Introduction to Neural Network & Deep Learning

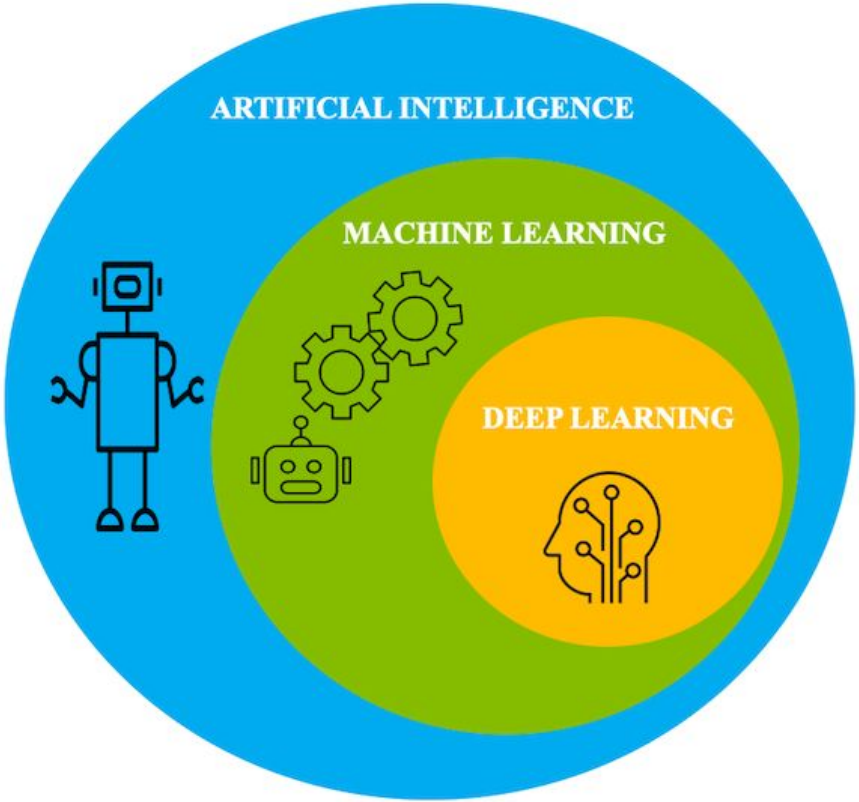
CSE 4237 - Soft Computing

Mir Tafseer Nayeem
Faculty Member, CSE AUST
tafseer.nayeem@gmail.com

Introduction

- This is an introductory course that will let you build **cutting-edge** AI systems.
- Deep learning is also a new **"superpower"** that will let you build AI systems that just weren't possible a few years ago.
- So after completing it, you will be able to apply deep learning to your own applications.

Artificial Intelligence, Machine Learning, and Deep Learning



Difference between ML and DL

MACHINE LEARNING	DEEP LEARNING
Works on small amount of Dataset.	Works on Large amount of Dataset.
Dependent on Low-end Machine.	Heavily dependent on High-end Machine.
Divides the tasks into sub-tasks, solves them individually and finally combine the results.	Solves problem end to end.
Takes less time to train.	Takes longer time to train.
Testing time may increase.	Less time to test the data.

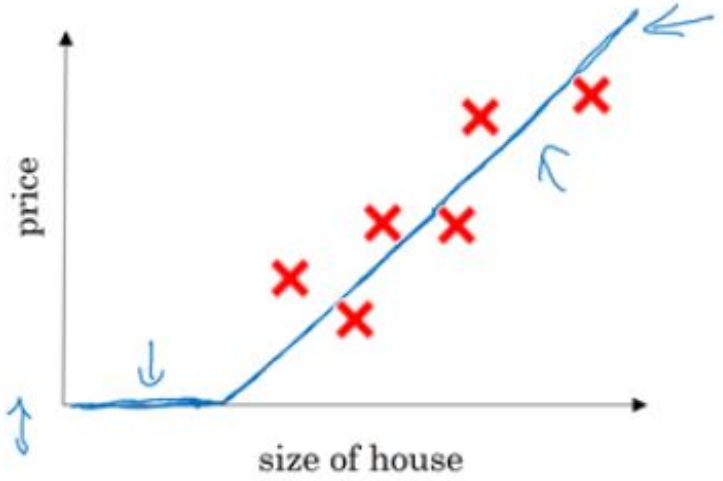
Applications

- Machine Translation
- Virtual Assistants
- Self-Driving Cars
- Medical Image Analysis
- Personalization
- Recommendation
- Fraud Detection
- Image Recognition
- Handwritten Character Recognition

