EE P 596
LLMs: From Transformers to ChatGPT

Lecture 2 | LLM Motivation | History of LLMs

Dr. Karthik Mohan, Jan 7 2026 | Winter Quarter course | PMP, ECE, UW

Course Outline

1. Building the foundations

- Logistics and Motivation
- ML fundamentals
- Logistic Regression
- Deep Learning

2. Transformers

- Transformers
- Discriminative and Generative
- Embeddings
- Applications

3. Generative AI

- LLMs
- GPT, GPT-2,GPT-3
- GPT 3.5, GPT 4
- Prompt Engineering
- Fine-tuning and Evaluating LLMs
- Open source vs closed LLMs

4. Miscellaneous Topics

- Auto Encoders
- Stable Diffusion
- Text to Image models
- Applications

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4. Miscellaneous Topics

- Auto Encoders
- Stable Diffusion
- Text to Image models
- SLMs
- Responsible AI

Course Webpage and Resources

https://bytesizeml.github.io/llm2026

What I would like you to take away!

Conceptually

- Better understanding of LLMs
- Of LLM application areas
- Of APIs
- Intuition behind LLM models
- Theory behind LLMs

Implementation

- Coding up baselines in Colab
- Comfort with APIs
- Use of Hugging Face models
- Showcasing your work on webpage
- Fine-tuning LLM models

Ideas

- Where can you apply LLMs next?
- How can you chain LLMs
- to solve a problem?

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Ideas

- Where can you apply LLMs next?
- Grasping cutting-edge technical papers
- Being able to do basic LLM designs
- for pet projects

Discord Setup and Message

Set up your access to the class discord channel
&
send a link to an interesting article on LLMs on the channel

Assignments

1. In-Class Exercises (15%)

- 3-4 questions per lecture
- Respond on a poll or a form
- Will be graded for credit

2. Coding Assignments (15%)

- Two Coding Assignments
- First two weeks of class

3. Mini-projects (45%)

- 3 for this class
- Get 2 weeks to work on each
- More involved than a coding assignment
- Could include a Kaggle Contest
- Could include a web demo

4. Project Presentation (15%)

- Present on one of the mini-projects
- Presentation on M or W of finals week
- 7 minutes per team + 3 minute questions
- Methodology + working demo and results

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Assignments

5. Paper Presentation (10%)

- Present on a technical paper
- Present in teams of 2
- Will be graded on presentation quality
- And ability to respond to questions

Assignments Summary

Summary

- In-Class Exercises - 15%
- Coding Assignments - 15%
- Mini-Projects - 45%
- Mini-Project Presentation - 15%
- Paper Presentation - 10%

Assignment 1

- To be assigned today and due next Tuesday
- Focuses on set up for colab, apis + llm discovery and insights

Assignments Flow

- Assignment 1 and 2 due next and week after next
- Mini-Projects 1,2,3 follow
- Paper presentation slots will be available and presentation will happen last 15 mins of class

Course Flow

Engine vs API

Engines are different from APIs and we shouldn’t confuse the two.

Engine vs API

Engines are different from APIs and we shouldn’t confuse the two.

BERT and Llama are Engines/Foundation Models whereas ChatGPT 4o is an API

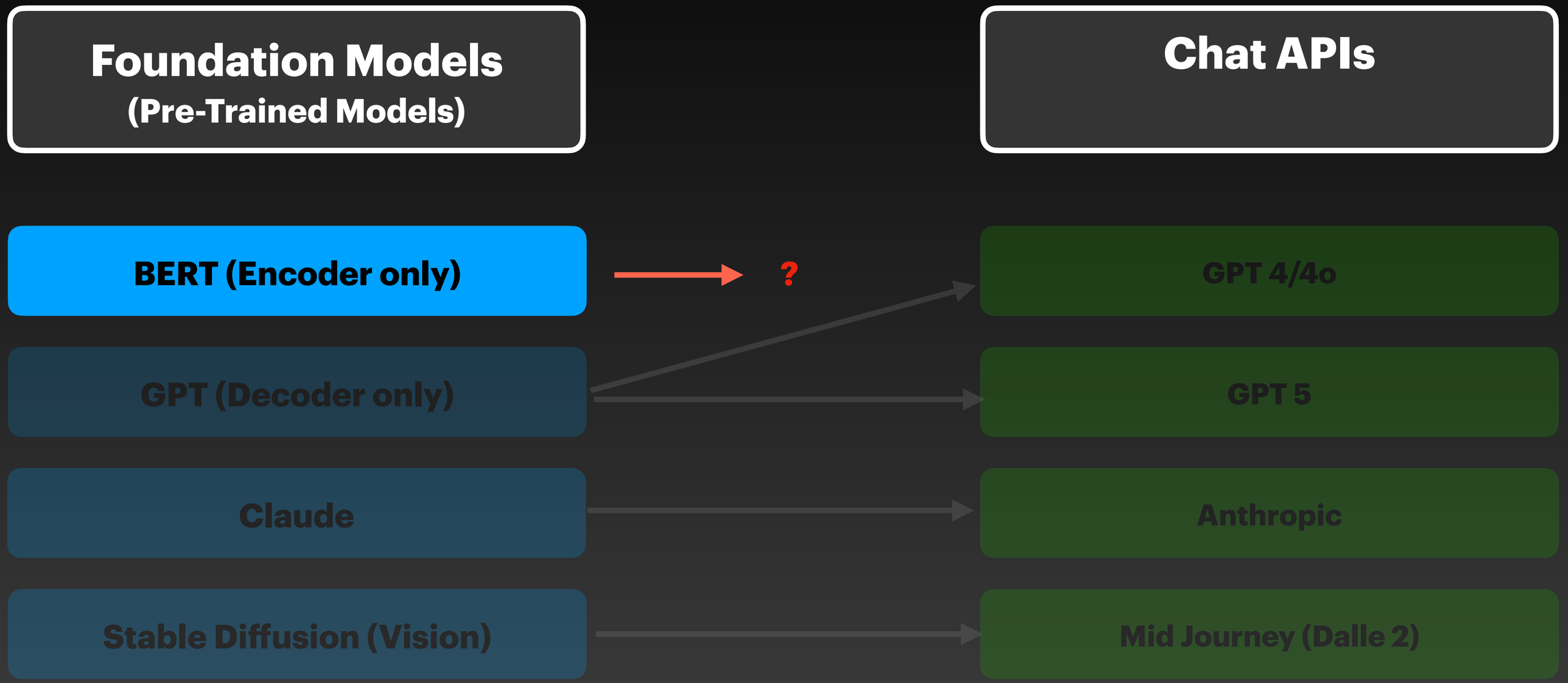
Engine vs API

Foundation Models
(Pre-Trained Models)

- BERT (Encoder only)
- GPT (Decoder only)
- Claude
- Stable Diffusion (Vision)

