ML SIG Day 3
Advanced Topics & Real-World Applications

- NEURAL NETWORKS
- TRANSFORMERS
- CURRENT ML TRENDS

Latest ML Trends

What's trending in 2025

1. Generative AI

DALL-E, Midjourney, Stable Diffusion

2. Large Language Models

GPT-4, Claude, Gemini

3. Computer Vision

Object Detection, Face Recognition

4. AI in Healthcare

Drug Discovery, Medical Imaging

But why and how do these applications work?

THE ANSWER LIES IN *TRAINING MASSIVE DEEP NEURAL NETWORKS*.

But what is a Neural network?

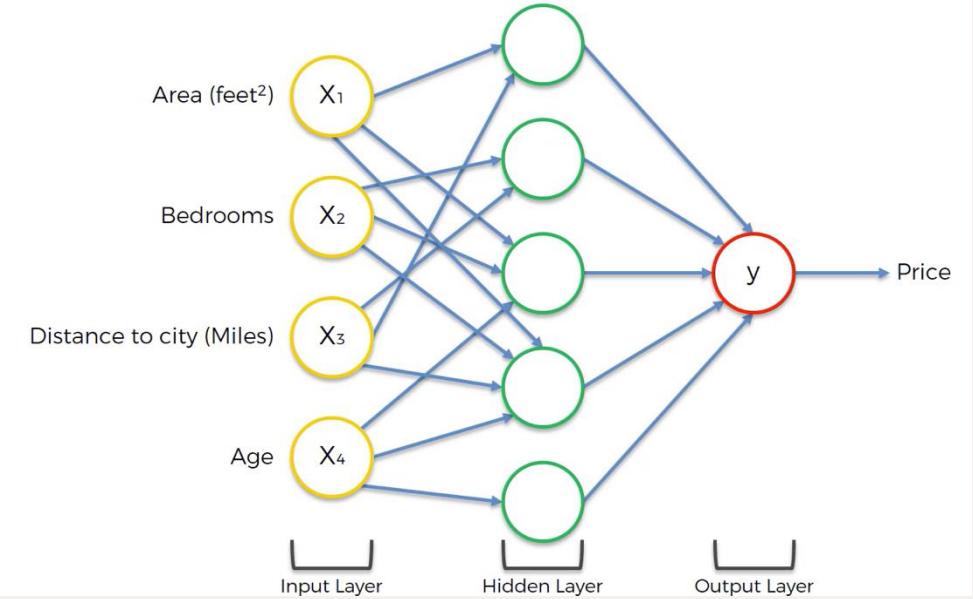
Earliest computer scientists were inspired by the structure of human brain as a catalyst to aid the development of machines mimicking human behavior around *1940s* leading to the development of ***"Perceptron" – the first neural network*** (for binary classification)

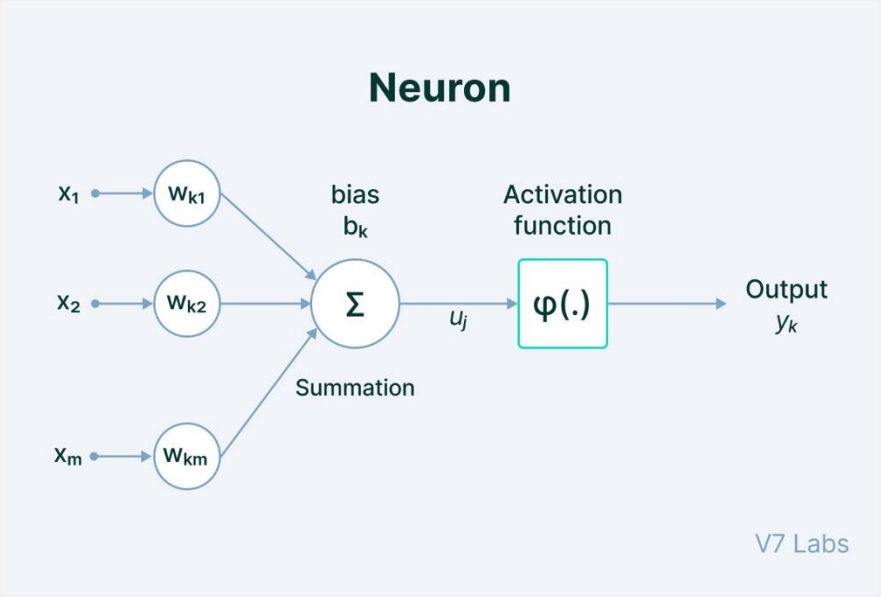
Broadly speaking, there have been three waves of development of deep learning: deep learning known as **cybernetics** in the *1940s–1960s*, deep learning known as **connectionism** in the *1980s–1990s*, and the current resurgence under the name ***deep learning*** beginning in 2006. *(goodfellow et. al 2016)* .

