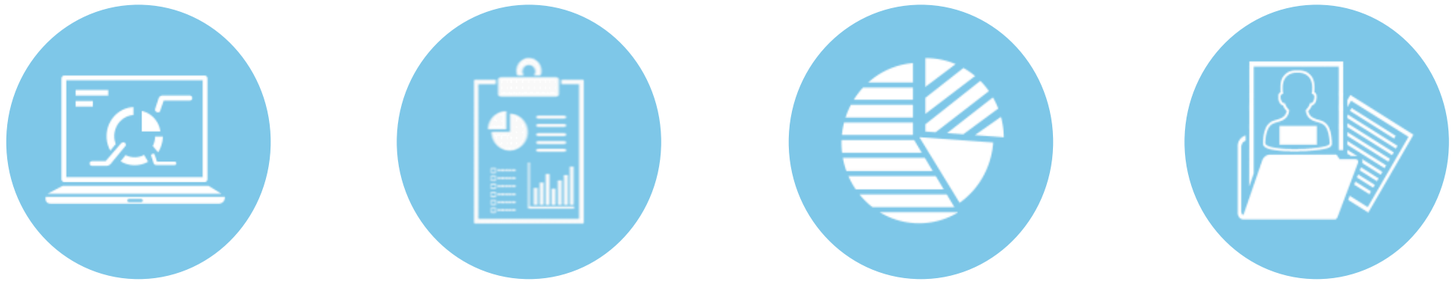
Machine Learning

Lesson 8—Introduction to Deep Learning



Learning Objectives

- Analyze the meaning and importance of Deep Learning
- Describe Artificial Neural Networks
- Define TensorFlow and explain linear regression in TensorFlow

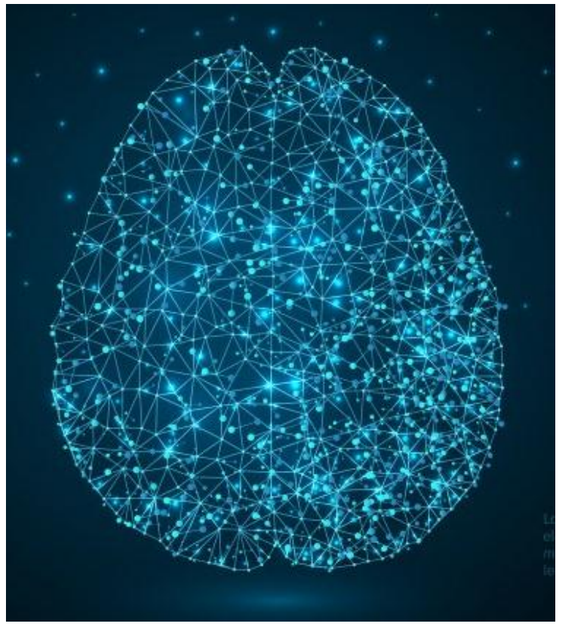
Introduction to Deep Learning

Topic 1: Meaning and Importance of Deep Learning

What Is Deep Learning?

> Deep Learning is a specialized form of Machine Learning that uses supervised, unsupervised, or semi-supervised learning to learn data representations. It is similar to the structure and function of the human nervous system.

Why Deep Learning?



- Experts have discovered multi-layered learning networks that can be leveraged for deep learning as they learn in layers.
- The vast availability of Big Data enables machines to be trained.
- Scientists have figured out that high-performing graphics processing units (GPU) can be used for deep learning.
- GPUs allow parallel computing, unlike conventional Central Processing Units (CPU) that use sequential processing.

Difference: Machine Learning and Deep Learning

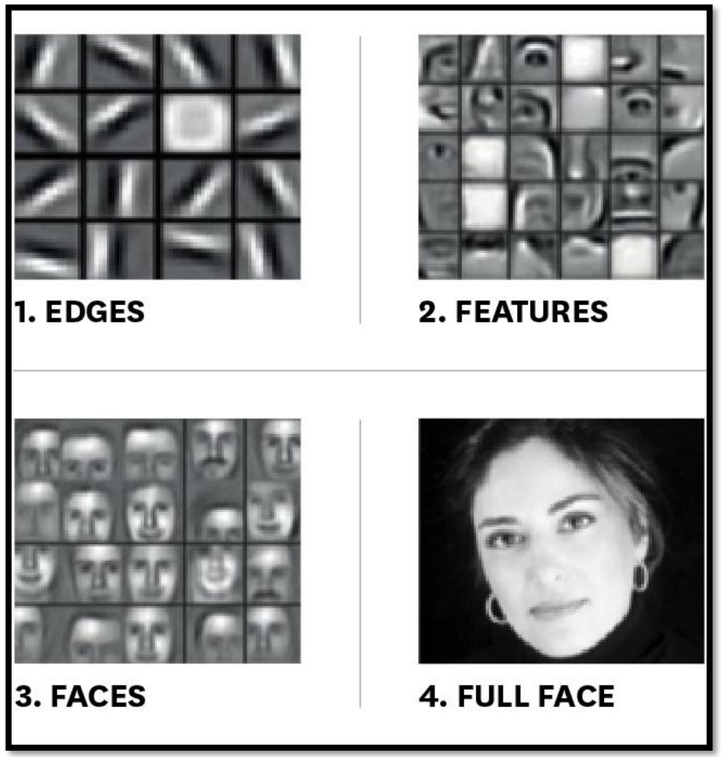
- Machine Learning allows one to learn algorithms that represent the relationship between input and output.

- Deep Learning is a more specialized form of Machine Learning that allows one to learn the representations of data itself, which leads to more complex decision-making, such as object detection, speech processing, or text recognition.

Introduction to Deep Learning

Topic 2: Artificial Neural Networks

Neural Networks

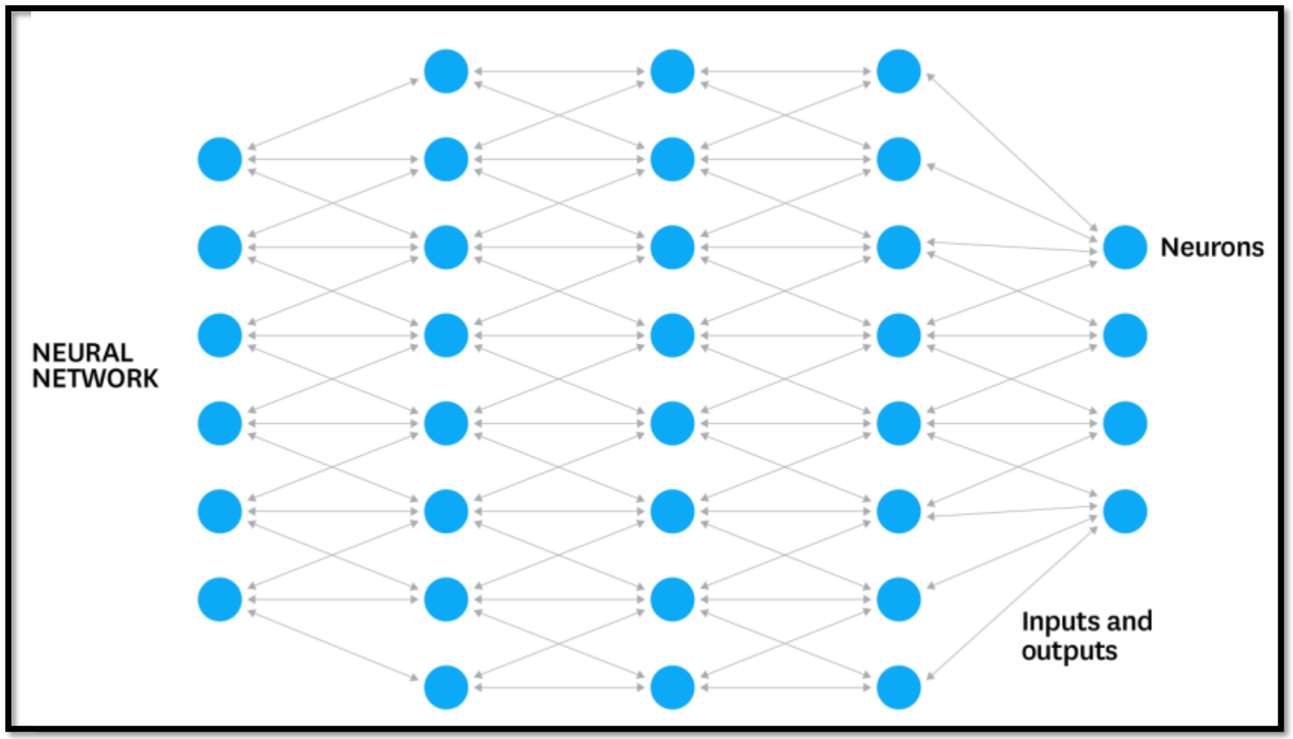


- Deep learning relies on multiple layers of training.
- In the example given on the left, the first layer recognizes edges.
- The second layer recognizes facial features like a nose or an ear.
- The third layer recognizes faces. The full face is eventually recognized in the fourth layer.

Source: hbr.org

Neural Networks

The computational models in deep learning are loosely inspired by the human brain, where neurons take input and pass along outputs.

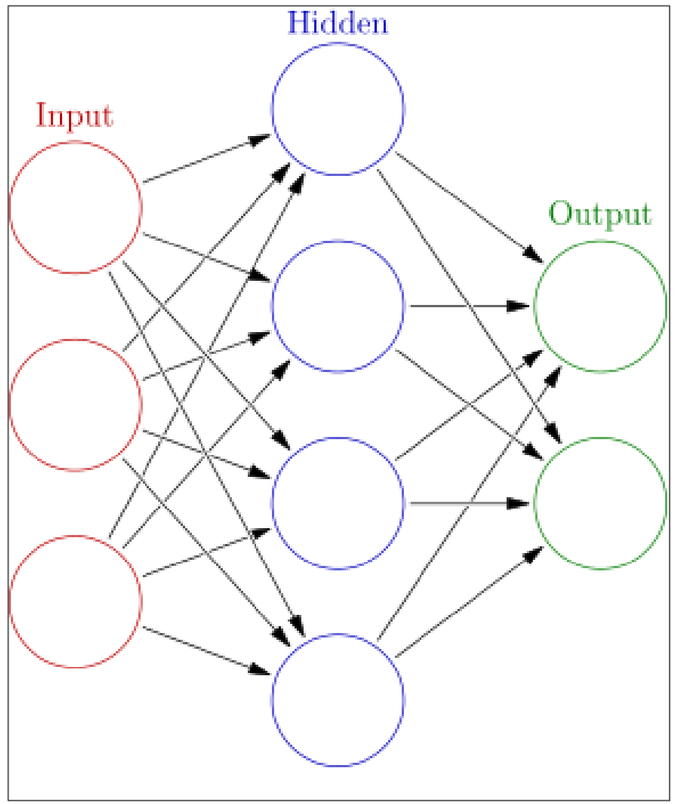


Source: hbr.org

Artificial Neural Network (ANN)

> "Artificial Neural Network is a computing system made up of a number of simple, highly interconnected processing elements which process information by their dynamic state response to external inputs."
>
> - Robert Hecht-Nielsen

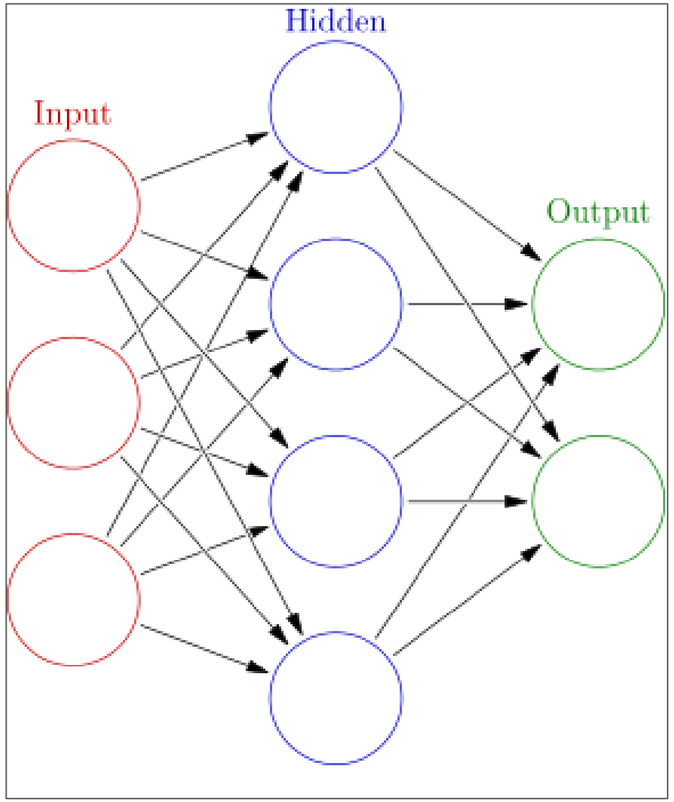
Artificial Neural Network



- It is an interconnected group of nodes akin to the vast network of layers of neurons in a brain.
- Each circular node represents an artificial neuron and an arrow represents a connection from the output of one neuron to the input of another.
- Inputs are passed into the first layer.
- Individual neurons receive the inputs, with each of them receiving a specific value. After this, an output is produced based on these values.
- The outputs from the first layer are then passed into the second layer to be processed. This continues until the final output is produced.

Source: Wikipedia

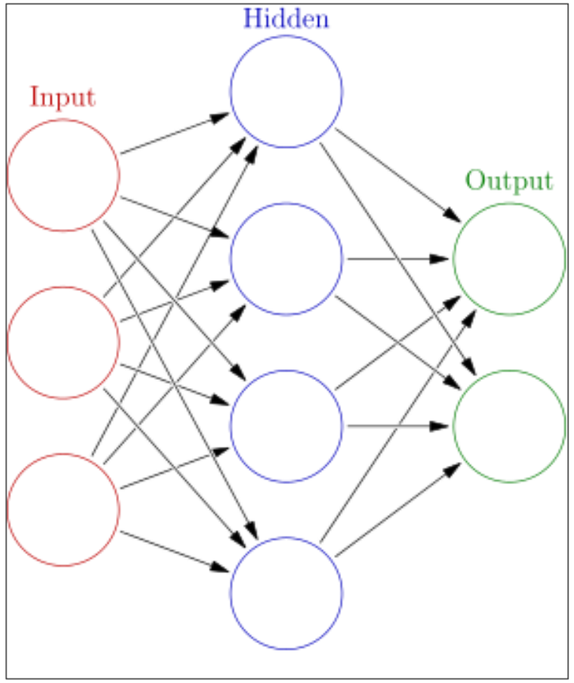
Artificial Neural Network



- The assumption is that the correct output is predefined.
- Each time data is passed through the network, the end result is compared with the correct one, and tweaks are made to their values until the network creates the correct final output each time.
- The network, in effect, trains itself.

Source: Wikipedia

ANN and Human Brain



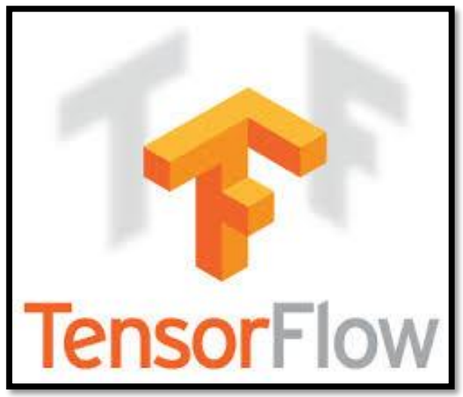
- ANNs are processing devices (algorithms or actual hardware) that are loosely modeled after the neuronal structure of the mammalian cerebral cortex, but on a much smaller scale. A real mammalian brain has billions of neurons.
- For example, an artificial brain can learn how to identify chairs from photos. Over time, it will learn what the characteristics of chairs are and increase its probability of identifying them. Other practical examples are computer vision and speech recognition.

