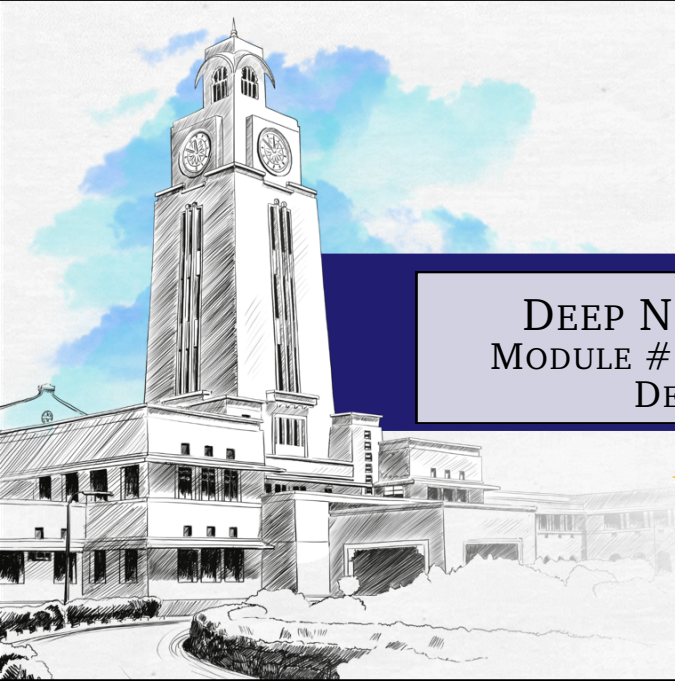

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Deep Neural Network

Module # 1: Introduction to Deep Learning

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The instructor is gratefully acknowledging
the authors who made their course
materials freely available online.
This deck is prepared by Seetha Parameswaran.

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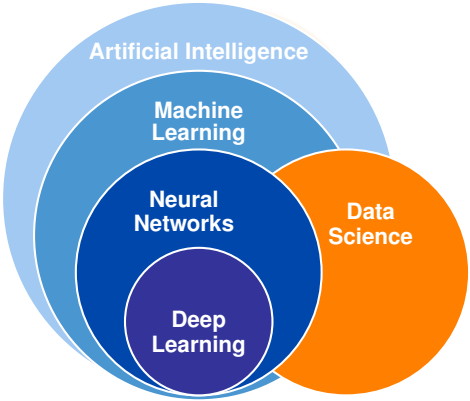
What is Deep Learning?

- Deep Learning is a type of **machine learning** based on **artificial neural networks** in which multiple layers of processing are used to extract progressively higher level features from data.
- Deep learning is a method in artificial intelligence (AI) that teaches computers to process data in a way that is **inspired by the human brain**.
- Deep learning is a machine learning technique that teaches computers to do what comes naturally to humans: **learn by example**.
- Deep learning is a subset of machine learning, which is essentially a neural network with **three or more layers**.
- Deep Learning gets its name from the fact that we add more **Layers** to learn from the data.

Where in AI sits DL?

- AI is a general field that encompasses machine learning and deep learning, but that also includes many more approaches that don't involve any learning.



AI – ML – DL

AI : Artificial intelligence is the **science** of making things smart. The aim is make machines perform human tasks. Eg: Robot cleaning a room.

ML : Machine learning is an **approach** to AI. The machine learns or perform tasks through learning by experience.

DL : Deep Learning is a **technique** for implementing machine learning to recognise patterns.

Deep (Machine) Learning

- Deep learning is a specific subfield of machine learning.
- Learning representations from data that puts an emphasis on learning successive layers of increasingly meaningful representations.
- The **deep** in deep learning stands for this idea of successive layers of representations.
- The number of layers that contribute to model the data is called the **depth** of the model.
- In deep learning, the layered representations are learned via models called **neural networks**, structured in literal layers stacked on top of each other.

