https://github.com/TAMIDSpiyalong/Gen-AI

Lecture 1: 9:00-9:40

Yalong Pi (Texas A&M Institute of Data Science)

Address: Office 221C, John R. Blocker Building

Email: piyalong@tamu.edu

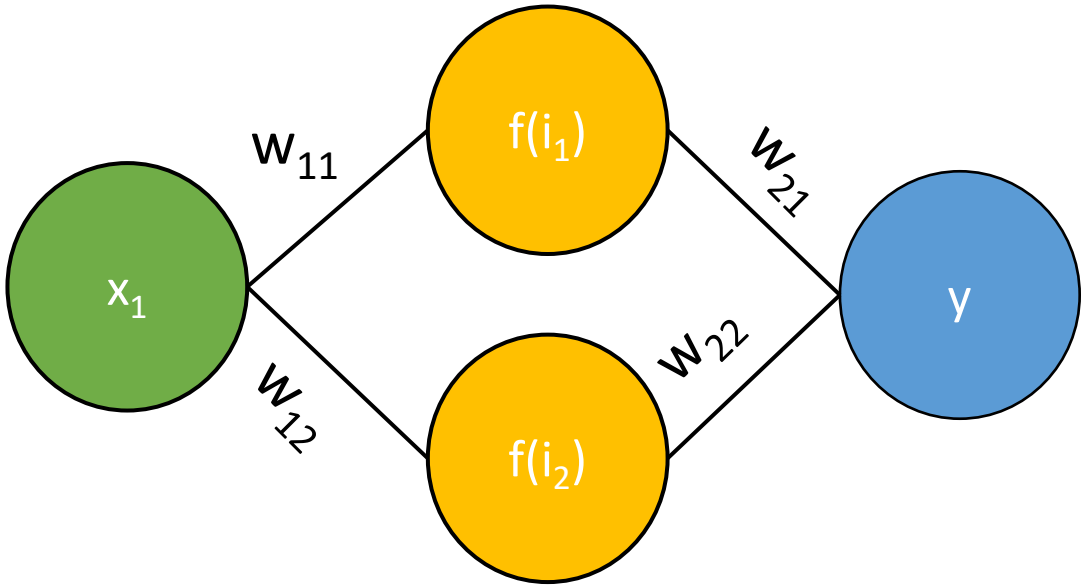
- B.S., Mechanical Engineering, 2007-2011
- M.S., Civil Engineering, 2011-2013
- Ph.D., Architecture, 2017-2020

- Research Scientist, 2020-present
- Architect, 2016-2017
- Project manager, 2013-2016

Agenda

- **Part 1: Background and Theory on Generative AI**
- Fundamentals of machine learning
- Tokenization and word embedding
- Transformers for Language Models
- **Part 2: Applications and Hands-On Exercises**
- Prompt Engineering
- Generative AI Applications
- Evolution of Generative AI and Future Directions

