those vibrations (or sound waves) still happen whether or not there's someone there to hear them. But philosophically, if sound is defined by perception, and there's no one there to perceive it, is it truly a sound? Either way, the tree might just be trying to make a dramatic point without an audience!

Artificial Neural Networks

ANN is an information processing system that has certain performance characteristics in common with biological nets.

- A neuron acts like a tiny information hub, receiving incoming signals, processing them, and then either forwarding these signals to other neurons or stopping their propagation.
- Receives input from sources
- Computes weighted sum
$$h1 = x_1w_1 + x_2w_2 + \dots x_nw_n$$
- Passes through an activation function
- Sends the signal to succeeding neurons

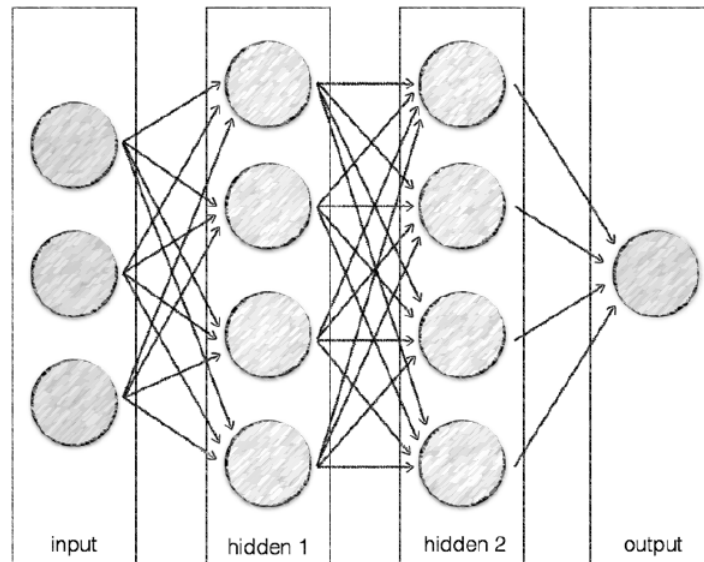


Source: databricks: Deep Learning Fundamentals

ANNs

Artificial Neural Network

- Organized into layers of neurons as a Blackbox model
- Typically, 3 or more: input, hidden and output



Source; databricks - Deep Learning Fundamentals

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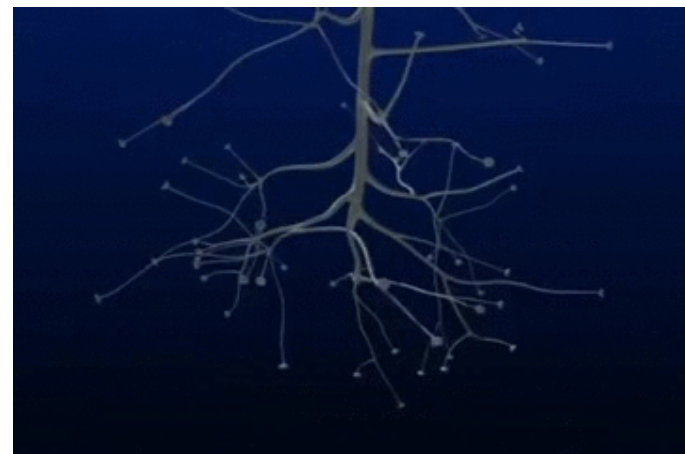
ANNs

A *neuron* receives a signal, processes it, and propagates the signal (or not)

- The brain is comprised of around 100 billion neurons, each connected to ~10k other neurons: 10^{15} synaptic connections

- ANNs are a *simplistic* imitation of a brain

comprised of dense net of simple structures



Source: databricks: Deep Learning Fundamentals

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Backup

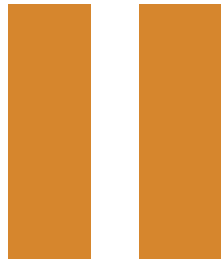
Google Colab

A Beginner's Guide

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Hands On.....



BREAK



**Please come back @
10:15 AM EST
9:15 AM CST**

BACK-UP

References

In addition to the references in each slide the below are leveraged throughout this course.

Gareth James, D. W. (2023). An Introduction to Statistical Learning: with Applications in Python. Springer.

VanderPlas, J. (2017). Python Data Science Handbook. O'Reilly.

Wolff, S. G. (2018). Less is more: optimizing classification performance through feature selection in a very-high-resolution remote sensing object-based urban application. GIScience & Remote Sensing. doi:10.1080/15481603.2017.1408892

Prince, S. J. (January 28, 2024). Understanding Deep Learning. MIT Press.