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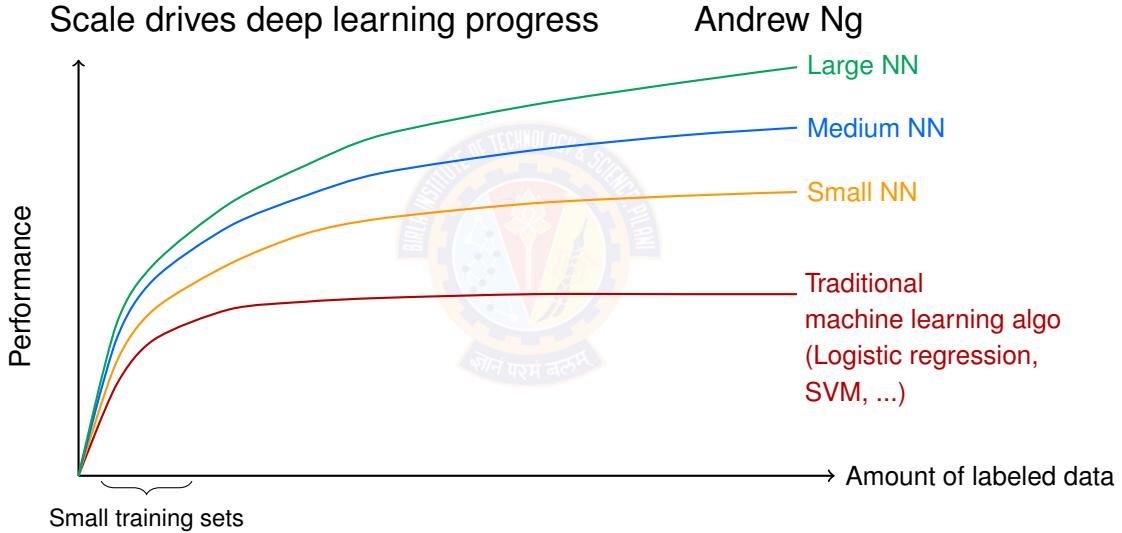
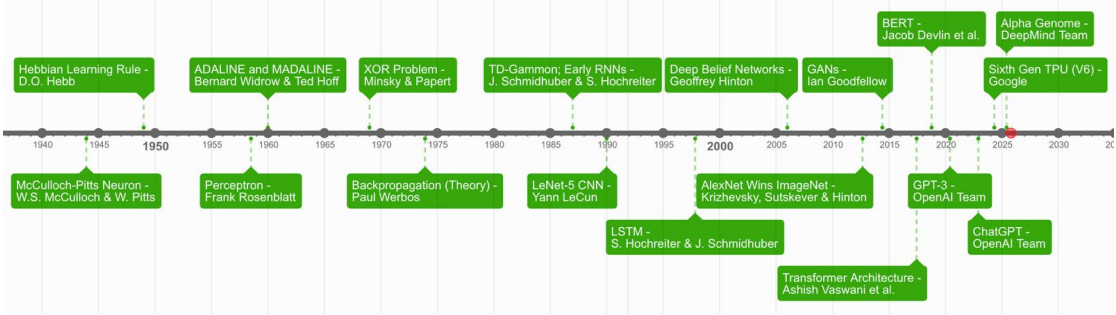
Why Deep Learning?

- Large amounts of data
- Lots and lots of unstructured data like images, text, audio, video
- Cheap, high-quality sensors
- Cheap computation - CPU, GPU, Distributed clusters
- Cheap data storage
- Learn by examples
- Automated feature generation
- Better learning capabilities
- Scalability
- Advance analytics can be applied

Why Deep Learning?



Deep Learning: Timeline



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TECHNEWSWORLD EMERGING TECH SEARCH

Computing Internet IT Mobile Tech Reviews Security Technology Tech Blog Reader Service

Microsoft AI Beats Humans at Speech Recognition

By Richard Adhikari
Oct 20, 2016 11:40 AM PT

Print Email

Image: Adobe Stock

Microsoft's Artificial Intelligence and Research Unit earlier this week reported that its speech recognition technology had surpassed the performance of human transcriptionists.

Most Popular Newsletters News Aler

How do you feel about Black Friday and Cyber Monday?

- They're great -- I get a lot of bargains!
- The deals are too spread out -- I'd prefer just one day.
- They're a fun way to kick off the holiday season.
- I don't like the commercialization of Thanksgiving Day.
- They're crucial for the retail industry and the economy.
- The deals typically aren't that good.

