

Unit 4: Session 4

Initial Plan

This session: Sentiment Analysis and Recommendation Systems

Next Session: Association Rule Mining and Market Basket Analysis

Revised Plan

This session: Neural Networks, LLMs, Prompt Engineering

Next Session:

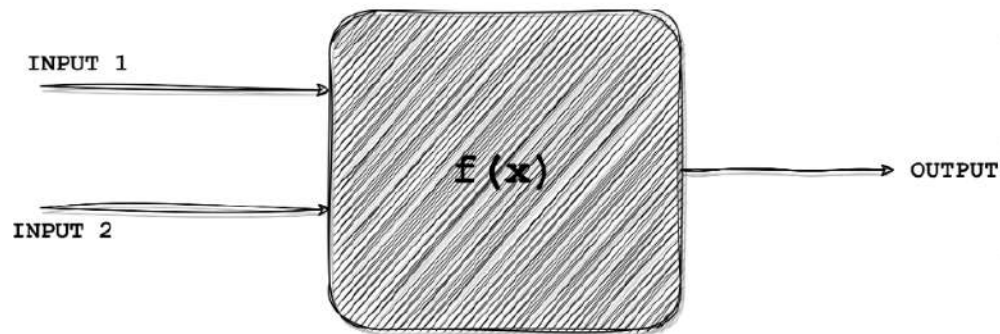
- Recommendation Systems
 - Association Rule Mining and Market Basket Analysis
- Sentiment Analysis

Neural Networks, LLMs and Prompt Engineering

Unit 4: Session 4

Neural Networks

Neural Networks: Intuition



INPUT 1	INPUT 2	OUTPUT
5	6	17
2	3	8
1	1	3
3	4	?

Can you guess the equation?

Neural Networks: Intuition

The Equation is:

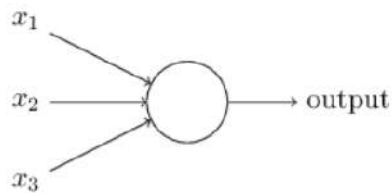
$$1x + 2y + 0 = \text{output}$$

Key Takeaways

- Input and Output are known
- We need to find the equation
- We can not modify the input and output
- We can multiply the input by a constant which is called weight
- We can add a constant to the output which is called bias

Neural Networks: Intuition - Perceptrons

Perceptrons were developed in the 1950s and 1960s by the scientist Frank Rosenblatt, inspired by earlier work by Warren McCulloch and Walter Pitts.



- Takes several binary inputs, x_1, x_2, \dots
 - Produces a single binary output
-

Rosenblatt proposed a simple rule to compute the output.

- We assign **weights** to each input, w_1, w_2, \dots which are real numbers expressing the importance of the respective inputs to the output.
- The neuron's output, 0 or 1, is determined by whether the weighted sum $\sum w_i x_i$ is less than or greater than some **threshold value**.

Neural Networks: Intuition - Perceptrons Example

There is concert in town and I want to go.

- Is the weather good?
- Does my friend accompany me?
- Is the concert near public transit?

Weather	Friend	Transit	Bias	Total / Threshold (5)	Go?
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

$$(Weather \times \text{Importance of weather}) + (Friend \times \text{Importance of friend}) + (Transit \times \text{Importance of transit}) + bias = output$$

Neural Networks: Intuition - Perceptrons Example

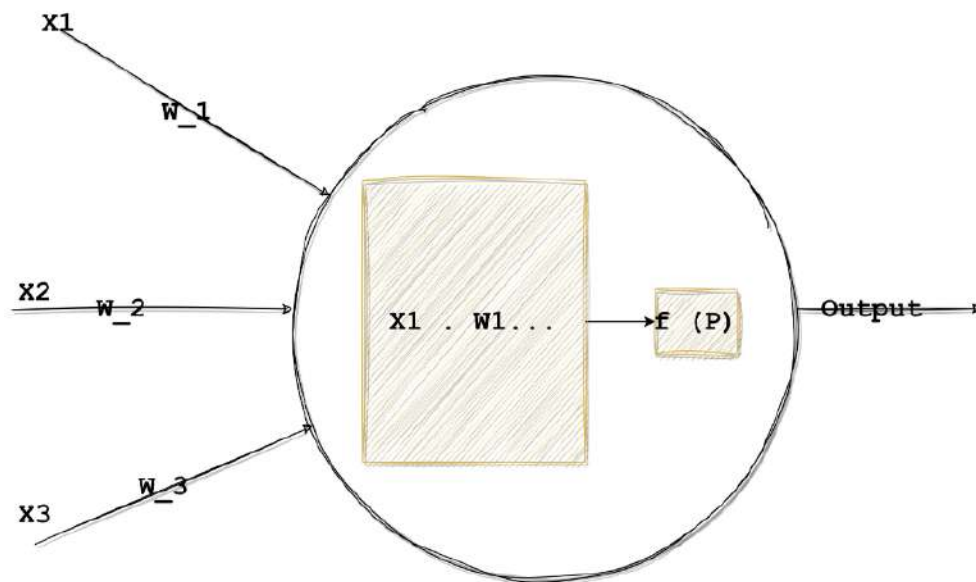
$$(\textit{Weather} \times \text{Importance of weather}) + (\textit{Friend} \times \text{Importance of friend}) + (\textit{Transit} \times \text{Importance of transit}) + \textit{bias} = \textit{output}$$

Findings

- Weights determine how important each input is to the output
- The bias shifts the decision boundary

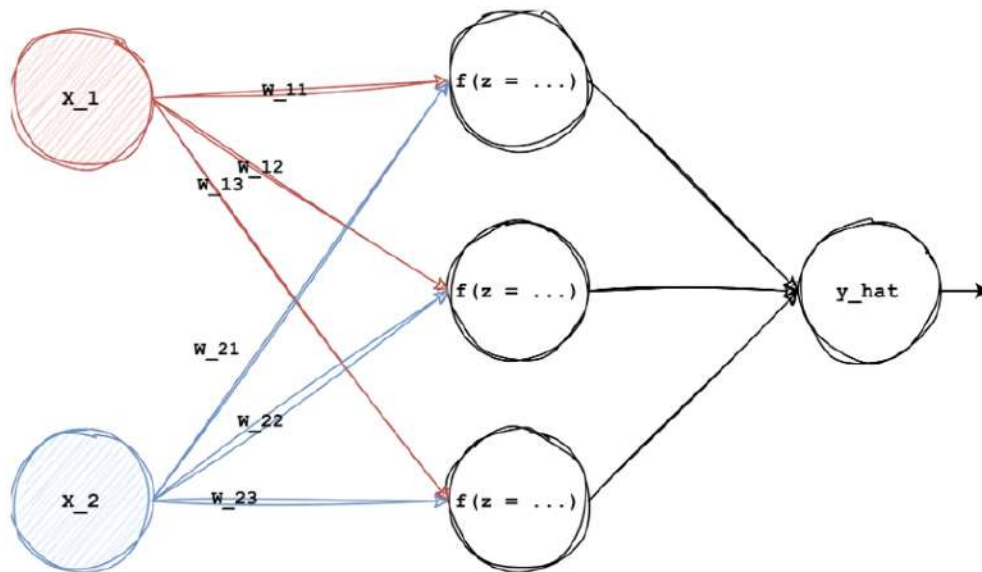
$$x_1w_1 + x_2w_2 + x_3w_3 + \textit{bias} = \textit{output}$$

Neural Networks: Intuition - Neuron



Neural Networks: Intuition

- Neural Network



INPUT 1	INPUT 2	OUTPUT
5	6	17
2	3	8
1	1	3
3	4	?