Fundamentals of machine learning



Back Propagation

x	y
1	10
2	20
5	30

$$y_{pred} = w_{21} * x_1 * w_{11} + w_{22} * x_1 * w_{12}$$

$$Loss = (y_{pred} - y_{true})^2$$

$$W_n' = Wn - LR\ (\partial Loss/\partial W_n)$$

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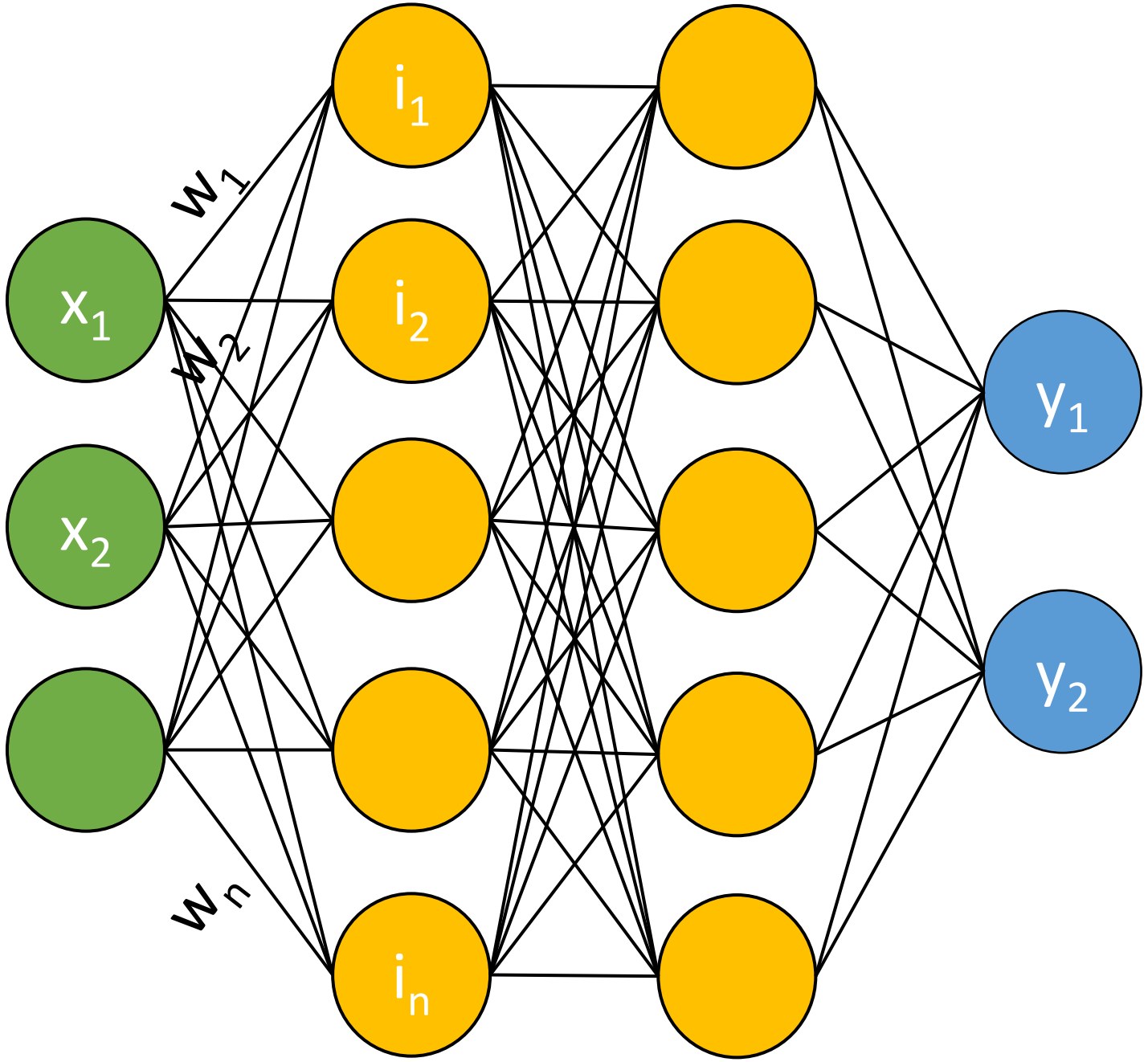
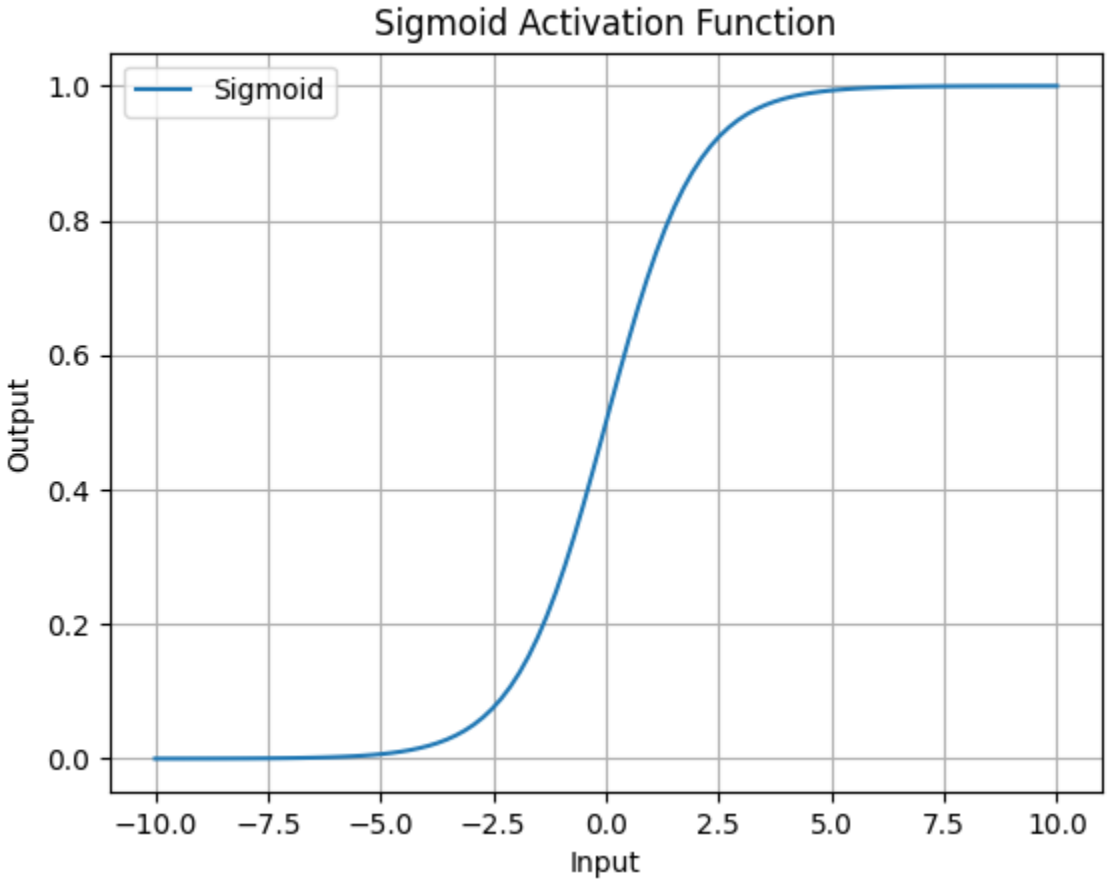
For each connection:

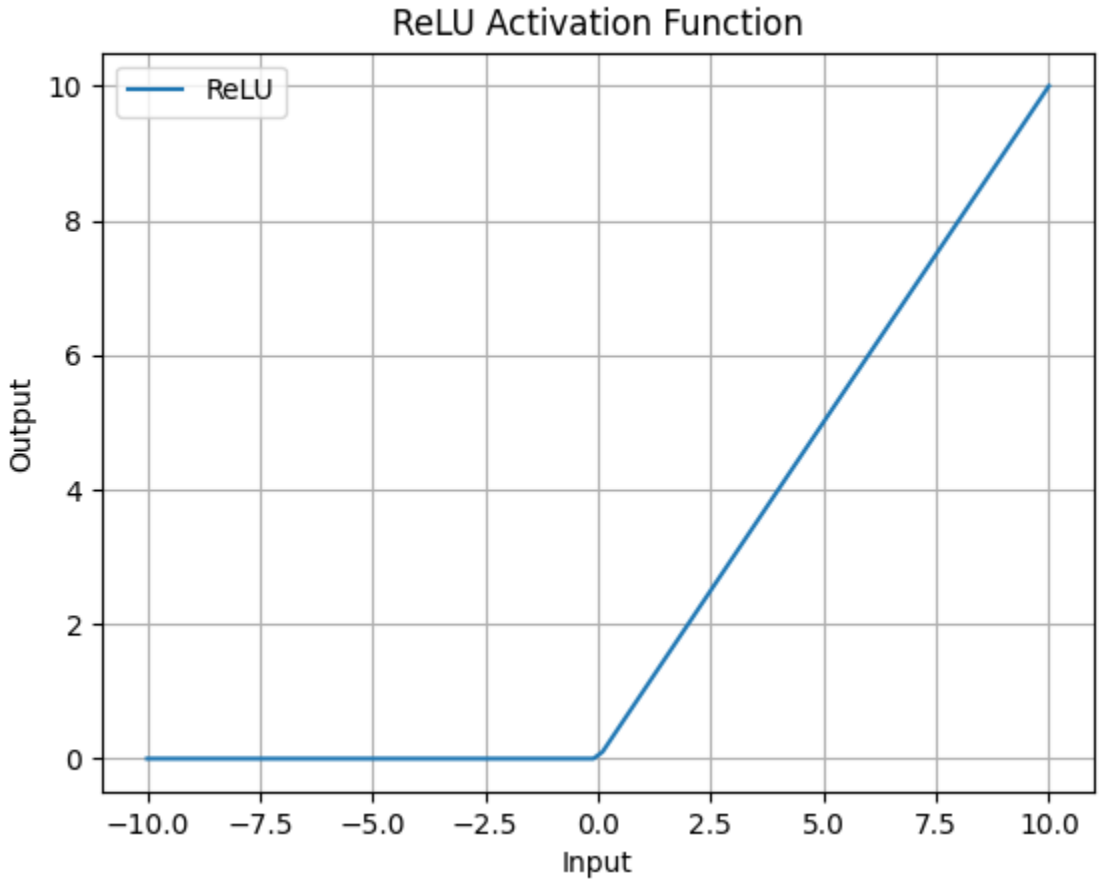
$$I_n = f(\sum_n x_n w_n + b)$$

- f is the activation function
- w_n is the weight
- b is the bias.
- A DNN has millions of weights and biases