Example 1 – Single Neural Network

- Given data about the **size of houses** you want to **fit a function** that will predict their **price**. **(Housing Price Prediction)**
- It is a **linear regression** problem because the price as a function of size is a continuous output.

We know the prices can never be negative



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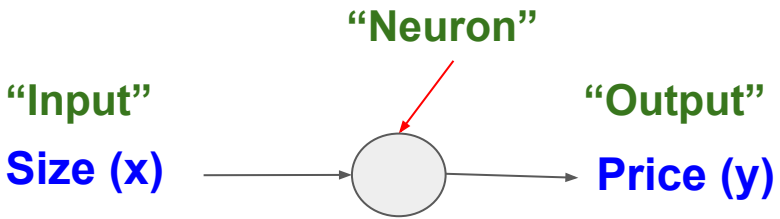
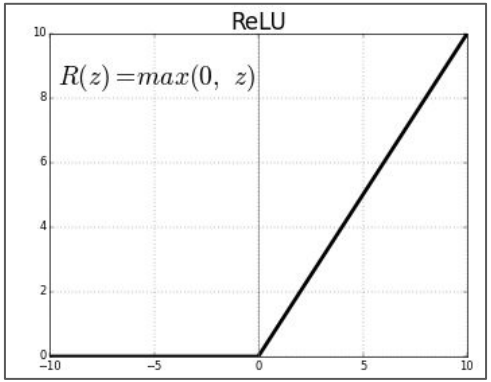
Example 1 – Single Neural Network



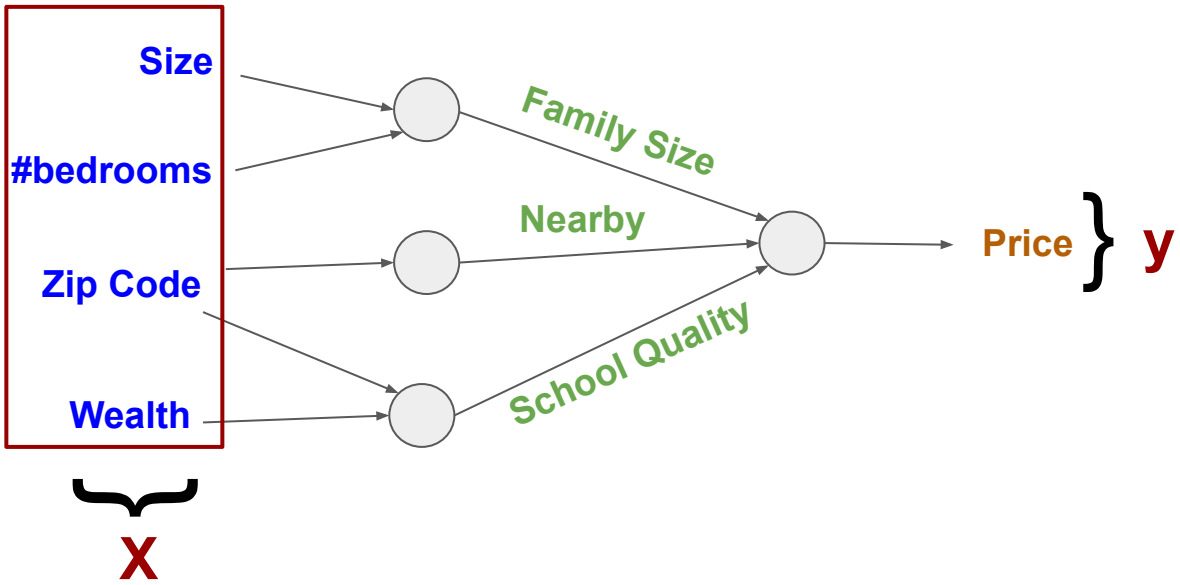


- This **single neuron** implements the function of the housing price prediction. So we are creating a function called **Rectified Linear Unit (ReLU)** which **starts at zero**.