Vote to See Results

E-Commerce Times

- Black Friday Shoppers Hungry for New Experiences, New Tech
- Pay TV's Newest Innovation: Giving Users Control
- Apple Celebrates Itself in $300 Coffee Table Tome
- AWS Enjoys Top Perch in IaaS, PaaS Markets
- US Comptroller Gears Up for Blockchain and

Breakthroughs with Neural Networks

Image Segmentation and Recognition

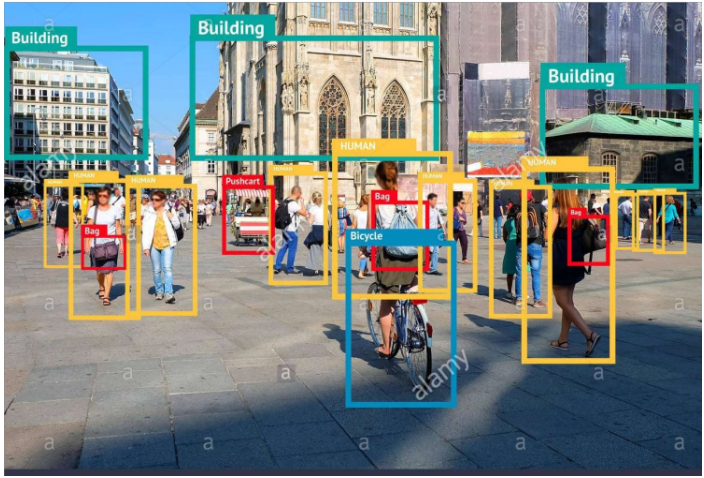
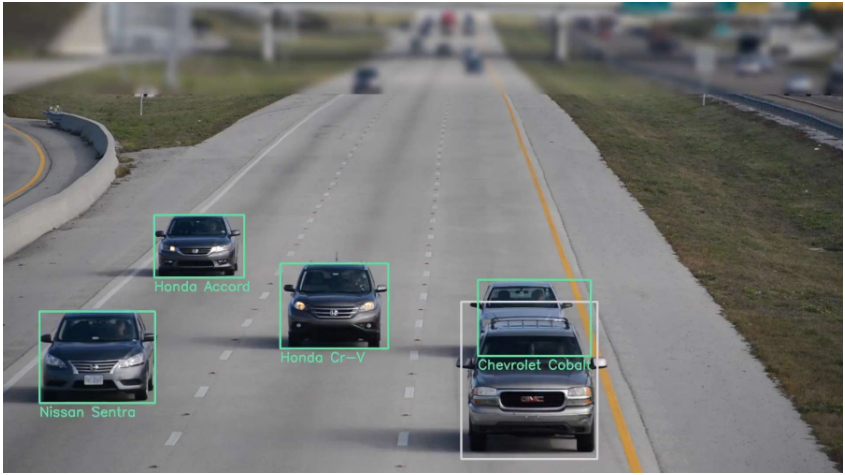


Image Recognition



Breakthroughs with Neural Networks

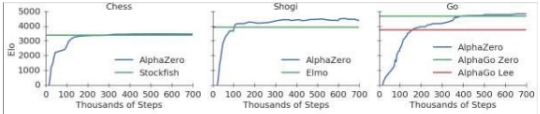
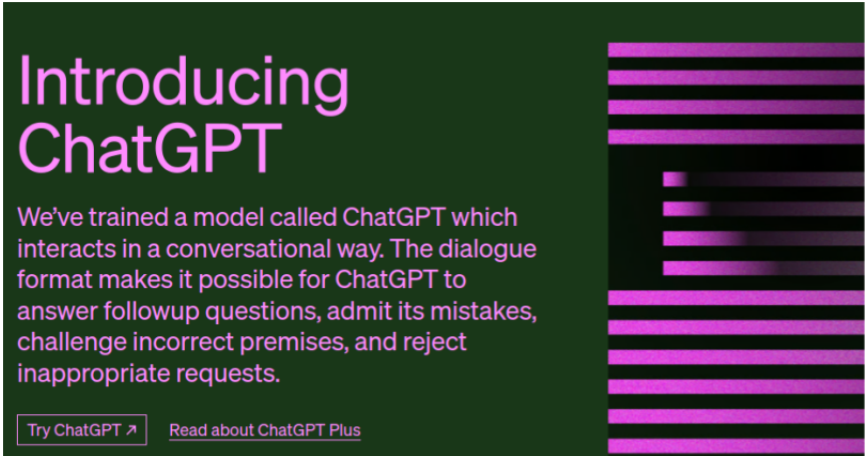


Figure 1: Training *AlphaZero* for 700,000 steps. Elo ratings were computed from evaluation games between different players when given one second per move. **a** Performance of *AlphaZero* in chess, compared to 2016 TCEC world-champion program *Stockfish*. **b** Performance of *AlphaZero* in shogi, compared to 2017 CSA world-champion program *Elmo*. **c** Performance of *AlphaZero* in Go, compared to *AlphaGo Lee* and *AlphaGo Zero* (20 block / 3 day) (*29*).

Breakthroughs with Neural Networks



Applications of Deep Learning

Application	Input	Output	Neural Network
Real Estate	House features	House Price	Std NN
Photo Tagging	Image	Text	CNN
Object detection	Image	Bounding box	CNN
Speech Recognition	Audio	Text transcript	RNN
Translation	English Text	French Text	RNN
Autonomous driving	Image, Sensors Radars	Position of other cars, objects, signals	Hybrid NN

Many more applications...

- a program that predicts tomorrow's weather given geographic information, satellite images, and a trailing window of past weather.
- a program that takes in a question, expressed in free-form text, and answers it correctly.
- a program that given an image can identify all the people it contains, drawing outlines around each.
- a program that presents users with products that they are likely to enjoy but unlikely, in the natural course of browsing, to encounter.

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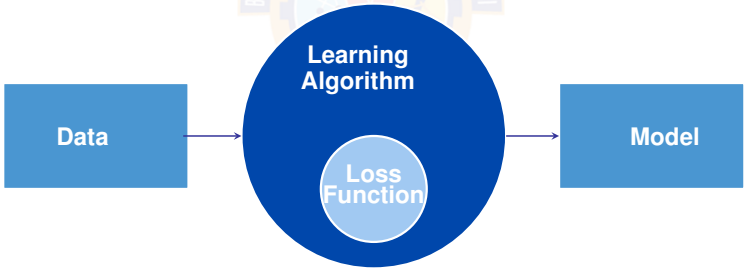
Core Components of DL Problem

- The **data** that we can learn from.
- A **model** of how to transform the data.
- An **objective function** that quantifies how well (or badly) the model is doing.
- An **algorithm** to adjust the model's parameters to optimize the objective function.



1. Data

- Collection of examples.
- Data has to be converted to an useful and a suitable numerical **representation**.
- Each example (or data point, data instance, sample) typically consists of a set of attributes called **features** (or covariates), from which the model must make its predictions.
- In the supervised learning problems, the attribute to be predicted is designated as the **label** (or target).

1. Data

- *Data* $= \mathcal{D} = \{X, t\}$
- Number of features = Number of Dimensions = d
- Number of examples = N
- As the number of features increase, we say the dimensionality increases.

Features

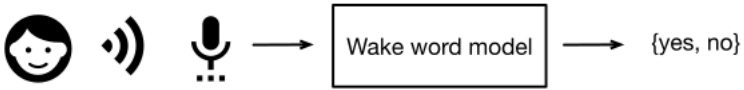
(Target)

Examples

ID	Bedrooms	Location	Sq Ft	Price
1	3	Urban	1500	**350K**
2	2	Suburban	1200	**280K**
3	4	Urban	2000	**520K**
4	3	Rural	1800	**310K**
5	2	Suburban	1100	**245K**
6	5	Urban	2500	**680K**
7	3	Rural	1600	**275K**
8	4	Suburban	1900	**425K**

2. Model

- Model denotes the **computational machinery** for ingesting data of one type, and spitting out predictions of a possibly different type.
- Deep learning models consist of many successive transformations of the data that are chained together top to bottom, thus the name deep learning.