Activation Functions

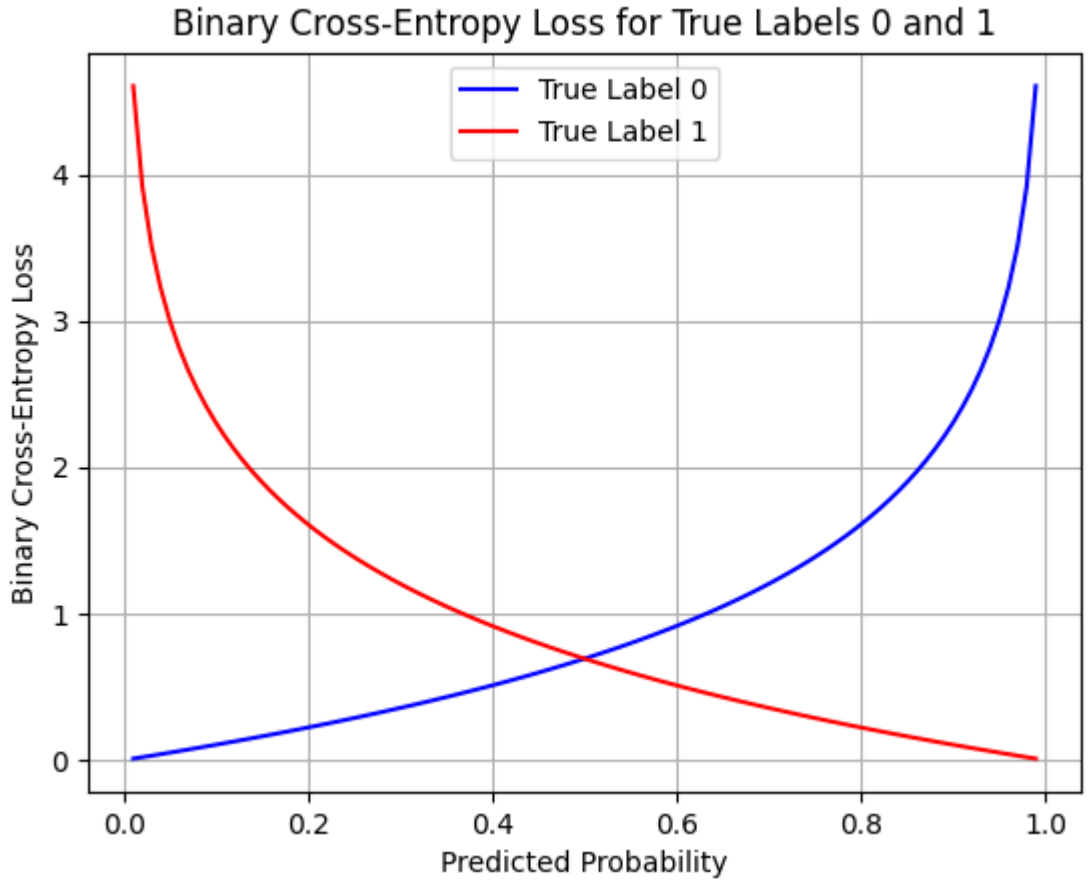




Binary Cross Entropy

$$L(y, \hat{y}) = -[\, y * \log(\hat{y}) + (1 - y) * \log(1 - \hat{y}) \,]$$

Where:
- y is the true label (0 or 1)
- ŷ is the predicted probability (between 0 and 1)
- log can be ln



Softmax

$\sigma(Z)_i = \exp(z_i) / \Sigma(\exp(z_j))$

Where:

- z_i is the i input score (logits)
- Σ is the sum over all input scores (logits)
- $\sigma(z)_i$ is the probability assigned to class i

Example:

[-0.37, -1.06, -0.07, -1.47, -0.90] **->** [0.265, 0.133, 0.358, 0.088, 0.155]

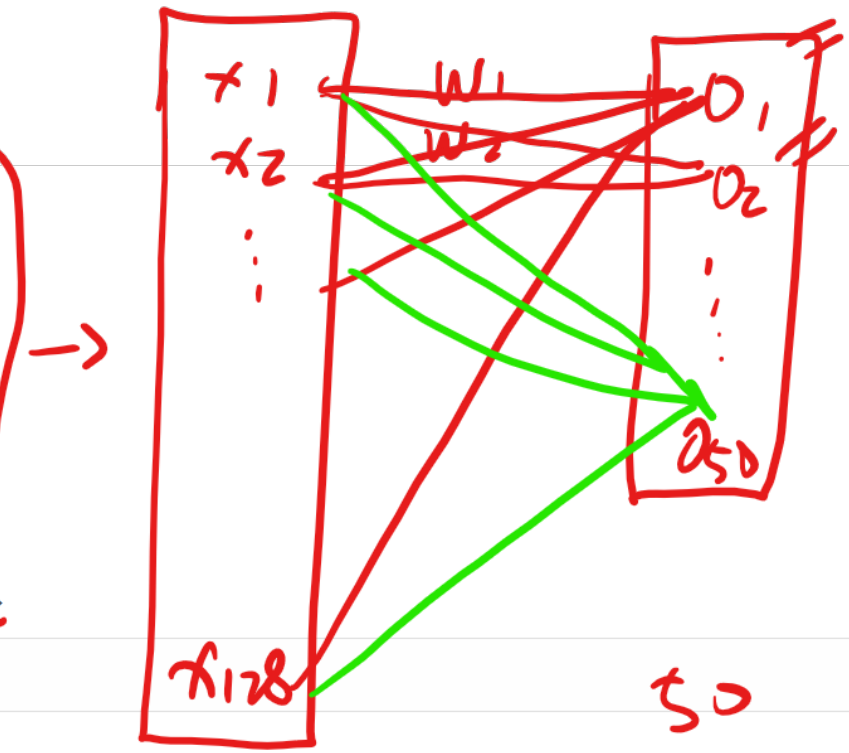
Prediction\Ground Truth	Positive	Negative
Positive	TP	FP
Negative	FN	TN