Chat APIs

Engine vs API



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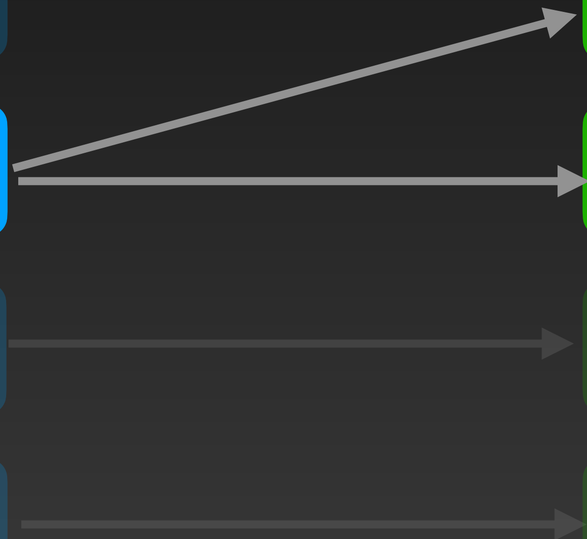

GPT 4/GPT 4o

GPT 5.2 (Thinking)

Anthropic

Mid Journey (Dalle 2)

Engine vs API

Foundation Models
(Pre-Trained Models)

Chat APIs

BERT (Encoder only)

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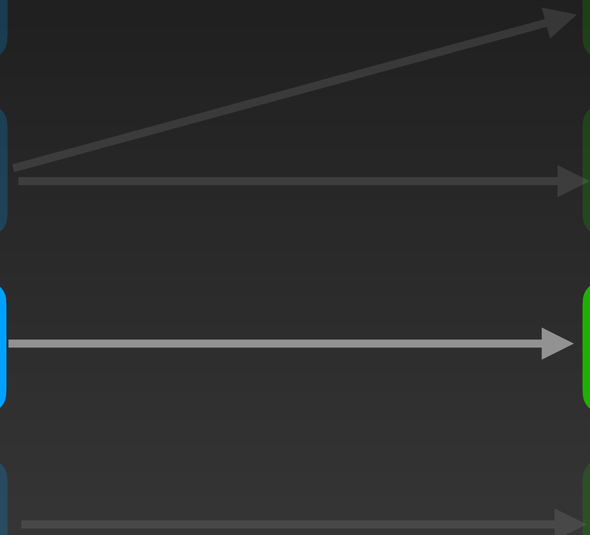
GPT 4/4o

GPT 5

Opus 4.5, Sonnet 4.5

Mid Journey (Dalle 2)



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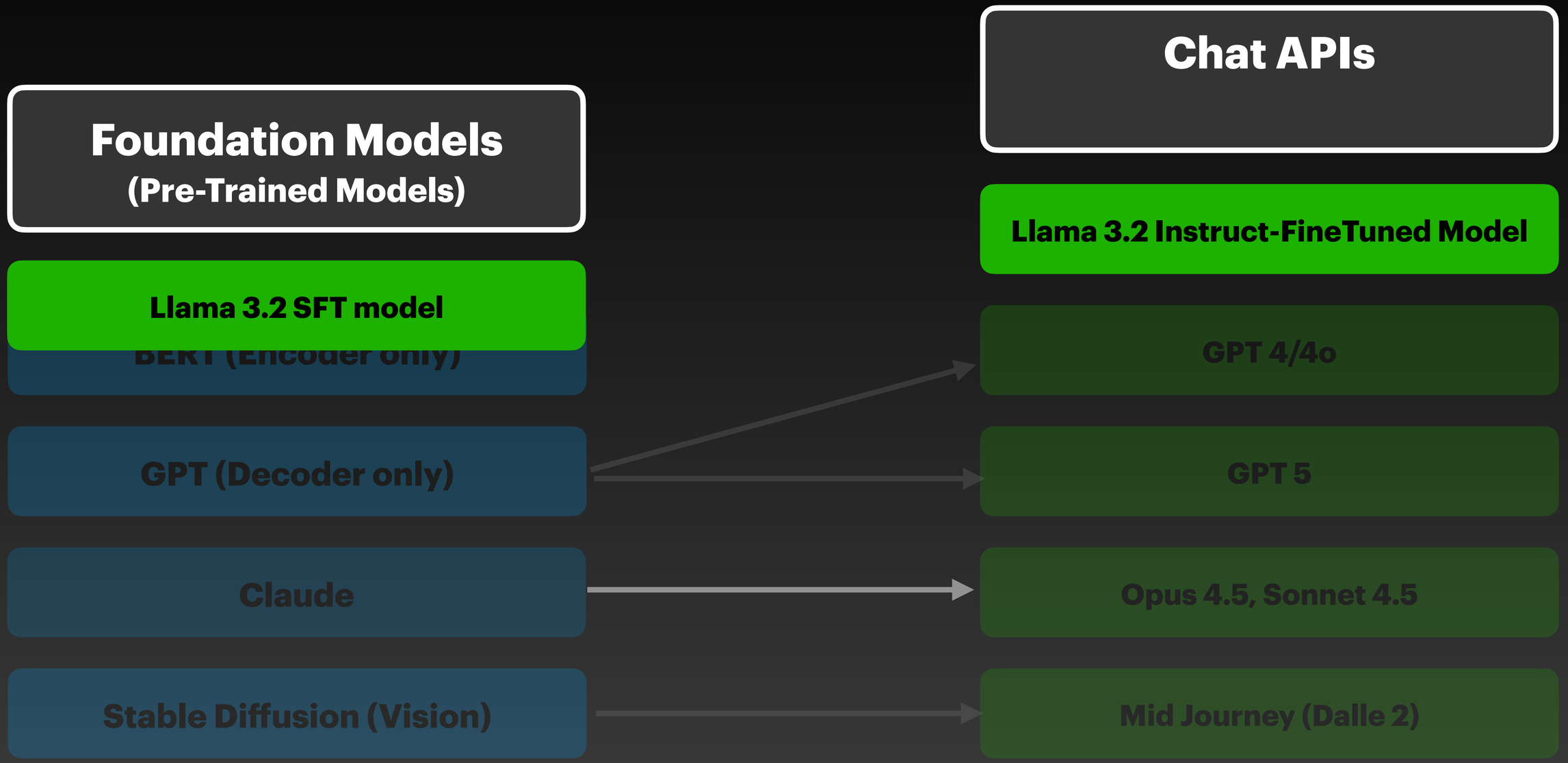

Engine vs API

Foundation Models
(Pre-Trained Models)

Llama 3.2 SFT model

BERT (Encoder only)

GPT (Decoder only

Claude

Stable Diffusion (Visi

Chat APIs

Llama 3.2 Instruct-FineTuned Model

GPT 4/4o

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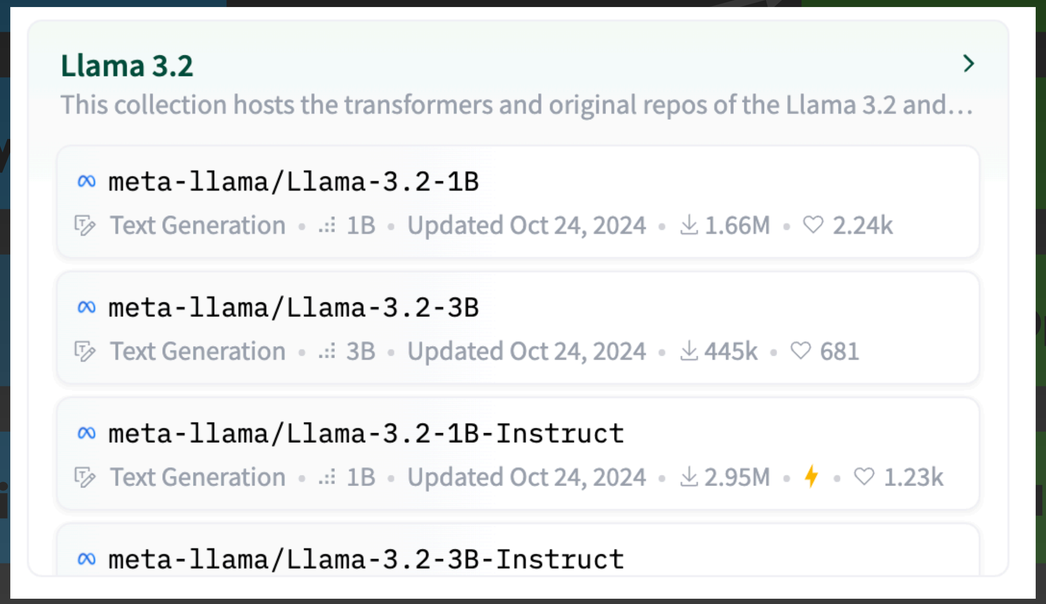

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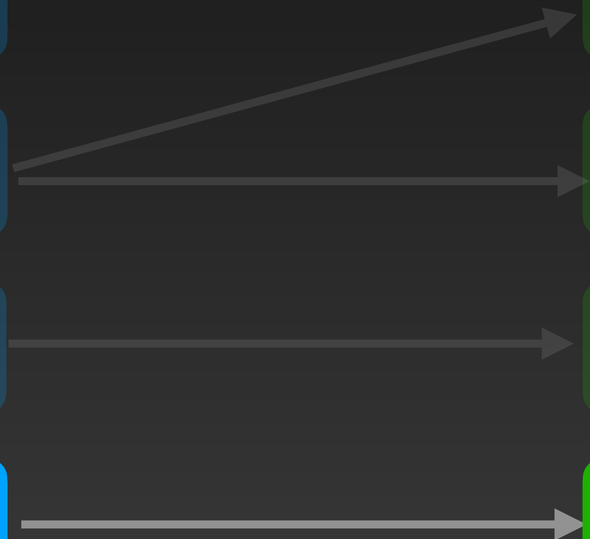

Engine vs API

Foundation Models
(Pre-Trained Models)

Chat APIs

BERT (Encoder only)

GPT (Decoder only)

Large Vision Model (LVM)
Pre-Trained Model
Foundation Model

GPT 4/ GPT 4o

GPT 5

Claude

Opus, Sonnet

Stable Diffusion (Vision)

Mid Journey (Dalle 2)

Engine vs API

Foundation Models
(Pre-Trained Models)

t APIs

LLM - Large Language Model
Pre-Trained Model
Foundation Model

BERT (Encoder only)

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Stable Diffusion (Vision)

GPT 3.5

GPT 4

Opus, Sonnet

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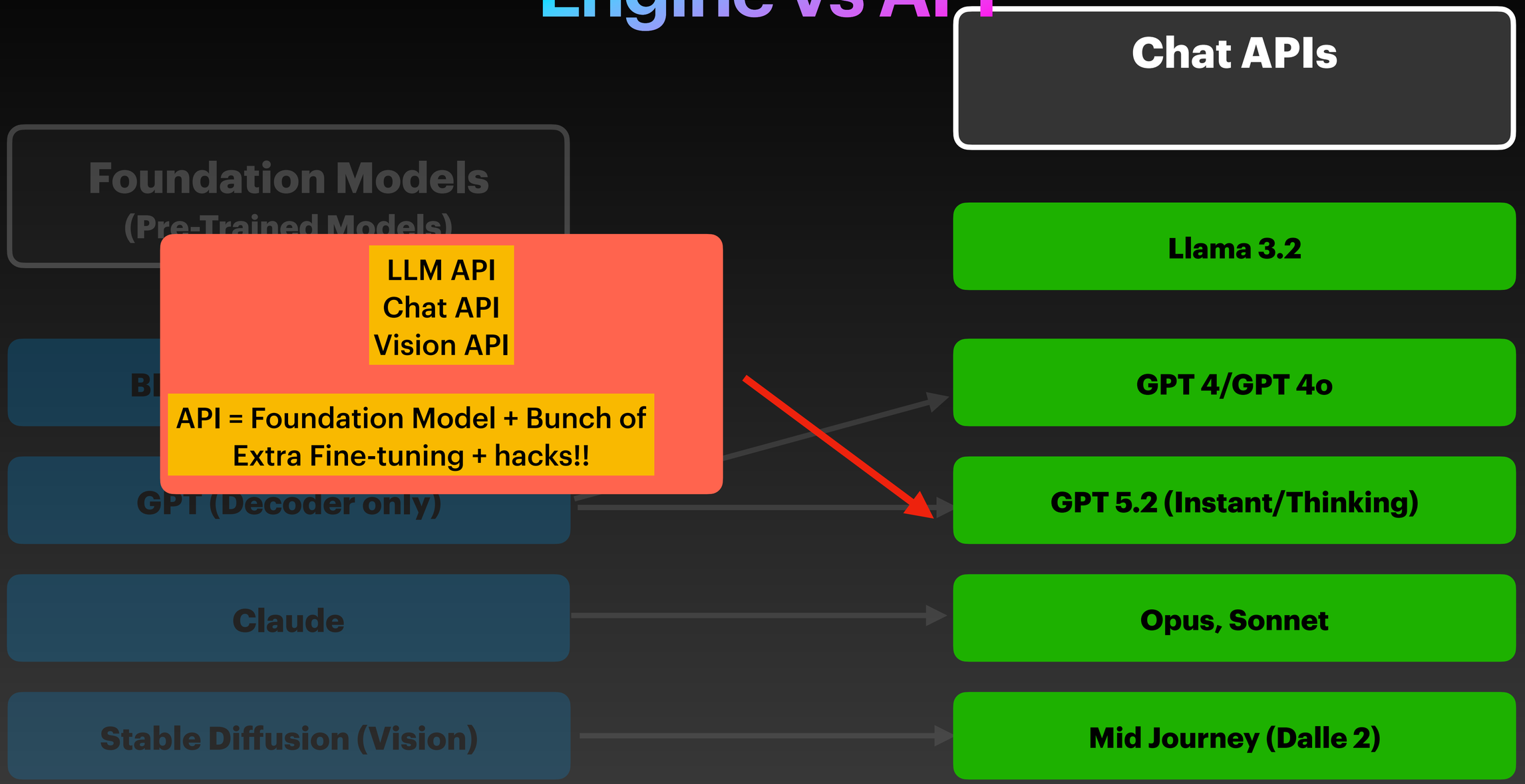
Engine vs API



What is a Language Model?

Scientific Data-driven Model that helps machines understand language and patterns in sentence construction

What is a Language Model?

Example: I just got promoted. I am feeling so ———

What is a Language Model?

Example: I just got promoted. I am feeling so happy

What is a Language Model?

Example: I just checked my application status and it got ———. It’s frustrating!

What is a Language Model?

Example: I just checked my application status and it got rejected. It's frustrating!

What is a Large Language Model (LLM)?

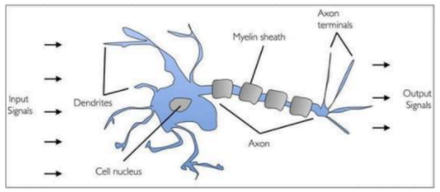
LLMs are language models that are learned from massive corpuses of text, that are mined from the web. They are known to be sophisticated in understanding language and can be **generative** in nature.

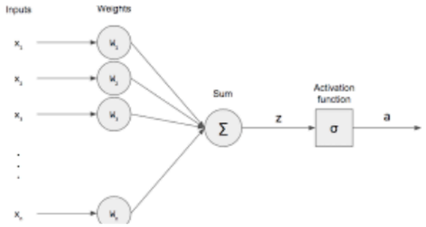
History of (Large) Language Models

How did machines work with language before and how we do it now?

History of (Large) Language Models

Perceptron





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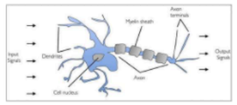
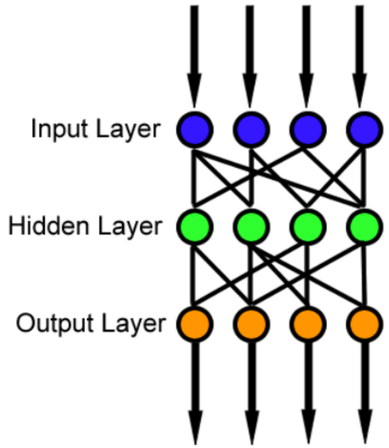
Perceptron



Feed Forward NN



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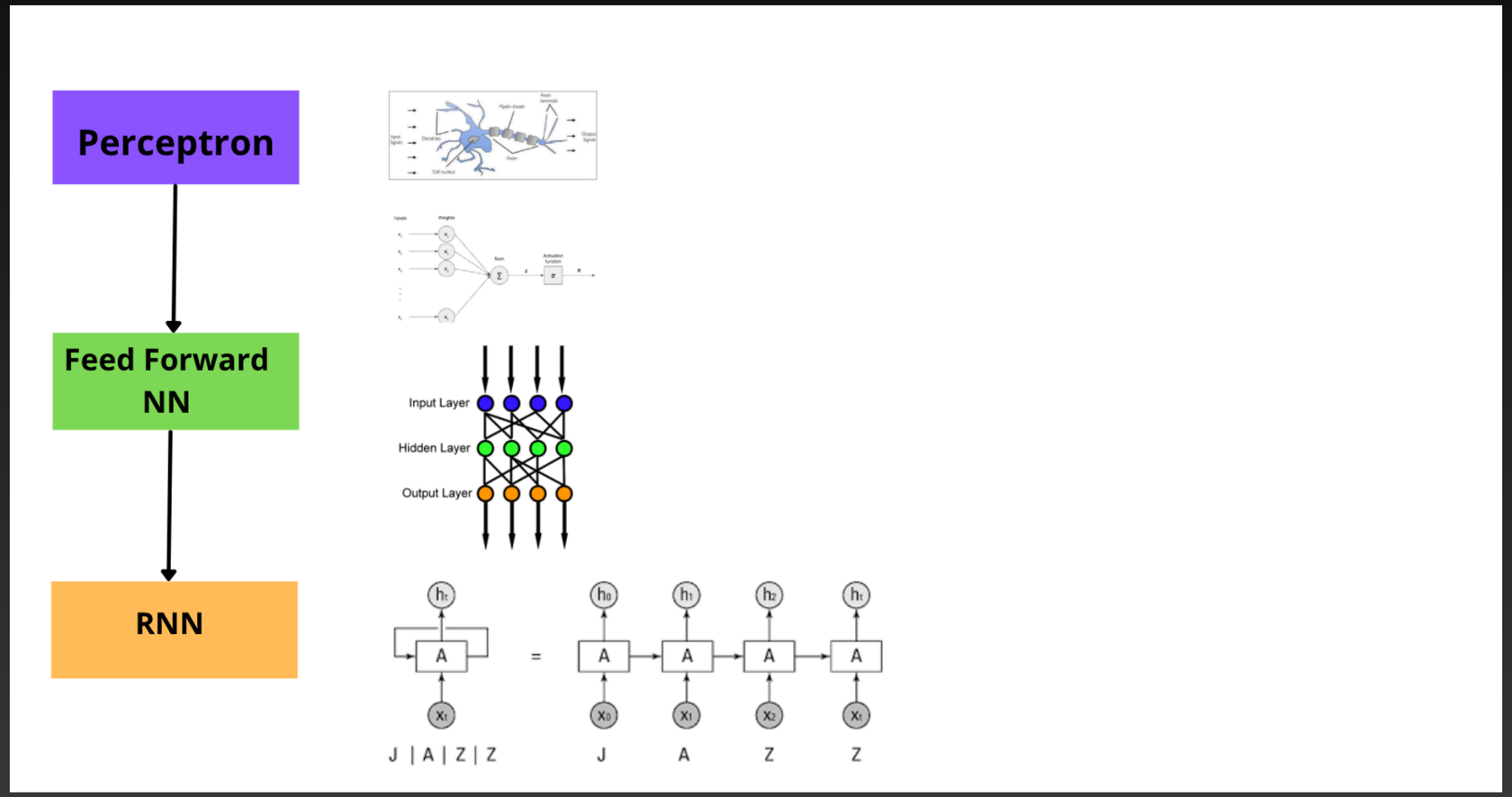

History of (Large) Language Models

RNN Issue:

I just arrived in NY. In a few days, I would like to visit the city, ———

History of (Large) Language Models

RNN Issue:

I just arrived in NY. In a few days, I would like to visit the city, NY

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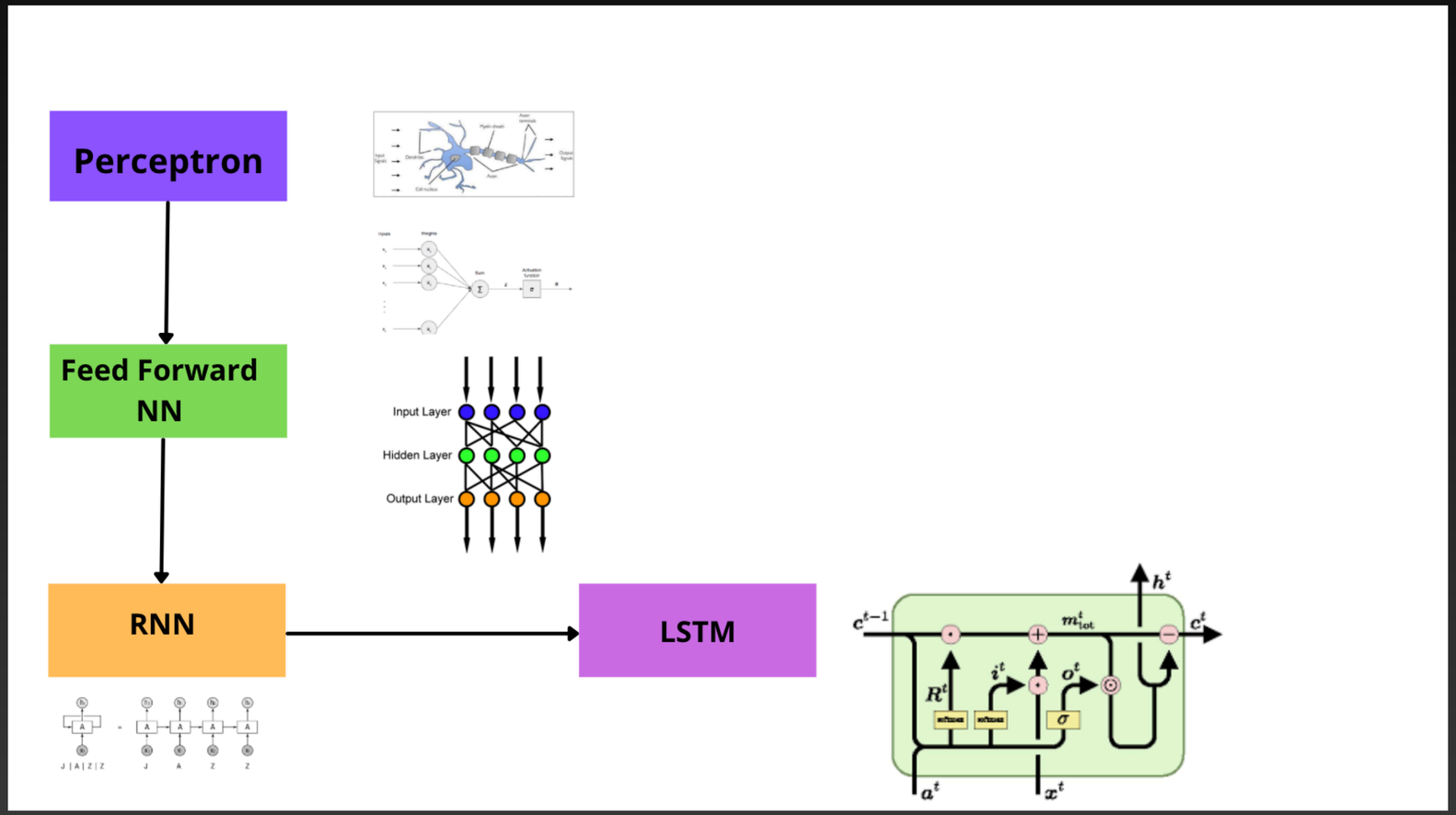


History of (Large) Language Models

LSTM

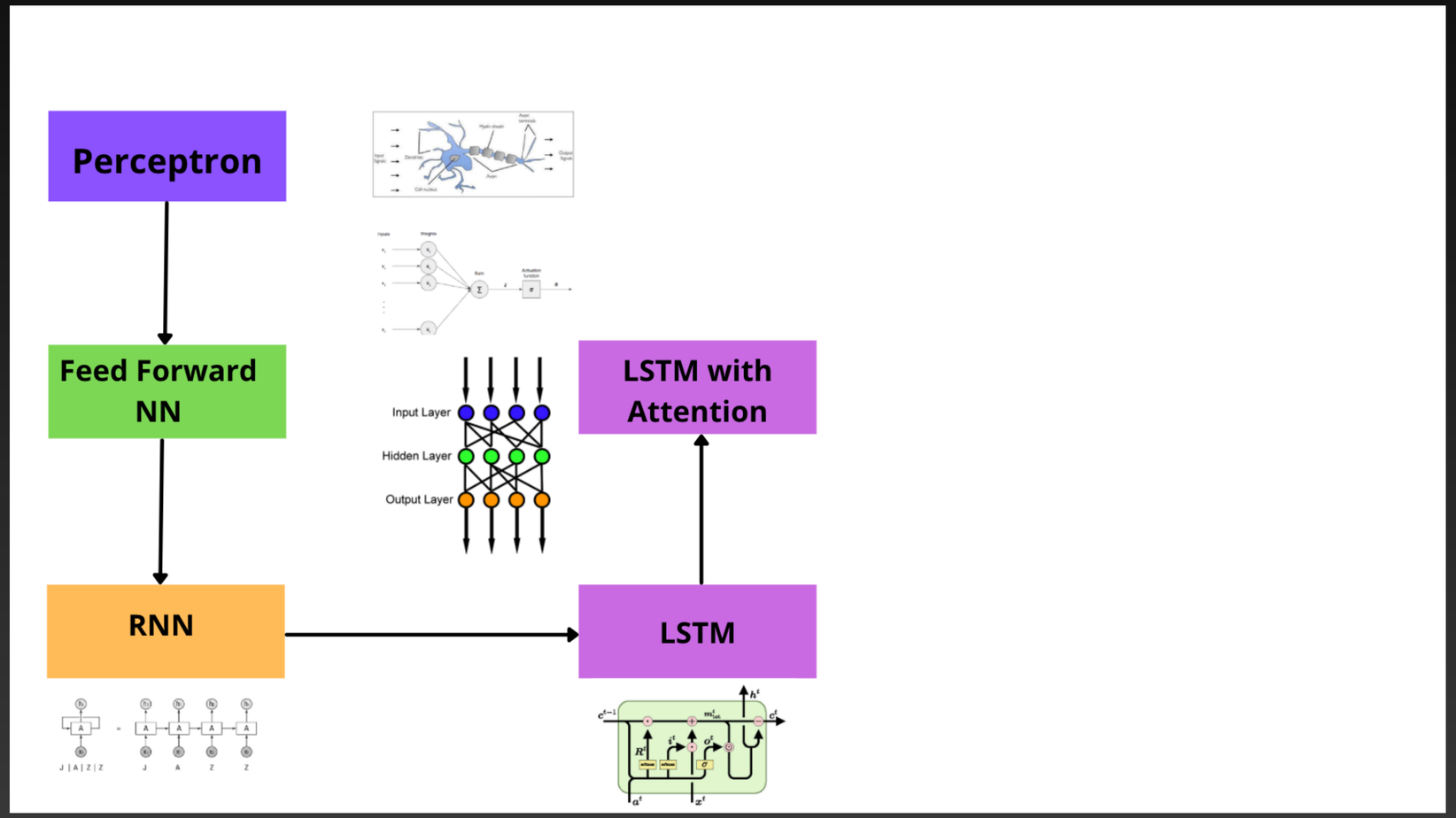
I just arrived in NY. In a few days, I would like to visit the city, ———

History of (Large) Language Models

LSTM

I just arrived in NY. In a few days, I would like to visit the city, Seattle

History of (Large) Language Models



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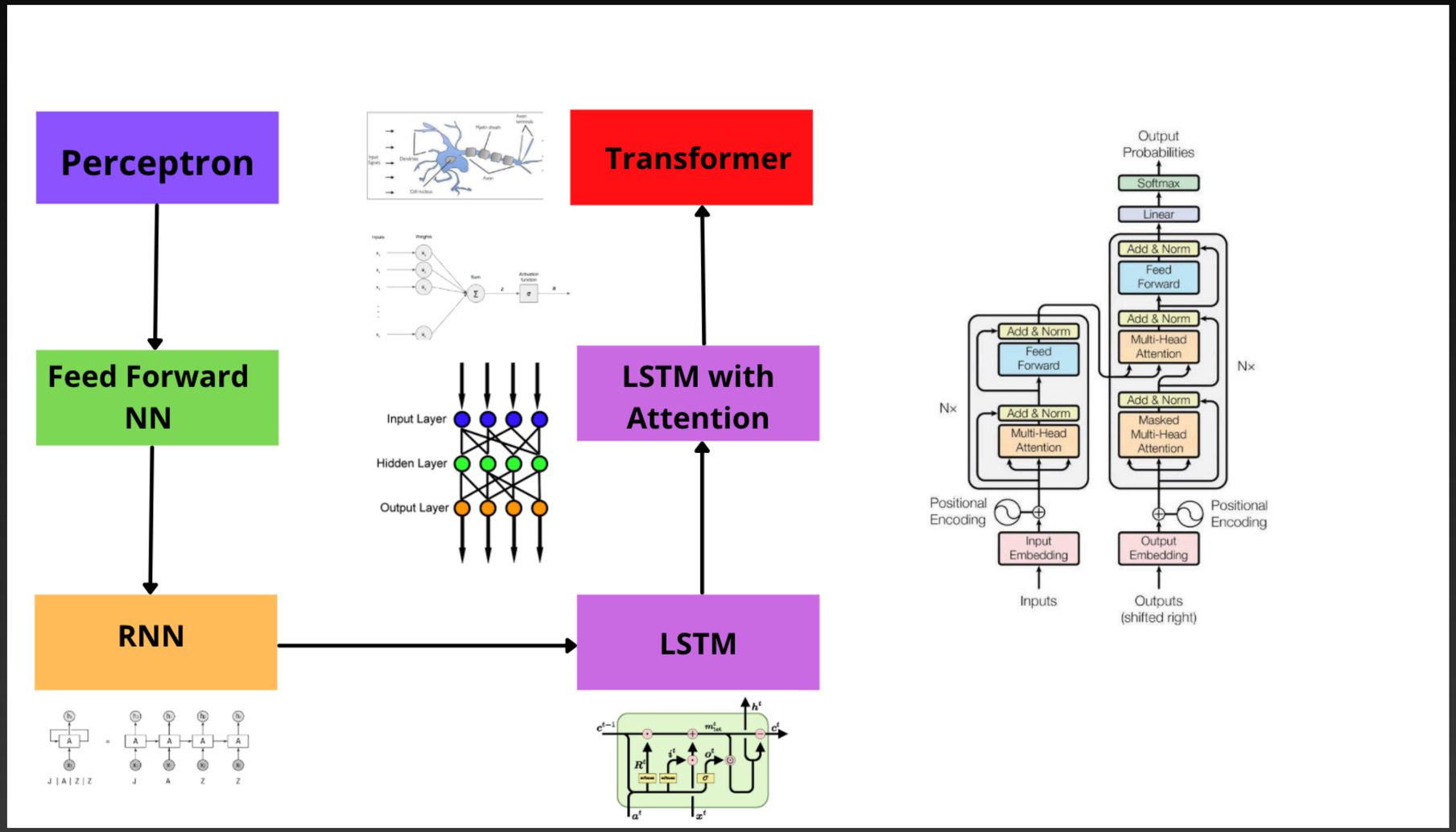

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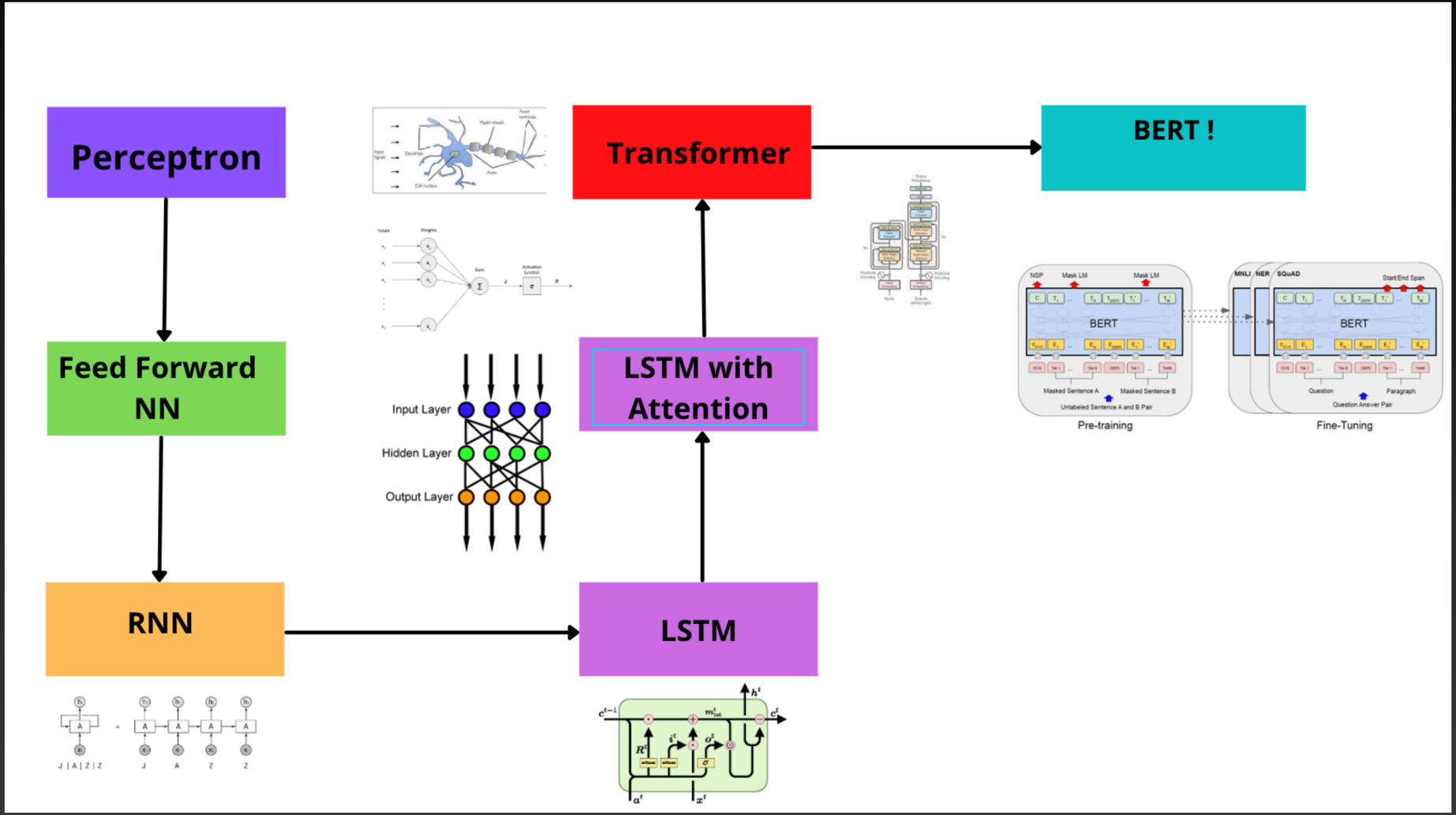

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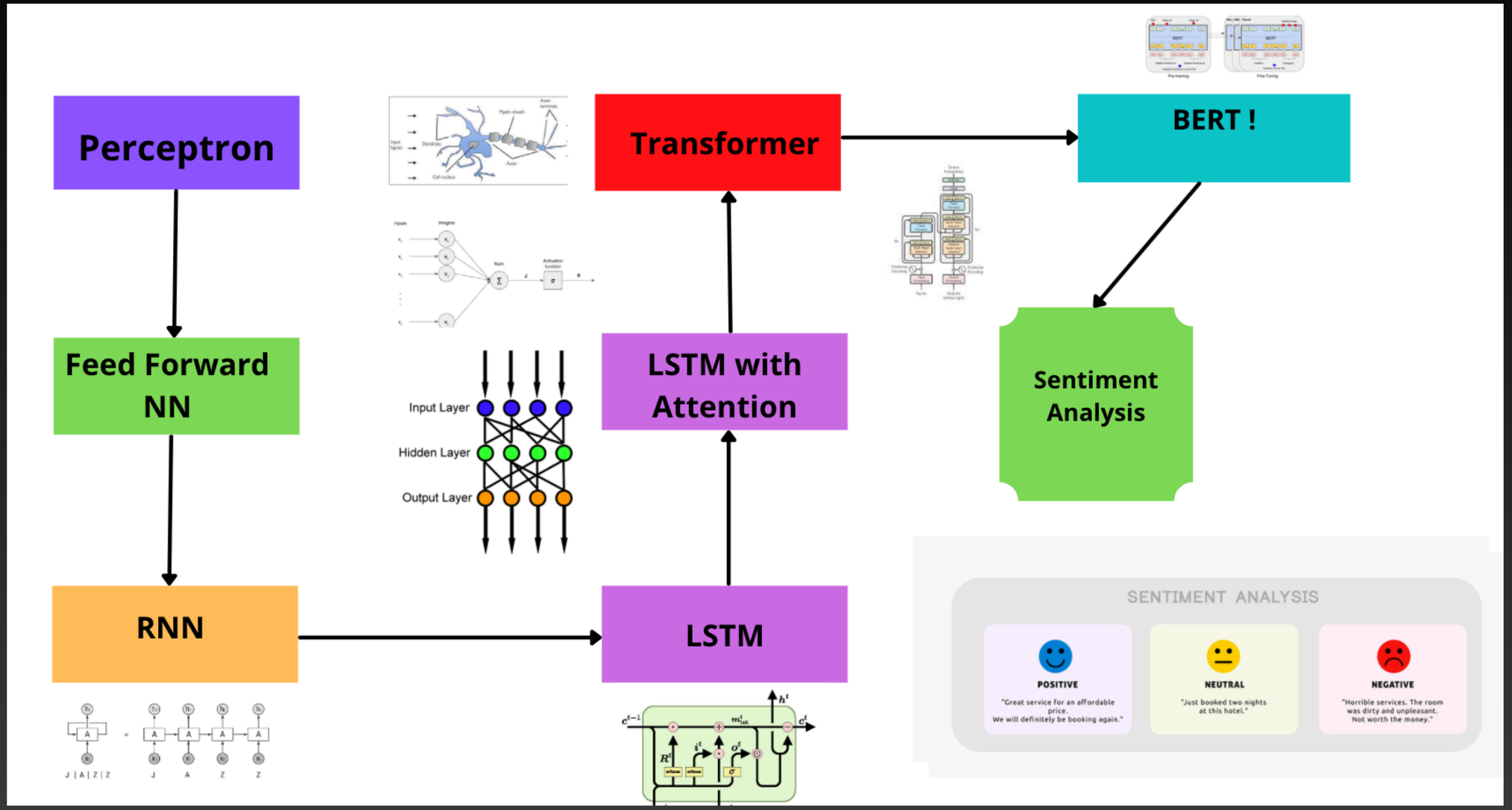


History of (Large) Language Models

Perceptron

Feed Forward NN

RNN

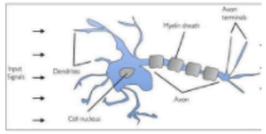
LSTM

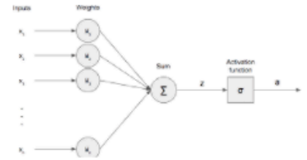
LSTM with Attention

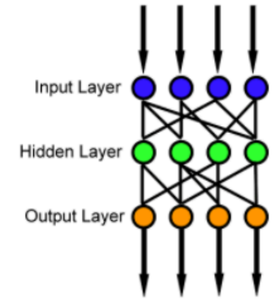
Transformer

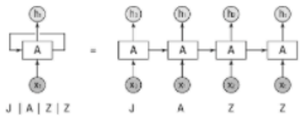
BERT !

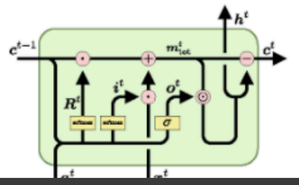
Extractive Summarization

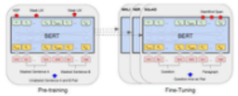


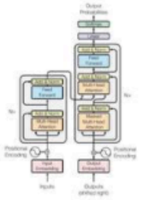


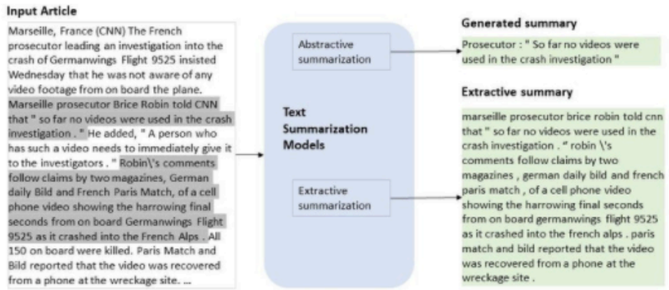












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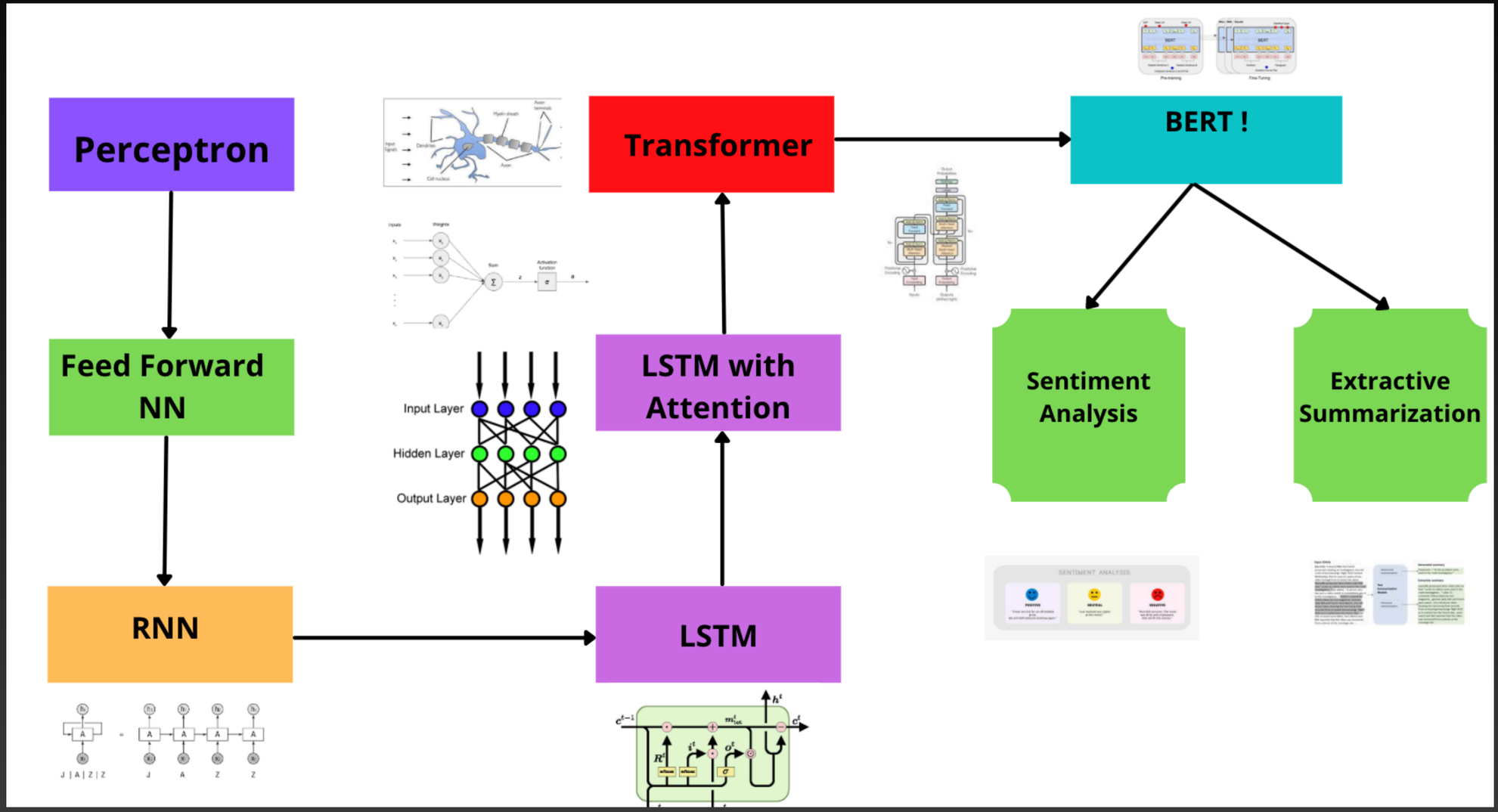

History of (Large) Language Models

GPT vs BERT

While BERT is purely about encoding and is called an encoding Transformer. GPT is purely a decoder and is called a decoding transformer.

History of (Large) Language Models

GPT-x

GPT-x (GPT, GPT-2, GPT-2.5, etc) are decoding transformers that are trained to predict the next token given the past and do a very good job at it! That's how they can generate entire paragraphs that look logical, grammatical and structured.

1 Trillion Tokens!

	RedPajama	LLaMA*
CommonCrawl	878 billion	852 billion
C4	175 billion	190 billion
Github	59 billion	100 billion
Books	26 billion	25 billion
ArXiv	28 billion	33 billion
Wikipedia	24 billion	25 billion
StackExchange	20 billion	27 billion
Total	1.2 trillion	1.25 trillion

1 Trillion Tokens requires how many books?

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1 Book ~ 50k Tokens

15 Million Books ~ 1 Trillion Tokens

ChatGPT use cases for NLP

ChatGPT use cases for NLP

Table 1: Distribution of use case categories from our API prompt dataset.

Use-case	(%)
Generation	45.6%
Open QA	12.4%
Brainstorming	11.2%
Chat	8.4%
Rewrite	6.6%
Summarization	4.2%
Classification	3.5%
Other	3.5%
Closed QA	2.6%
Extract	1.9%

Table 2: Illustrative prompts from our API prompt dataset. These are fictional examples inspired by real usage—see more examples in Appendix A.2.1.

Use-case	Prompt
Brainstorming	List five ideas for how to regain enthusiasm for my career
Generation	Write a short story where a bear goes to the beach, makes friends with a seal, and then returns home.
Rewrite	This is the summary of a Broadway play: """ {summary} """ This is the outline of the commercial for that play: """

The distribution of prompts used to finetune InstructGPT

Practical applications of LLMs you want to talk about

Discuss in groups of 3 or 4

- What business applications or pet projects are you looking at?
- Pick a company (e.g. Amazon or Instacart or Walmart or eBay - Go their website or app and use that as context for discussion)
- How can we use LLMs for the specific product feature in the above context?
- Would LLMs be good to have or actually needed for the application?

Dialing it back a bit...

Deep Learning Foundations

Dialing it back a bit...

Deep Learning Foundations

Lets switch gears to some fundamentals and pre-requisite review