Natural Language Processing

Emergent abilities of LLMs

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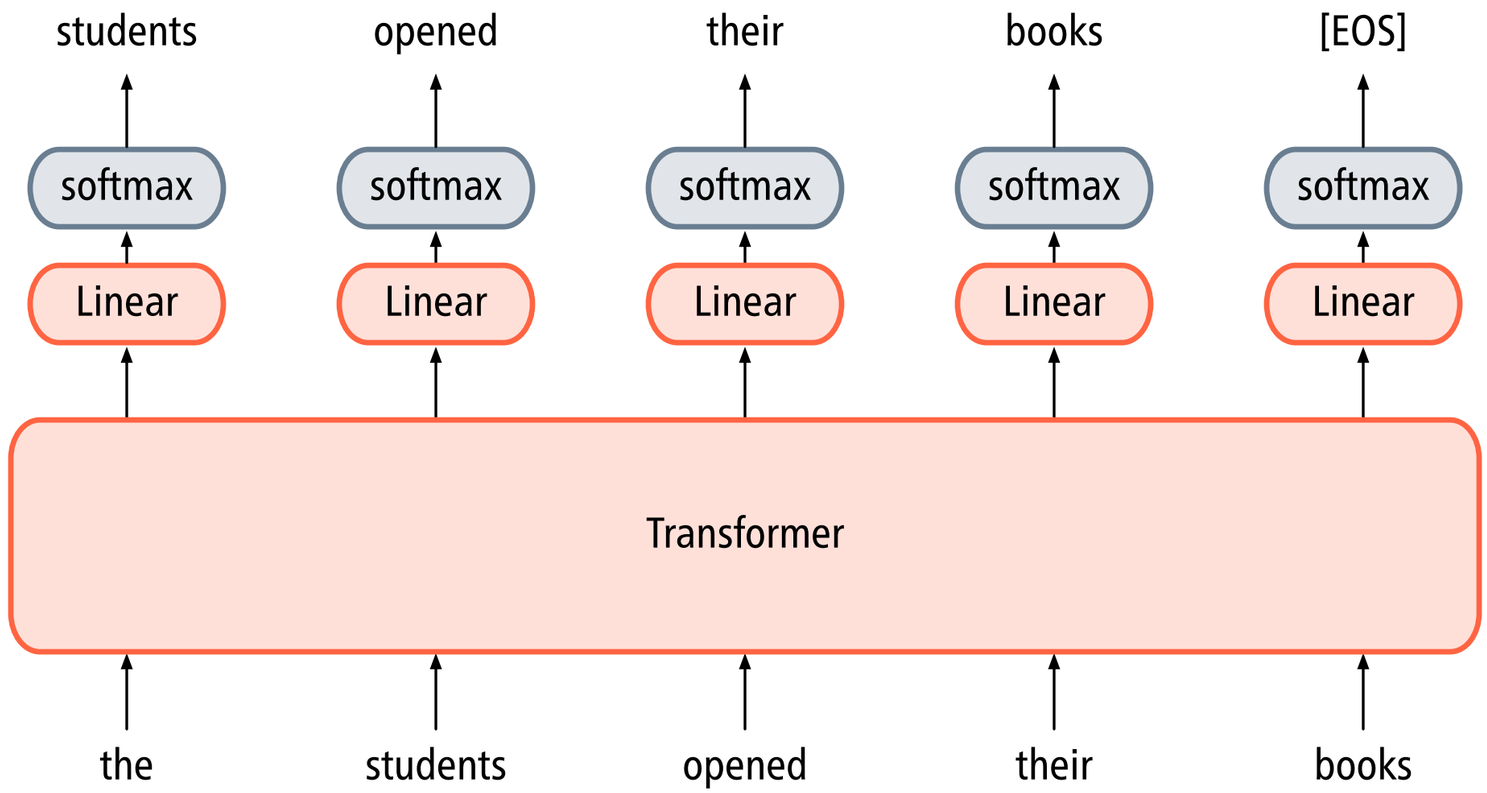
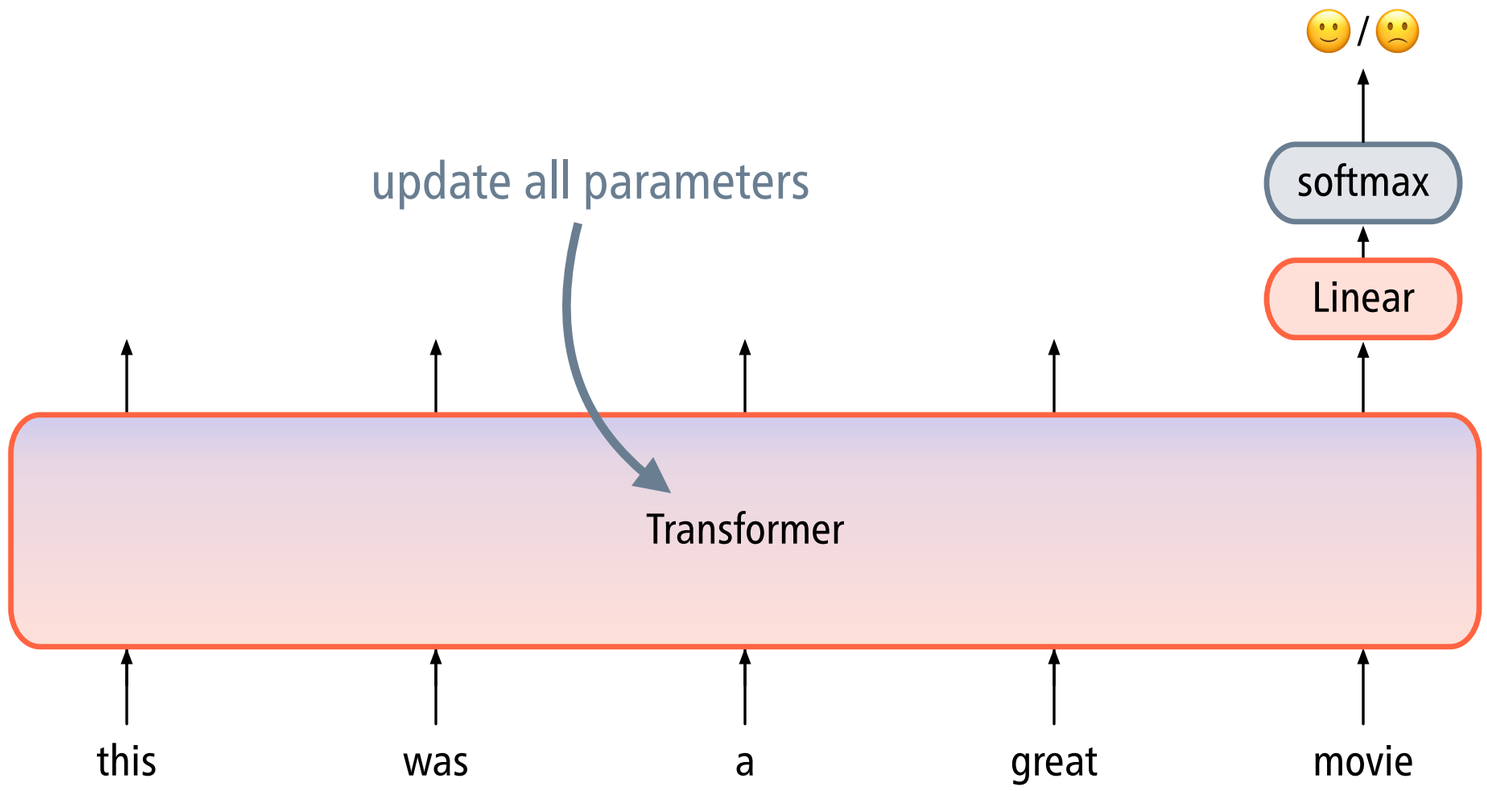
Pretraining and finetuning



