Language Models:

The Hidden Secrets

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Agenda

13:30 - 14:00	Inro to Deep Learning, LLM's and other buzzwords
14:00 - 14:30	Pretraining, Finetuning and RLHF (more buzzwords)
14:30 - 14:45	Break
14:45 - 15:15	Easley deploying your own LLM and make it do things for you
15:15 - 15:45	The secret sauce behind GPT-4

Yotam Nahum

Co-Founder & CTO
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- **Head of AI Dep. (Major)** – Israeli Air Force
- **Senior Researcher** – The Data Science Institute
- **Research fields & publications** – Social Networks, NLP, Recommendation Systems, Cryptography
- **IDC, Columbia University**

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What’s the different between Machine Learning and AI?


BUZZWORDS
BUZZWORDS EVERYWHERE

Inro to
Deep Learning,
LLM’s,
And
other buzzwords

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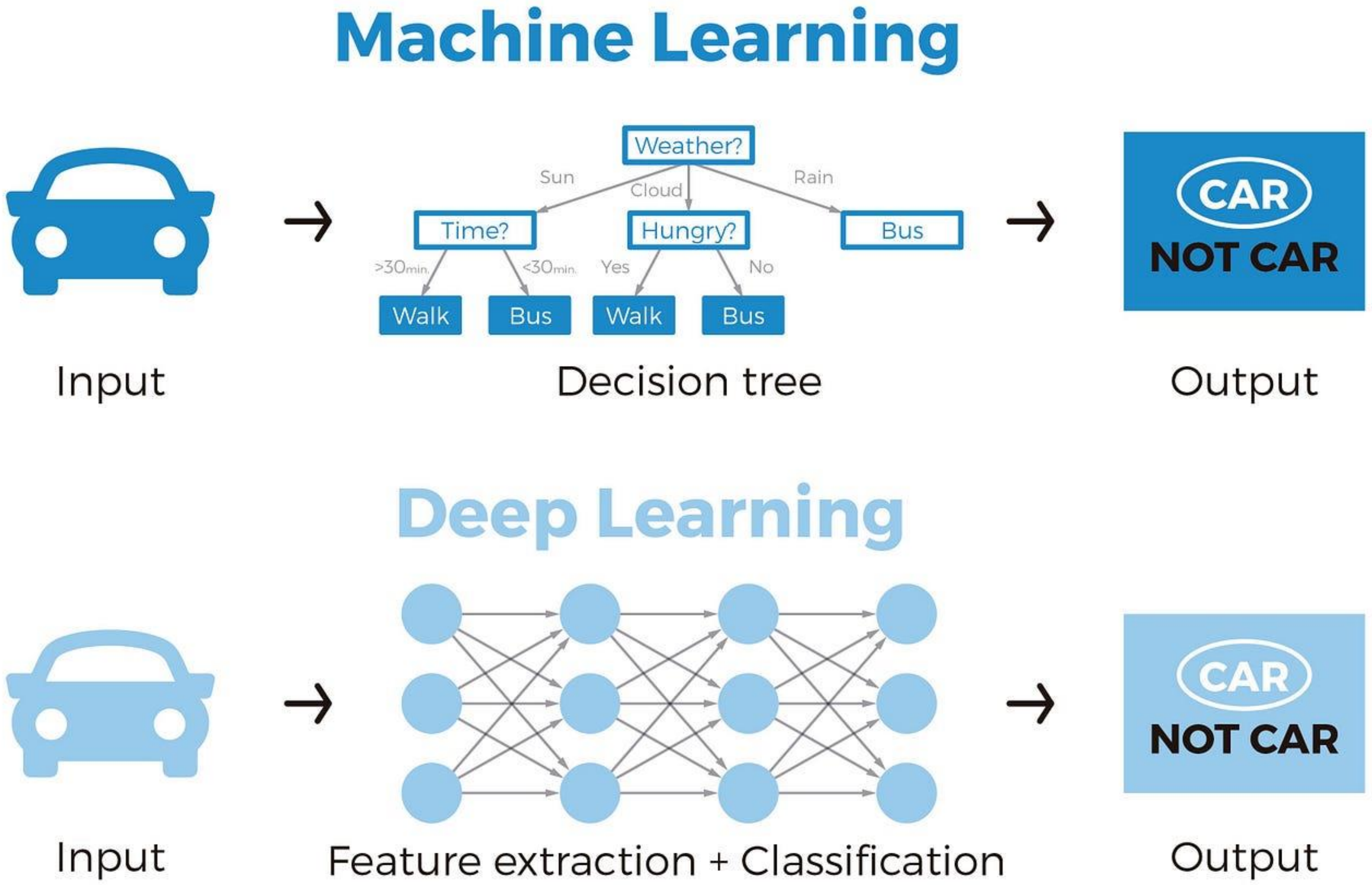
Machine Learning vs. Deep Learning



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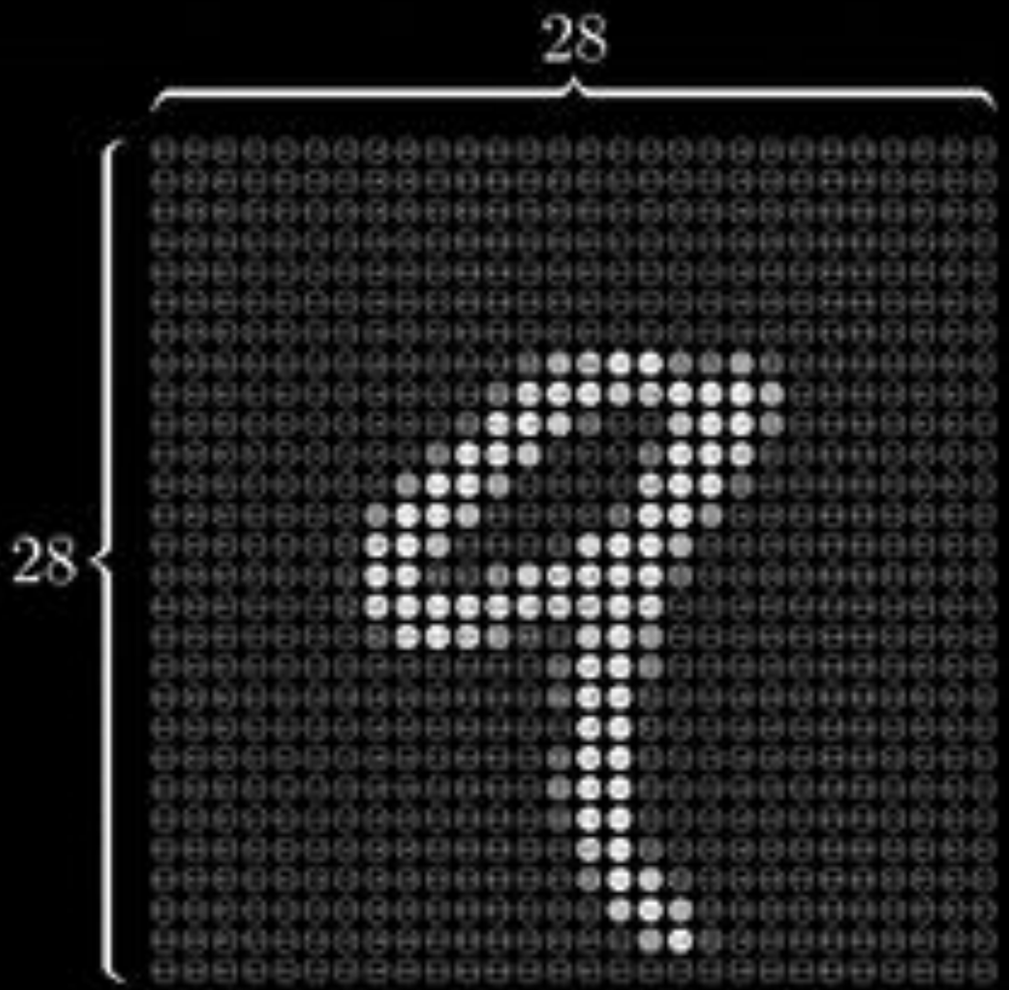
So no more feature engineering?



$$28 \times 28 = 784$$

```python
def generate_resource_report_prompt(question, research_summary):
    """Generates the resource report prompt for the given question and research summary.

    Args:
        question (str): The question to generate the resource report prompt for.
        research_summary (str): The research summary to generate the resource report prompt for.

    Returns:
        str: The resource report prompt for the given question and research summary.
    """
    return f'"""{research_summary}""" Based on the above information, generate a bibliography
recommendation report for the following' \
           f' question or topic: "{question}". The report should provide a detailed analysis of each
recommended resource,' \
           ' explaining how each source can contribute to finding answers to the research question.' \
           ' Focus on the relevance, reliability, and significance of each source.' \
           ' Ensure that the report is well-structured, informative, in-depth, and follows Markdown
syntax.' \
           ' Include relevant facts, figures, and numbers whenever available.' \
           ' The report should have a minimum length of 1,200 words.'
```

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Large Language Models as Optimizers

arXiv:2309.03409v1 [cs.LG] 7 Sep 2023

Source	Instruction	Acc
Baselines		
(Kojima et al., 2022)	Let's think step by step.	71.8
(Zhou et al., 2022b)	Let's work this out in a step by step way to be sure we have the right answer.	58.8
	(empty string)	34.0
Ours		
`PaLM 2-L-IT`	Take a deep breath and work on this problem step-by-step.	**80.2**
`PaLM 2-L`	Break this down.	79.9
`gpt-3.5-turbo`	A little bit of arithmetic and a logical approach will help us quickly arrive at the solution to this problem.	78.5
`gpt-4`	Let's combine our numerical command and clear thinking to quickly and accurately decipher the answer.	74.5