Content Credit: Andrew Ng

Example 2 – Multiple Neural Network

- The price of a house can be affected by other features such as **size, number of bedrooms, zip code and wealth**.



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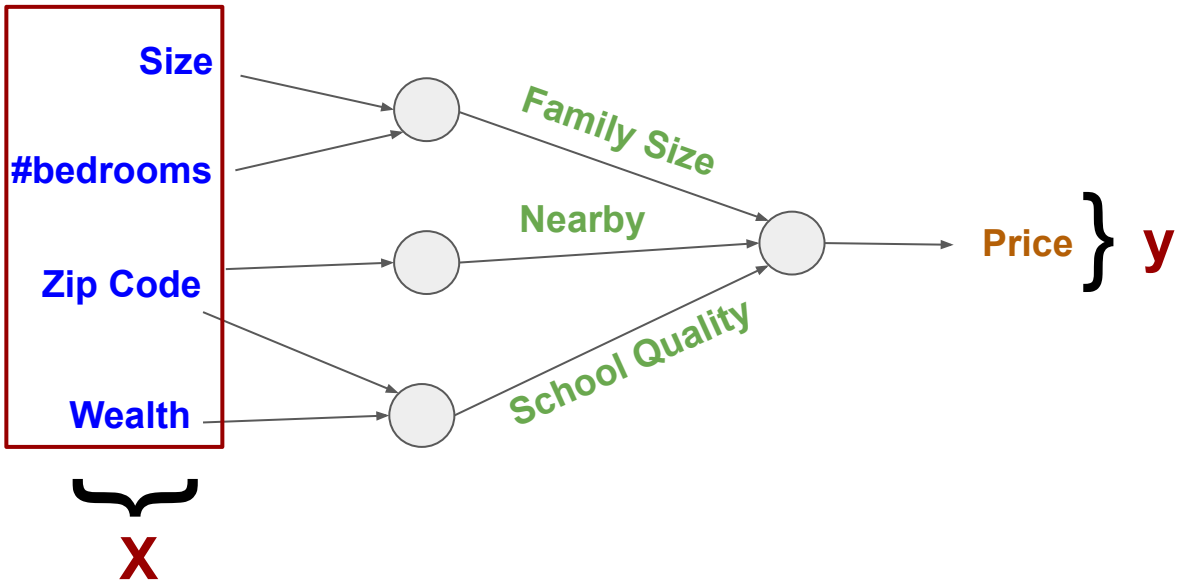
Example 2 – Multiple Neural Network

- By stacking together single neurons, we now have a slightly larger neural network



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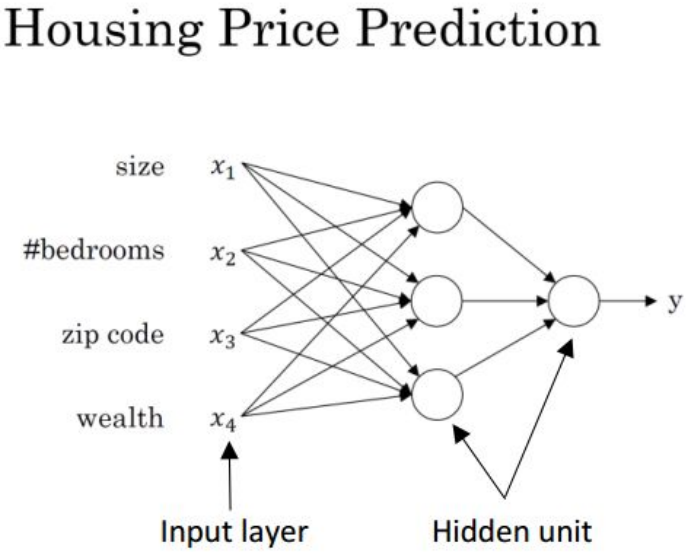
Example 2 – Multiple Neural Network

- The role of the neural network is to predict the price and it will automatically generate the hidden unit values.
- We only need to give the inputs x and the output y for a number of examples of your training set. Neural Network will automatically figure out the values in the hidden layers.