$$\begin{bmatrix} 5w_{11}^1 + 6w_{21}^1 & 5w_{12}^1 + 6w_{22}^1 & 5w_{13}^1 + 6w_{23}^1 \\ 2w_{11}^1 + 3w_{21}^1 & 2w_{12}^1 + 3w_{22}^1 & 2w_{13}^1 + 3w_{23}^1 \\ 1w_{11}^1 + 1w_{21}^1 & 1w_{12}^1 + 1w_{22}^1 & 1w_{13}^1 + 1w_{23}^1 \end{bmatrix}$$

$$= \begin{bmatrix} 5 & 6 \\ 2 & 3 \\ 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} w_{11}^1 & w_{12}^1 & w_{13}^1 \\ w_{21}^1 & w_{22}^1 & w_{23}^1 \end{bmatrix} = X \cdot W$$

Neural Networks: Concepts

Forward Propagation

- Input > Hidden Layer > Output
- Weights are randomly initialized
- Output is calculated using the weights

Loss calculation

- Estimate the error between the predicted and actual output
- Choose a loss function - e.g. Mean Squared Error

Backpropagation

- Calculate the gradient of the loss function with respect to the weights
- Update the weights

Explore Neural Network

Tensorflow Playground

Convolutional Neural Network

<http://experiments.mostafa.io/public/ffbpnn/>

<https://stanford.edu/~shervine/teaching/cs-229/cheatsheet-deep-learning>

<https://poloclub.github.io/cnn-explainer/>

<https://medium.com/analytics-vidhya/what-do-you-mean-by-forward-propagation-in-ann-9a89c80dac1b>

Neural Networks: Key concepts

- Neuron
- Activation Function
- Forward Propagation
- Loss Function
- Backpropagation
- Gradient Descent

LARGE

LANGUAGE

MODELS

What is a Language Model?

Fill in the blank:

When I hear rain on my roof, I _____ in my kitchen.

Option	Probability
Cook soup	9.4%
Make coffee	5.2%
Nap	2.5%
Relax	0.1%

What is a Language Model?

Type the next characters:

Ty_____

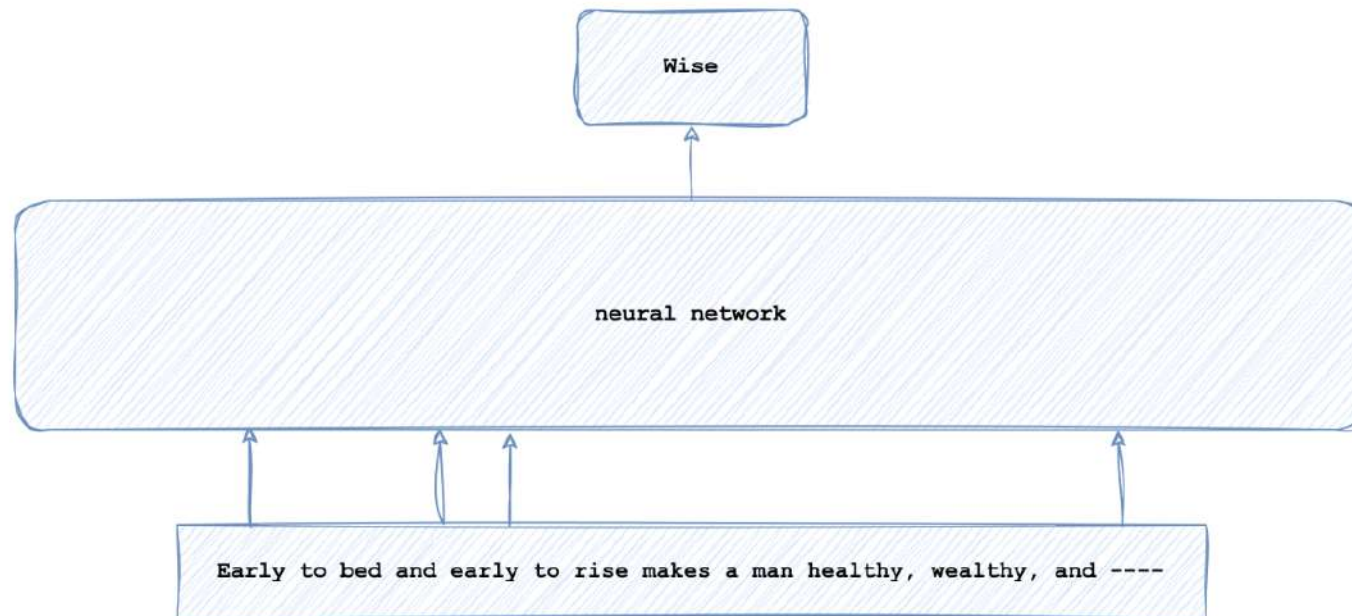
- Tye
- Typ
- Typi
- Typin
- Typing

Language Model may consider

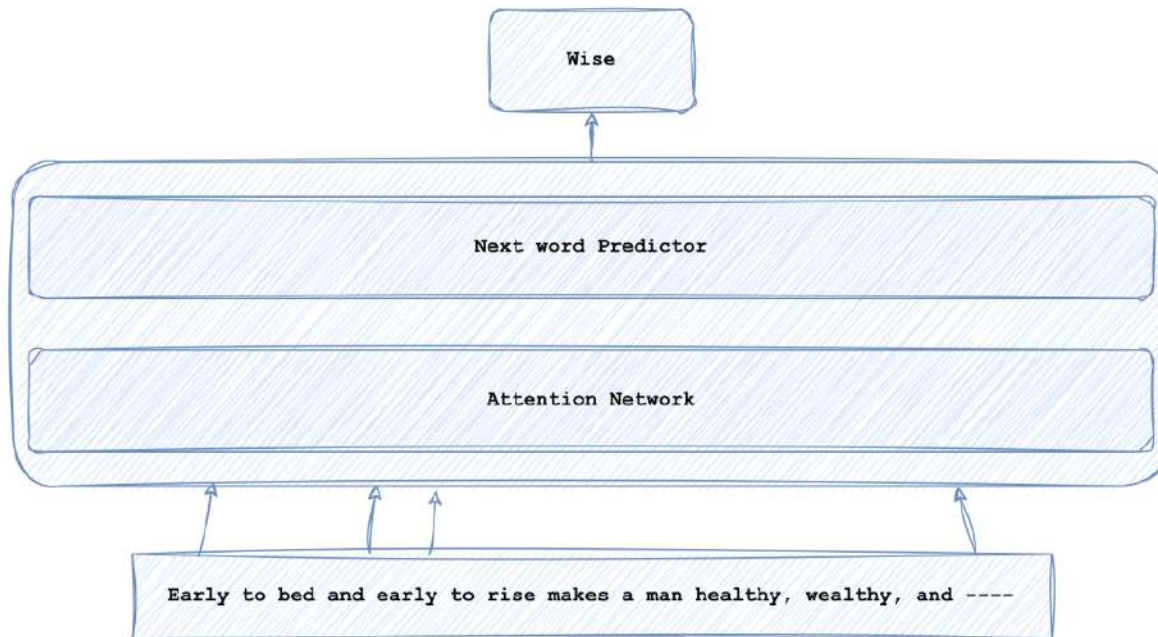
- How many times have you typed "Typing"?
- How many time the word "Typing" appears in the English language?

What is a Language Model?