In a nutshell we can describe the primary objective of neural networks as "***pattern recognizers***"

Basic structure of a Neural Network

- General example of house price prediction

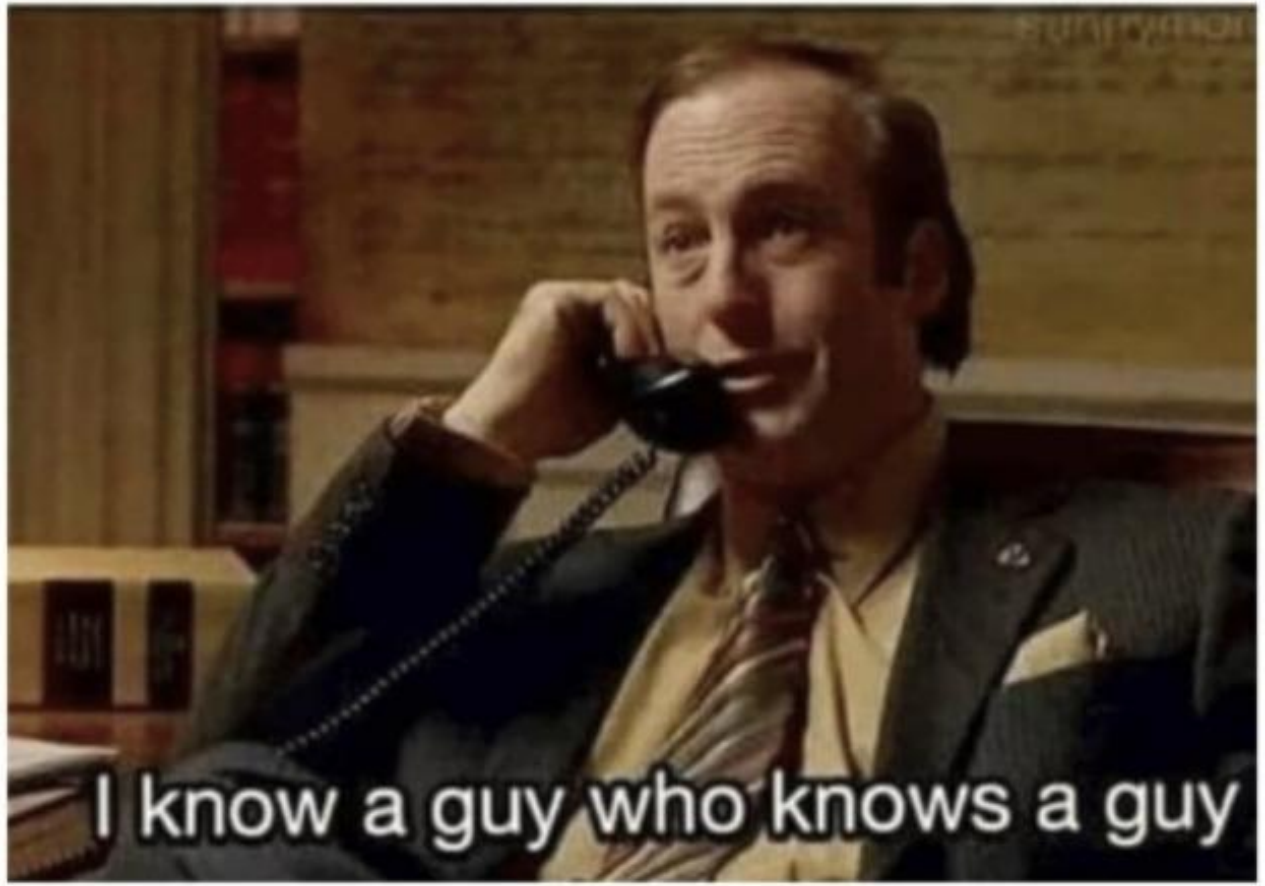




- Structure of a neuron inside a NN

How Neural Networks work?

Neurons:



Why are neural networks popular right now ?

IF THE HISTORY DATES BACK TO THE 1940'S WHY ARE THEY SUDDENLY GETTING POPULAR?

🧐

The answer lies in the following:

- Availability of massive corpora of digital data!
- Computational resources such as GPUs makes it feasible to train massive neural networks (NVIDIA $$ 🤑😄)
- Development in the field of deep learning led to algorithms such as backpropagation – used to train multi layer perceptrons (MLP)

Let’s build a simple neural network from scratch , without any libraries or import functions!

Why? Because learning without understanding the things under the hood yields nothing!

