人工智能技术及应用

Artificial Intelligence and Application

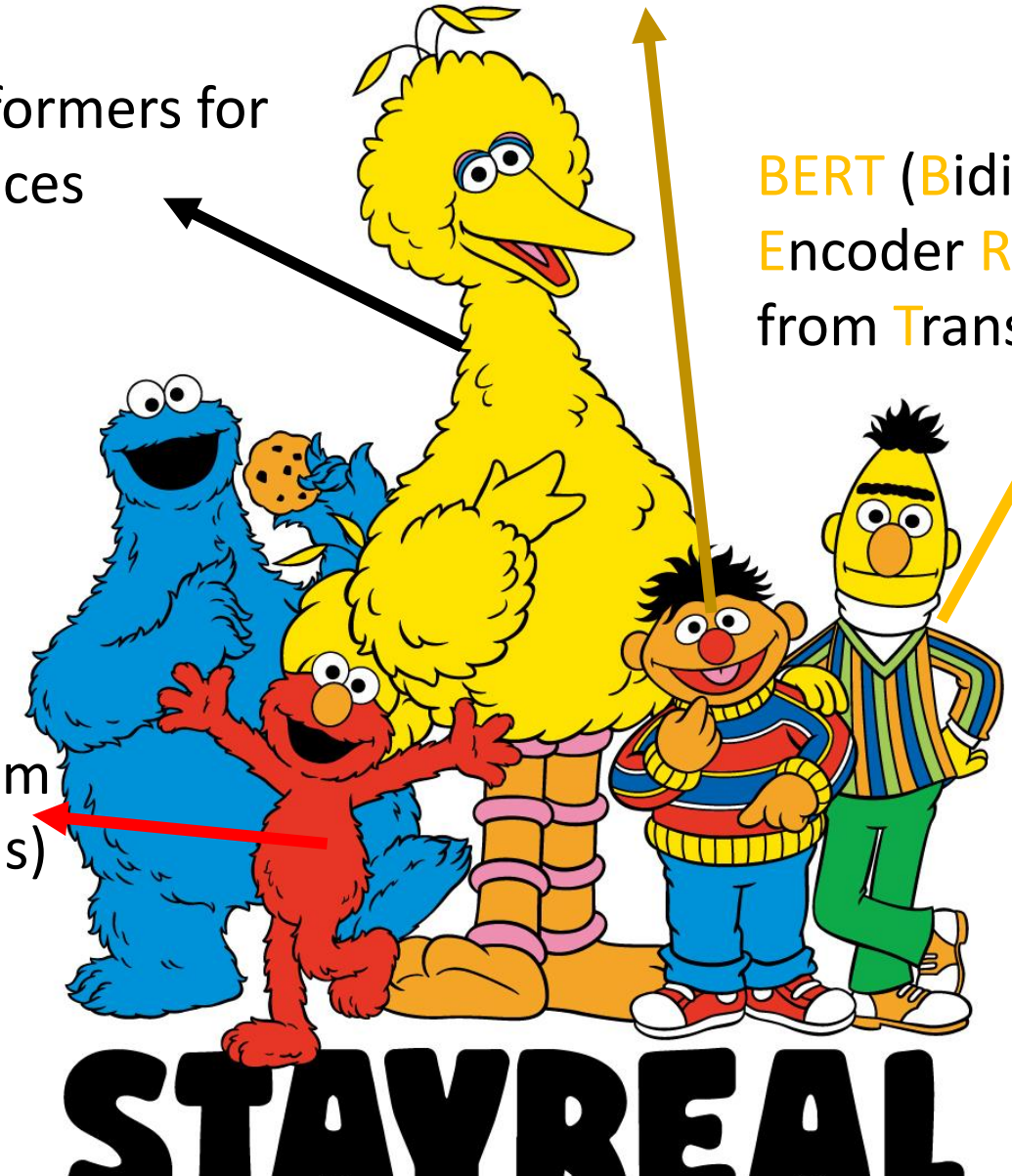
Self-Supervised Learning

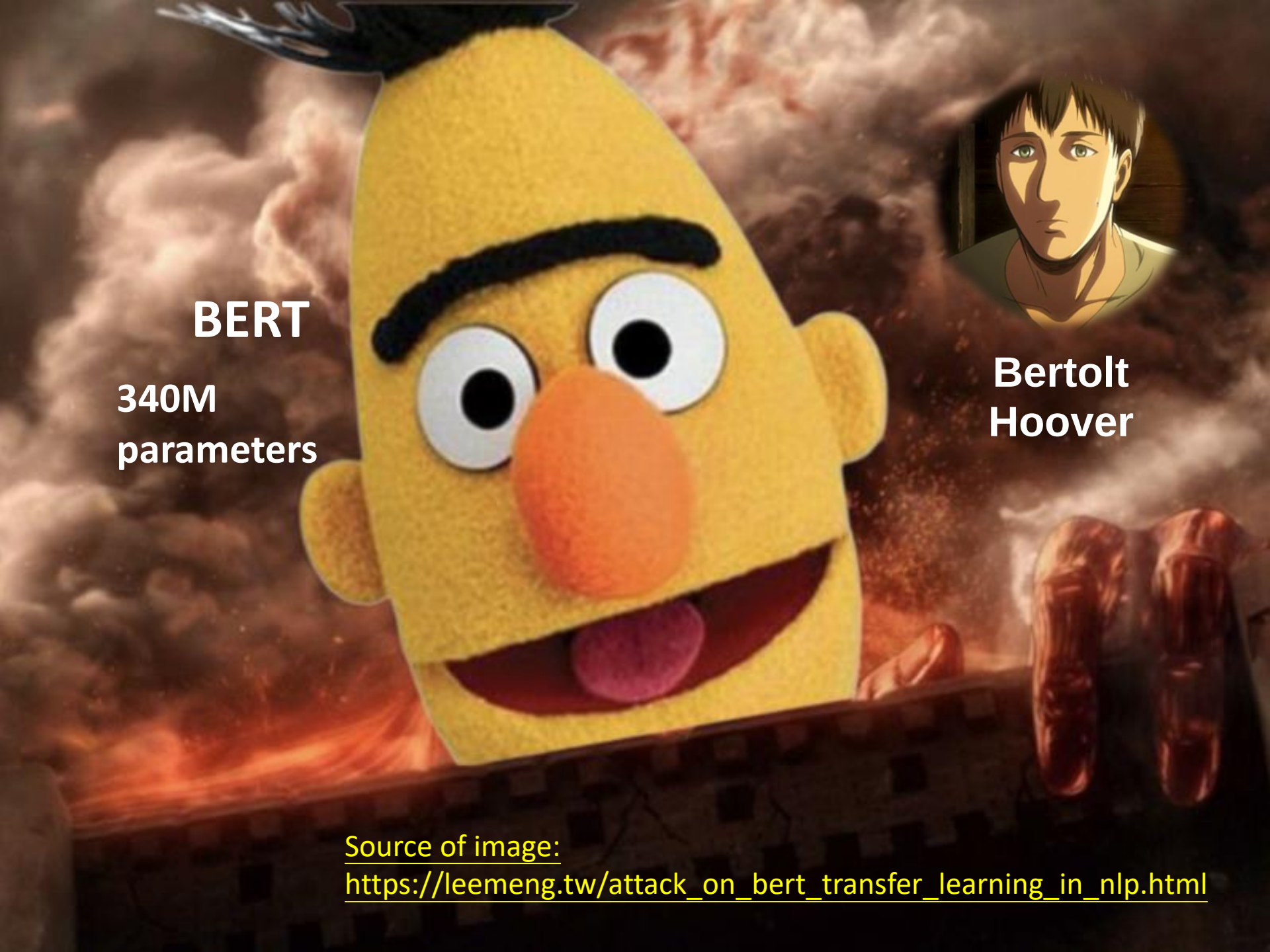
ERNIE (Enhanced Representation through Knowledge Integration)

Big Bird: Transformers for Longer Sequences

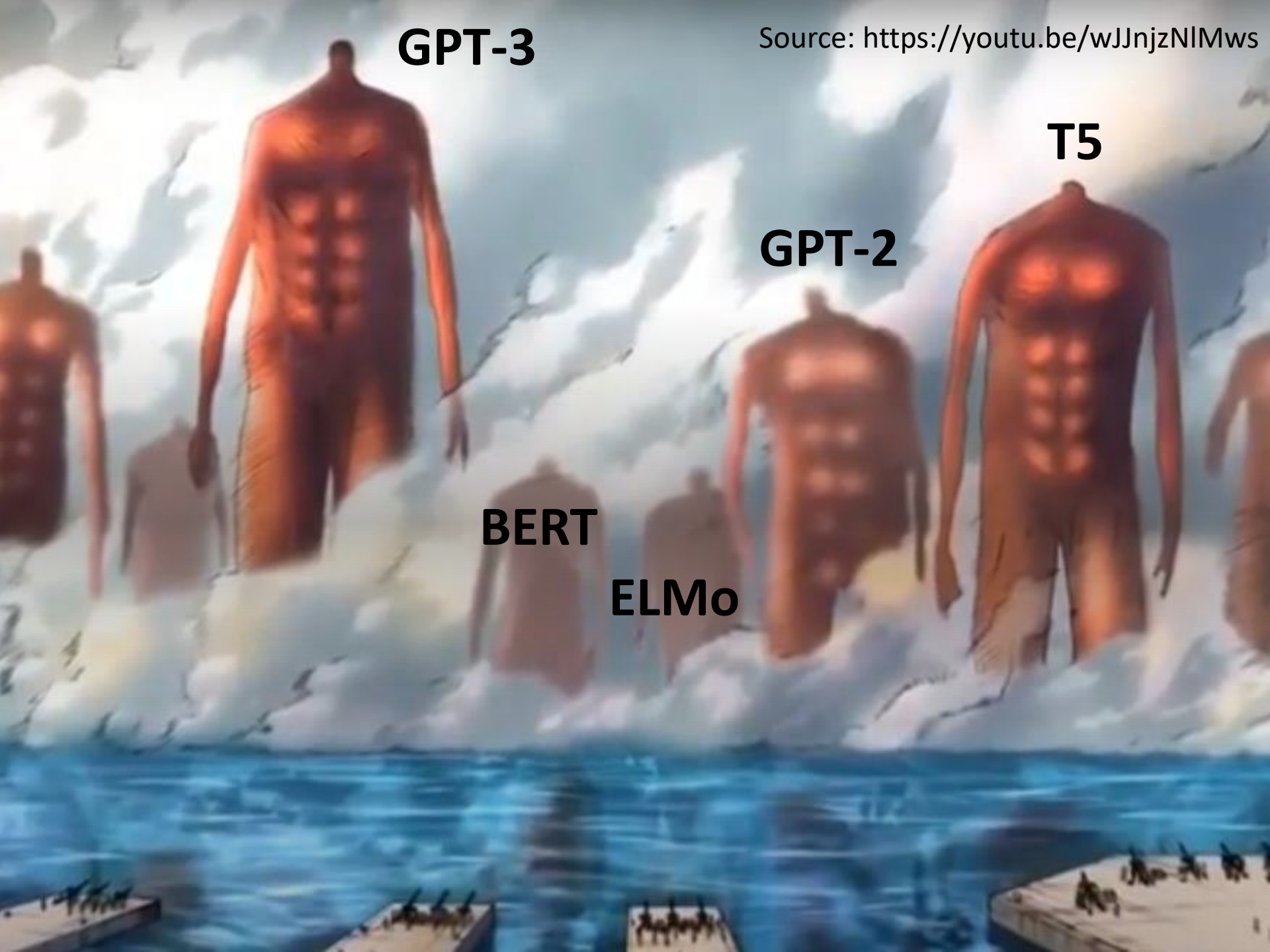
BERT (Bidirectional Encoder Representations from Transformers)

ELMo (Embeddings from Language Models)

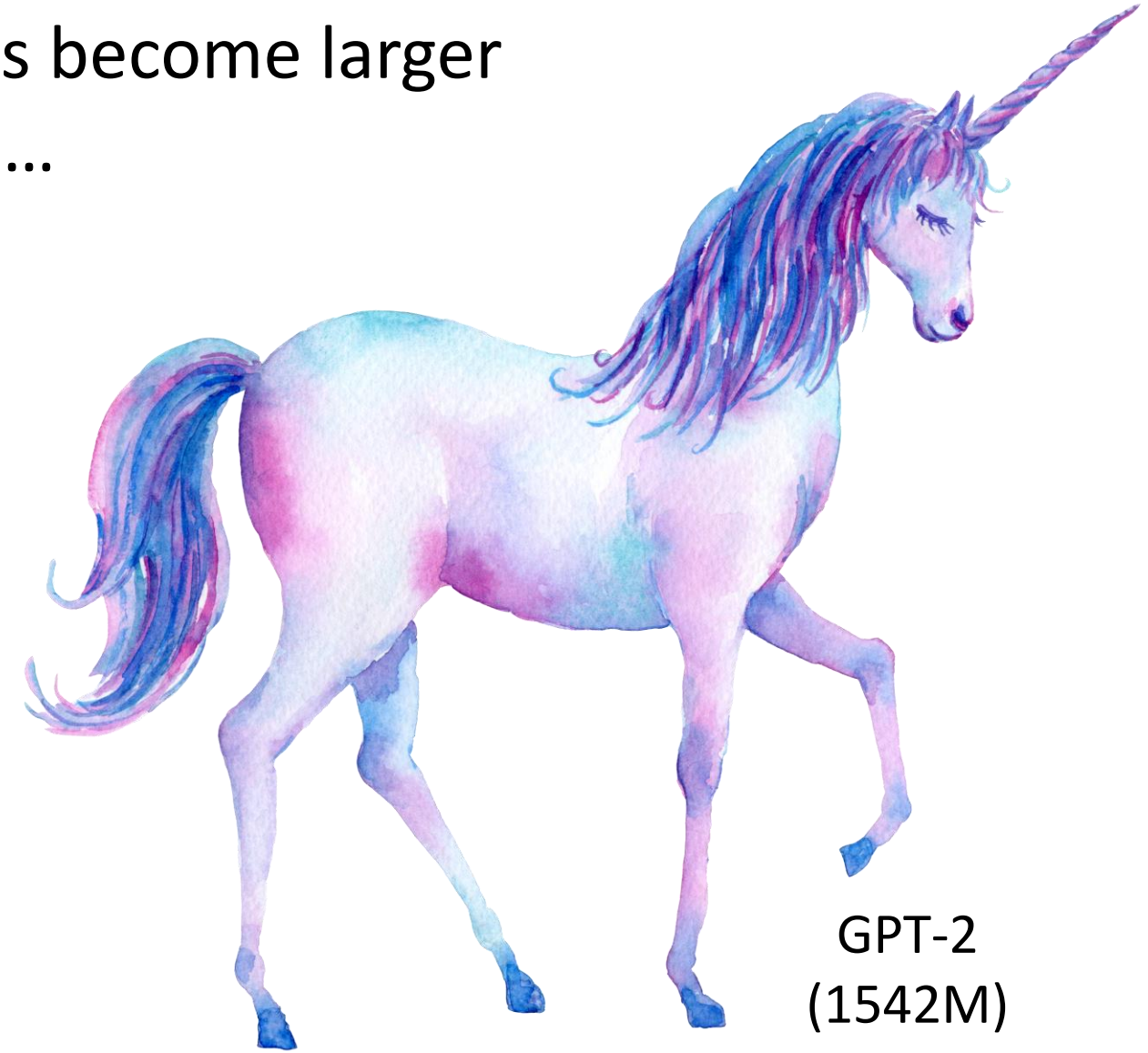




Source of image:
https://leemeng.tw/attack_on_bert_transfer_learning_in_nlp.html


GPT-3
Source: https://youtu.be/wJJnjzNlMws
T5
GPT-2
BERT
ELMo

The models become larger and larger …



ELMO (94M)

BERT (340M)

GPT-2 (1542M)

Source of image: https://huaban.com/pins/1714071707/

The models become larger and larger …

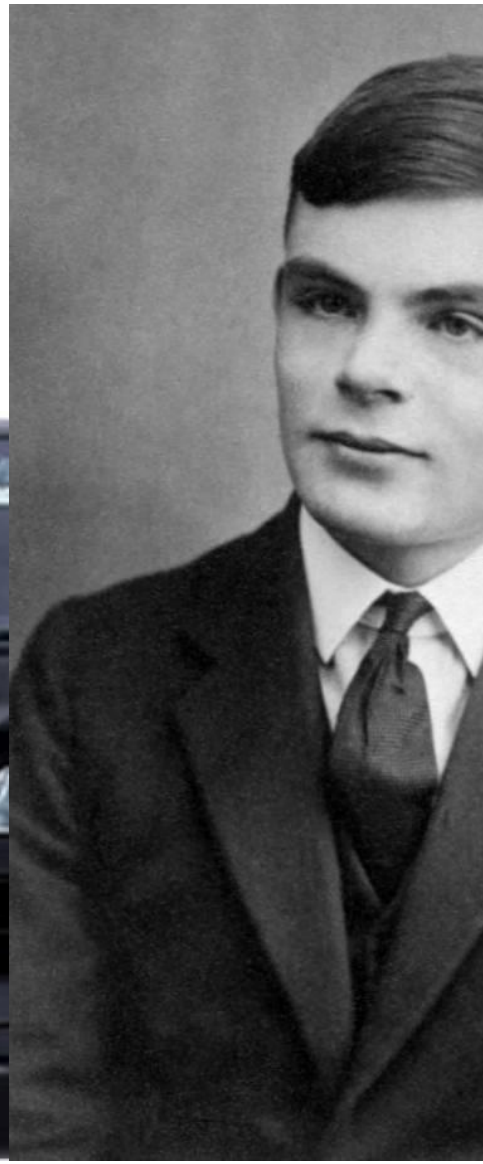
GPT-3 is **10** times larger than Turing NLG. (175B)

GPT-2

Megatron (8B)

T5 (11B)

Turing NLG (17B)



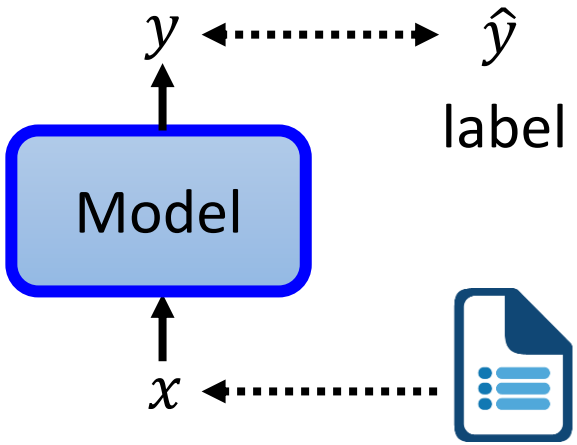
Outline

BERT series

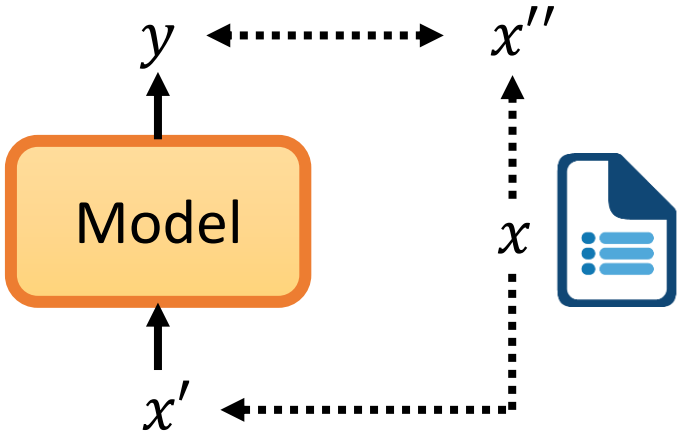
GPT series

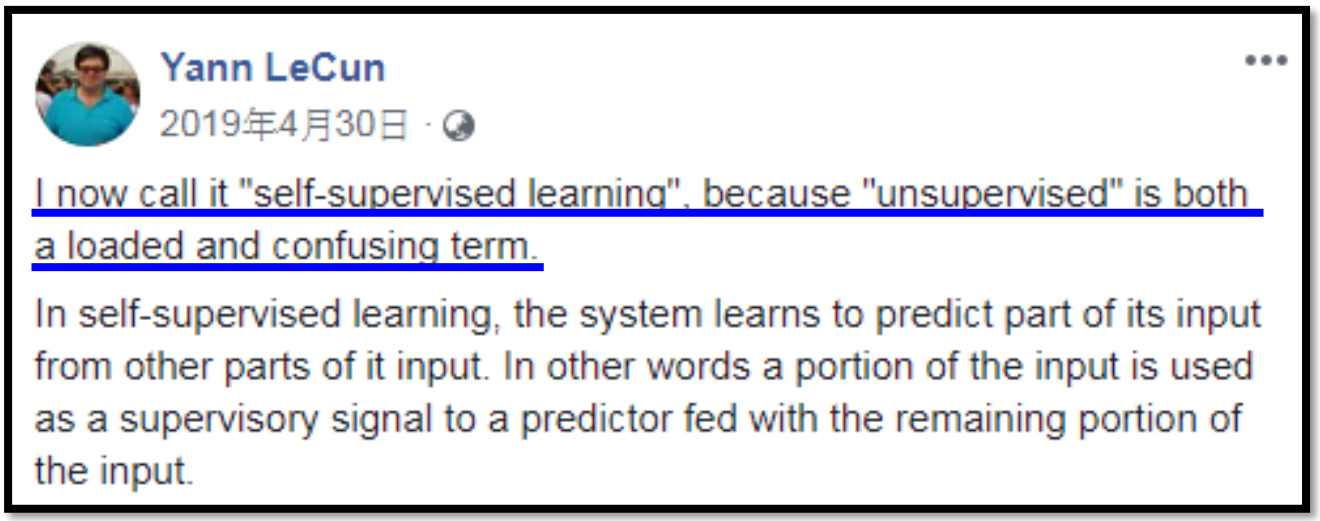
Self-supervised Learning

Supervised



Self-supervised





Yann LeCun

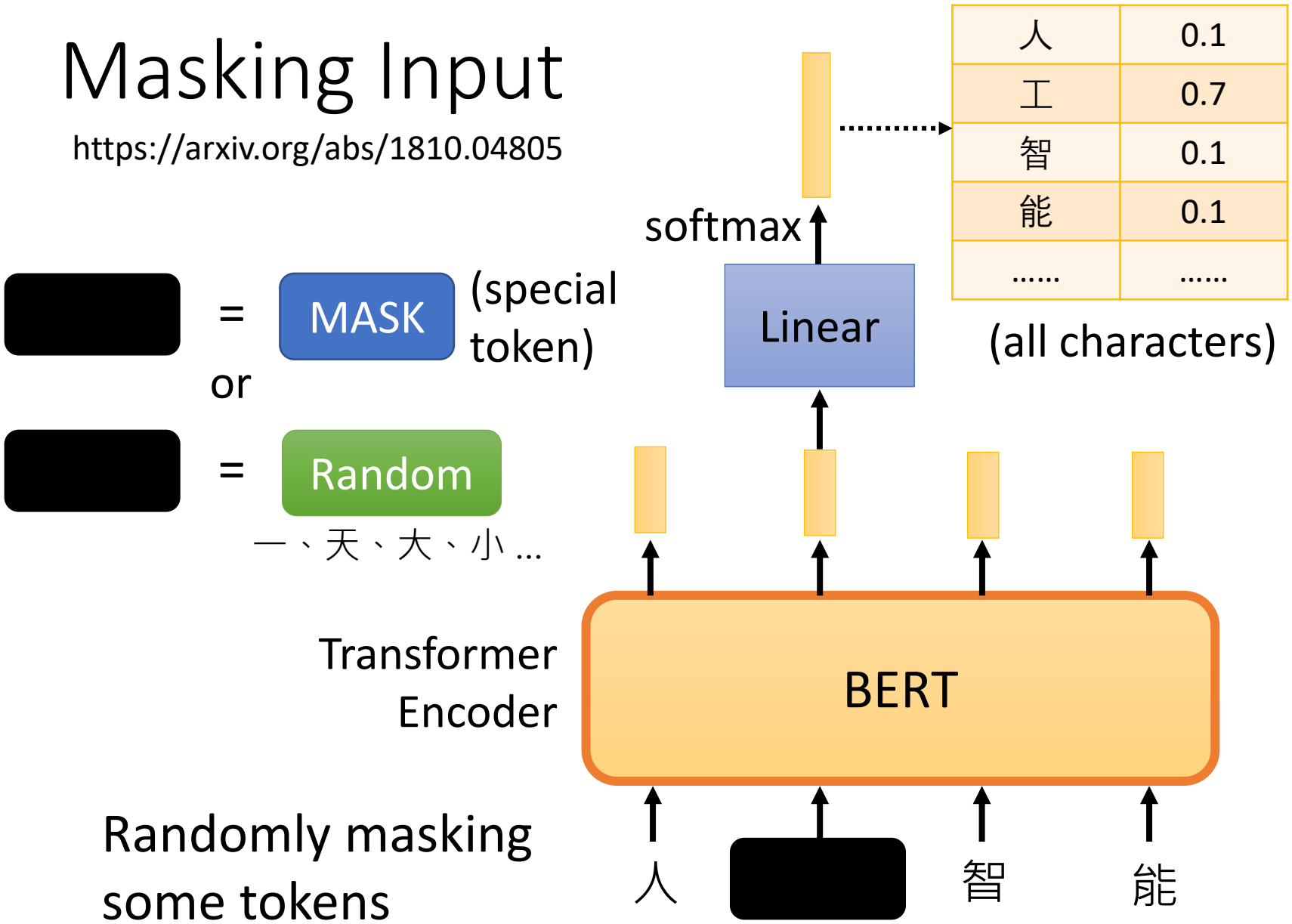
2019年4月30日 ·

I now call it "self-supervised learning", because "unsupervised" is both a loaded and confusing term.

In self-supervised learning, the system learns to predict part of its input from other parts of it input. In other words a portion of the input is used as a supervisory signal to a predictor fed with the remaining portion of the input.

Masking Input

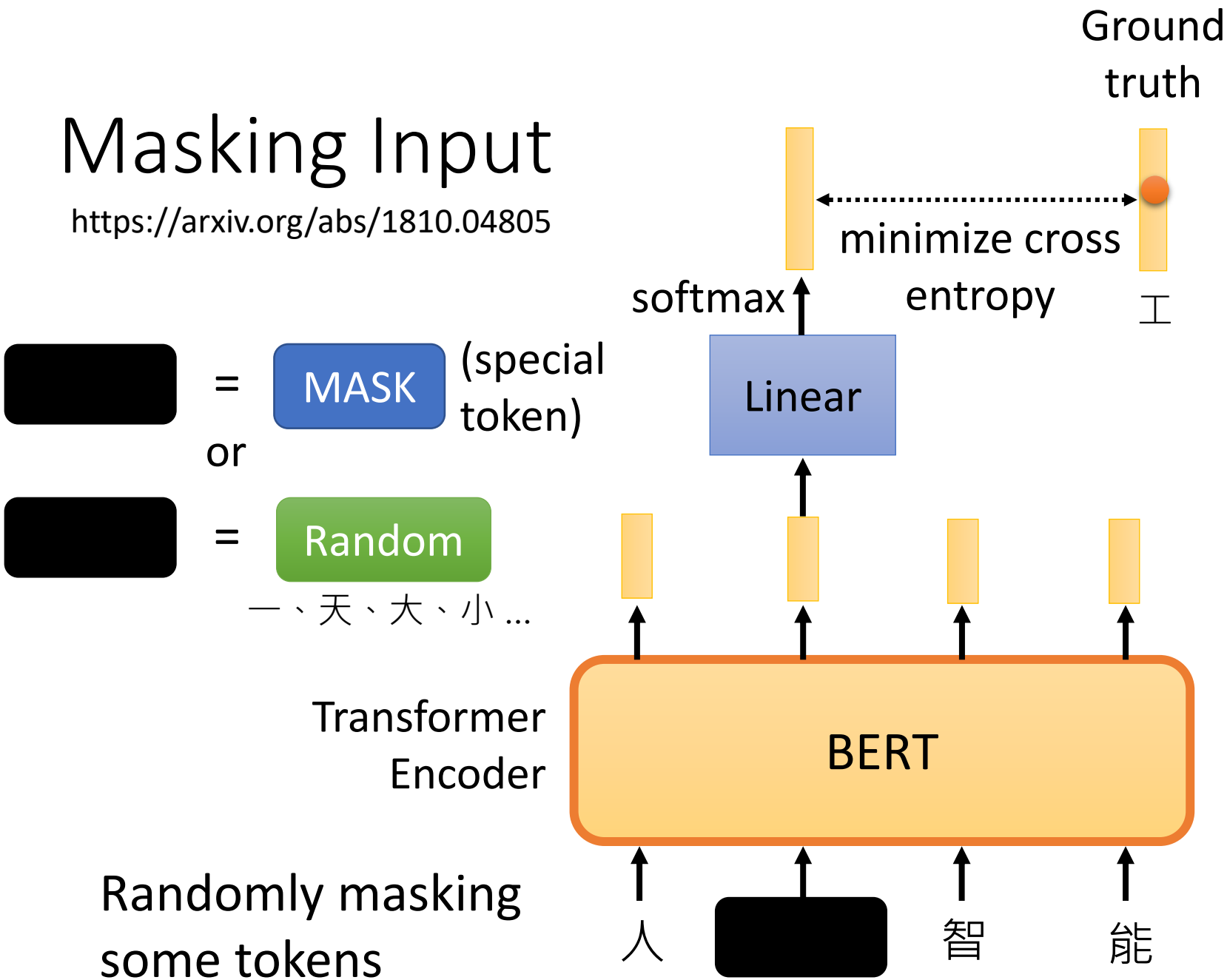
https://arxiv.org/abs/1810.04805



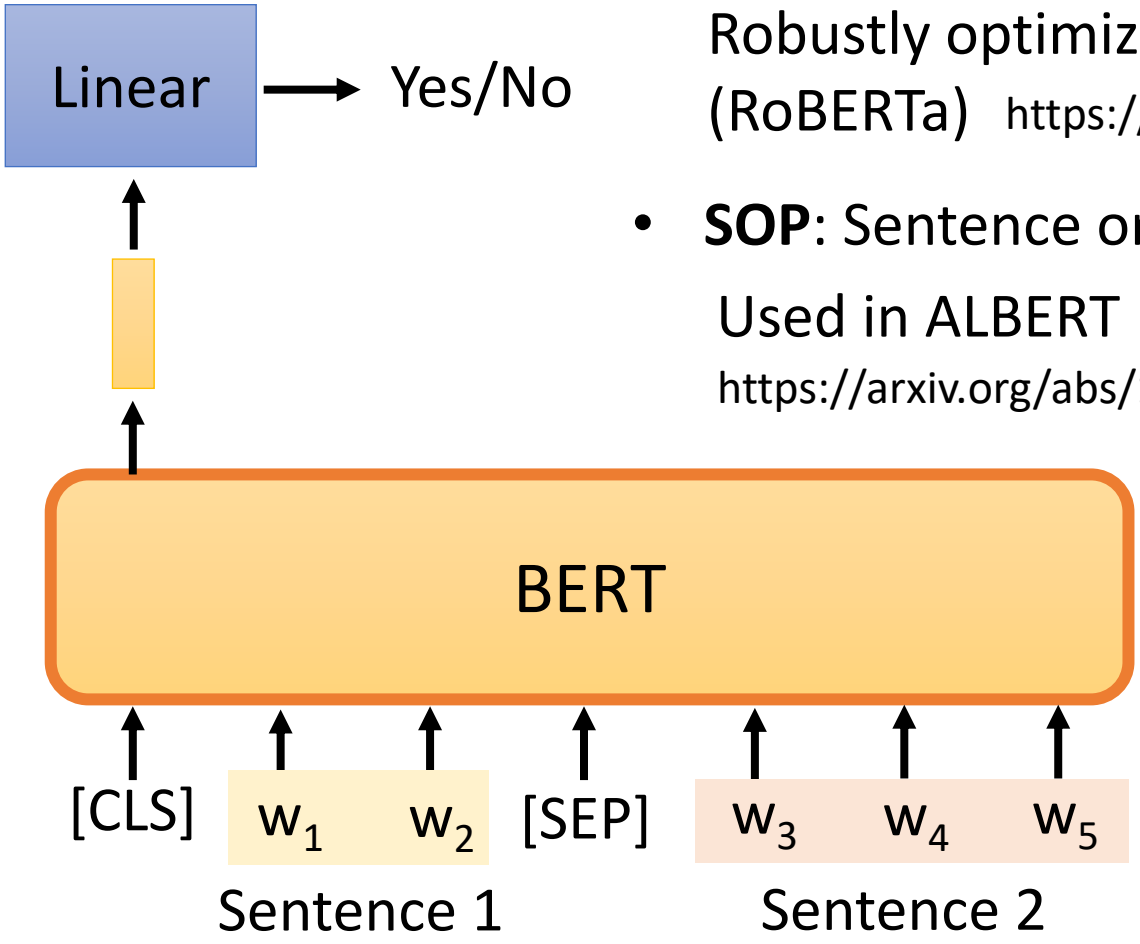
Randomly masking some tokens

Masking Input

https://arxiv.org/abs/1810.04805



Next Sentence Prediction

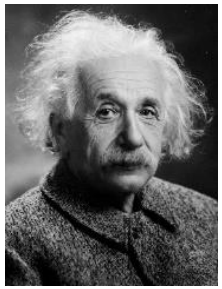


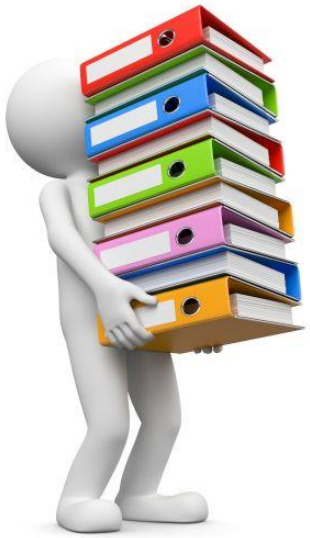
- This approach is not helpful.

  Robustly optimized BERT approach (RoBERTa) https://arxiv.org/abs/1907.11692

- **SOP**: Sentence order prediction

  Used in ALBERT
  https://arxiv.org/abs/1909.11942





Self-supervised Learning

Pre-train

BERT

- Masked token prediction
- Next sentence prediction

Fine-tune

Model for Task 1

Model for Task 2

Model for Task 3

Downstream Tasks

- The tasks we care
- We have a little bit labeled data.

GLUE

General Language Understanding Evaluation (GLUE)

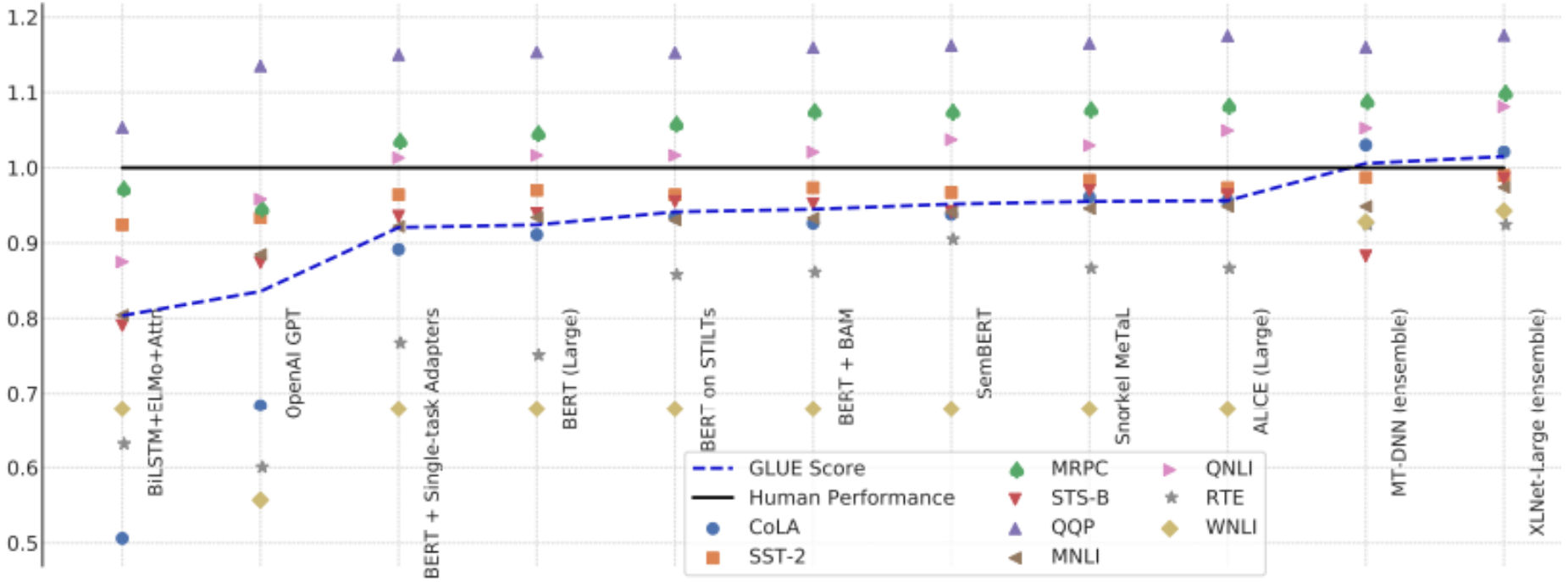
https://gluebenchmark.com/

- Corpus of Linguistic Acceptability (CoLA)
- Stanford Sentiment Treebank (SST-2)
- Microsoft Research Paraphrase Corpus (MRPC)
- Quora Question Pairs (QQP)
- Semantic Textual Similarity Benchmark (STS-B)
- Multi-Genre Natural Language Inference (MNLI)
- Question-answering NLI (QNLI)
- Recognizing Textual Entailment (RTE)
- Winograd NLI (WNLI)

GLUE also has Chinese version (https://www.cluebenchmarks.com/)

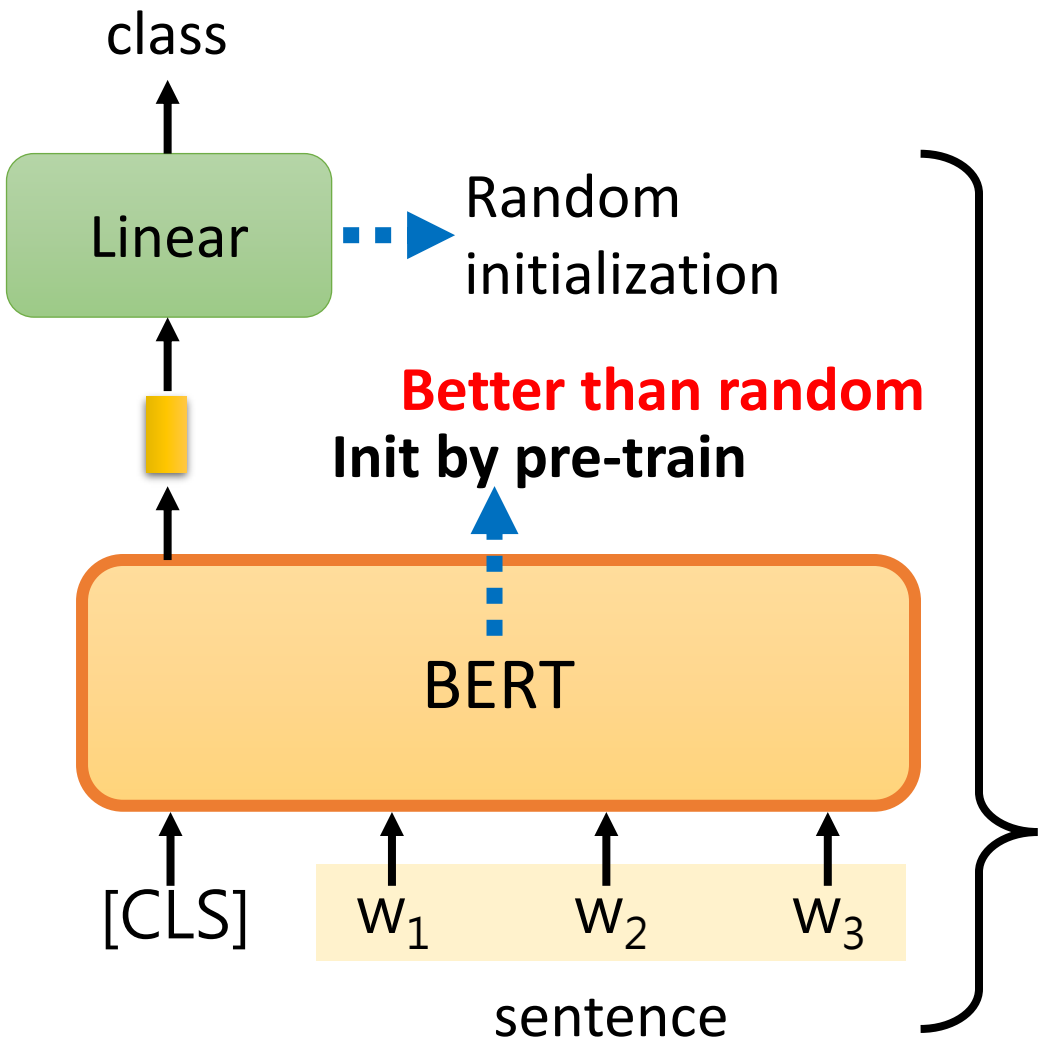
BERT and its Family

- GLUE scores



Source of image: https://arxiv.org/abs/1905.00537

How to use BERT – Case 1



Input: sequence
output: class

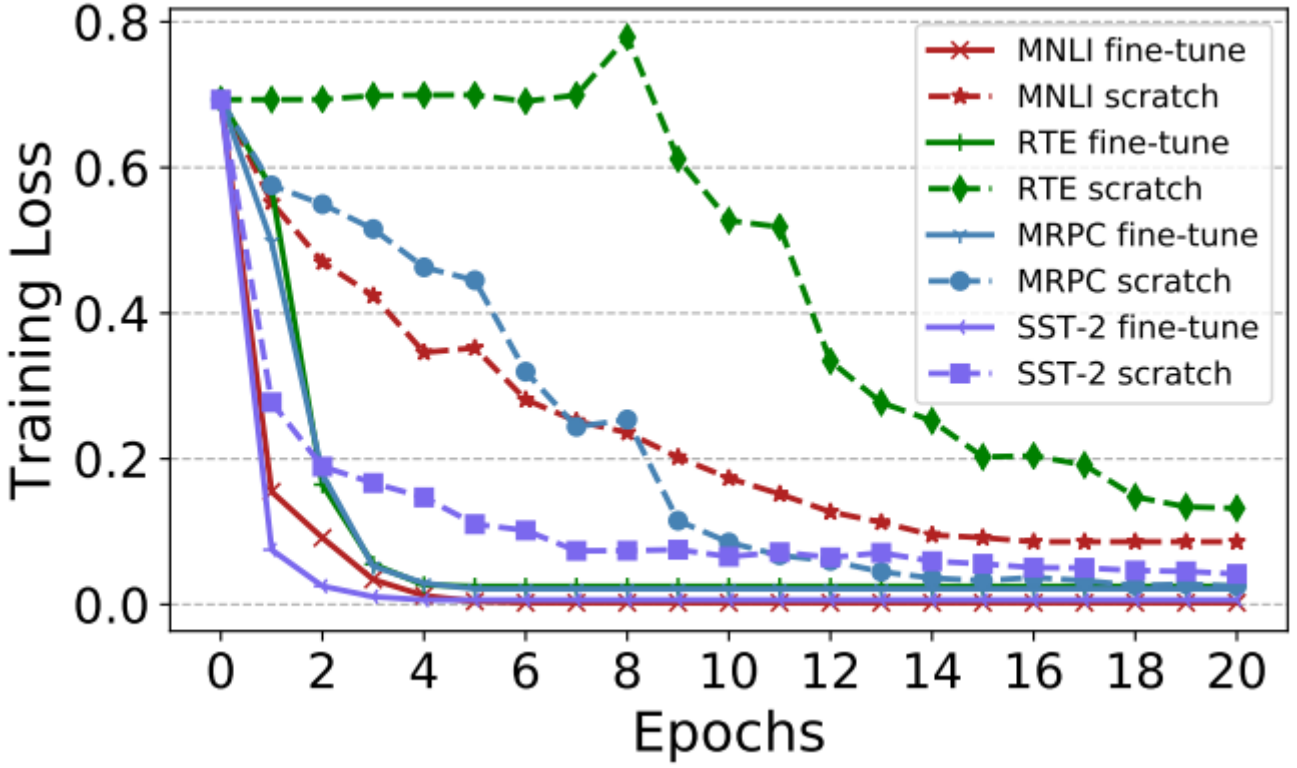
Example:
Sentiment analysis

this is good
↓
positive

This is the model to be learned.

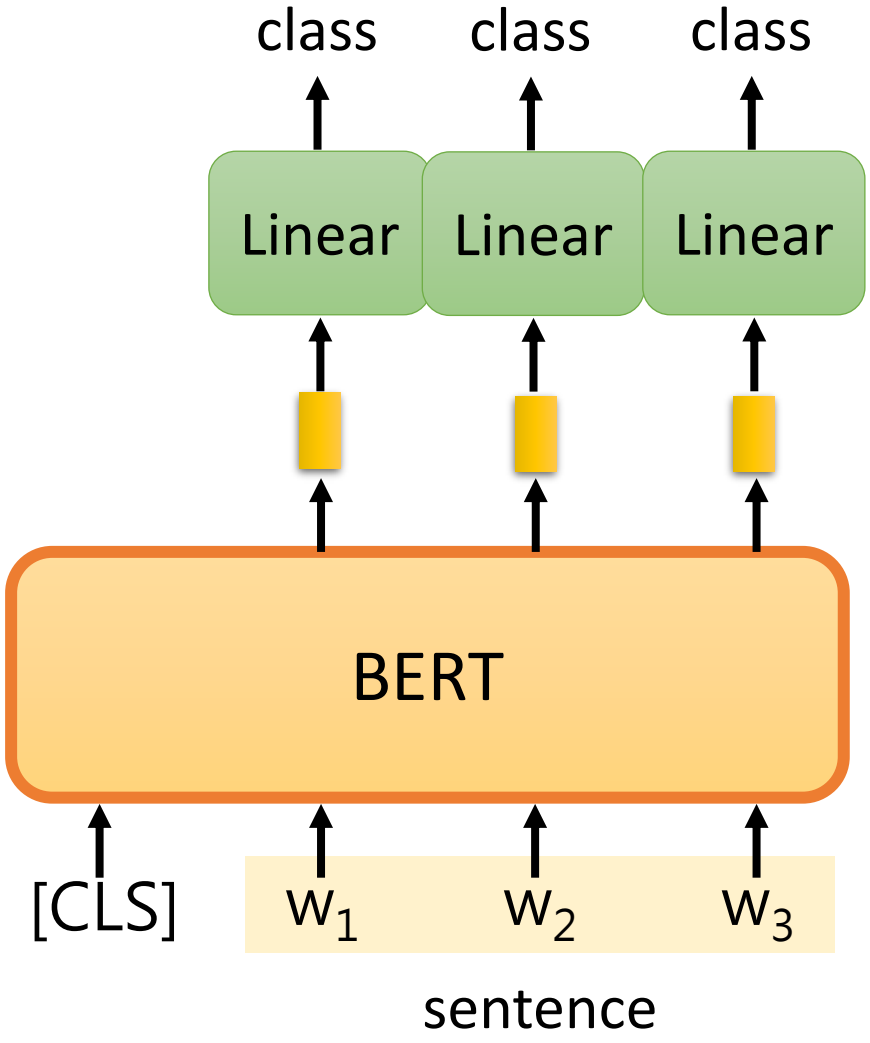
Pre-train v.s. Random Initialization

(fine-tune) (scratch)



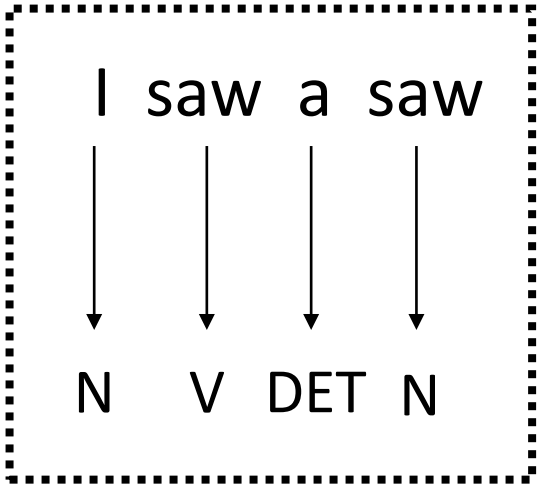
Source of image: https://arxiv.org/abs/1908.05620

How to use BERT – Case 2



Input: sequence
output: same as input

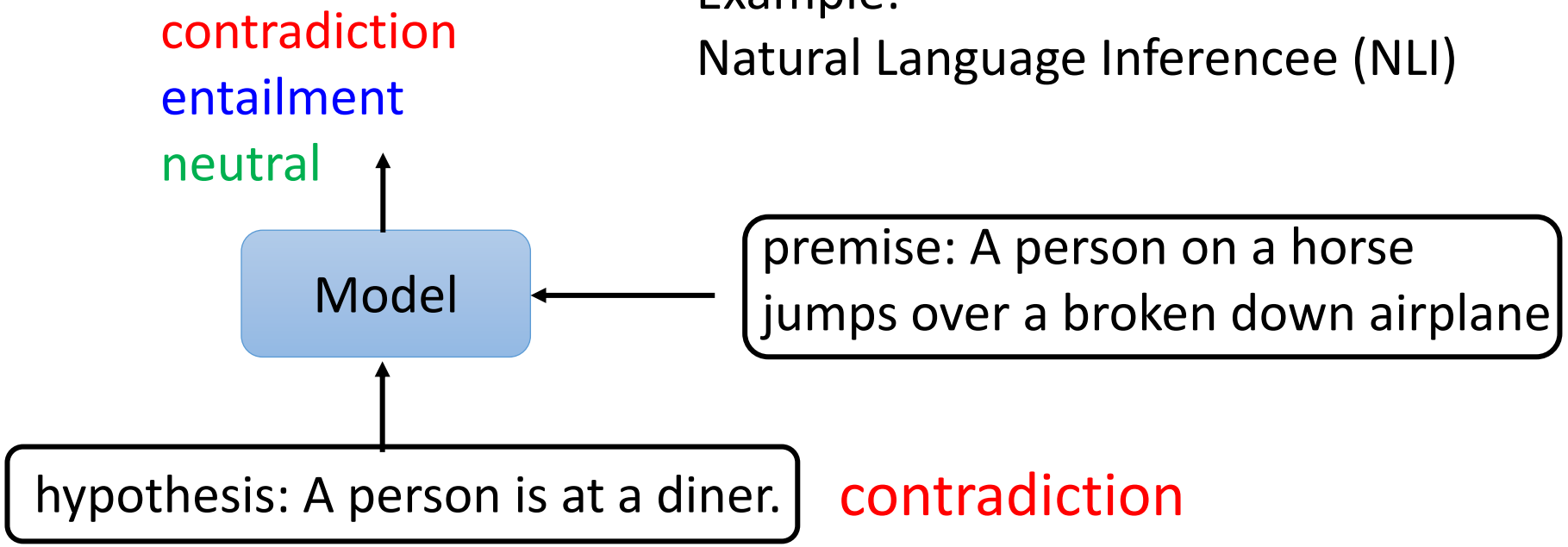
Example:
POS tagging



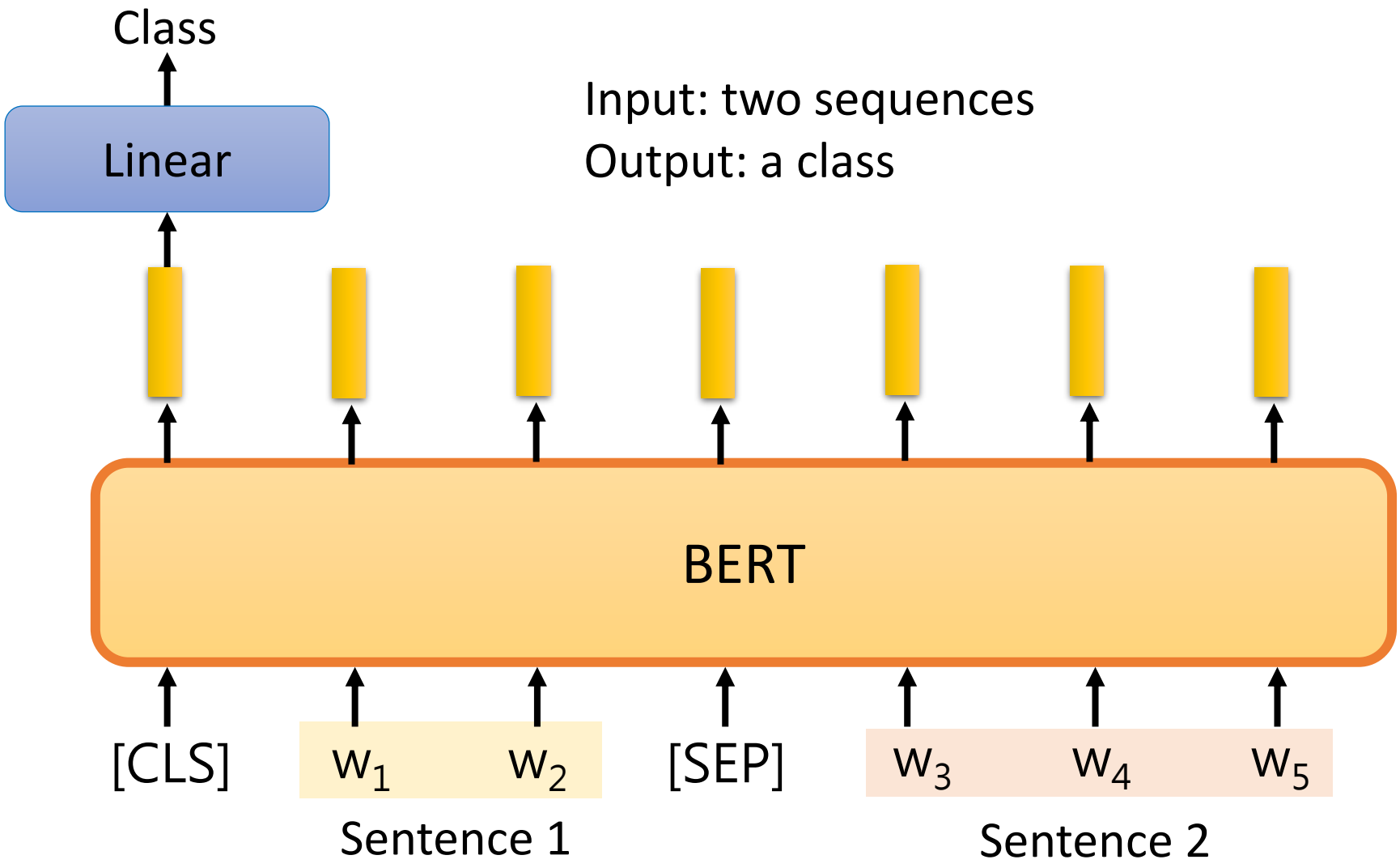
How to use BERT – Case 3

Input: two sequences
Output: a class

Example:
Natural Language Inferencee (NLI)



How to use BERT – Case 3

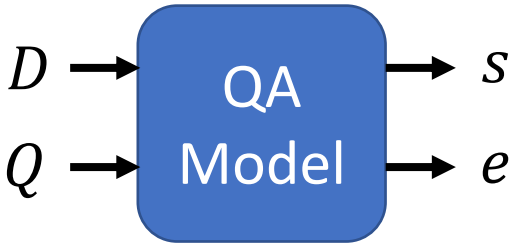


How to use BERT – Case 4

- Extraction-based Question Answering (QA)

Document: $D = \{d_1, d_2, \cdots, d_N\}$

Query: $Q = \{q_1, q_2, \cdots, q_M\}$



output: two integers (s, e)

Answer: $A = \{d_s, \cdots, d_e\}$

In meteorology, precipitation is any product of the condensation of 17 spheric water vapor that falls under gravity. The main forms of precipitation include drizzle, rain, sleet, snow, graupel and hail... Precipitation forms as smaller droplets coalesce via collision with other rain drops or ice crystals within a cloud. Short, intense periods of rain 77 atte 79 cations are called "showers".

What causes precipitation to fall?
gravity

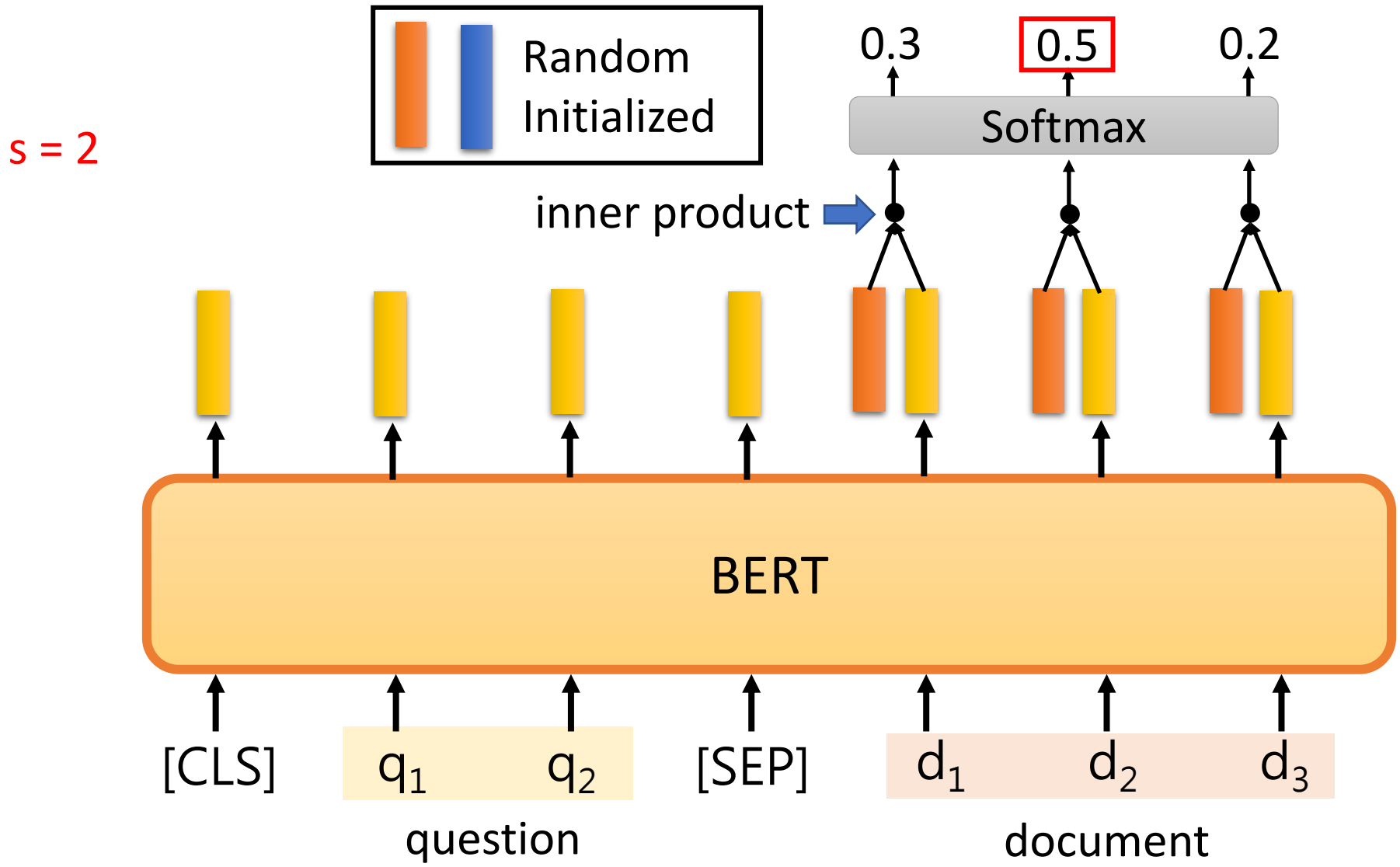
$s = 17, e = 17$

What is another main form of precipitation besides drizzle, rain, snow, sleet and hail?
graupel

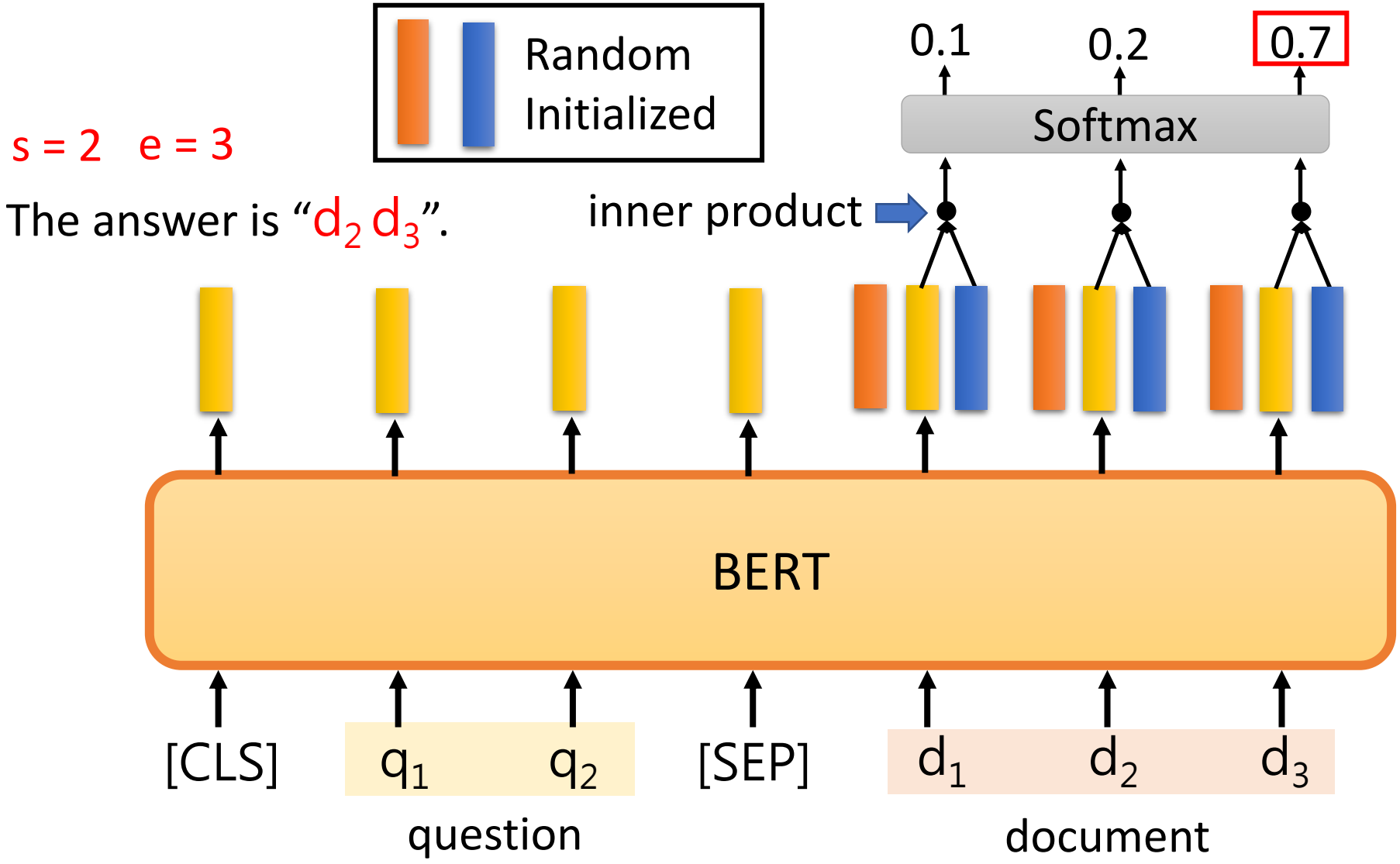
Where do water droplets collide with ice crystals to form precipitation?
within a cloud

$s = 77, e = 79$

How to use BERT – Case 4



How to use BERT – Case 4

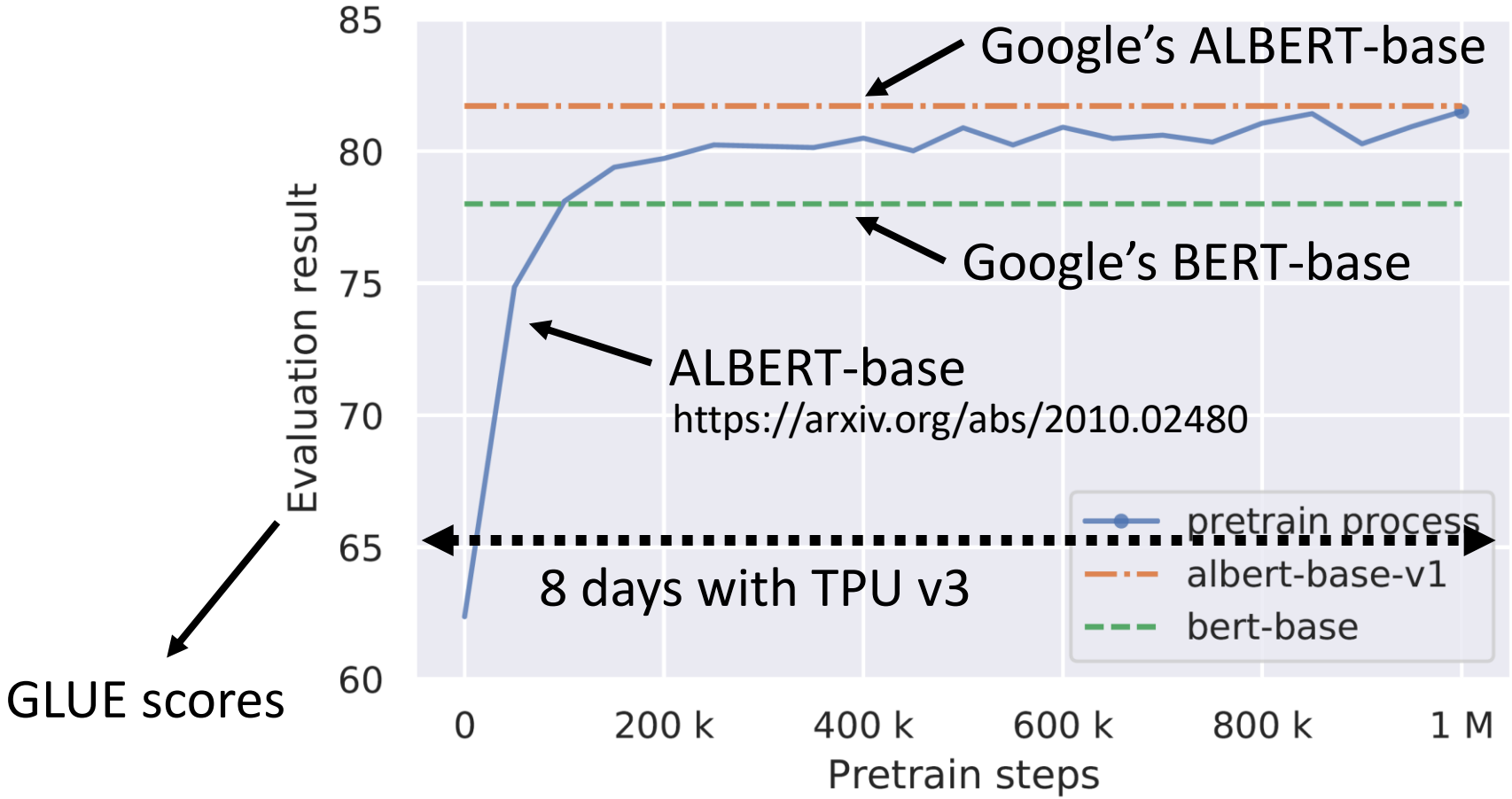


That's all!

Training BERT is challenging!

Training data has more than **3 billions** of words.

3000 times of **Harry Potter series**



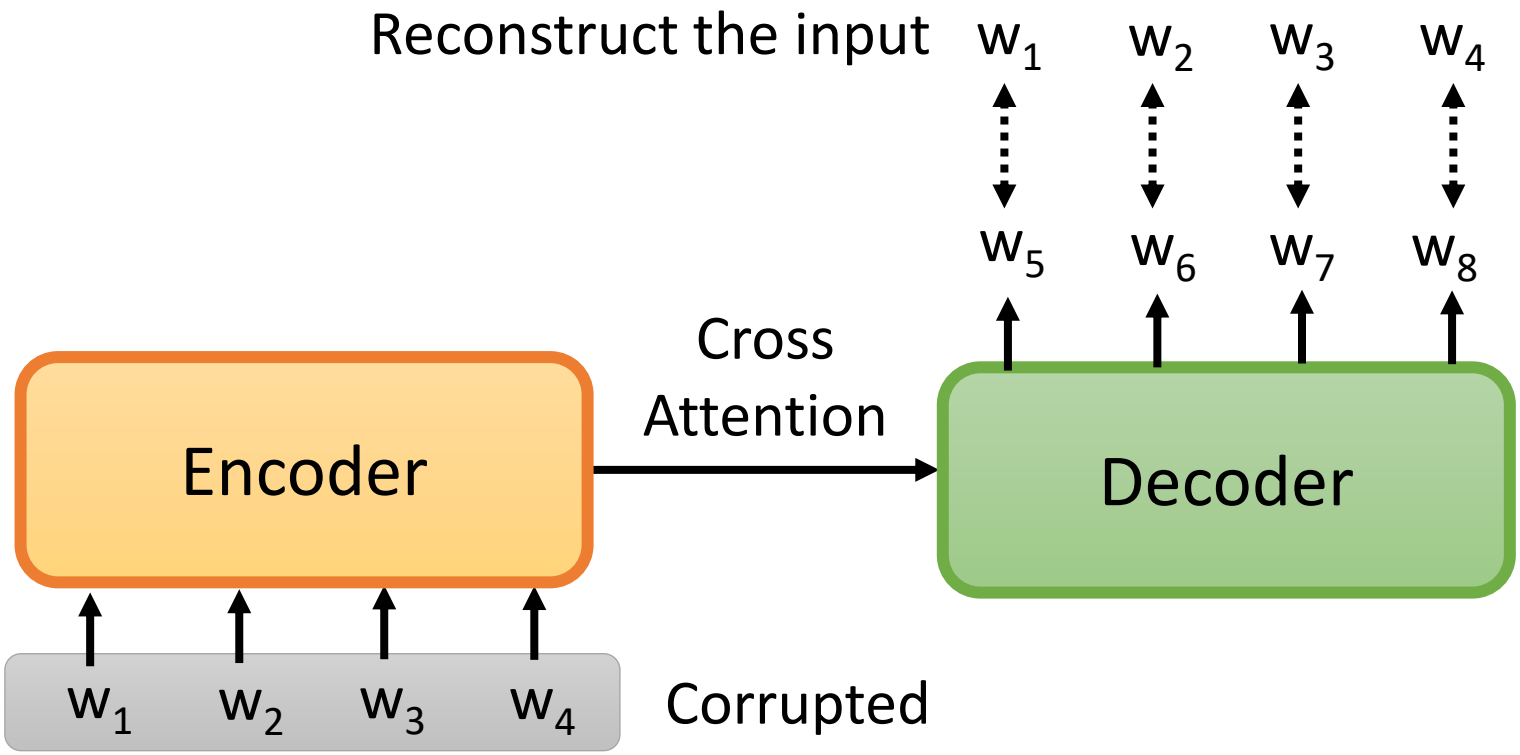
BERT Embryology (胚胎学)

https://arxiv.org/abs/2010.02480

When does BERT know POS tagging, syntactic parsing, semantics?

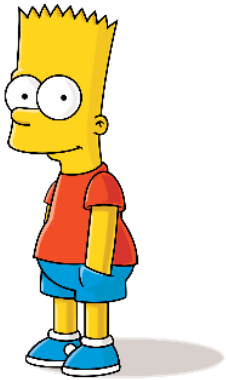
The answer is counterintuitive!

Pre-training a seq2seq model



MASS / BART

MASS



BART

A B [SEP] C D E

A B [SEP] C ■ E

A B [SEP] C E

(Delete “D”)

C D E [SEP] A B

(permutation)

D E A B [SEP] C

(rotation)

A ■ B [SEP] ■ E

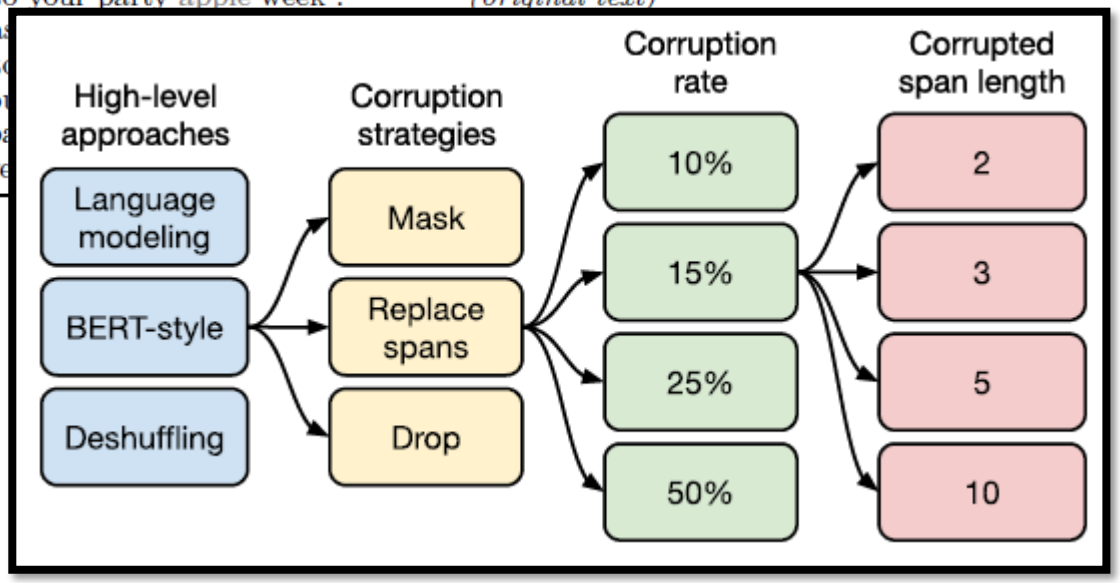
Text Infilling

https://arxiv.org/abs/1905.02450
https://arxiv.org/abs/1910.13461

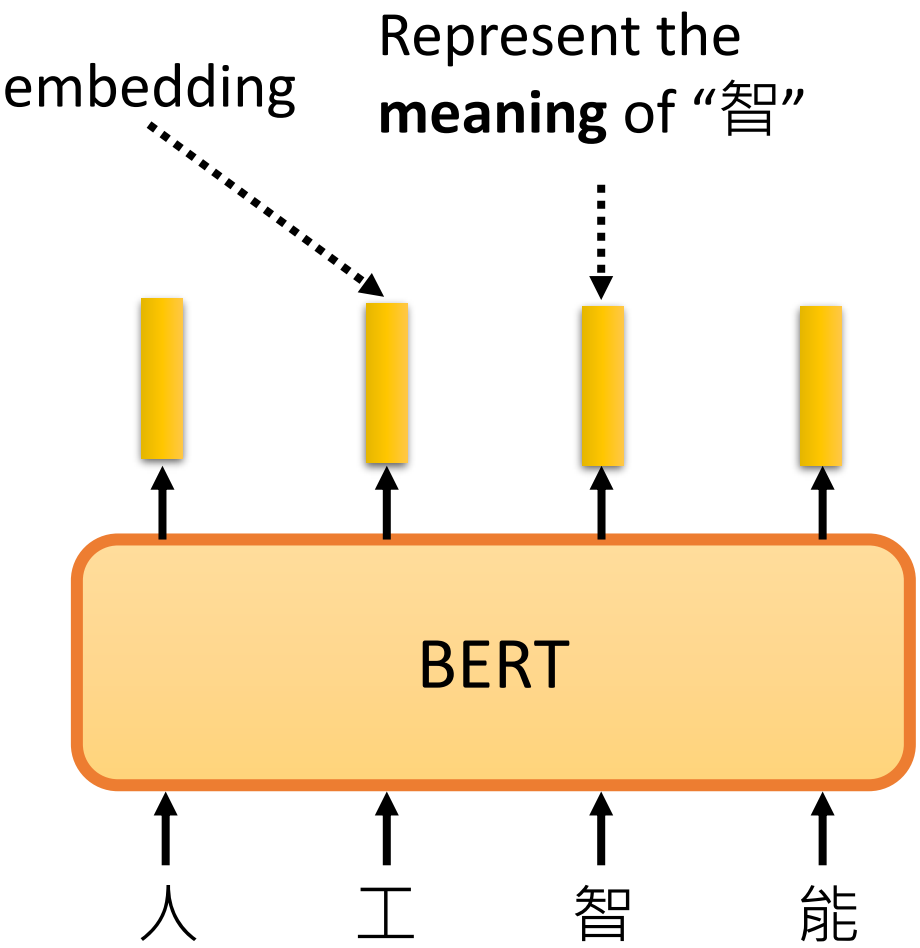
T5 – Comparison

- Transfer Text-to-Text Transformer (T5)
- Colossal Clean Crawled Corpus (C4)

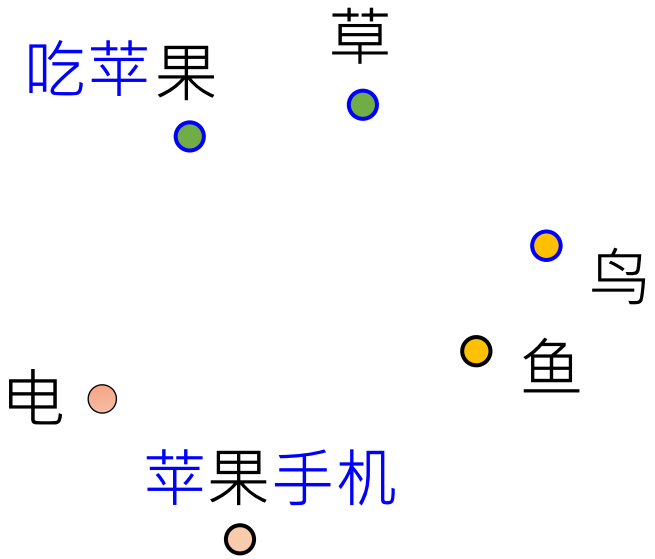
Objective	Inputs	Targets
Prefix language modeling	Thank you for inviting	me to your party last week .
BERT-style	Thank you <M> <M> me to your party apple week .	*(original text)*
Deshuffling	party me for your to . las	
I.i.d. noise, mask tokens	Thank you <M> <M> me t	
I.i.d. noise, replace spans	Thank you <X> me to yo	
I.i.d. noise, drop tokens	Thank you me to your pa	
Random spans	Thank you <X> to <Y> we	



Why does BERT work?

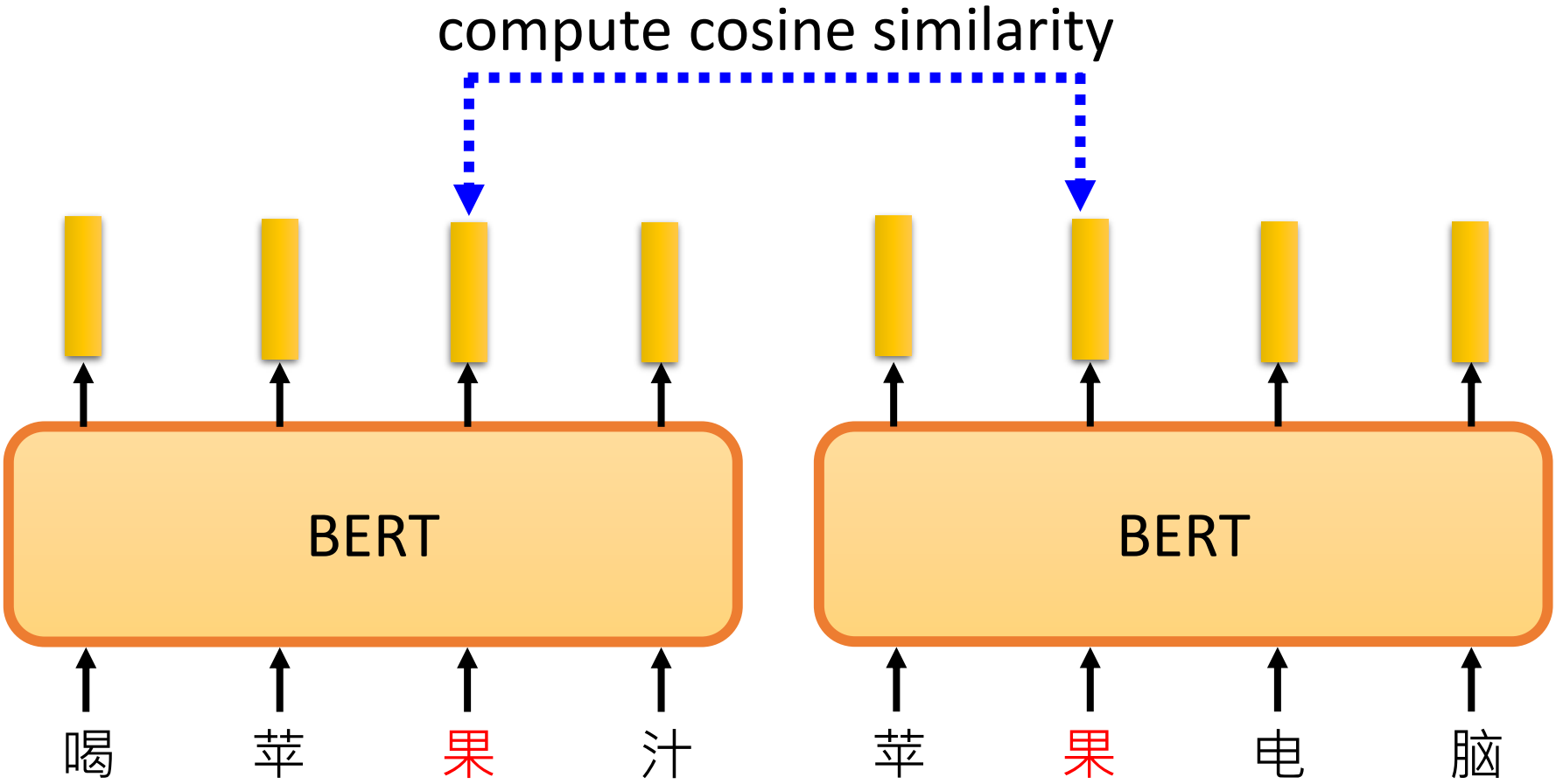


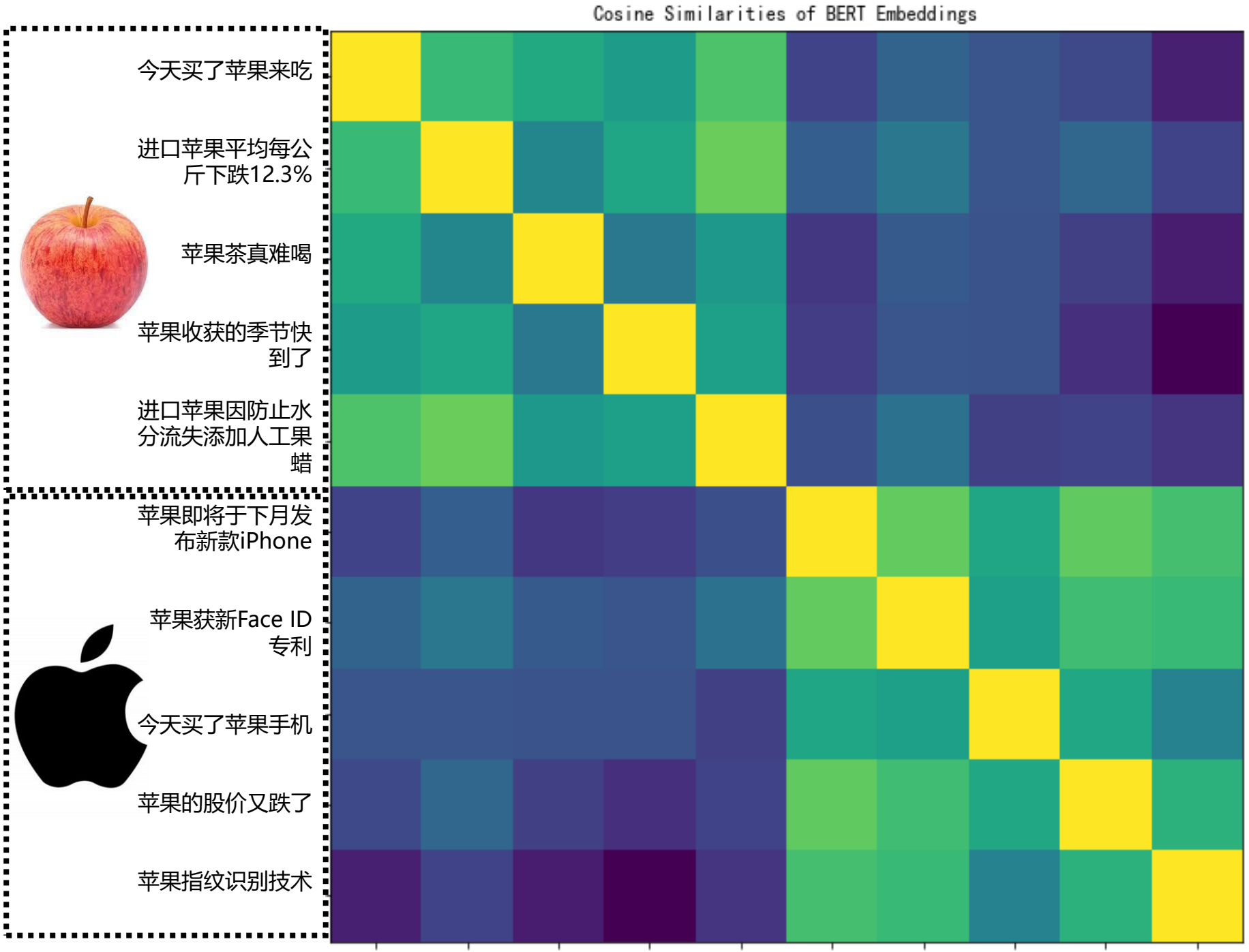
The tokens with similar meaning have similar embedding.



Context is considered.

Why does BERT work?



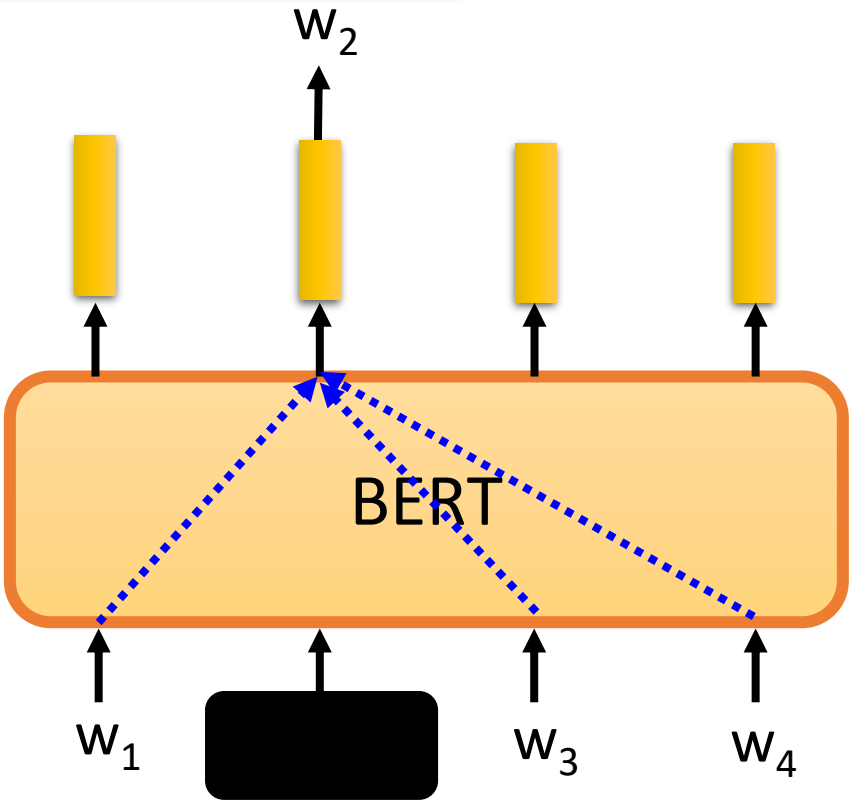

Cosine Similarities of BERT Embeddings
今天买了苹果来吃
进口苹果平均每公斤下跌12.3%
苹果茶真难喝
苹果收获的季节快到了
进口苹果因防止水分流失添加人工果蜡
苹果即将于下月发布新款iPhone
苹果获新Face ID专利
今天买了苹果手机
苹果的股价又跌了
苹果指纹识别技术

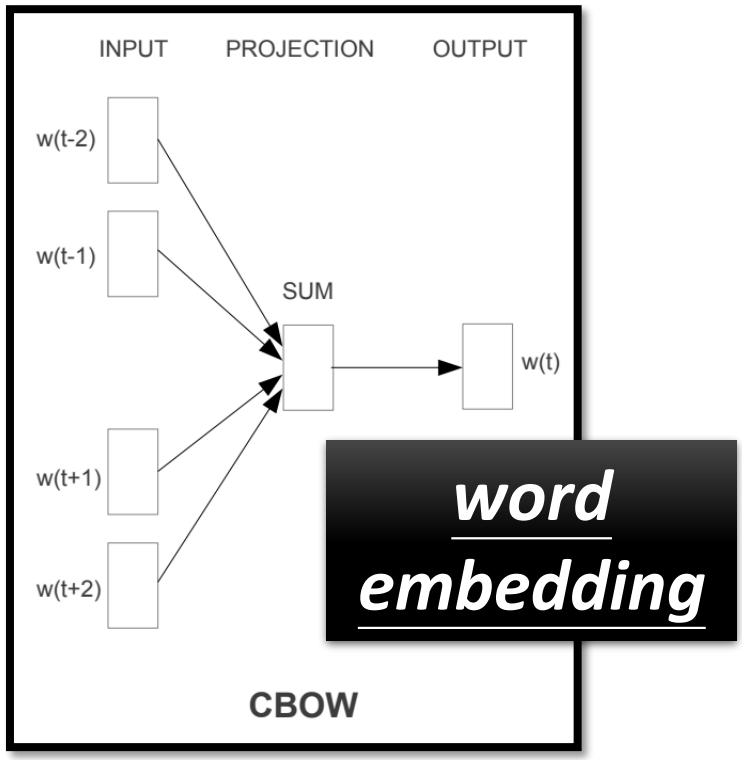
Why does BERT work?

Contextualized word embedding

You shall know a word by the company it keeps

John Rupert Firth





word embedding

https://arxiv.org/abs/2103.07162

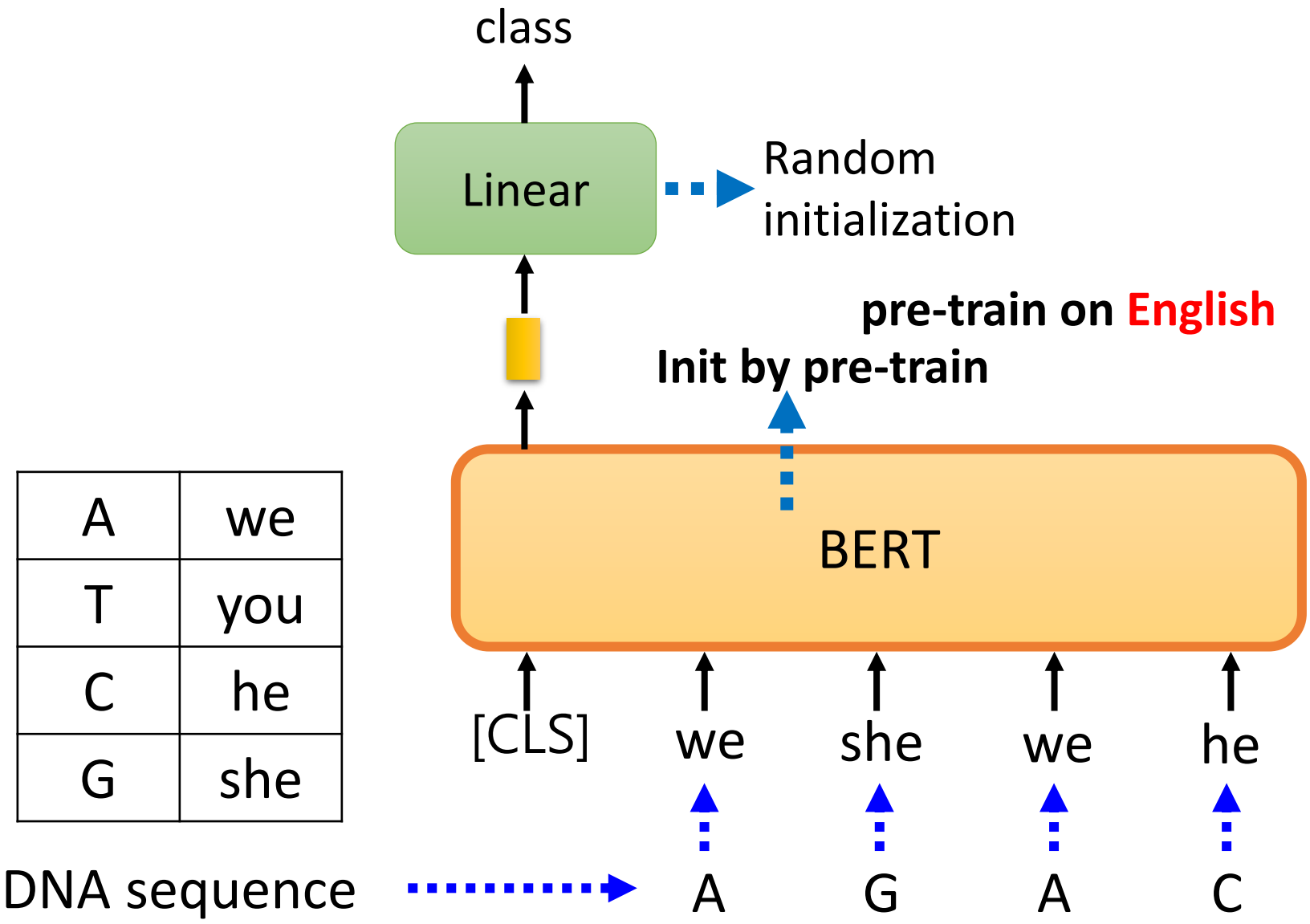
Why does BERT work?

- Applying BERT to **protein**, **DNA**, **music classification**

class	DNA sequence
EI	CCAGCTGCATCACAGGAGGCCAGCG
EI	AGACCCGCCGGGAGGCGGAGGACC
IE	AACGTGGCCTCCTTGTGCCCTTCCCC
IE	CCACTCAGCCAGGCCCTTCTTCTCCT
IE	CCTGATCTGGGTCTCCCCTCCCACCC
IE	AGCCCTCAACCCTTCTGTCTCACCCT
IE	CCACTCAGCCAGGCCCTTCTTCTCCT
N	CTGTGTTCACCACATCAAGCGCCGGC
N	GTGTTACCGAGGGCATTTCTAACAGT
N	TCTGAGCTCTGCATTTGTCTATTCTCC

Why does BERT work?

https://arxiv.org/abs/2103.07162



A	we
T	you
C	he
G	she

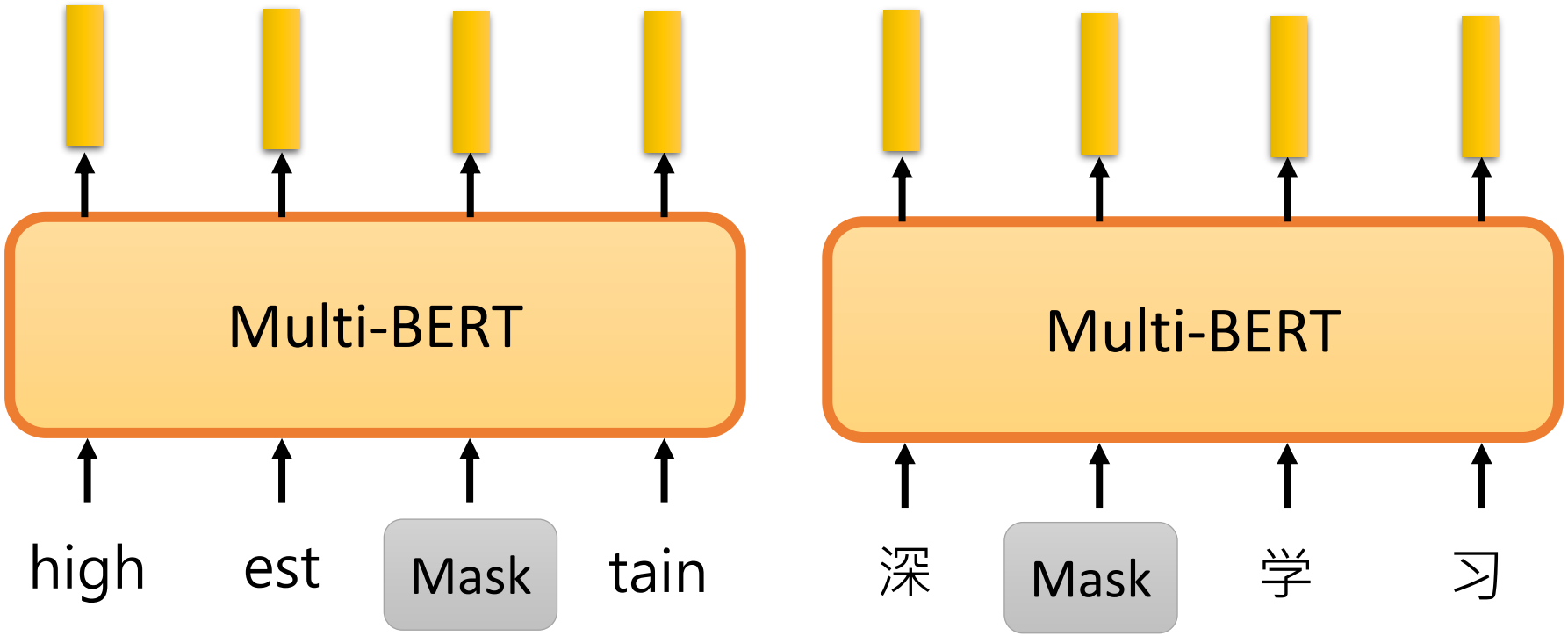
https://arxiv.org/abs/2103.07162

Why does BERT work?

- Applying BERT to **protein**, **DNA**, **music classification**

	Protein			DNA				Music
	localization	stability	fluorescence	H3	H4	H3K9ac	Splice	composer
specific	69.0	76.0	63.0	87.3	87.3	79.1	94.1	-
BERT	64.8	74.5	63.7	83.0	86.2	78.3	97.5	55.2
re-emb	63.3	75.4	37.3	78.5	83.7	76.3	95.6	55.2
rand	58.6	65.8	27.5	75.6	66.5	72.8	95	36

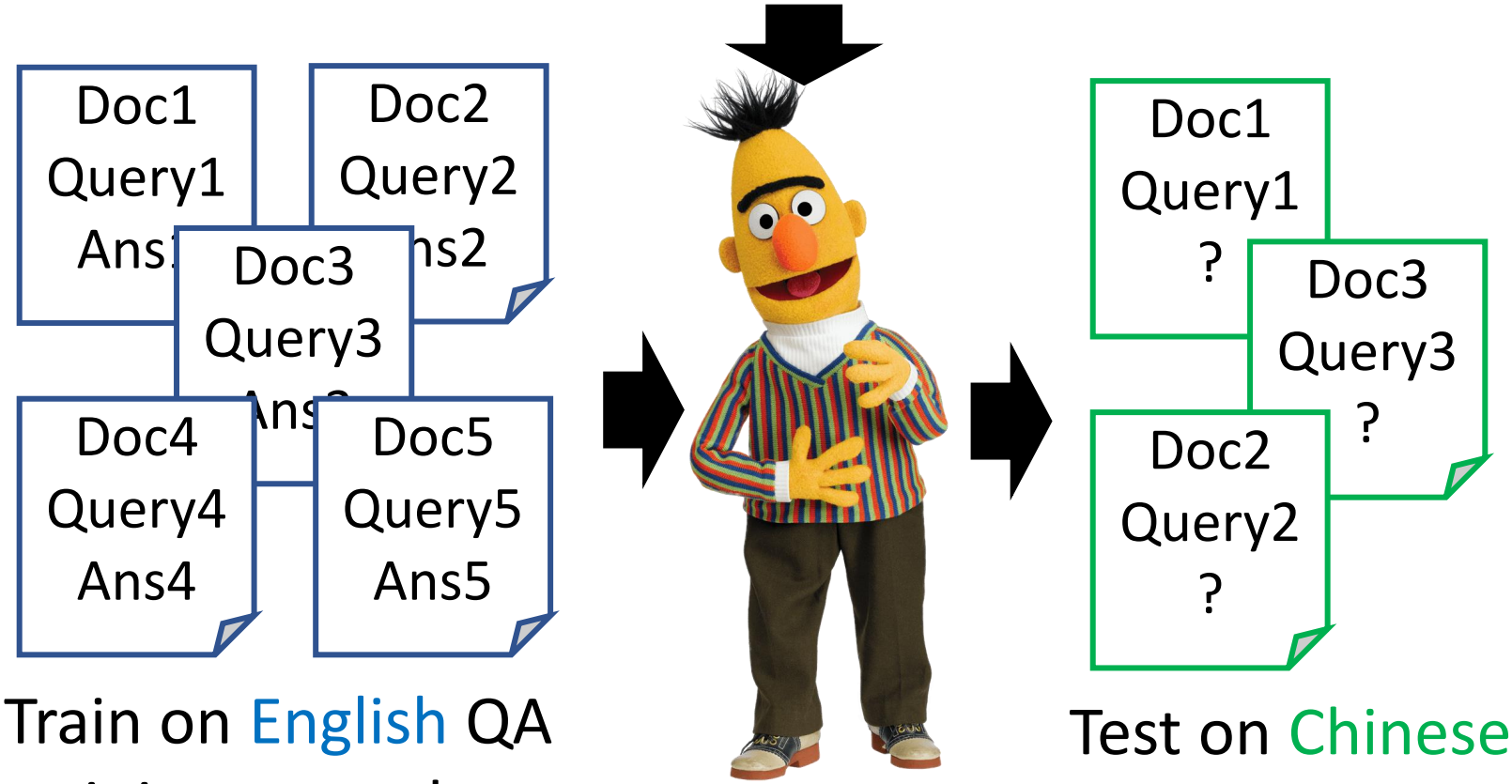
Multi-lingual BERT



Training a BERT model by many different languages.

Zero-shot Reading Comprehension

Training on the sentences of 104 languages



Train on English QA training examples

Multi-BERT

Test on Chinese QA test

Zero-shot Reading Comprehension

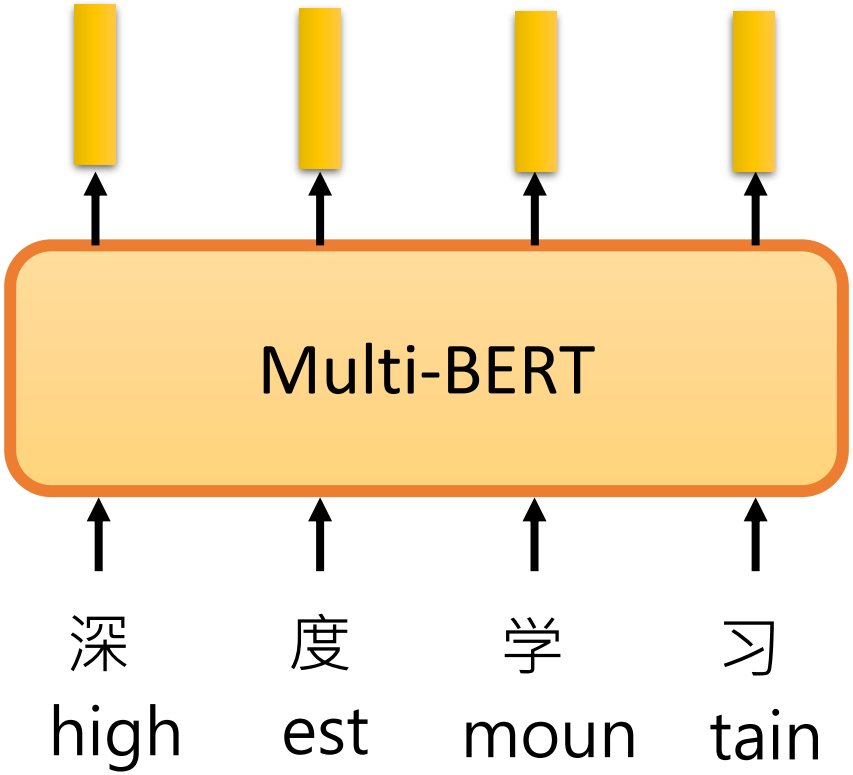
- English: SQuAD, Chinese: DRCD

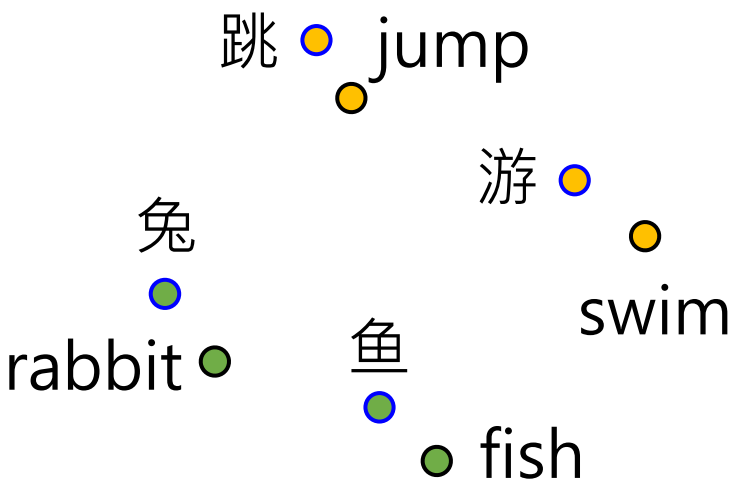
Model	Pre-train	Fine-tune	Test	EM	F1
QANet	none	Chinese	Chinese	66.1	78.1
BERT	Chinese	Chinese		82.0	89.1
	104 languages	Chinese		81.2	88.7
		English		63.3	78.8
		Chinese + English		82.6	90.1

F1 score of Human performance is 93.30%

https://arxiv.org/abs/1909.09587

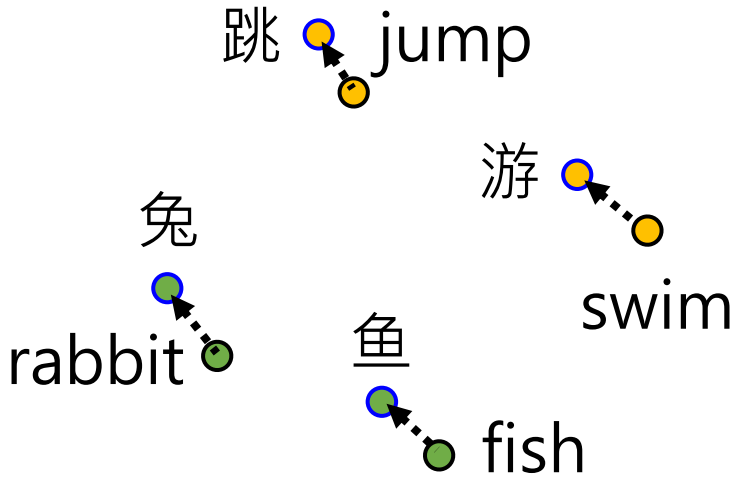
Cross-lingual Alignment?





https://arxiv.org/abs/2010.10041

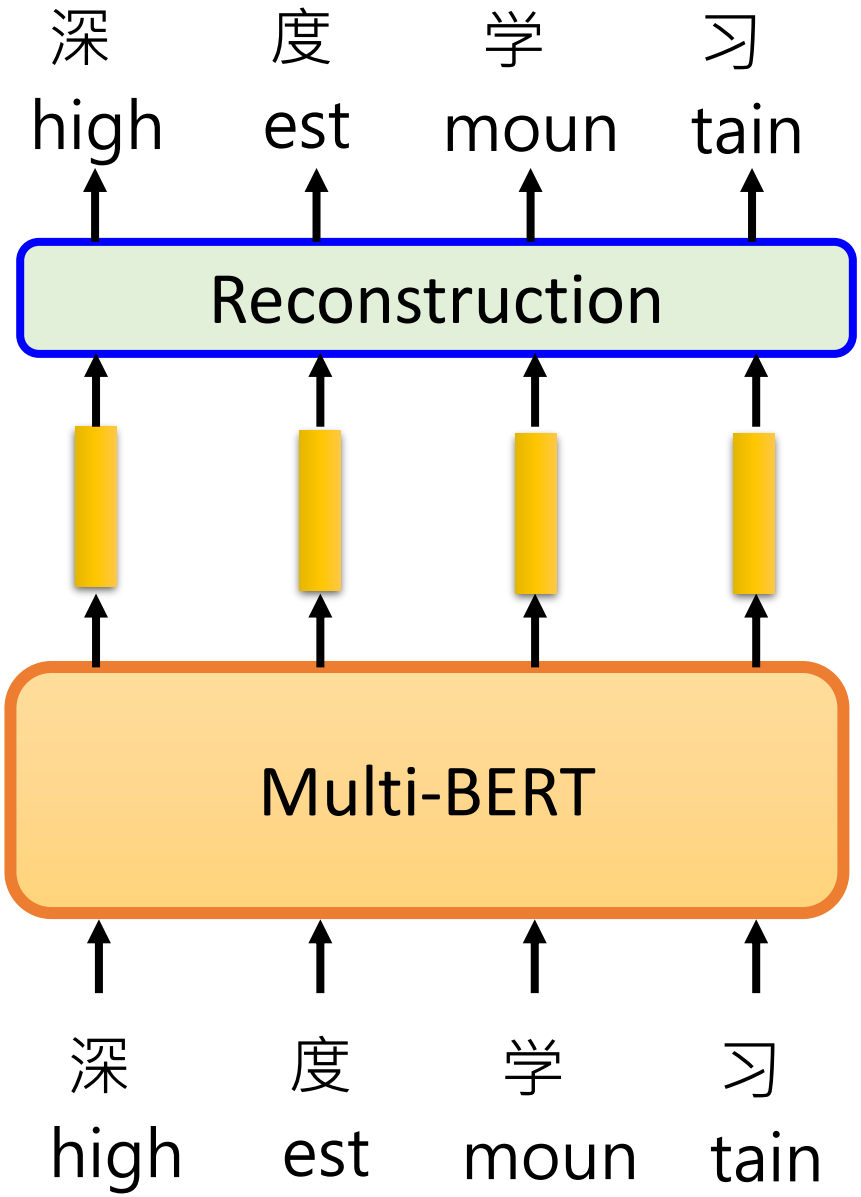
Weird???



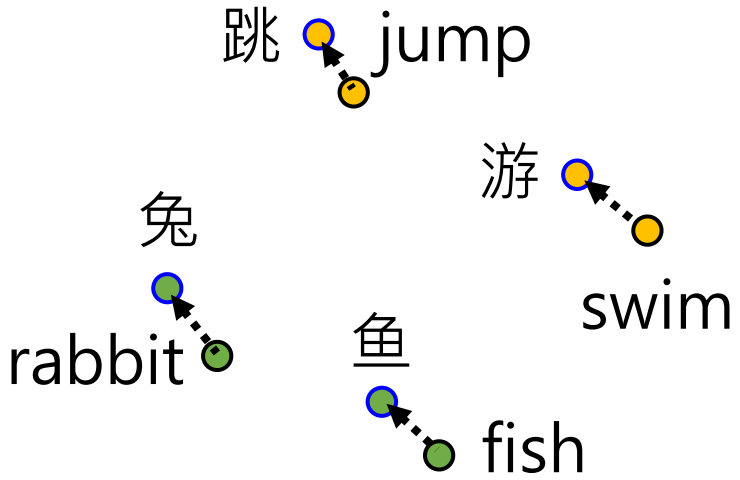
If the embedding is language independent …

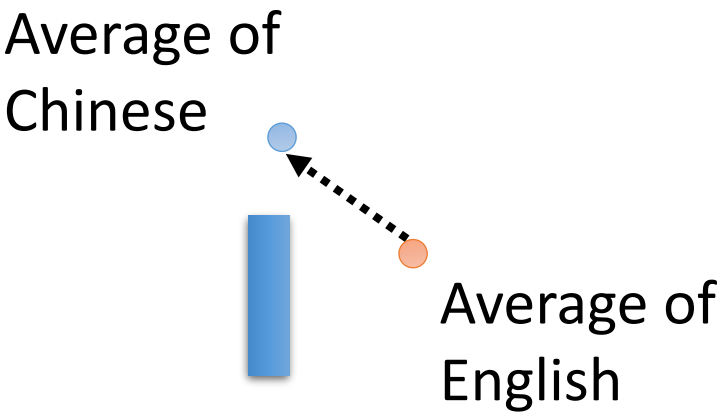
How to correctly reconstruct?

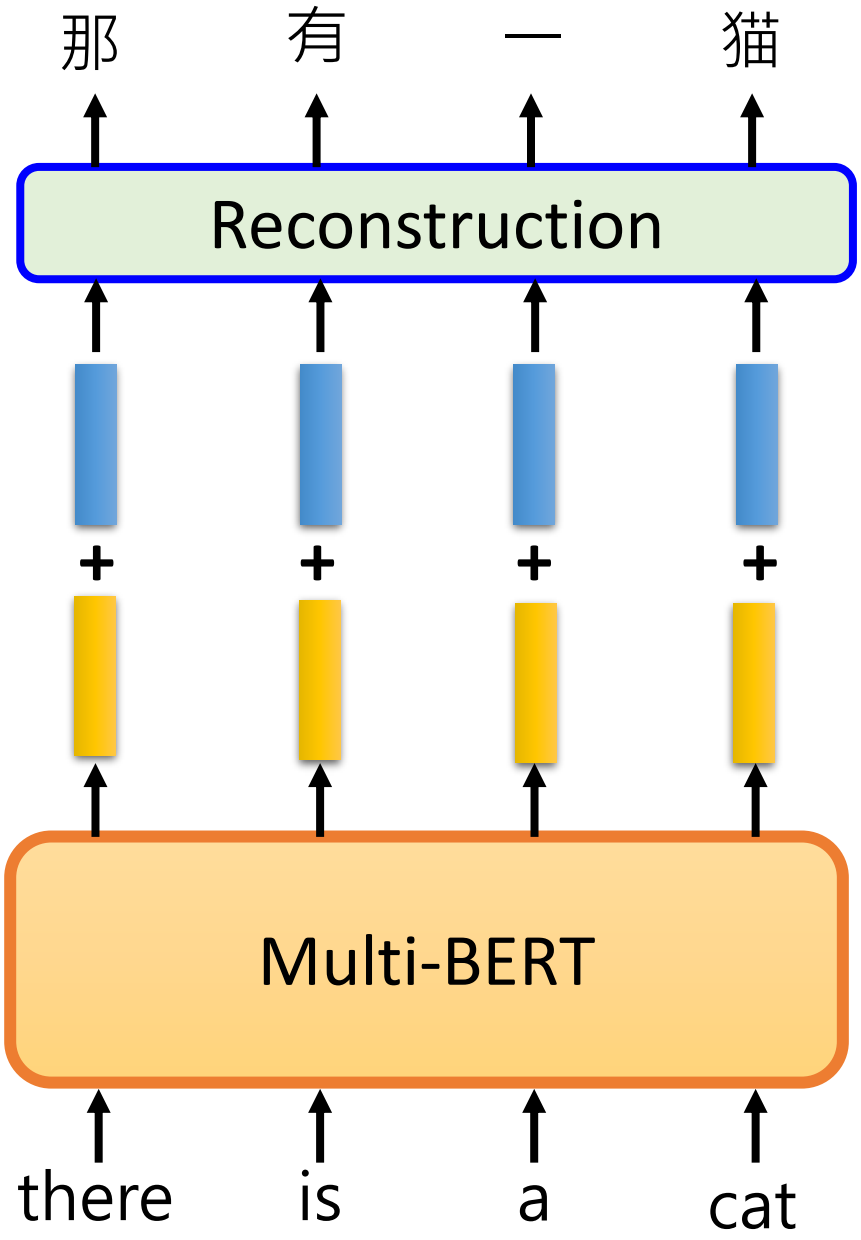
There must be language information.



Where is Language?

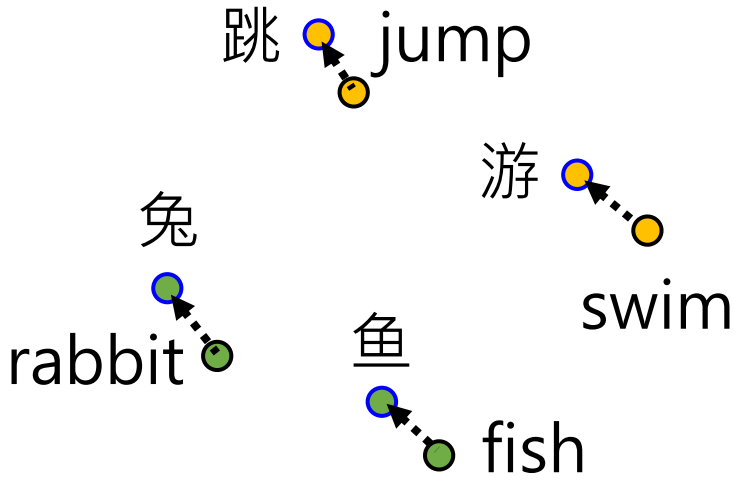


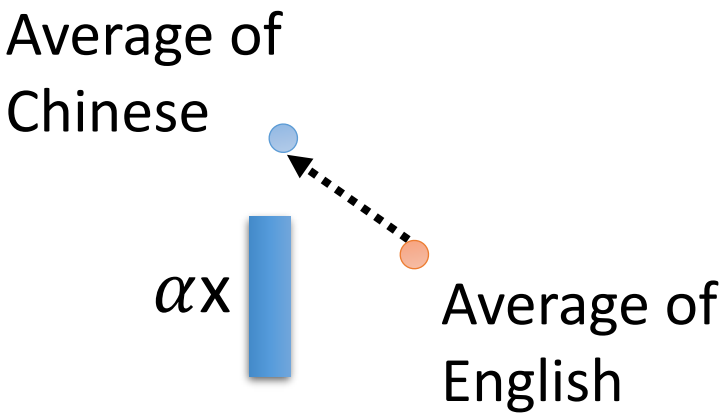




If this is true …

https://arxiv.org/abs/2010.10041





Input (en)	The girl that can help me is all the way across town. There is no one who can help me.
Ground Truth (zh)	能帮助我的女孩在小镇的另一边。没有人能帮助我。。
en→zh, $\alpha = 1$	. 孩，can 来我是all the way across 市。。There 是无人人can help 我。
en→zh, $\alpha = 2$	. 孩的的家我是这个人的市。。他是他人人的到我。
en→zh, $\alpha = 3$	。，的的的他是的个的的，。： 他是他人，的。他。

Unsupervised token-level translation ☺