- Machine Learning model that predicts and generates plausible language
- Can be used to generate text, translate text, summarize text, etc.
- It takes a sequence of words as input and predicts the probability of the next word in the sequence



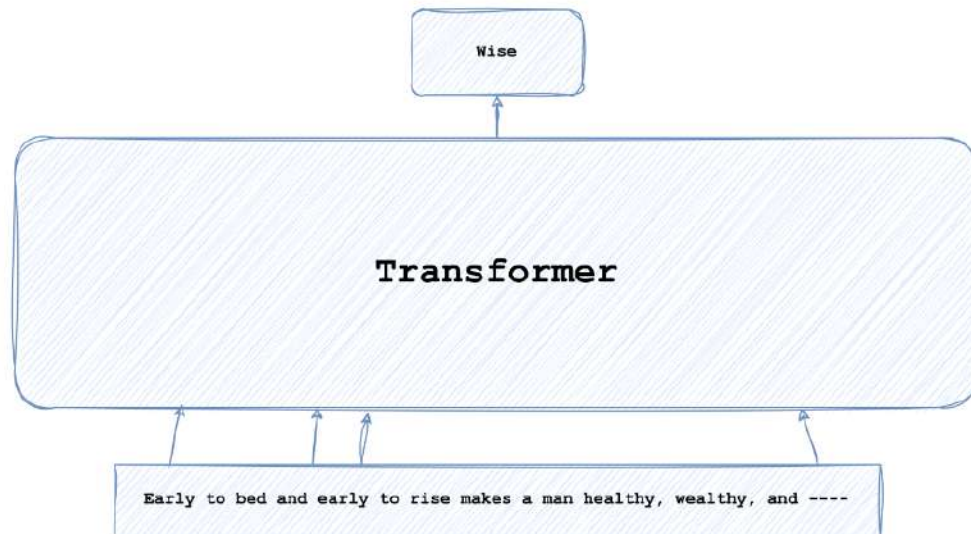
What is a Language Model?



Attention Network

- The model learns to pay attention to the relevant words in the input sequence

Transformer



- Transformer is a neural network architecture that solves sequence-to-sequence tasks while handling long-range dependencies with ease
- It is based on the attention mechanism
- It is used in Google Translate, Google Assistant, etc.
- Transformer consists of an encoder and a decoder
- Full paper: <https://arxiv.org/abs/1706.03762>

Large Language Models

- Large Language Models (LLMs) are trained on large amounts of text data

Language Model	Vendor	Parameter Count
GPT-3	OpenAI	175 billion
GShard	Google	600 billion
Switch Transformer	Google	1.6 trillion
T5	Google	11 billion
GPT-2	OpenAI	1.5 billion
BERT	Google	340 million
RoBERTa	Facebook	355 million

PROMPT ENGINEERING

What is Prompt Engineering?

- Prompt Engineering is the art of asking the right questions to the language model
- Doesn't require any coding experience
- Just need creativity and persistence

Prompt Best Practices

- Clearly communicate what content or information is important
- Use specific, varied examples
- Break down complex prompts into simpler prompts

Types of Prompts

- Describe (Describe a topic)
- Inform (Ask a question)
- Narrate (Write a story)
- Opinions (What do you think about a topic)
- Research (What are the pros and cons of a topic)
- Translate (Translate a sentence)
- Summarize (Summarize a text)

Types of Prompts

Direct Prompts

One shot prompt

Prompt:

Can you give me a list of ideas for blog posts for tourists visiting New York City for the first time?

Prompt:

Create a four-column spreadsheet of 10 highly-rated science fiction movies, year of release, average audience rating, and top 3 keywords from audience reviews.

Make sure to cite the source of the audience rating.

Types of Prompts

Multi-step Prompts

```
Great product, 10/10: Positive  
Didn't work very well: Negative  
Super helpful, worth it: Positive
```

```
What is the sentiment of the following review?  
It doesn't work!:
```

Types of Prompts

Chain-of-thought prompting

Zero-shot CoT

Prompt:

I went to the market and bought 10 apples. I gave 2 apples to the neighbor and 2 to the repairman. I then went and bought 5 more apples and ate 1. How many apples was I left with?

Let's think step by step.

Prompt Strategies

- Repeat keywords, phrases and ideas
- Specify the desired output format
- You can all caps to emphasize keywords
- Use synonyms or alternative phrasing

Look for examples in the Prompt Hero website

More example: <https://ai.google.dev/examples?keywords=prompt>

THE END :)