Colab Link


dont worry about it if you don't understand

Transformer – Magic behind today's breakthroughs

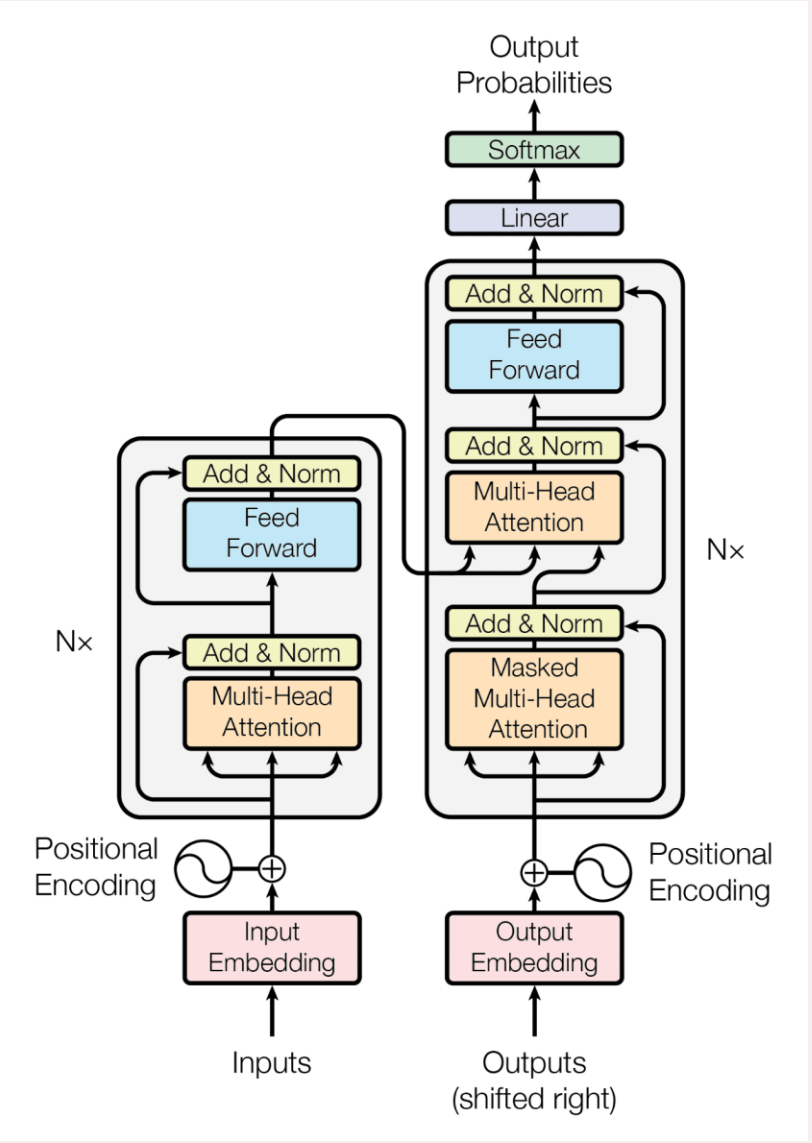
- The transformer architecture is at the heart of groundbreaking models like ChatGPT.
- To put it simply:

A transformer is a type of artificial intelligence model that learns to understand and generate human-like text by analysing patterns in large amounts of text data.

- The art of text generation has been envisioned for long by the computer scientists, the first such text-generation model was *ALIZA* in the 1960's which was then considered a huge deal.
- Current SOTA models (ChatGPT, Gemini) achieve remarkable results due to a concept called the "Self-Attention" specifically designed to comprehend context and meaning by analysing the relationship between different words in a sentence.

Transformer Architecture

- No need to understand it right now !! Be happy to ignore it, this is just for general info.
- The architecture was proposed in 2017 in the paper "*Attention is all you need*".
- **FUN FACT : CO AUTHOR OF THAT PAPER IS OUR PICT ALUMNI – NIKI PARMAR**



Can we use such models for our personal use/projects?

The answer is YES!

Open-source platforms like HuggingFace provide a means to do exactly that. Let's have a quick demo!

Impact of AI in real life

Generative AI

Dall- E 3 : **diffusion + transformer conditioning**

Midjourney :**custom diffusion (artistic style)**

Stable Diffusion : Diffusion with VAE

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Gpt-4 : rlhf , Moe, Code + Text

Claude : Constitutional AI, alignment-first

Gemini : Search integration, retrieval augmentation

What's In Tech

Computer Vision

Object detection : Yolo, Ssd , PyTorch, TensorFlow ,TensorRT

Face recognition : FaceNet, DeepFace, ArcFaceDlib, InsightFace

AI in Healthcare

Drug Discovery : GNNs , rl , DeepChem , RDKit Medical Imaging : Vision Transformers , MONAI , NiftyNet

Generative AI

- Creating Presentation Graphics
- Generating UI Mockups for app/website
- Synthesizing design ideas

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- Debugging Code and explaining errors
- Summarizing Research Papers
- Practicing Viva Questions

Computer Vision

- Attendance Automation
- Handwriting Digit Recognition
- Autonomous Vehicles

AI in Healthcare

- ECG or X-ray analysis.
- Patient monitoring systems.
- Personalized Treatment Plans