Source: Wikipedia

Introduction to Deep Learning

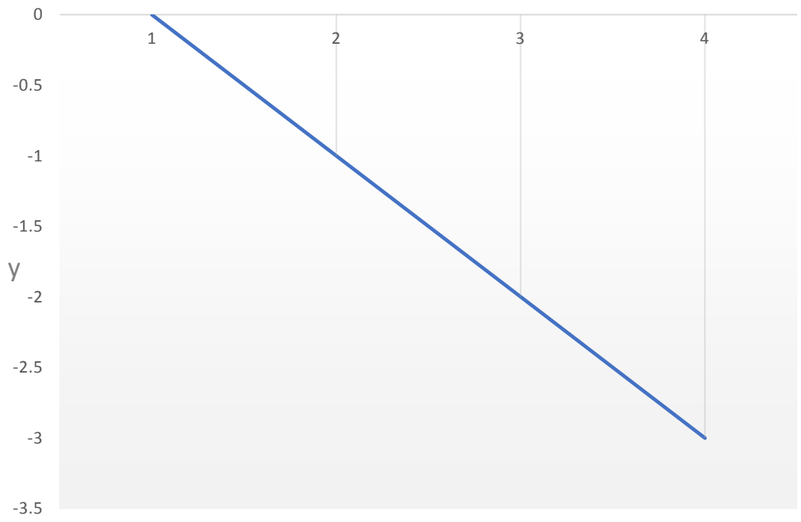
Topic 3: TensorFlow

TensorFlow



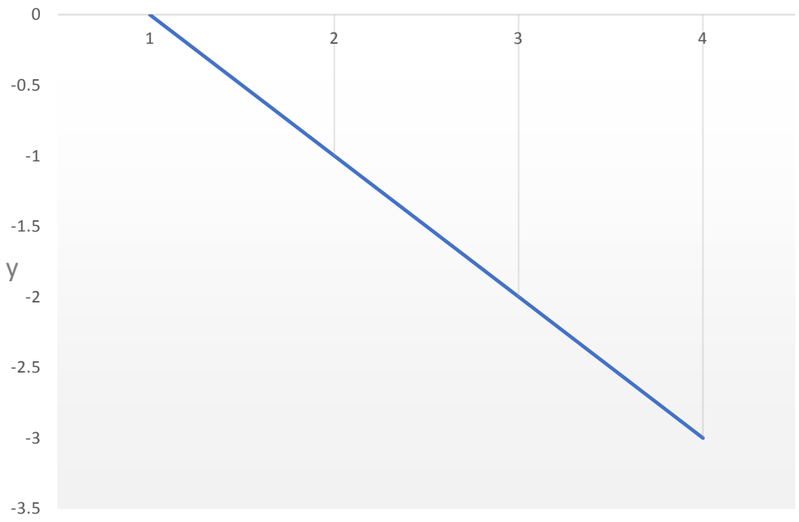
- TensorFlow is the open source Deep Learning library provided by Google.
- It allows development of a variety of neural network applications such as computer vision, speech processing, or text recognition.
- It uses data flow graphs for numerical computations.

Linear Regression in TensorFlow




```
import numpy as np
import tensorflow as tf
# Model parameters
W = tf.Variable([.3], tf.float32)
b = tf.Variable([-.3], tf.float32)
# Model input and output
x = tf.placeholder(tf.float32)
linear_model = W * x + b
y = tf.placeholder(tf.float32)
# loss
loss = tf.reduce_sum(tf.square(linear_model - y))  # sum of the squares
# optimize
optimizer = tf.train.GradientDescentOptimizer(0.01)
train = optimizer.minimize(loss)
```

Linear Regression in TensorFlow

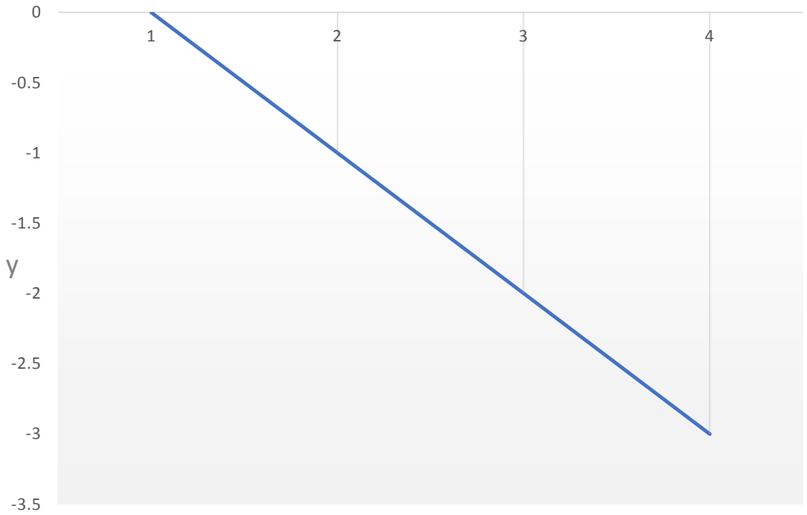



```
# training data
x_train = [1,2,3,4]
y_train = [0,-1,-2,-3]
# training loop
init = tf.global_variables_initializer()
sess = tf.Session()
sess.run(init) # reset values to wrong
for i in range(1000):
  sess.run(train, {x:x_train, y:y_train})


# evaluate training accuracy
curr_W, curr_b, curr_loss  = sess.run([W, b, loss], {x:x_train, y:y_train})
print("W: %s b: %s loss: %s"%(curr_W, curr_b, curr_loss))
```

Training Data

Linear Regression in TensorFlow



When executed, the code produces the following output:

W: [-0.9999969] b: [0.99999082] loss: 5.69997e-11

Algorithm learned:

y = (-0.9999969) * x + 0.99999082

Key Takeaways

- Deep Learning is a specialized form of Machine Learning modeled on human brain function and its neuron architecture.
- Deep Learning is exploding due to availability of Big Data and high performing GPU hardware.
- Deep Learning involves layers of neurons that work together to solve complex problems like face recognition, natural language processing, or health diagnosis.
- Google TensorFlow is a popular library for developing Deep Learning applications.

Quiz

QUIZ 1

Deep learning is particularly useful for more complex tasks like _____.

a. Speech processing

b. Text recognition

c. Regression

d. Both (a) and (b)

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The correct answer is **d.**

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QUIZ 2

How does a neural network function?

a. It has layers of neuron which process increasingly complex features.

b. When information moves from one neuron layer to another, weights are applied.

c. The final neuron layer compares predicted output with known outputs and sends a signal to adjust the values.

d. All of the above

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This concludes “Introduction to Deep Learning”