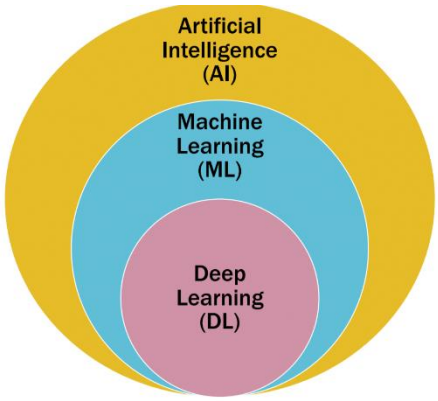
BMEG3105: Data Analytics for Personalized Genomics and Precision Medicine

Lecture 19 Deep Learning

- **The relationship between AI, Machine Learning and Deep Learning**



AI: Any techniques which enable computers to mimic human behavior

Machine Learning: A subset of AI, which effectively perform a specific task without using explicit instructions, relying on patterns and inference from the data.

Deep Learning: A subset algorithm of ML, which takes advantage of multi-layer neural networks.

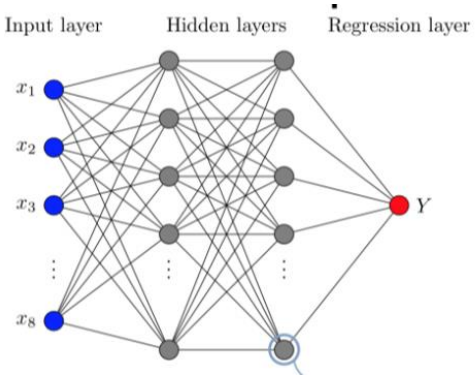
- **Why we use deep learning rather than logistic regression**

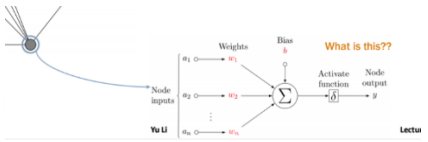
  Relationship between among different variables within the image may be much more complicated than simple linear combination

- **The relationship between LR and neural networks**

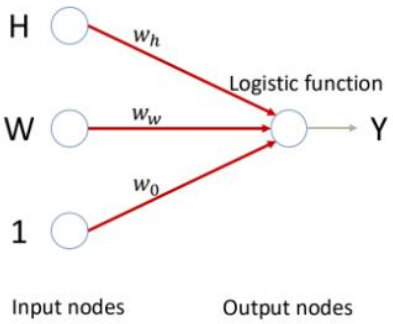
  To resolve complicated problems:

  1) Increase the number of nodes
  2) Increase the number of layers
  3) Add non-linear functions





Above is one node of the neural network



$$Y^{output} = \frac{1}{1 + e^{-(w_h H + w_w W + w_0)}}$$

Above is the function of the network

- **Fully connected layers:**

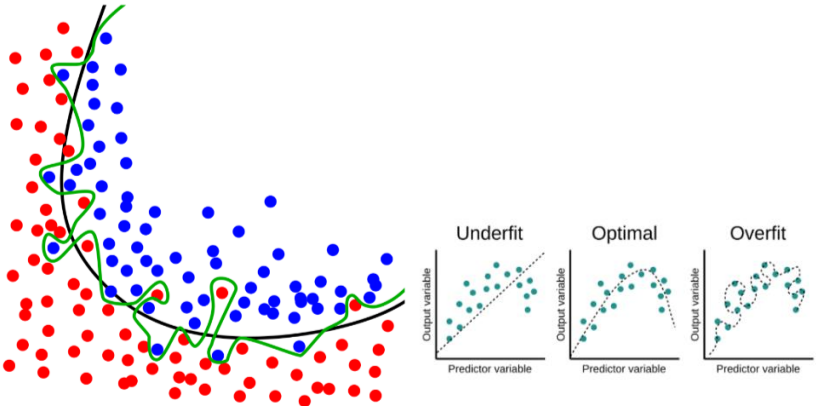
  1) A general function approximator
  2) We can approximate any function if we have enough nodes and layers
  3) Universal approximation theorem

- **An example of image for the number of the parameters**

  256*256*3 means a image has three layers and its size is 256*256. So if the internal layer has 100 nodes, the parameters we will have is :