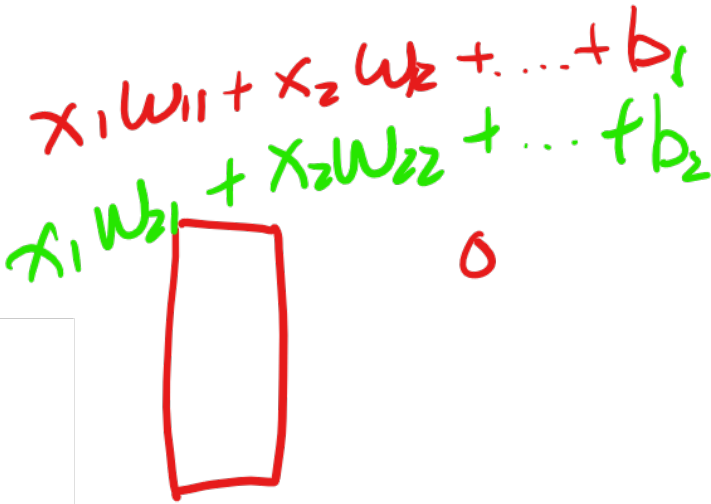
$$accuracy = \frac{TP + TN}{TP + FP + TN + FN}$$

$$precision = \frac{TP}{TP + FP}$$

$$recall = \frac{TP}{TP + FN}$$

```
-4.37806658e-02, -9.67954174e-02, -1.28794938e-01,
 1.45295113e-01,  3.34722281e-01, -2.49092355e-02,
-7.21996874e-02,  7.60333985e-02,  1.09788142e-01,
-5.91083243e-02,  1.77998230e-01,  1.05147131e-01,
 2.73706466e-01,  1.63680017e-01,  2.92986393e-01,
 1.62288636e-01,  1.92936987e-01, -7.25108087e-02,
 1.48647577e-01,  1.20697133e-01,  1.75806686e-01,
-8.22802186e-02,  3.19161601e-02,  9.75683853e-02,
-2.27390900e-01, -1.89130962e-01, -7.75573701e-02,
 7.51652941e-02, -9.91581455e-02,  9.62962583e-03,
 6.42622411e-02, -1.50064066e-01,  1.14945382e-01,
 5.34672337e-03,  1.96428418e-01, -2.10412573e-02,
 5.44419959e-02, -3.22782189e-01,  5.69203123e-03,
-1.00528084e-01, -7.29111880e-02, -1.84138656e-01,
-1.51076904e-02, -6.30587935e-02]], dtype=float32)
```





In [ ]:
```
hub_layer(train_examples[:3]).shape
```

Out[ ]:
```
TensorShape([3, 128])
```

Let's now build the full model:

In [ ]:
```
model = tf.keras.Sequential()
model.add(tf.keras.layers.Dense(50, activation='relu',input_dim=128))
model.add(tf.keras.layers.Dense(10, activation='relu'))
model.add(tf.keras.layers.Dense(1))
```

128 → 50

128 × 50 + 50 = 6450


```
plt.show()
```

early stop

save the best

Tokenization and word embedding

Tokenization

“I want pizza”

“我想要披萨”

“ピザが欲しいです”

“Eu quero pizza”

“أريد بيتزا”

“मुझे पिज़्ज़ा चाहिए”

“Quiero pizza”

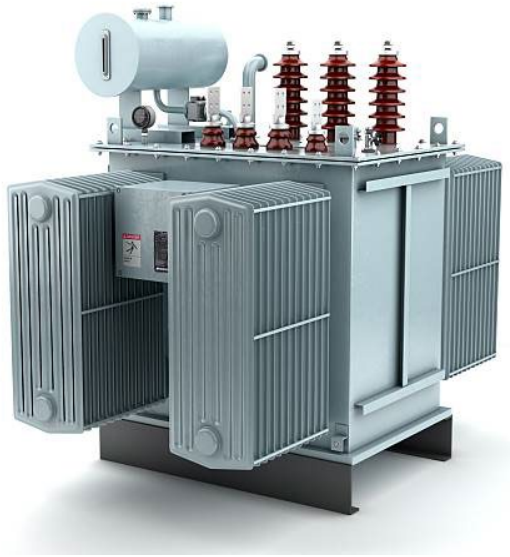
“피자가 먹고 싶어요”