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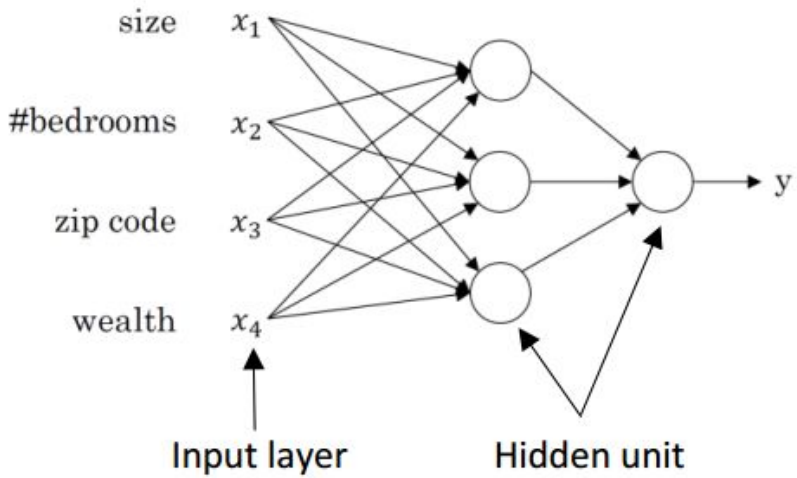
- We only need to give the inputs x and the output y for a number of examples of your training set. Neural Network will automatically figure out the values in the hidden layers.
- Given enough data (*training examples*) neural networks are extremely good at figure out functions that accurately map from x to y.

Input layer and the layer in the middle (*hidden layers*) are densely connected because every input is connected to every hidden unit.



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Supervised learning for Neural Network

- In supervised learning, we are given a data set and already know what our correct output should look like (human annotation / gold label)
- We have some input(x) and we learn a function to map output(y)

Input(x)	Output (y)	Application
Home features	Price	Real Estate
Ad, user info	Click on ad? (0/1)	Online Advertising
Image	Object (1,...,1000)	Photo tagging
Audio	Text transcript	Speech recognition
English	Chinese	Machine translation
Image, Radar info	Position of other cars	Autonomous driving

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Different types of Neural Networks for Supervised Learning

- CNN or Convolutional Neural Networks (Useful in computer vision)
- RNN or Recurrent Neural Networks (Useful in Speech recognition or NLP)
- Standard NN (Useful for Structured data)
- Hybrid/custom NN or a Collection of NNs types

Structured vs Unstructured Data

- Structured data is like the databases and tables.
  - Each of the features (e.g. Size, #bedrooms etc has a well defined meaning)
- Unstructured data is like images, video, audio, and text.
  - Harder for computer to make sense of this kind of data
- Structured data gives more money because companies relies on prediction on its big data.

Structured Data

Size	#bedrooms	···	Price (1000$s)
2104	3		400
1600	3		330
2400	3		369
⋮	⋮		⋮
3000	4		540

User Age	Ad Id	···	Click
41	93242		1
80	93287		0
18	87312		1
⋮	⋮		⋮
27	71244		1

Unstructured Data

Audio

Image

Four scores and seven years ago…

Text

Content Credit: Andrew Ng

Why is deep learning taking off?