Step 1: Pretrain on language modelling

Large quantities of text, general facts about language

Pretraining and finetuning



Step 2: Finetune on specific tasks

Small quantities of labelled data, task-specific knowledge

Model growth

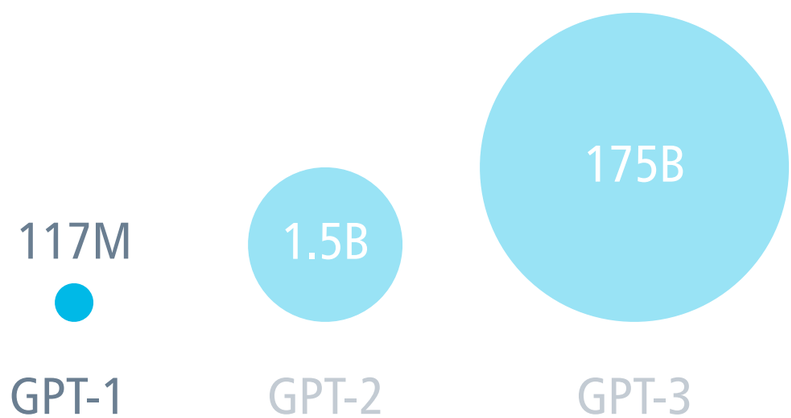
	GPT-1	GPT-2	GPT-3	GPT-4
Number of dimensions	768	1,600	12,288	?
Number of layers	12	48	96	120
Trainable parameters	0.117 B	1.542 B	175 B	1,800 B
Training data size	4 GB	40 GB	570 GB	?

Radford et al. (2018), Radford et al. (2019), Brown et al. (2020)

GPT-1: Effective pretraining

Language modelling is an effective pretraining method for a broad range of tasks in natural language understanding.

Radford et al. (2018)



Effective pretraining

Natural Language Inference (NLI)

Premise: A man inspects the uniform of a figure in some East Asian country.

Hypothesis: The man is sleeping.

Label: contradiction

Question answering

Question: The first postage stamp was made …

Candidate answers: A. in England, B. in America, C. by Alice, D. in 1910

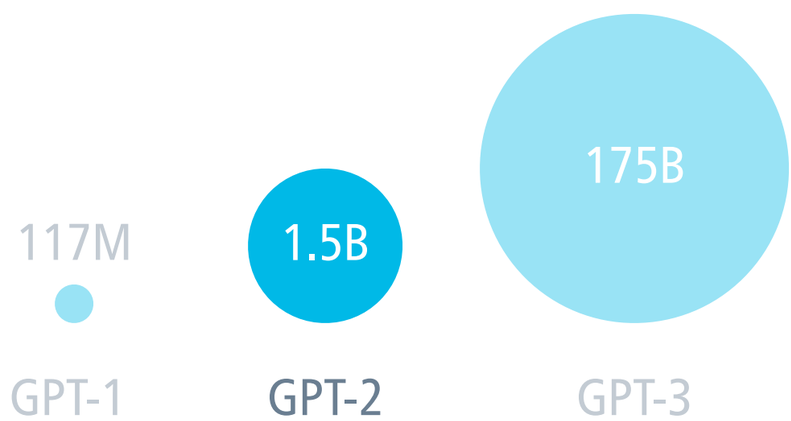
Method	MNLI +	MNLI –	QNLI	RTE	SNLI
Previous state-of-the-art	80.6	80.1	82.3	**61.7**	89.3
GPT-1 (Radford et al., 2018)	**82.1**	**81.4**	**88.1**	56.0	**89.9**

GPT-2: Emergent zero-shot learning

zero-shot learning

the ability of a machine learning model to solve tasks
out-of-the-box, with no examples and no gradient updates

Radford et al. (2019)



Zero-shot learning

Radford et al. (2019)

Sequence prediction

Question: Who took the first steps on the moon in 1969?