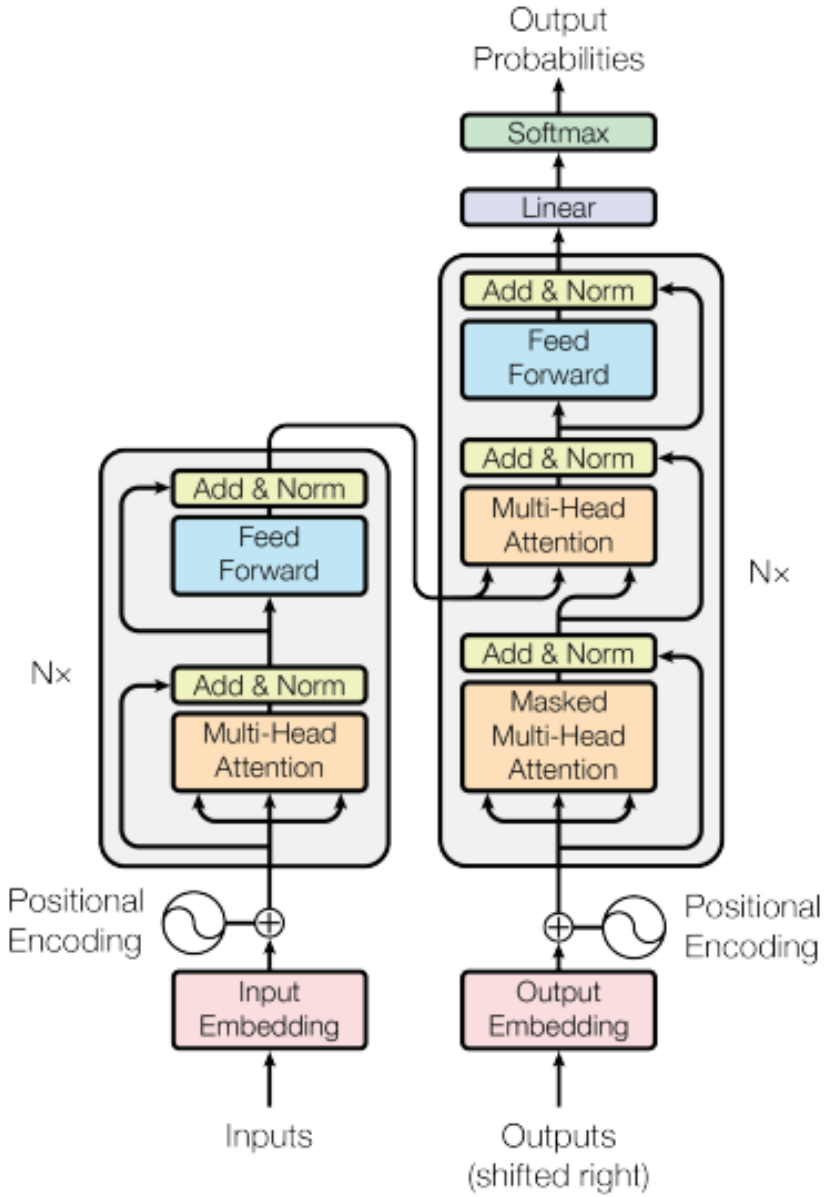
Word2Vec: Skig-gram and Negative Sampling

Transformers for Language Models of machine learning

Transformer

- GPT: Generative Pre-trained Transformer
- Vision Transformer: DETR
- Attention mechanism





Vaswani, A. (2017). Attention is all you need. *Advances in Neural Information Processing Systems*.

GPT 3

- Parameters 175 B
- Dataset 45T
- 96 attention heads
- 2048 token size
- Learn from their chief scientist: https://www.youtube.com/watch?v=kCc8FmEb1nY