Deep learning is taking off due to

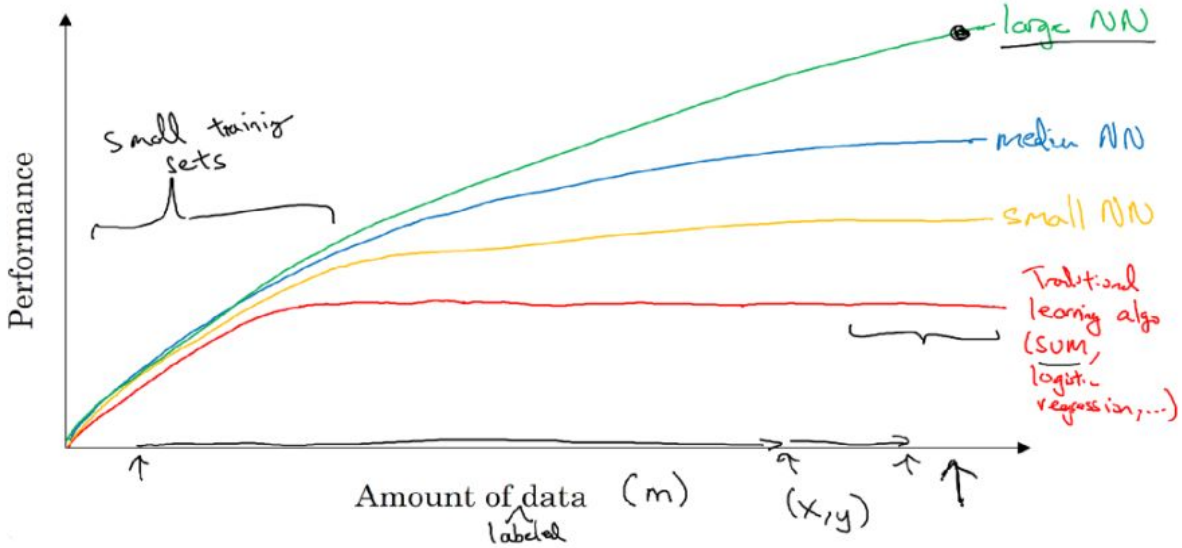
- Large amount of data available through the digitization of the society
- Faster computation
- Innovation in the development of neural network algorithm

Data

We have a lot of data because the world is using the computer a little bit more

- Mobiles
- IOT (Internet of things)

Scales drives deep learning progress



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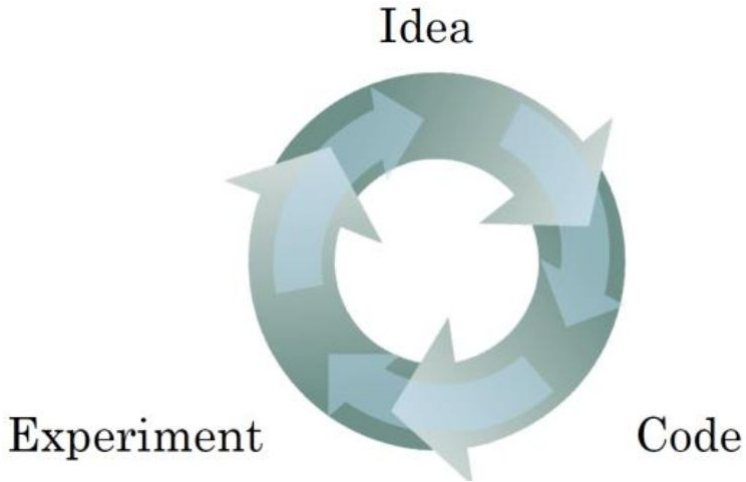
Scales drives deep learning progress

- Data
  - Being able to train a big enough neural network
  - Huge amount of labeled data
- Computation:
  - GPUs.
  - Powerful CPUs.
  - Distributed computing.
- Algorithm:
  - Creative algorithms has appeared that changed the way NN works.
  - For example using RELU function is so much better than using SIGMOID function in training a NN because it helps with the vanishing gradient problem.

The process of training a neural network is iterative.

It could take a good amount of time to train a neural network, which affects your productivity. Faster computation helps to iterate and improve new algorithm.



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