3. Objective Function

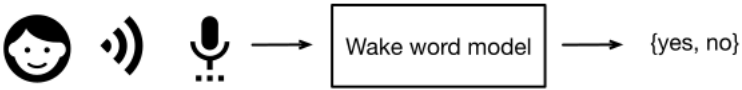
- **Learning means improving at some task over time.**
- **Objective functions** are formal measures to denote how good (or bad) a mathematical model is.
- By convention, objective functions are defined so that lower is better.
- Because lower is better, these functions are sometimes called **loss functions**.

4. Learning Algorithms

- **Learning Algorithm is an algorithm capable of searching for the best possible parameters for minimizing the loss function.**
- Popular algorithm for deep learning – **gradient descent**.

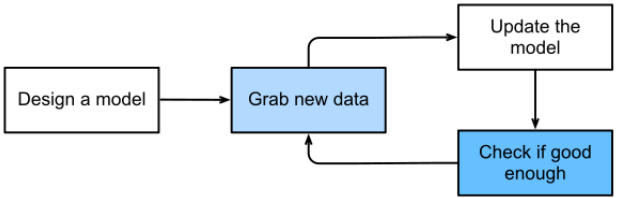
Example of the Framework

- We have to tell a computer explicitly how to map from inputs to outputs.
- We have to define the problem precisely, pinning down the exact nature of the inputs and outputs, and choosing an appropriate model family.
- Collect a huge dataset containing examples of audio and label those that do and that do not contain the wake word.



How to Create a Model?

- Start with a program whose behavior is determined by a number of parameters.
- How to determine the best possible set of parameters? Use data or examples.
- Parameters improve the performance of the program with respect to the loss function.



Train The Model

- Train the program with data to find the best set of parameters that improves the performance of the program with respect to the loss function. Once the parameters are finalised, we call the program a model.
  - Eg: The model receives a snippet of audio as input, and the model generates a selection among yes, no as output.
- The set of all distinct programs (input-output mappings) that we can produce just by manipulating the parameters is called a family of models.
  - Eg: We expect that the same model family should be suitable for ”Alexa” recognition and ”Hey Siri” recognition because they seem, intuitively, to be similar tasks.

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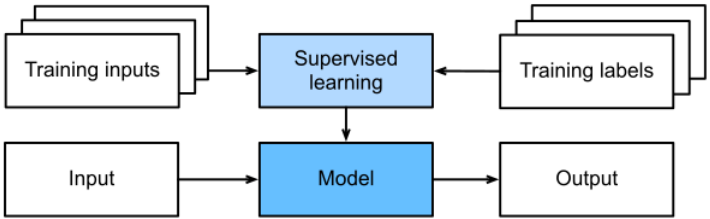
Learning Problems

1. Supervised Learning
   - Training by examples
   - The model is given a dataset which has the data and its labels
   - Eg: Classification, Regression
   - You will learn this in this course and Machine Learning Course
2. Unsupervised Learning
   - Situations where we feed the model a giant dataset containing only the features.
   - Eg: Clustering, Generate synthetic data (uses GAN), Density estimation
   - You will learn this in Advanced Deep Learning Course and Machine Learning Course
3. Reinforcement Learning
   - Develop an agent that interacts with an environment and takes actions over a series of time steps.
   - You will learn this in Deep Reinforcement Learning Course

Supervised Learning

- Task of predicting labels given input features.
- **Each feature-label pair is called an example.**
- **Goal is to produce a model that maps any input to a label prediction.**
- The supervision comes into play because for choosing the parameters, we (the supervisors) provide the model with a dataset consisting of labelled examples, where each example is matched with conditional probability of a label given input features.



Supervised Learning Tasks

- Regression
  - how much or how many question
- Classification
  - Binary classification
  - Multi-class classification
  - Multi-label classification
- Recommender systems
- Sequence Learning
  - Tagging and Parsing
  - Automatic speech recognition
  - Text to speech
  - Machine translation

1. Dive in Deep Learning (T1)- Chapter 1 `https://d2l.ai/`

Thank You!