Answer: **Neil Armstrong**

model output

Question: Which Stanford University alumna co-founded Coursera?

Answer: **Daphne Koller**

Sequence modelling

The trophy doesn't fit into the brown suitcase because it is too large.

it = … **p(trophy) > p(suitcase)**

The trophy doesn't fit into the brown suitcase because it is too small.

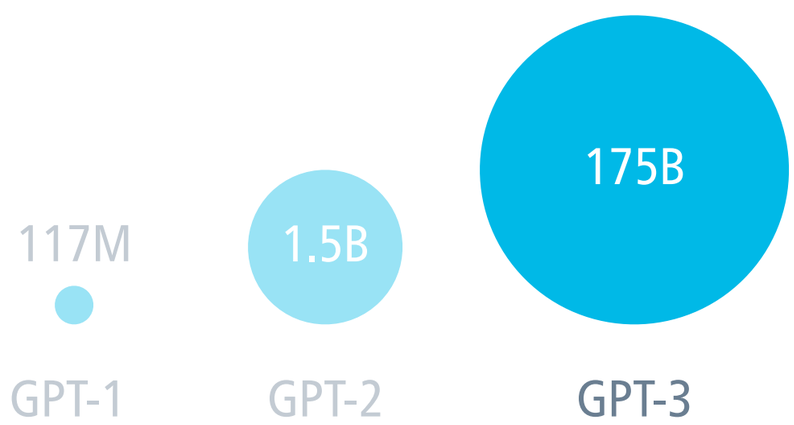
it = … **p(trophy) < p(suitcase)**

GPT-3: Emergent in-context learning

in-context learning

the ability of a machine learning model to learn tasks from a few examples, with no gradient updates

Brown et al. (2020)



In-context learning

Brown et al. (2020); examples from Jesse Mu

Word unscrambling

gaot => goat

sakne => snake

brid => bird

fsih => fish

dcuk => duck

cmihp => **chimp**

in-context learning

Machine translation

thanks => merci

hello => bonjour

mint => menthe

wall => mur

otter => loutre

bread => **pain**

in-context learning

Chain-of-thought prompting

Wei et al. (2022)

Standard prompting

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 balls. How many tennis balls does he have now?

A: The answer is 11.

Q: The cafeteria had 23 apples. If they used 20 to make lunch and bought 6 more, how many apples do they have?

A: **The answer is 11.**

Chain-of-thought prompting

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 balls. How many tennis balls does he have now?

A: Roger started with 5 balls. 2 cans of 3 balls each is 6 balls. 5 + 6 = 11. The answer is 11.

Q: The cafeteria had 23 apples. If they used 20 to make lunch and bought 6 more, how many apples do they have?

A: **The cafeteria had 23 apples originally. They used 20 to make lunch. So they had 23 – 20 = 3. They bought 6 more apples, so they had 3 + 6 = 9. The answer is 9.**

Zero-shot chain-of-thought prompting

Kojima et al. (2022)

Chain-of-thought prompting

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 balls. How many tennis balls does he have now?

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Zero-shot chain-of-thought prompting

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 balls. How many tennis balls does he have now?

A: The answer is 11.

Q: The cafeteria had 23 apples. If they used 20 to make lunch and bought 6 more, how many apples do they have?

A: Let's think step by step. **The cafeteria had 23 apples originally. They used 20 to make lunch, so they had 23 – 20 = 3. They bought 6 more apples, so they had 3 + 6 = 9. The answer is 9.**

Prompt engineering

designed by a LM

Prompt	Accuracy
Let's work this out in a step by step way to be sure we have the right answer.	**82.0**
Let's think step by step.	78.7
First, …	77.3
Let's think about this logically.	74.5
Let's solve this problem by splitting it into steps	72.2
Let's be realistic and think step by step.	70.8
Let's think like a detective step by step.	70.3
(Zero-shot)	17.7