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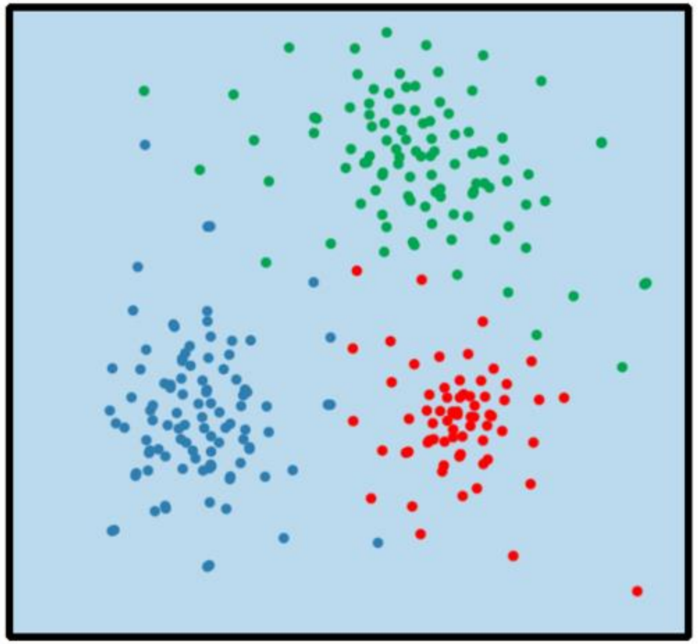
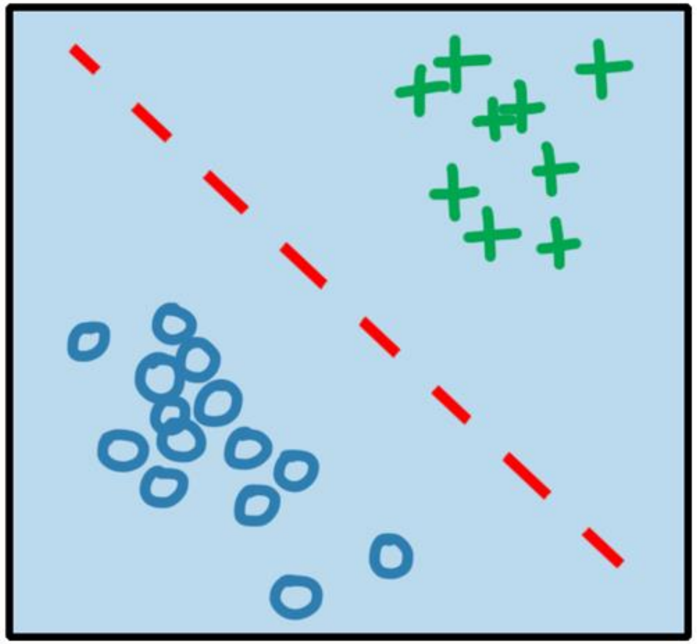
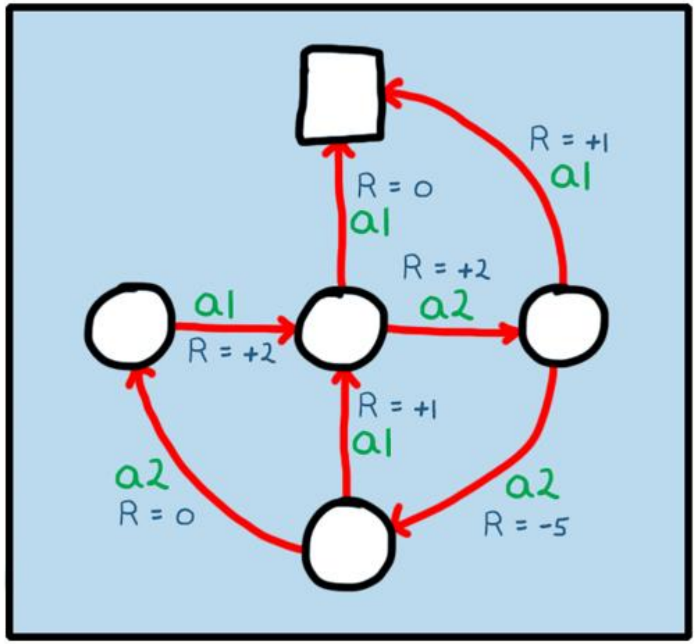
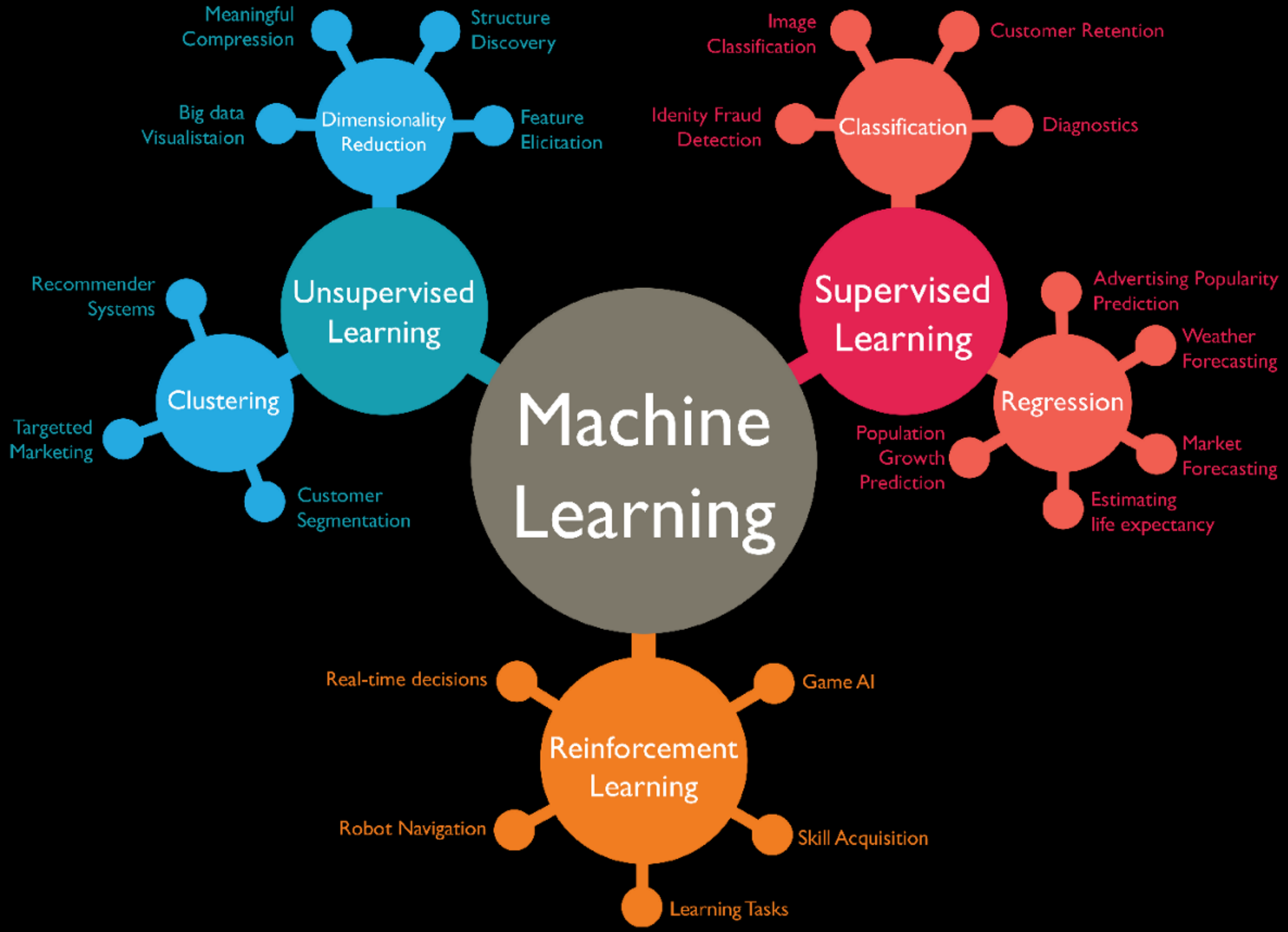
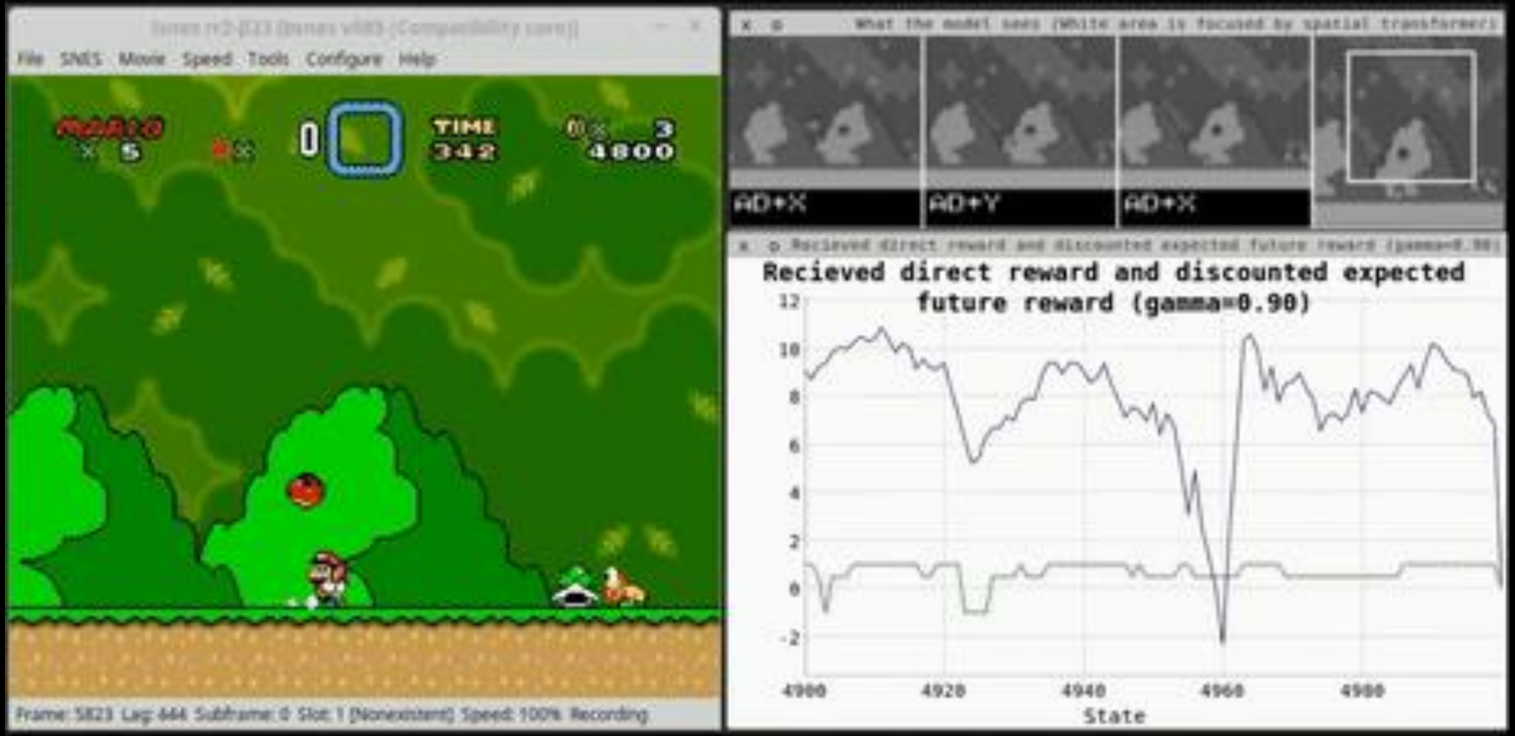
machine learning

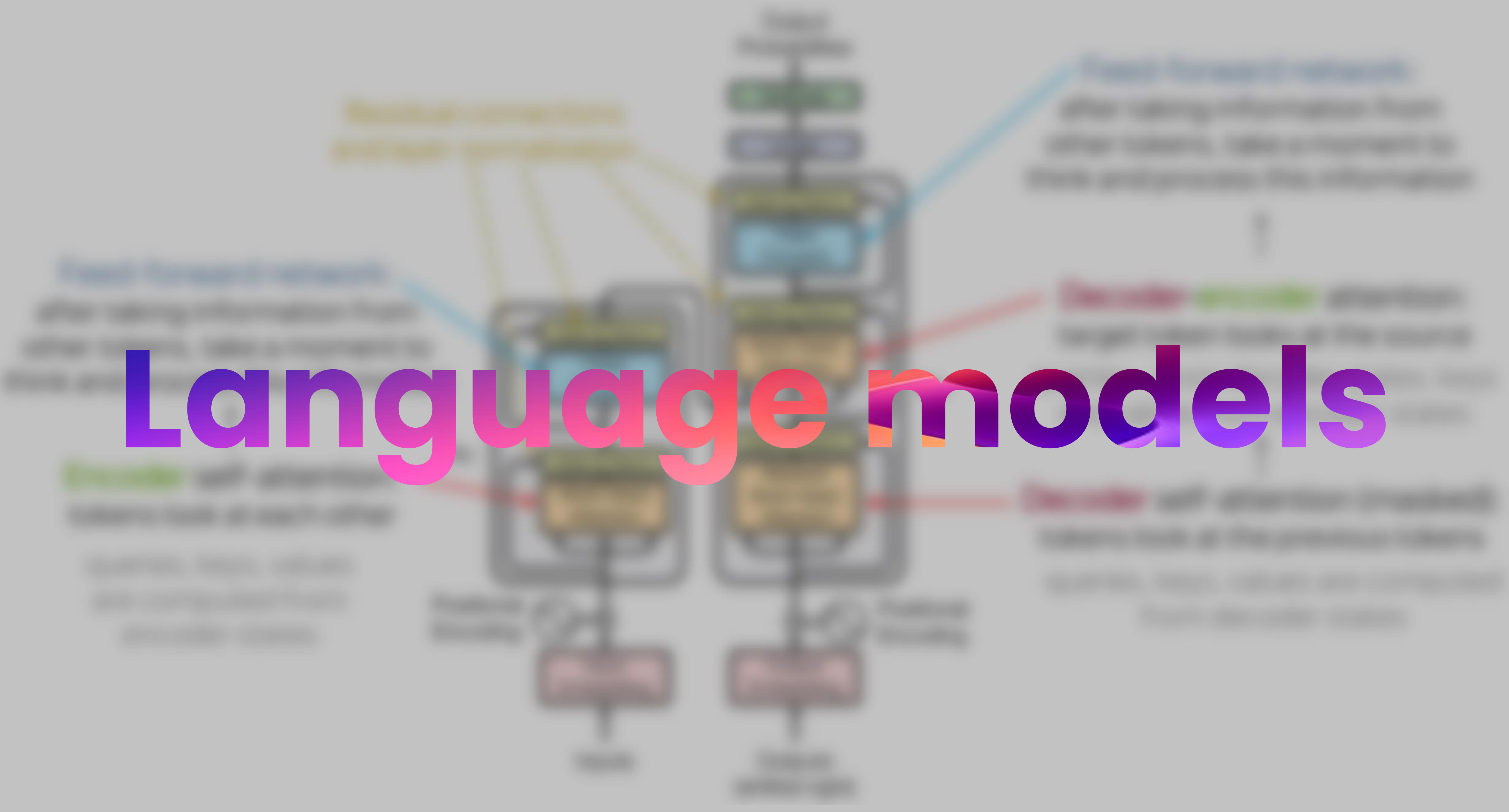
unsupervised learning	supervised learning	reinforcement learning
		


Machine Learning
Unsupervised Learning
Dimensionality Reduction
Meaningful Compression
Structure Discovery
Big data Visualistaion
Feature Elicitation
Clustering
Recommender Systems
Targetted Marketing
Customer Segmentation
Supervised Learning
Classification
Image Classification
Customer Retention
Idenity Fraud Detection
Diagnostics
Regression
Advertising Popularity Prediction
Weather Forecasting
Population Growth Prediction
Market Forecasting
Estimating life expectancy
Reinforcement Learning
Real-time decisions
Game AI
Robot Navigation
Skill Acquisition
Learning Tasks

Reinforcement Learning



Language models



Language models

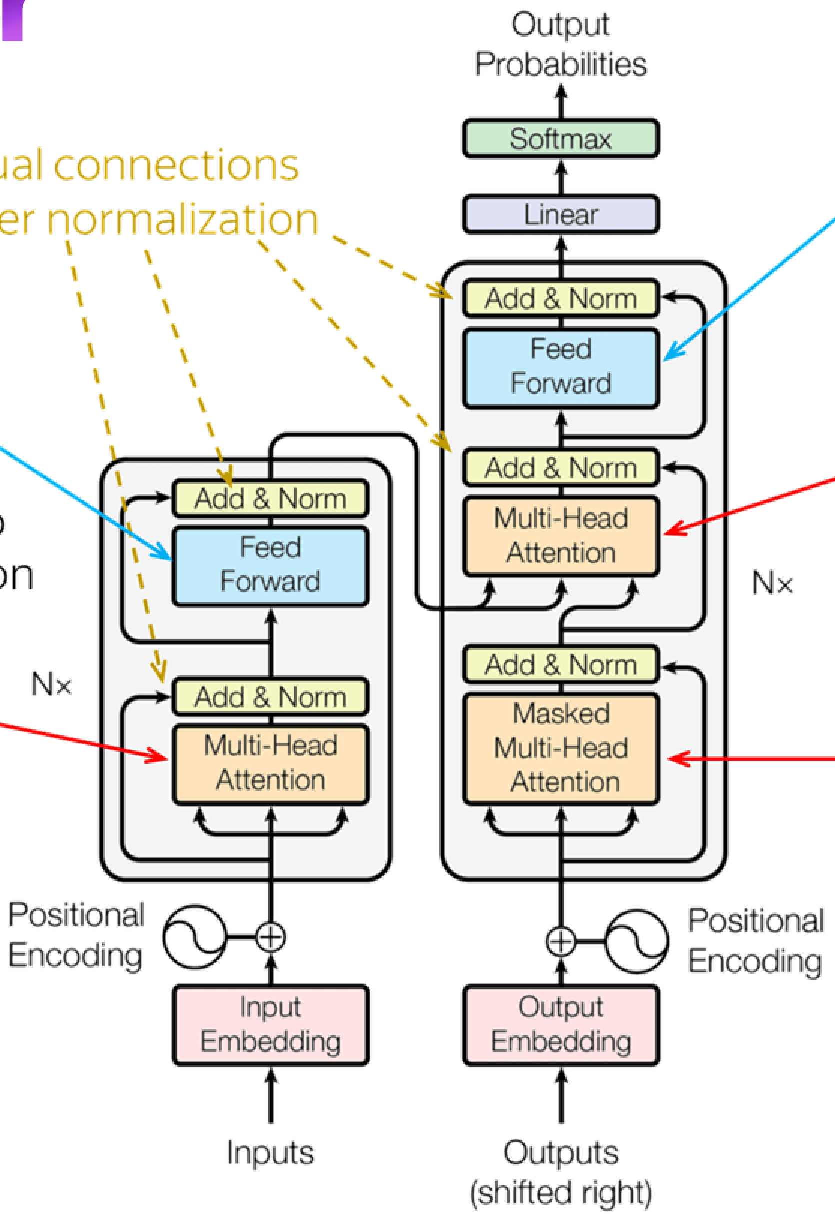
Transformer

Residual connections
and layer normalization

Feed-forward network:
after taking information from
other tokens, take a moment to
think and process this information

Encoder self-attention:
tokens look at each other

queries, keys, values
are computed from
encoder states



Feed-forward network:
after taking information from
other tokens, take a moment to
think and process this information

Decoder-encoder attention:
target token looks at the source

queries – from decoder states; keys
and values from encoder states

Decoder self-attention (masked):
tokens look at the previous tokens

queries, keys, values are computed
from decoder states

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Tokenization

Subword tokenization

```
tokenizer = AutoTokenizer.from_pretrained("bert-base-cased")
tokenized_text = tokenizer.tokenize(text)
print_tokenization_stats(text, tokenized_text, tokenizer)
```

original text: Using tokenizers is easy! And simple! OpenAI!

tokenized text: ['Using', 'token', '##izer', '##s', 'is ... '##I', '!']

length: 14

vocabulary size: 28996

Byte-Pair Encoding (BPE)

```
from transformers import AutoTokenizer

tokenizer = AutoTokenizer.from_pretrained("gpt2-xl ...
tokenized_text = tokenizer.tokenize(text)
print_tokenization_stats(text, tokenized_text, tok...
```

original text: Using tokenizers is easy! And simple! O...

tokenized text: ['Using', 'Ġtoken', 'izers', 'Ġis', 'Ġe...

length: 12

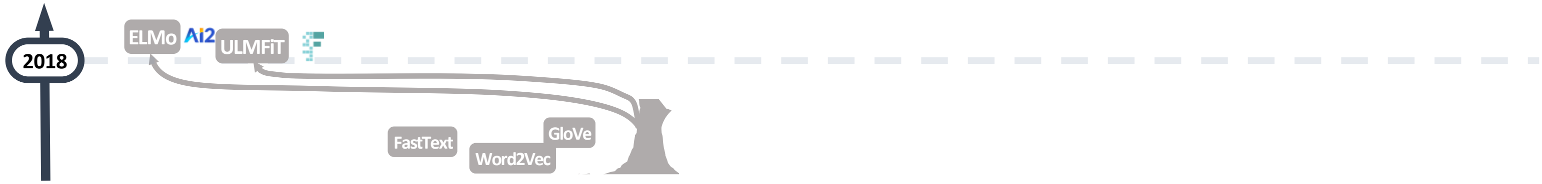
vocabulary size: 50257

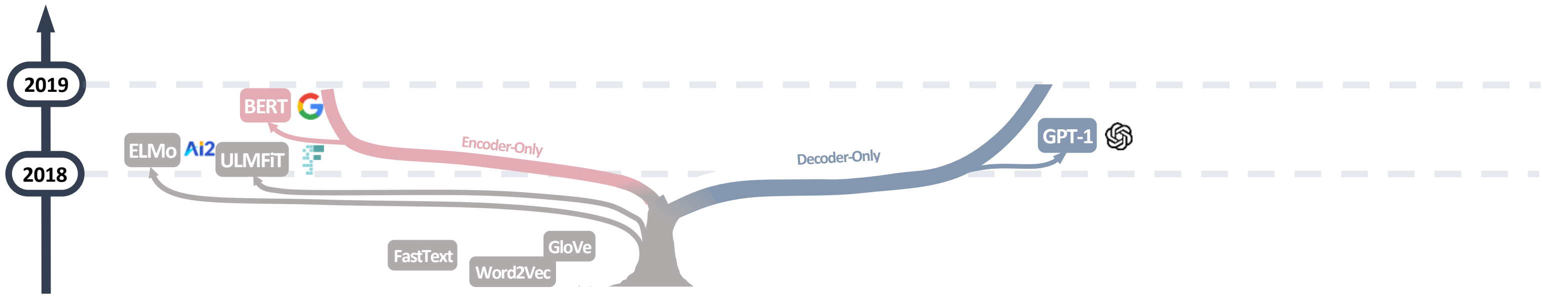
Sentence-piece tokenization

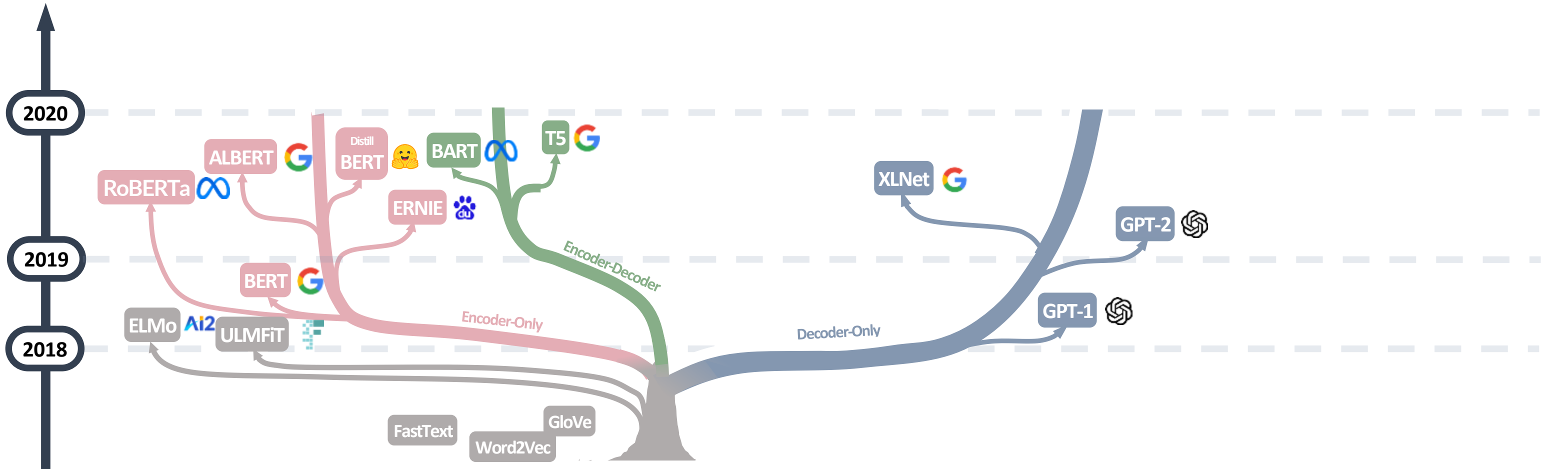
```
from transformers import AutoTokenizer

tokenizer = AutoTokenizer.from_pretrained("t5-base")
```

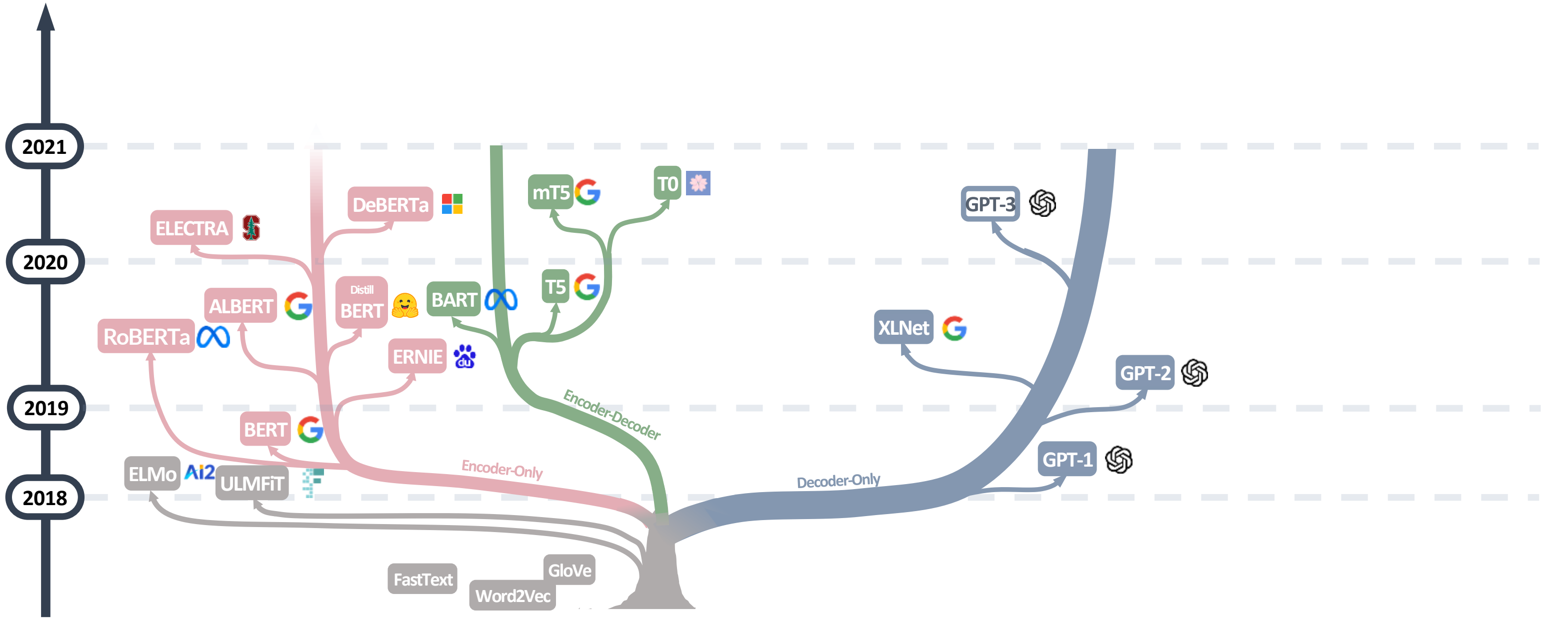

FastText
Word2Vec
GloVe


2018
ELMo
Ai2
ULMFiT
FastText
Word2Vec
GloVe

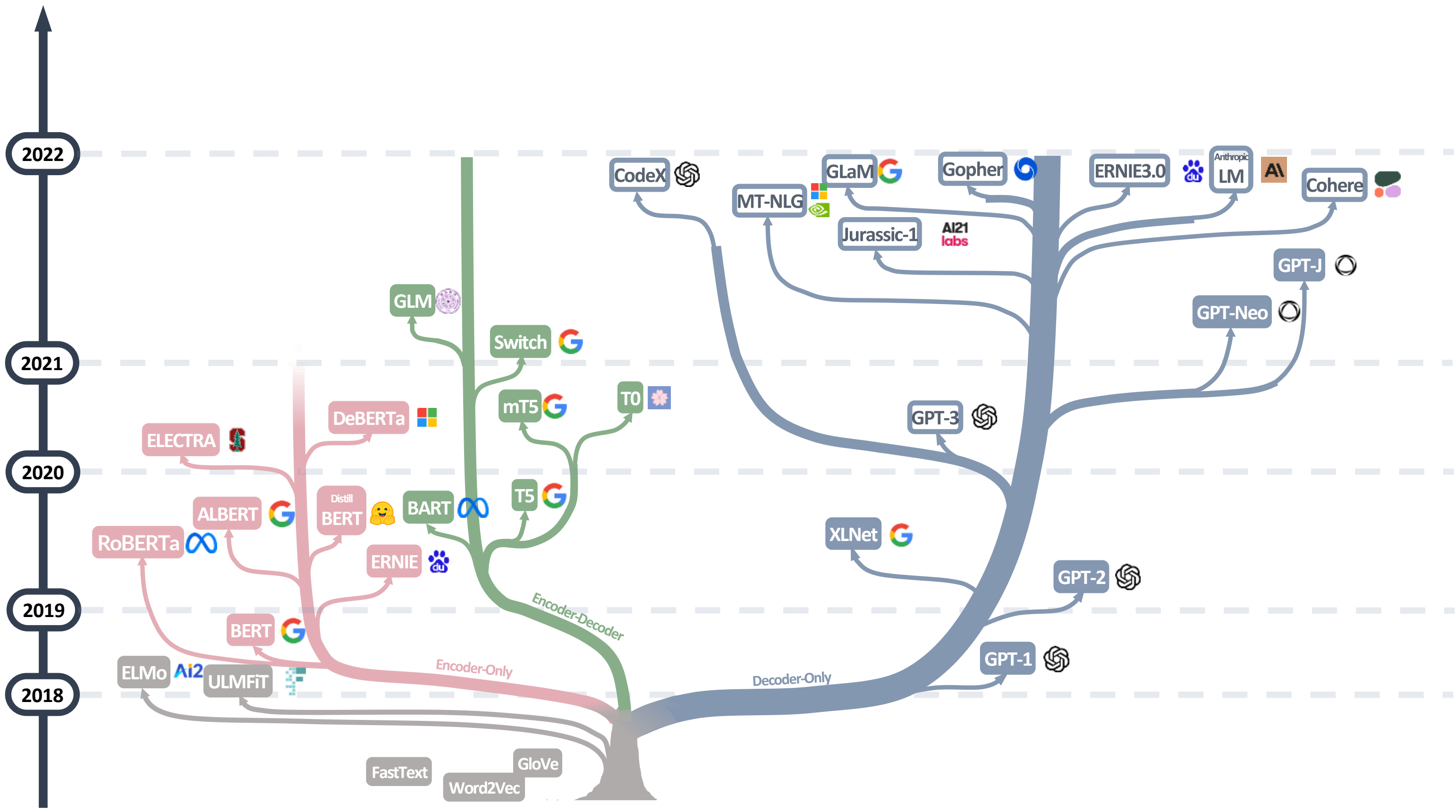

2019
2018
BERT
Encoder-Only
Decoder-Only
GPT-1
ELMo
Ai2
ULMFiT
FastText
GloVe
Word2Vec



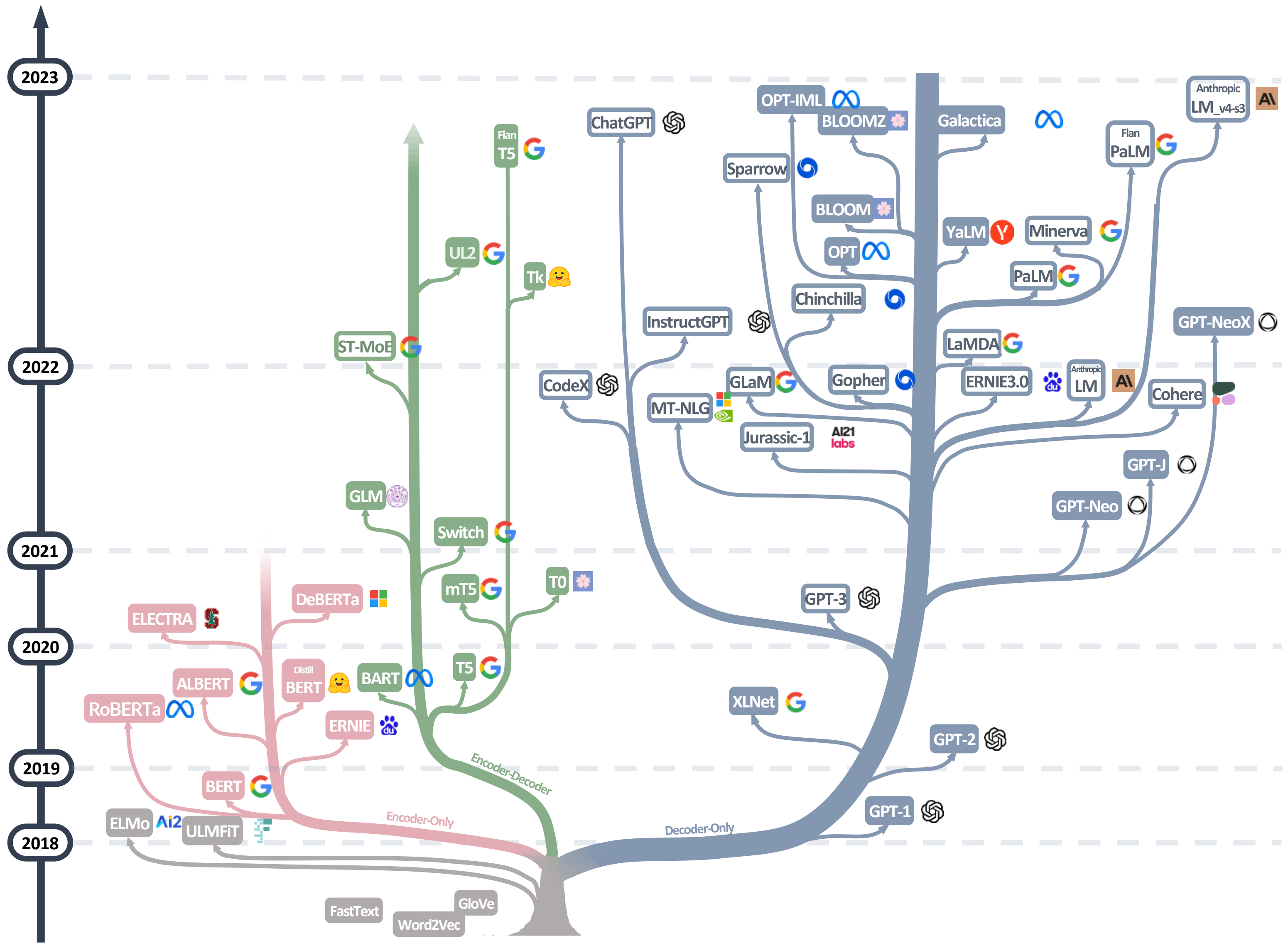
2020
2019
2018
RoBERTa
ALBERT
Distill BERT
BART
T5
ERNIE
BERT
ELMo
ULMFiT
Encoder-Only
Encoder-Decoder
Decoder-Only
XLNet
GPT-2
GPT-1
FastText
GloVe
Word2Vec

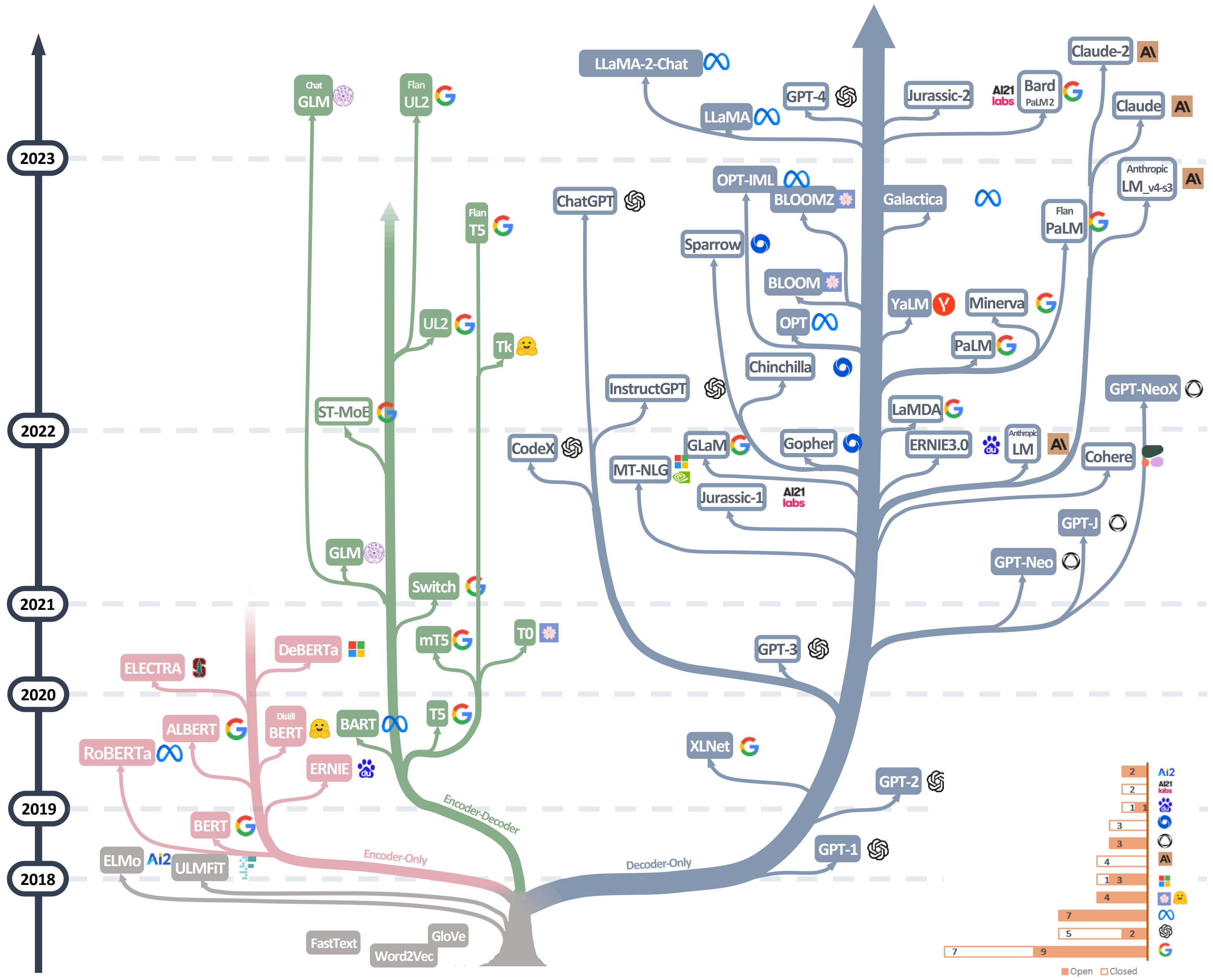


2021
2020
2019
2018
ELECTRA
DeBERTa
mT5
T0
GPT-3
ALBERT
Distill BERT
BART
T5
RoBERTa
ERNIE
XLNet
GPT-2
BERT
Encoder-Decoder
Encoder-Only
ELMo
Ai2
ULMFiT
GPT-1
Decoder-Only
FastText
GloVe
Word2Vec



2022
2021
2020
2019
2018
CodeX
MT-NLG
GLaM
Jurassic-1
AI21 labs
Gopher
ERNIE3.0
Anthropic LM
Cohere
GPT-J
GPT-Neo
GPT-3
XLNet
GPT-2
GPT-1
Decoder-Only
GLM
Switch
mT5
T0
T5
BART
Encoder-Decoder
DeBERTa
ELECTRA
ALBERT
Distill BERT
RoBERTa
ERNIE
BERT
Encoder-Only
ELMo
Ai2
ULMFiT
FastText
GloVe
Word2Vec


2023
2022
2021
2020
2019
2018
Flan T5
UL2
Tk
ST-MoE
GLM
Switch
mT5
T0
T5
BART
ChatGPT
OPT-IML
BLOOMZ
Galactica
Sparrow
BLOOM
OPT
YaLM
Minerva
PaLM
Flan PaLM
Anthropic LM_v4-s3
Chinchilla
InstructGPT
LaMDA
GPT-NeoX
CodeX
GLaM
Gopher
ERNIE3.0
Anthropic LM
Cohere
MT-NLG
Jurassic-1
AI21 labs
GPT-J
GPT-Neo
GPT-3
XLNet
GPT-2
GPT-1
ELECTRA
DeBERTa
ALBERT
Distill BERT
RoBERTa
ERNIE
BERT
ELMo
Ai2
ULMFiT
Encoder-Only
Encoder-Decoder
Decoder-Only
FastText
GloVe
Word2Vec

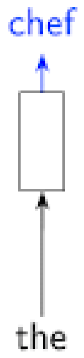


2023
2022
2021
2020
2019
2018
LLaMA-2-Chat
GPT-4
LLaMA
Jurassic-2
Bard
PaLM2
Claude-2
Claude
Chat GLM
Flan UL2
ChatGPT
OPT-IML
BLOOMZ
Galactica
Anthropic LM_v4-s3
Flan T5
Sparrow
Flan PaLM
BLOOM
YaLM
Minerva
UL2
Tk
OPT
PaLM
Chinchilla
InstructGPT
GPT-NeoX
ST-MoE
LaMDA
CodeX
GLaM
Gopher
ERNIE3.0
Anthropic LM
Cohere
MT-NLG
Jurassic-1
GPT-J
GLM
GPT-Neo
Switch
DeBERTa
mT5
T0
GPT-3
ELECTRA
ALBERT
Distill BERT
BART
T5
RoBERTa
ERNIE
XLNet
GPT-2
BERT
Encoder-Decoder
Encoder-Only
Decoder-Only
GPT-1
ELMo
ULMFiT
FastText
GloVe
Word2Vec
Open
Closed

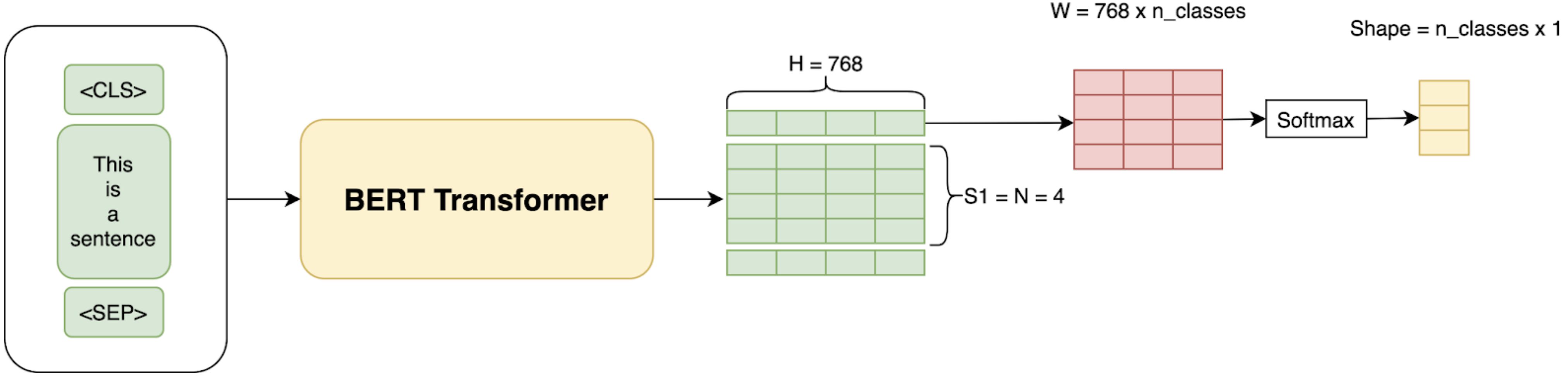
Encoders

the chef cooked the meal

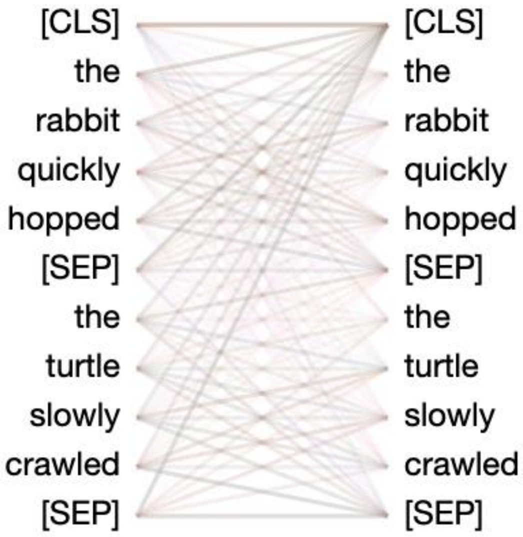
Decoders



Encoders

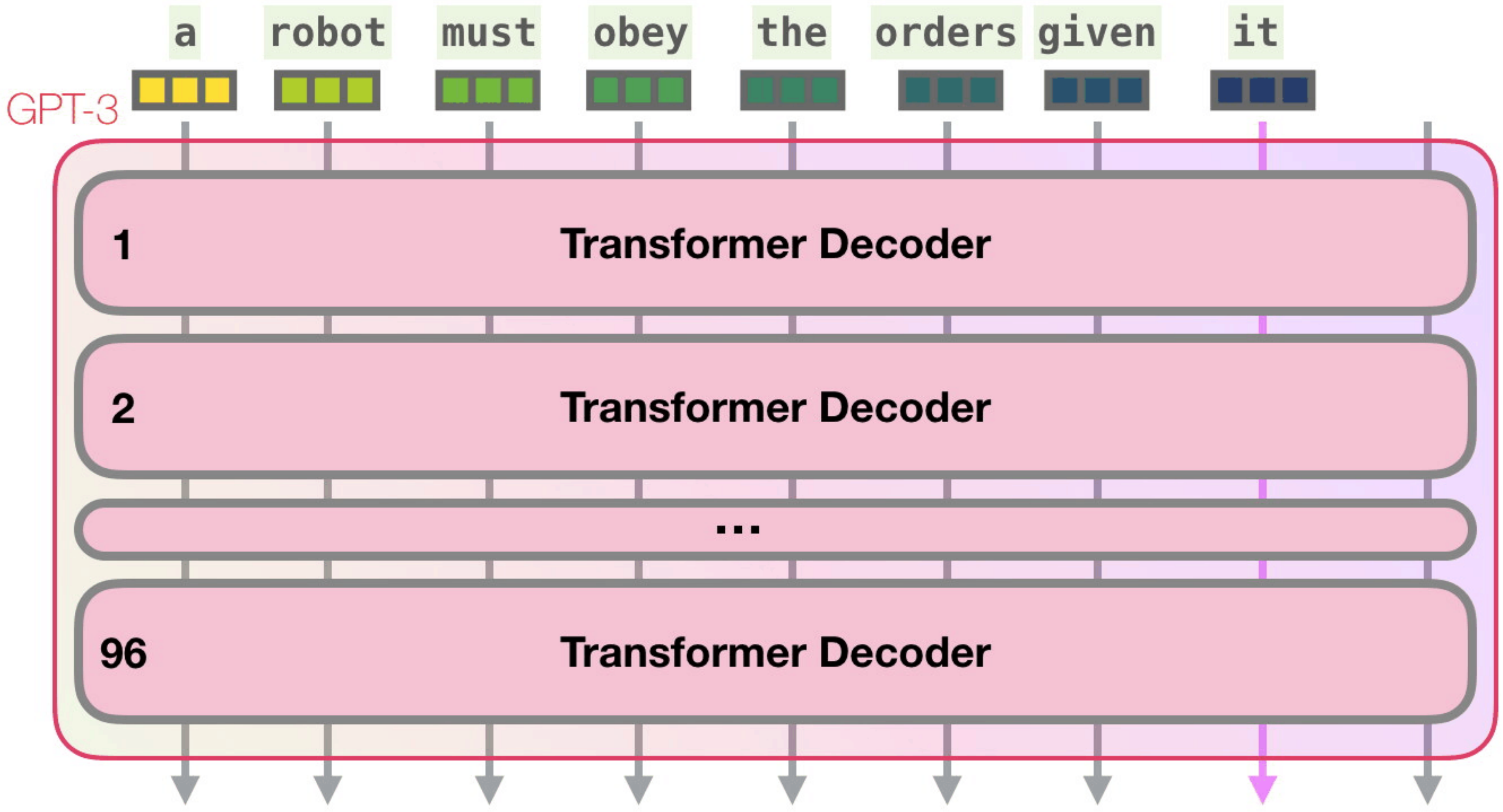


<CLS>
This
is
a
sentence
<SEP>
BERT Transformer
H = 768
S1 = N = 4
W = 768 x n_classes
Softmax
Shape = n_classes x 1



[CLS]
the
rabbit
quickly
hopped
[SEP]
the
turtle
slowly
crawled
[SEP]

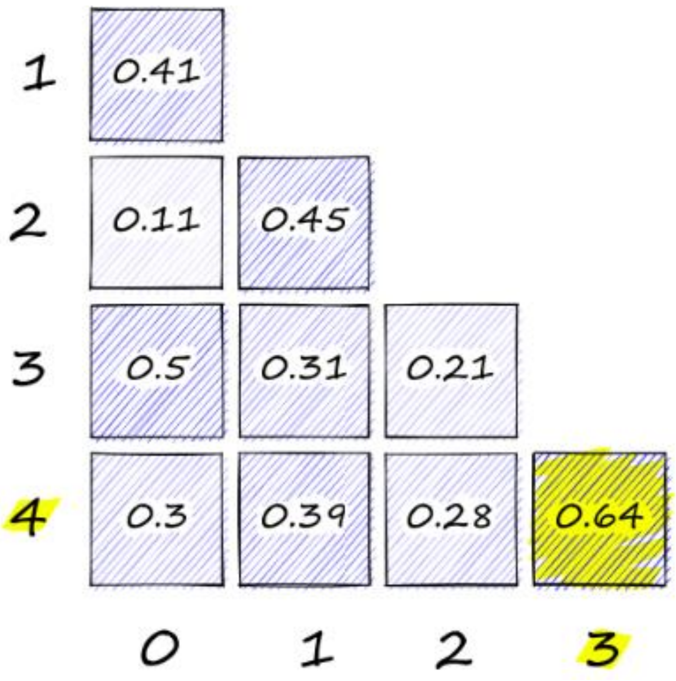
Decoders



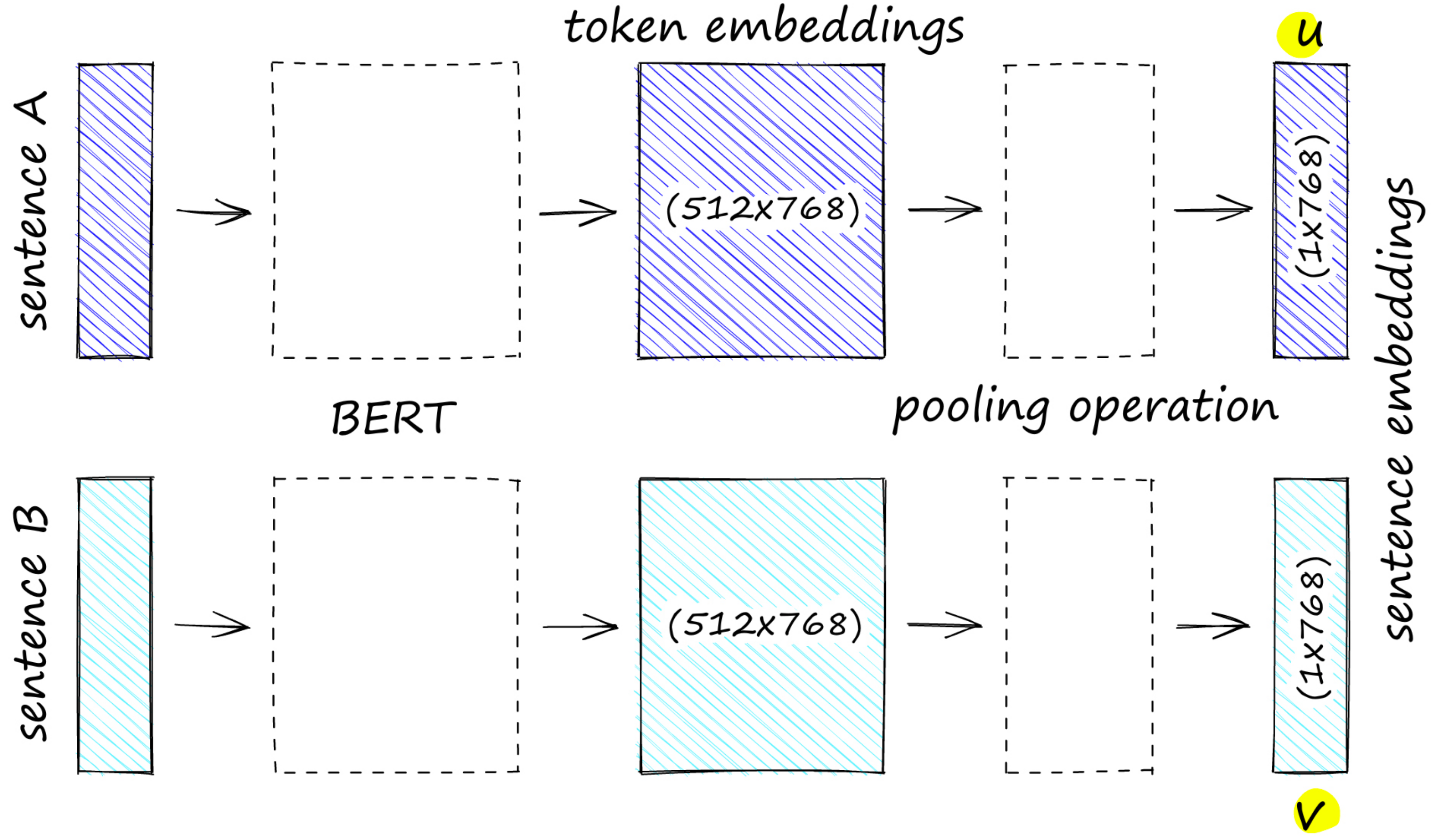
a
robot
must
obey
the
orders
given
it
GPT-3
1
Transformer Decoder
2
Transformer Decoder
...
96
Transformer Decoder

Metric Learning & Semantic Similarity

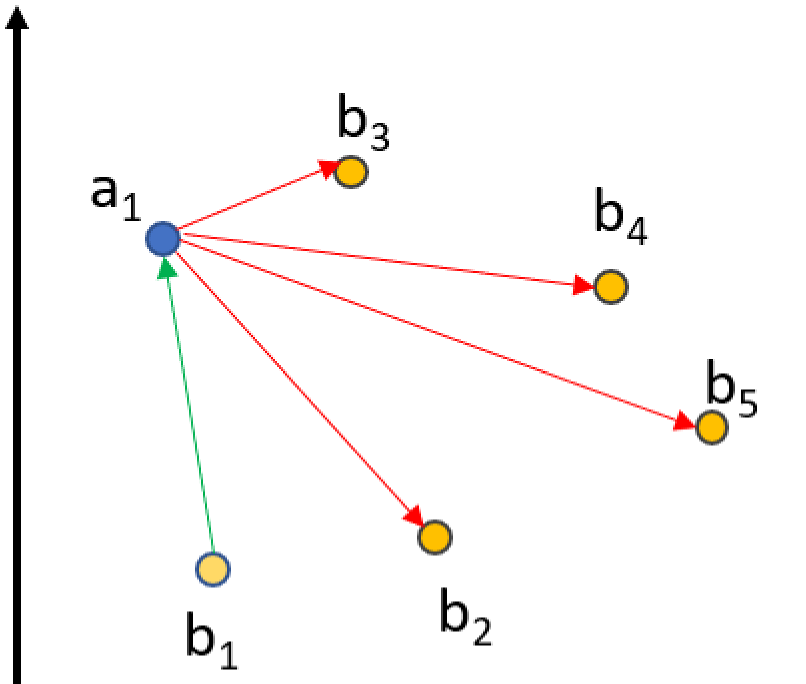
Index	Sentence
0	the fifty mannequin heads floating in the pool kind of freaked them out
1	she swore she just saw her sushi move
2	he embraced his new life as an eggplant
3	my dentist tells me that chewing bricks is very bad for your teeth
4	the dental specialist recommended an immediate stop to flossing with construction materials



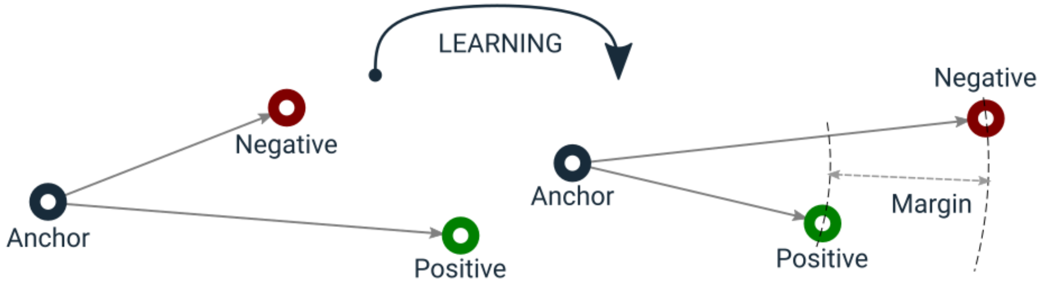
Metric Learning & Semantic Similarity



Metric Learning & Semantic Similarity



Multiple Negatives Ranking Loss



Triplet Loss

Pretraining, Finetuning and RLHF

(more buzzwords)

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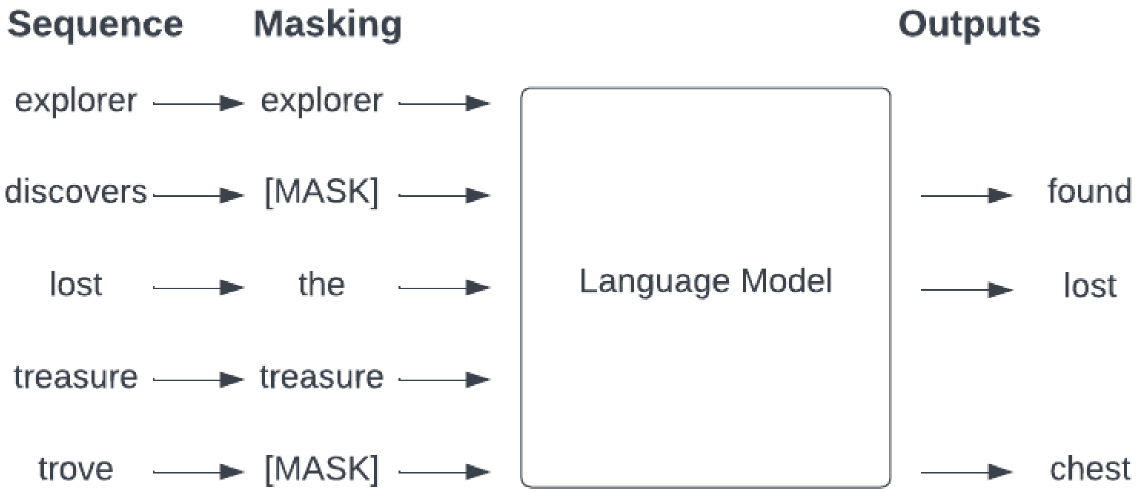
Methods

- **Pretraining**
- **Finetuning**
- Reinforcement Learning from Human Feedback (**RLHF**)

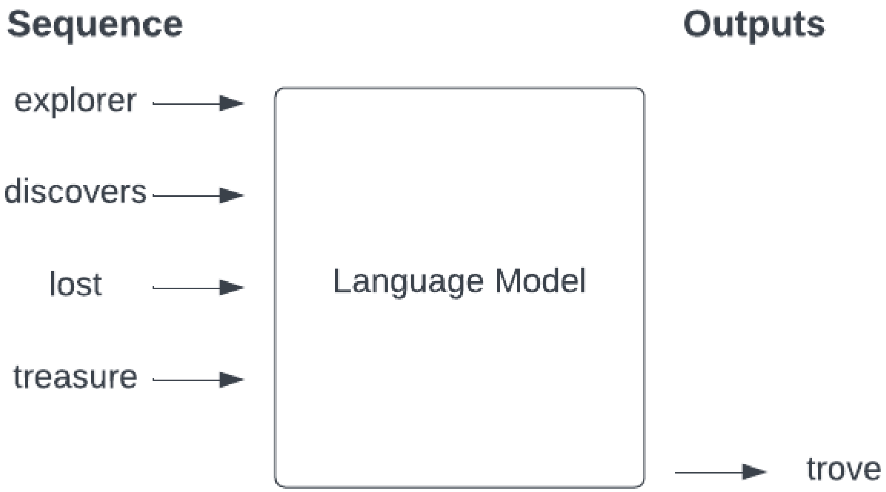
Pretraining

Pretraining objectives

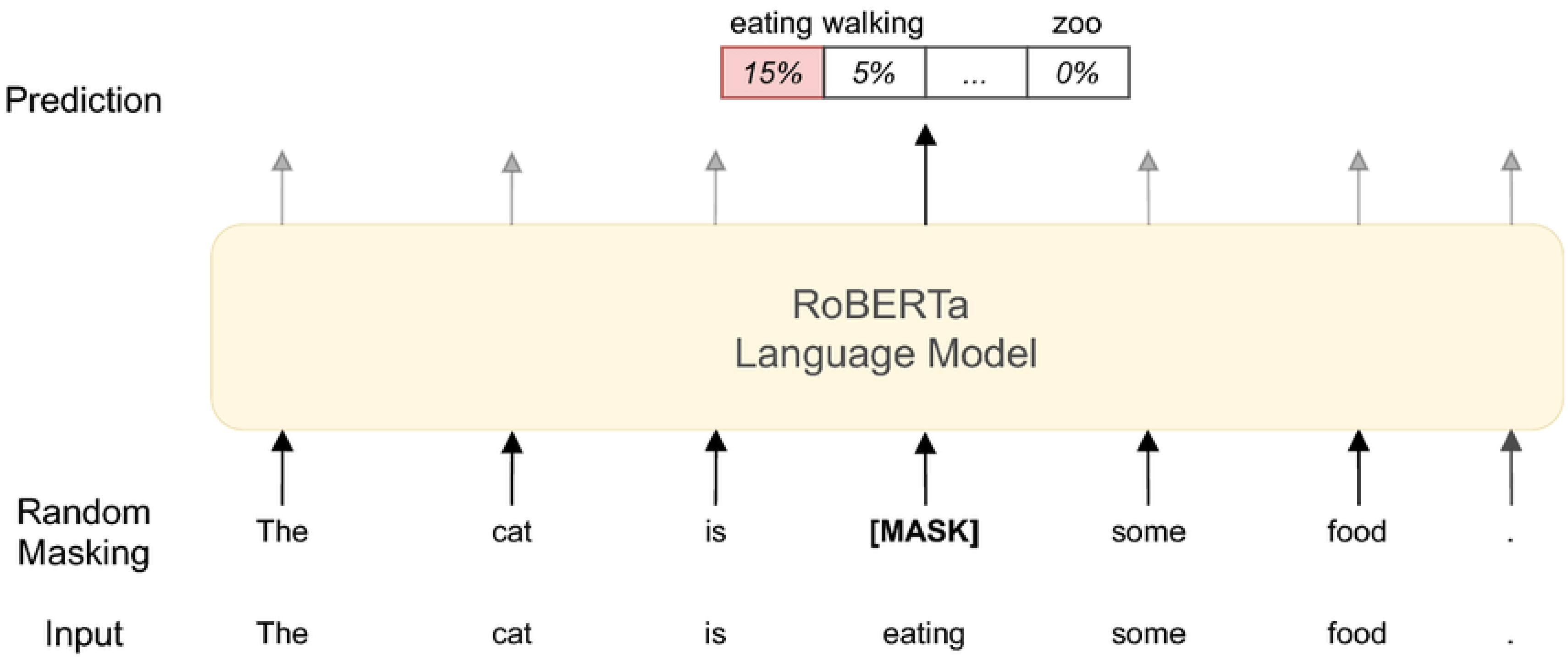
Encoders



Decoders



Masked Language Modelling (CLM)



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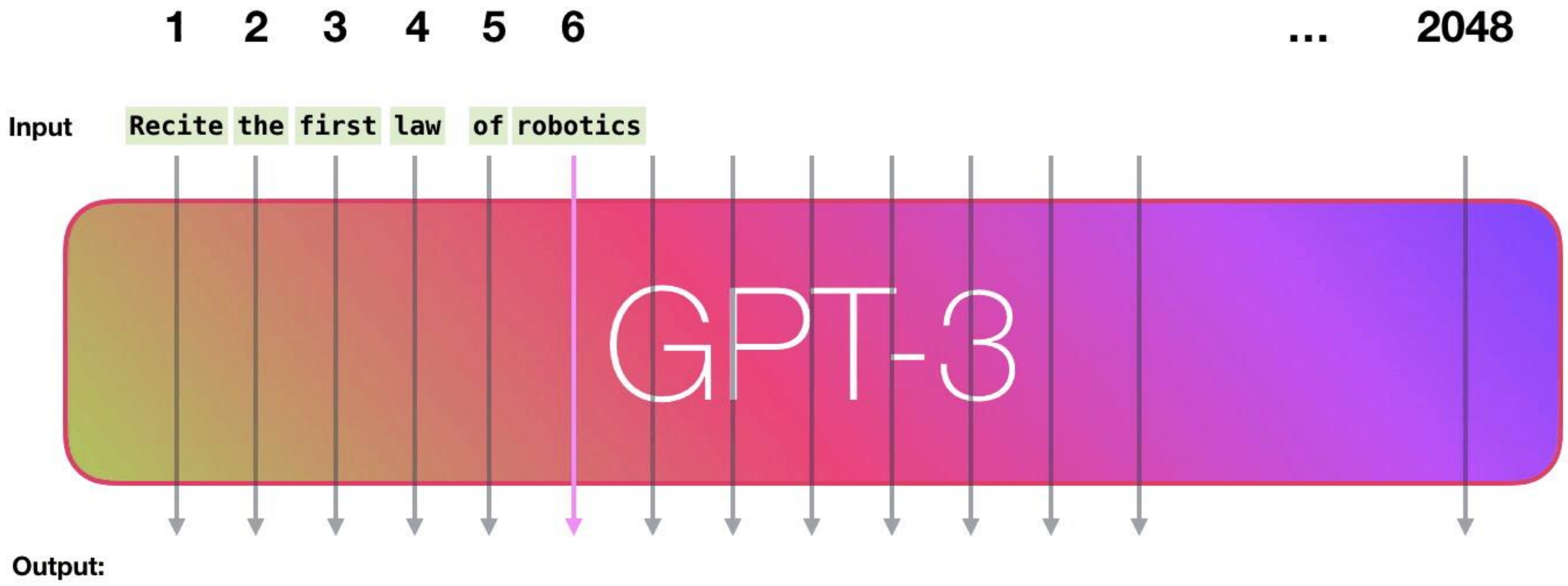
Causal Language Modelling (CLM)



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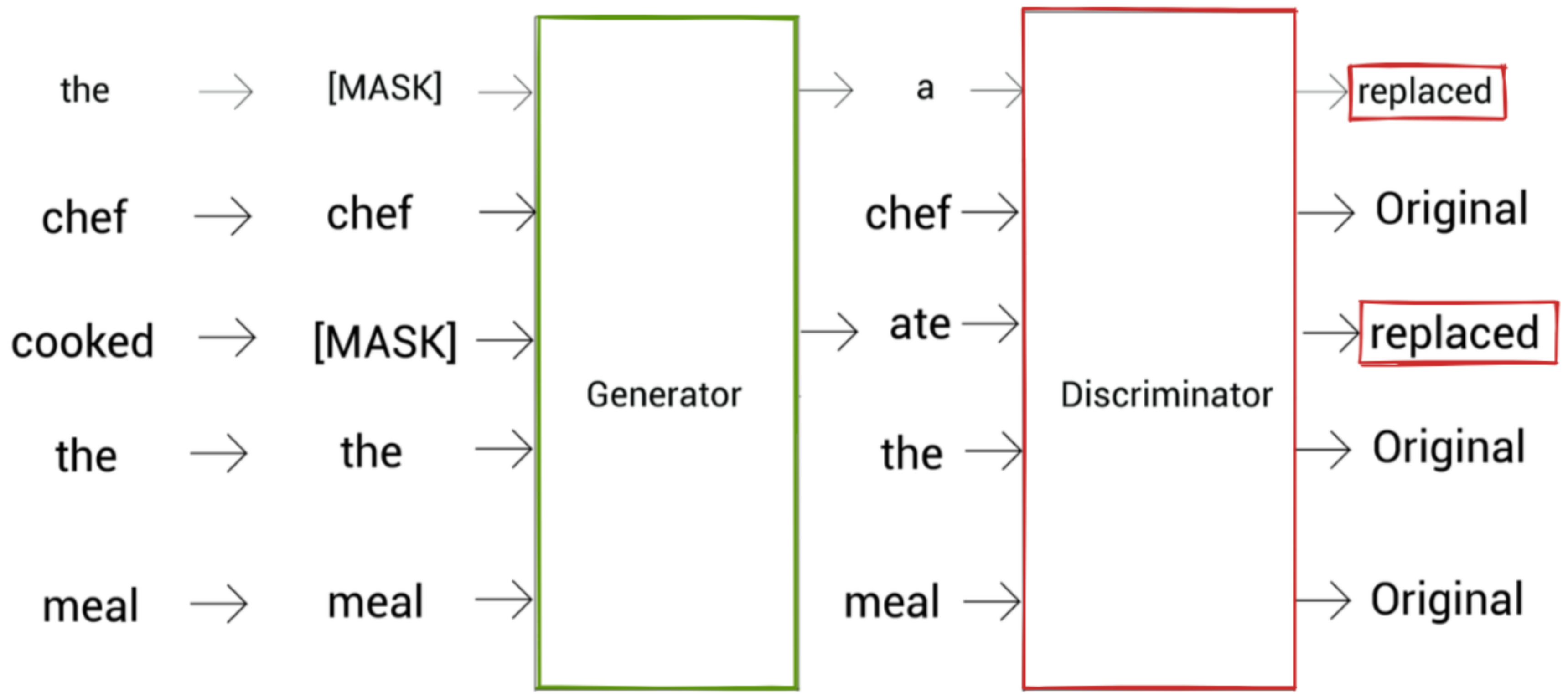
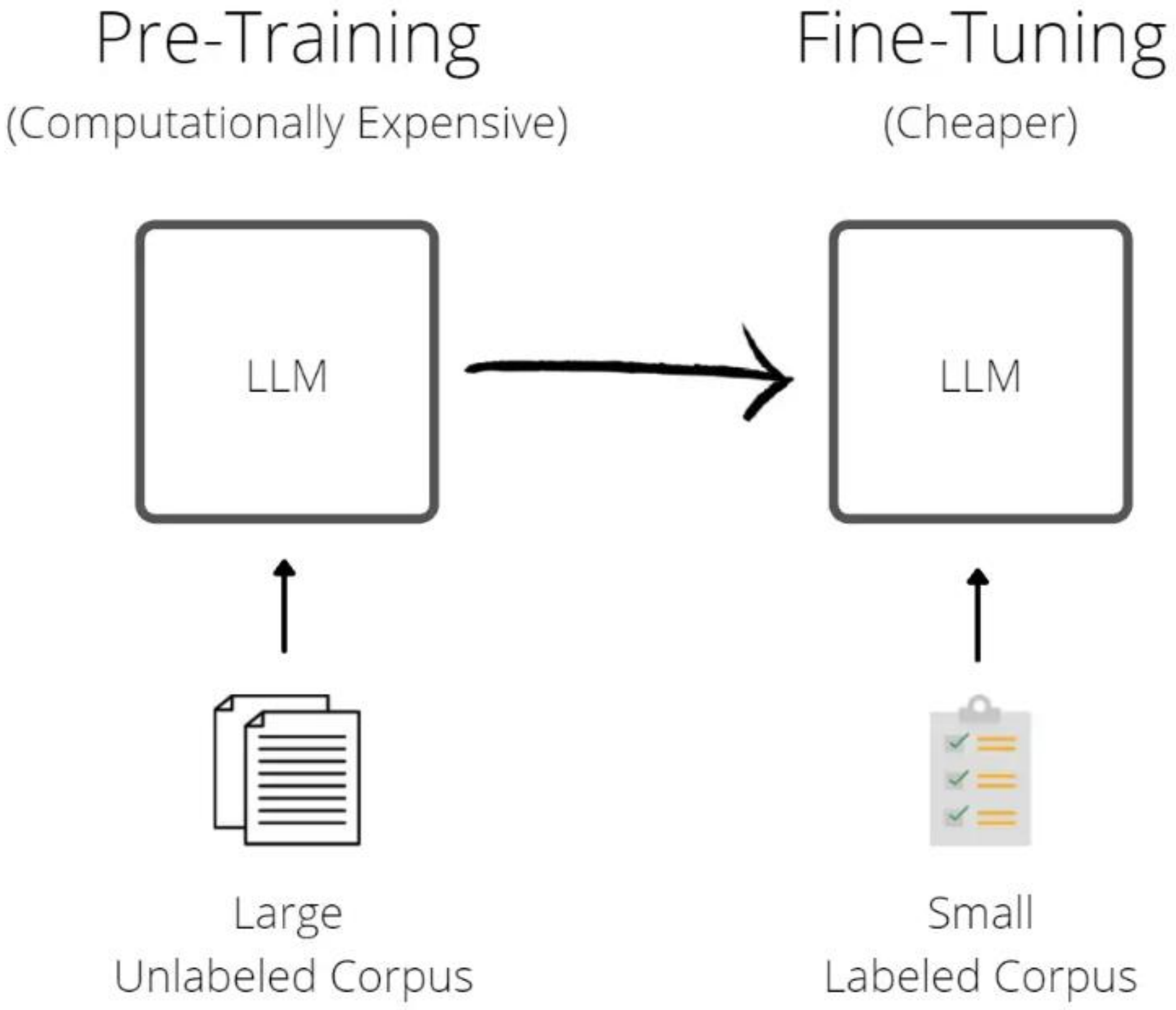
Replaced Token Detection (RTD)



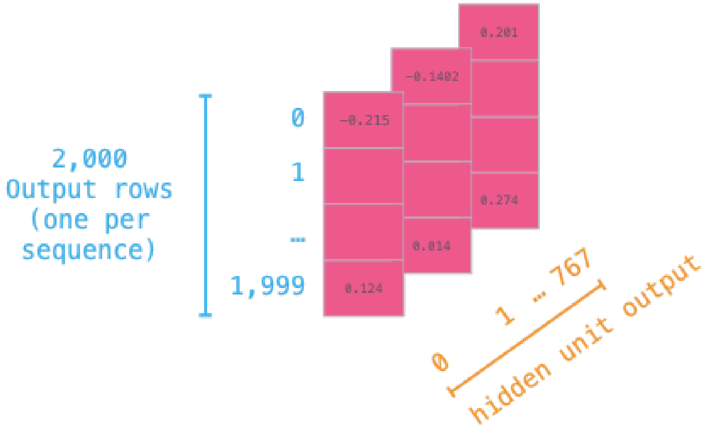
Generation of replacements is done using BERT

This is used as ELECTRA once training is done

Finetuning


Pre-Training
(Computationally Expensive)
Fine-Tuning
(Cheaper)
LLM
LLM
Large
Unlabeled Corpus
Small
Labeled Corpus

Classification

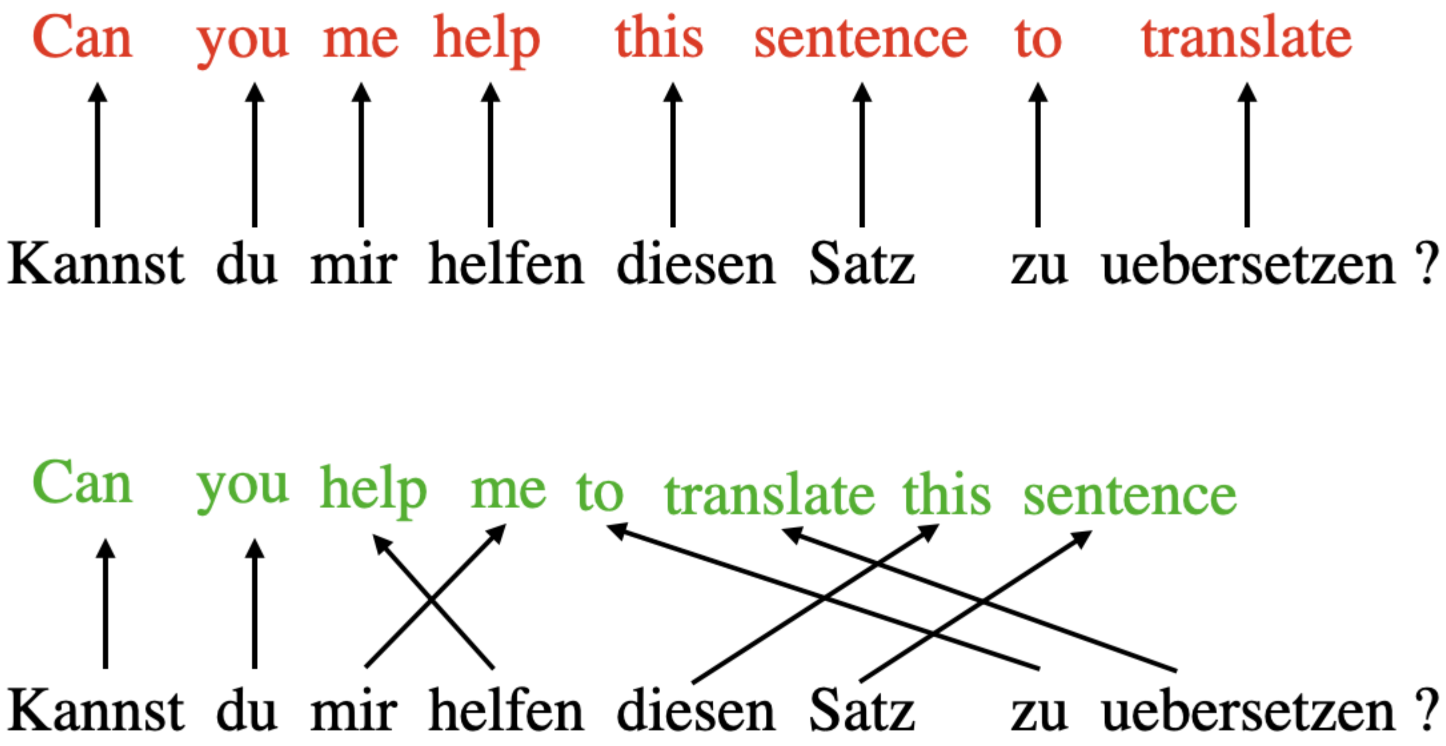


Is the same as

2,000 Output rows (one per sequence)

	Sentence Embeddings				label
	0	1	…	767	
0	-0.215	-0.1402	…	0.201	1
1					
2					
3					
4					
5					
6					
7					
8					
9					
…					
1,999	0.124	0.014	…	0.274	1

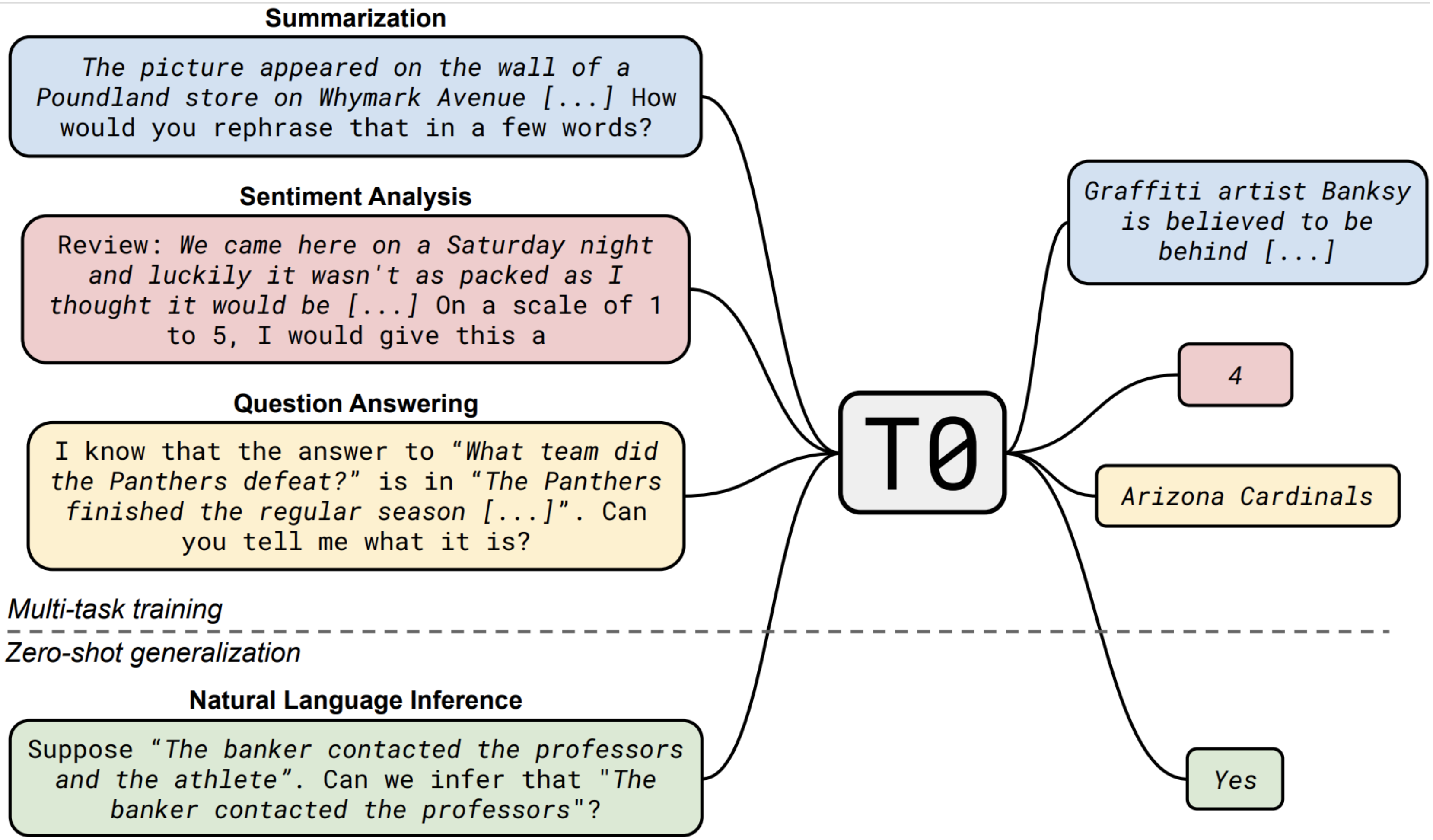
Translation



samplead

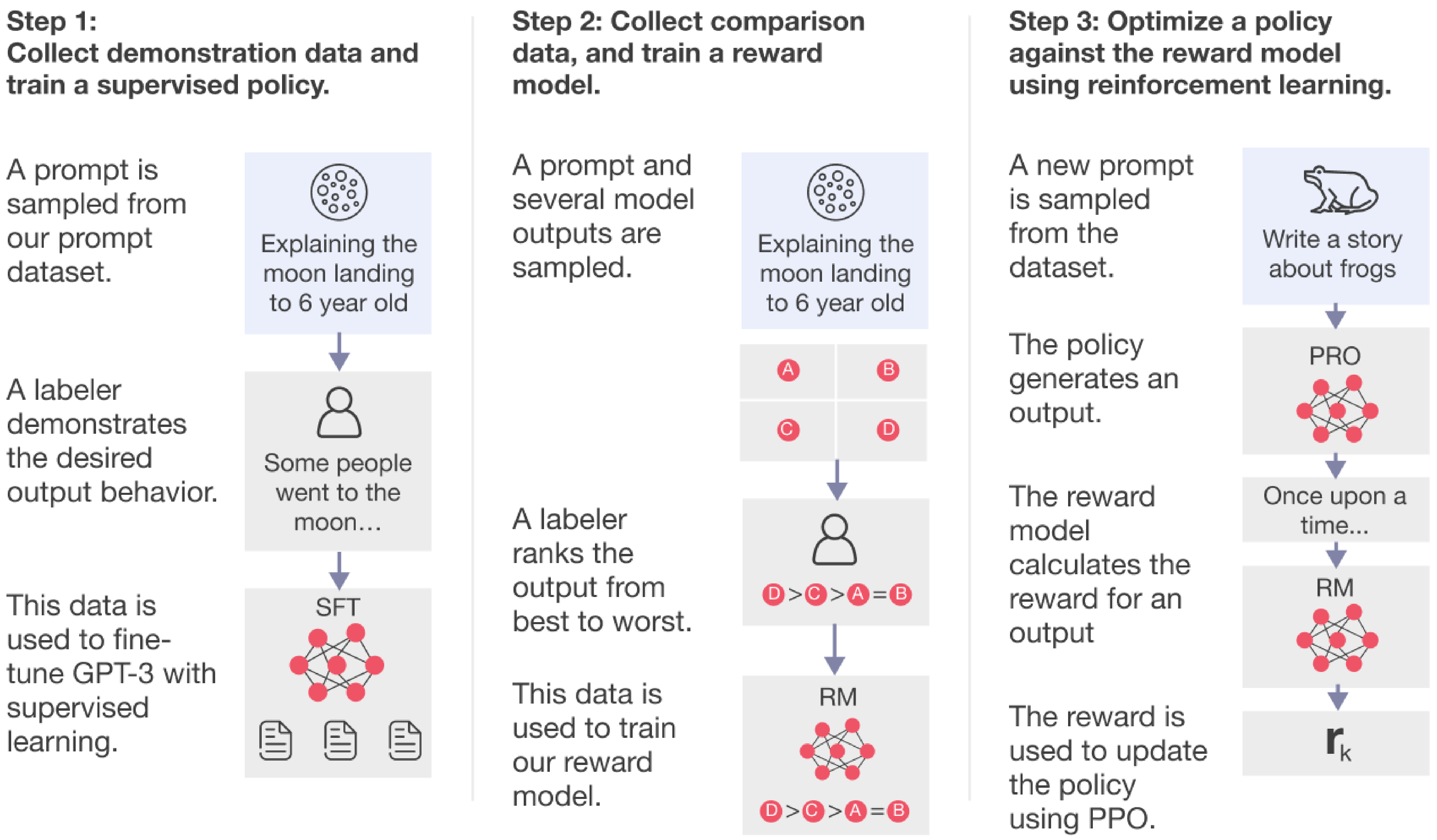
Generation?

Multi-Task


Summarization
The picture appeared on the wall of a Poundland store on Whymark Avenue [...] How would you rephrase that in a few words?
Sentiment Analysis
Review: We came here on a Saturday night and luckily it wasn't as packed as I thought it would be [...] On a scale of 1 to 5, I would give this a
Question Answering
I know that the answer to "What team did the Panthers defeat?" is in "The Panthers finished the regular season [...]". Can you tell me what it is?
Multi-task training
Zero-shot generalization
Natural Language Inference
Suppose "The banker contacted the professors and the athlete". Can we infer that "The banker contacted the professors"?
T0
Graffiti artist Banksy is believed to be behind [...]
4
Arizona Cardinals
Yes

RLHF

Reinforcement Learning from Human Feedback


Step 1:
Collect demonstration data and train a supervised policy.
A prompt is sampled from our prompt dataset.
Explaining the moon landing to 6 year old
A labeler demonstrates the desired output behavior.
Some people went to the moon...
This data is used to fine-tune GPT-3 with supervised learning.
SFT
Step 2: Collect comparison data, and train a reward model.
A prompt and several model outputs are sampled.
Explaining the moon landing to 6 year old
A
B
C
D
A labeler ranks the output from best to worst.
D > C > A = B
This data is used to train our reward model.
RM
D > C > A = B
Step 3: Optimize a policy against the reward model using reinforcement learning.
A new prompt is sampled from the dataset.
Write a story about frogs
The policy generates an output.
PRO
Once upon a time...
The reward model calculates the reward for an output
RM
The reward is used to update the policy using PPO.
r
k

Code

SBERT.net

Hugging Face

OpenAI

Tutorials & Courses

/lmg/
LLM
Training

HF Learn

Pinecone

Easley deploy your own LLM

samplead

Inference

- Serverless
- GPU/CPU

Amazon SageMaker

Hugging Face Inference

Let's Train!