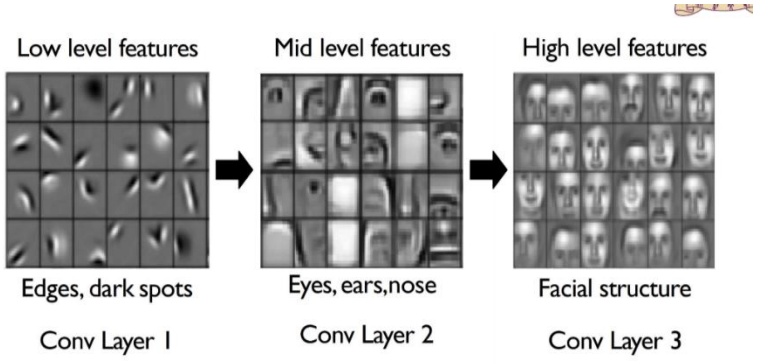
  (256*256*3+1)*1000+(1000+1)*1= 196,610,001

  But we can't make it too complex which may cause overfitting



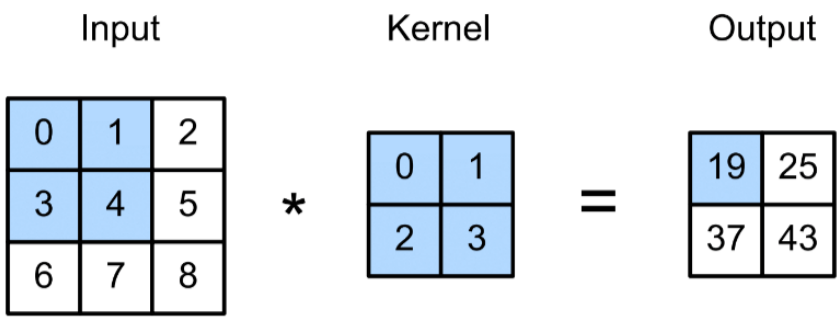
- **Neural network in images:**

  Use the convolutional layers to capture the features of the images:



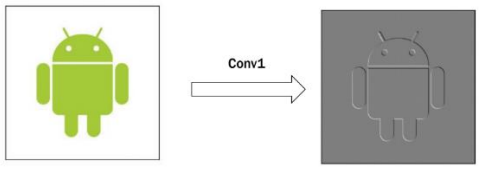
  Convolution operation (In two dimensions):

$$y[m,n] = x[m,n] * h[m,n] = \sum_{j=-\infty}^{} \sum_{i=-\infty}^{} x[i,j] \cdot h[m-i, n-j]$$



With different convolution kernel, we can get different features of the images:

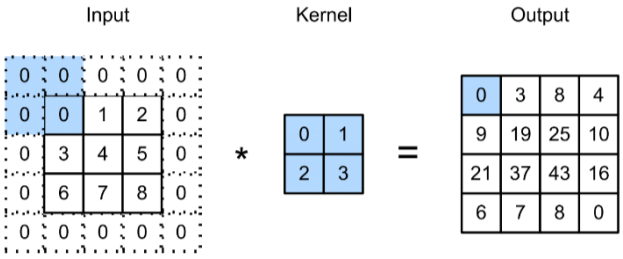
Example: get the outline of the picture



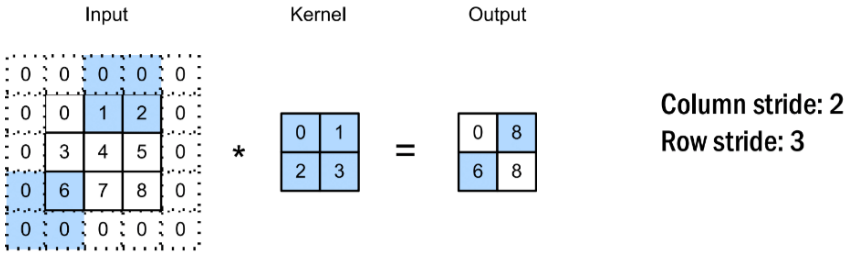
- **Convolutional layer:**
  1) Filter Size: usually 3*3 or 5*5
  2) How about the boundary of the image:

     To keep the dimension not changing, use padding method:

Padding



3) Stride is a parameter that dictates the movement of the kernel, or filter, across the input data, such as an image:



4) Pooling: a **pooling layer** is a kind of network layer that down samples and aggregates information that is dispersed among many vectors into fewer vectors: