Multilingual Language Models: NLP Beyond English

Berkeley N L P

Eric Wallace

CS 288

NLP Beyond English

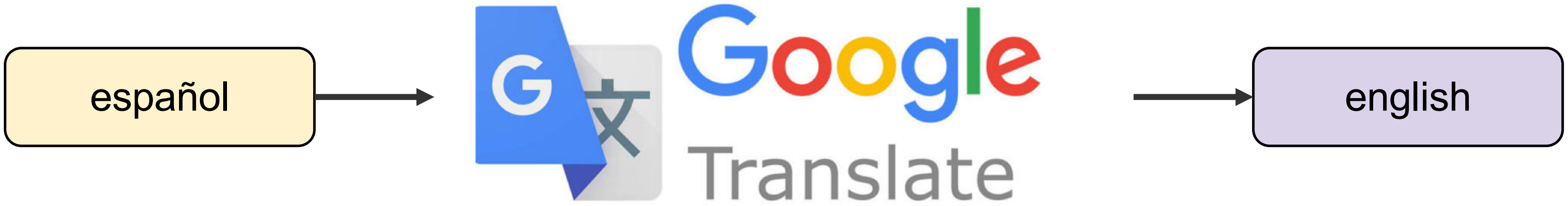
- An overwhelming majority of NLP research focuses on English!

How to build non-English NLP systems?

- translate baseline
- monolingual LMs for each language
- multilingual LMs

Translate Baseline

Translate Baseline

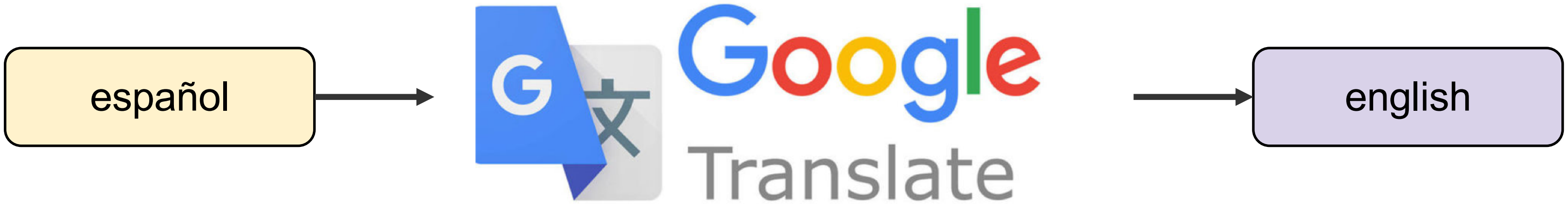


español

Google Translate

english

Translate Baseline



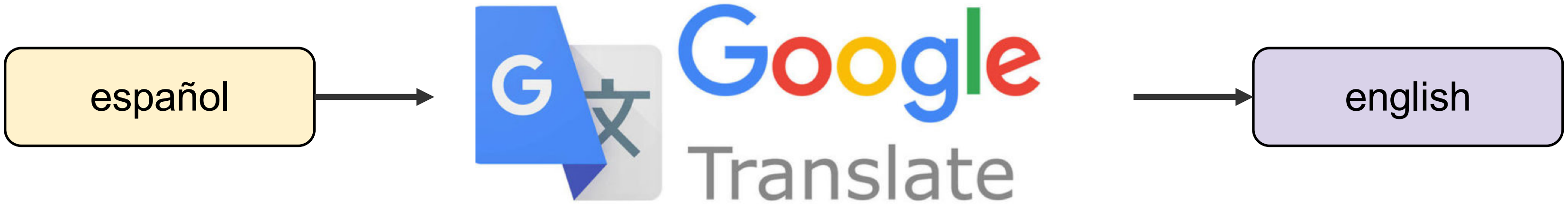
español

english

Pros:

- Straightforward to implement
- Strong baseline, especially for classification tasks

Translate Baseline



Pros:

- Straightforward to implement
- Strong baseline, especially for classification tasks

Cons:

- Suffers from cascading errors
- Limited to languages that translation systems support
- Can be slow and computationally expensive
- Translation is fundamentally lossy?

Monolingual LMs

Monolingual LMs

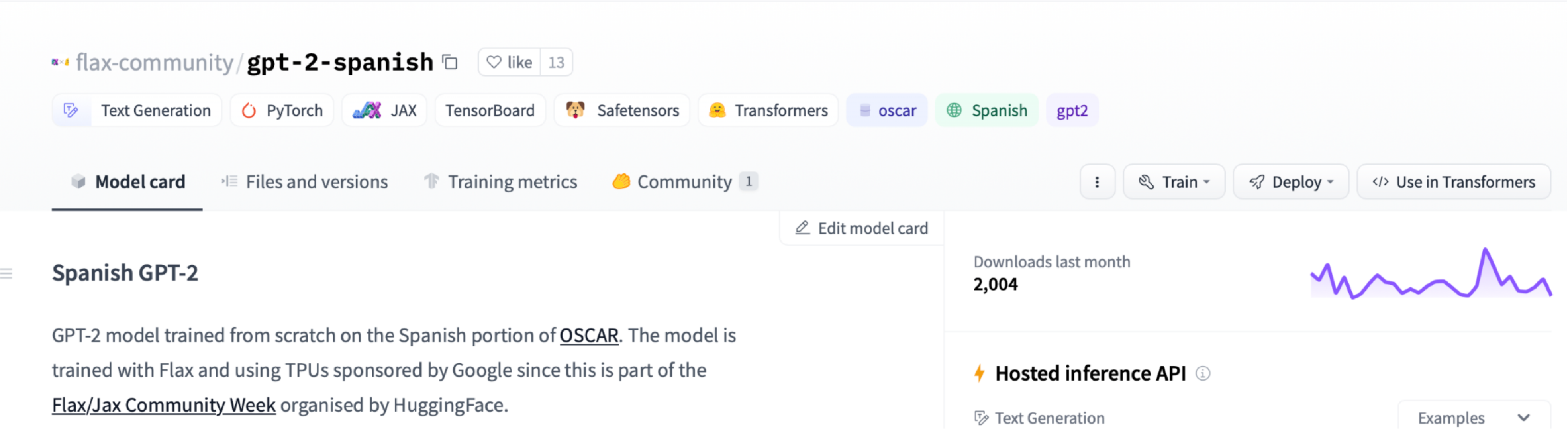
- Can we just repeat the LM pre-training pipeline for other languages?

Monolingual LMs

- Can we just repeat the LM pre-training pipeline for other languages?
    - Sort of!

Monolingual LMs

- Can we just repeat the LM pre-training pipeline for other languages?
  - Sort of!



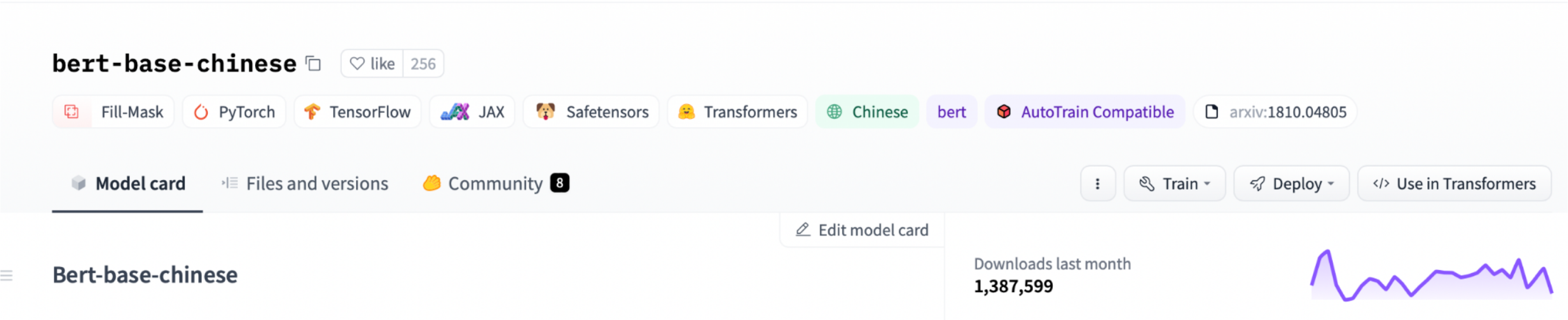
Downloads last month
2,004

Spanish GPT-2

GPT-2 model trained from scratch on the Spanish portion of OSCAR. The model is trained with Flax and using TPUs sponsored by Google since this is part of the Flax/Jax Community Week organised by HuggingFace.

Monolingual LMs

- Can we just repeat the LM pre-training pipeline for other languages?
  - Sort of!

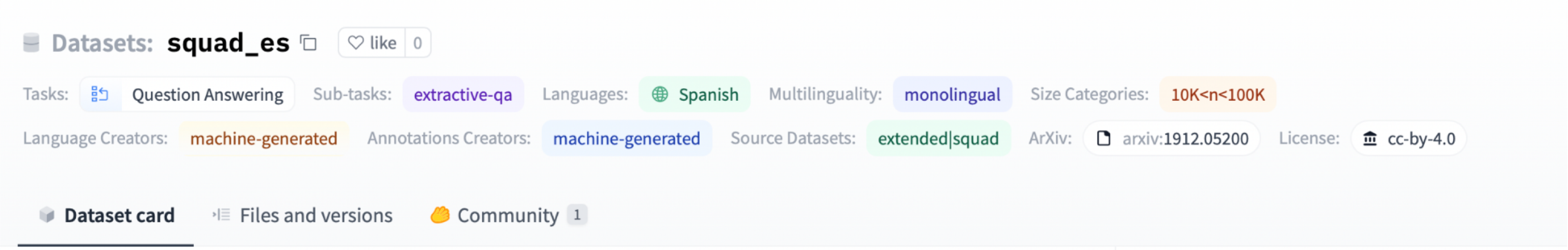


bert-base-chinese

Bert-base-chinese

Downloads last month
1,387,599

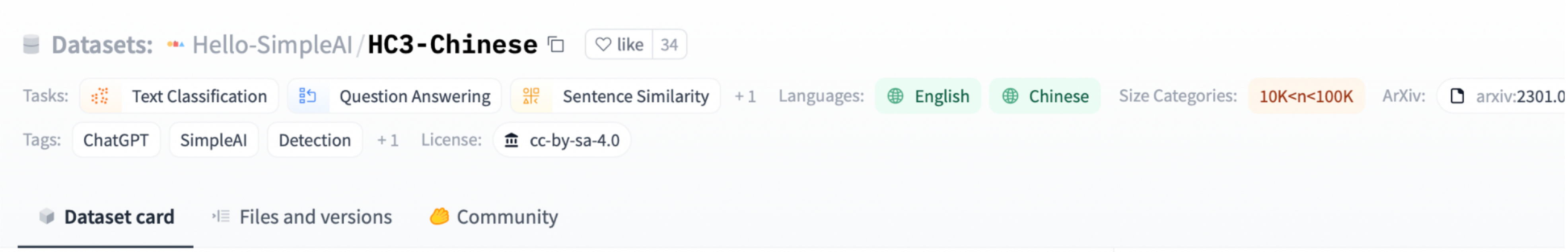
Evaluating LMs in Other Languages



Datasets: **squad_es** ♡ like 0

Tasks: Question Answering Sub-tasks: extractive-qa Languages: Spanish Multilinguality: monolingual Size Categories: 10K<n<100K

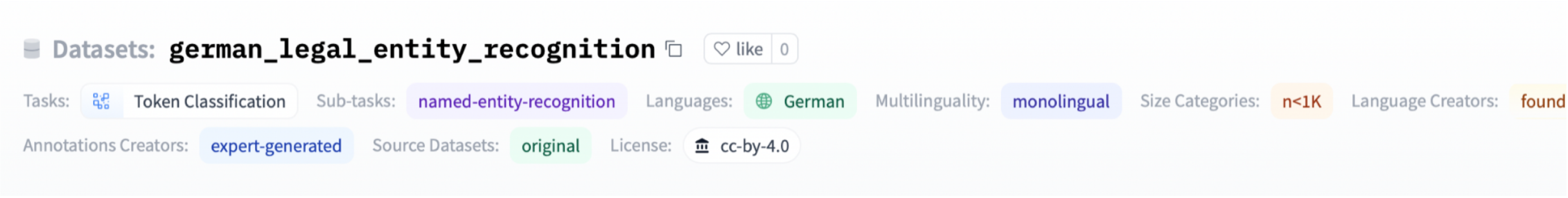
Language Creators: machine-generated Annotations Creators: machine-generated Source Datasets: extended|squad ArXiv: arxiv:1912.05200 License: cc-by-4.0



Datasets: Hello-SimpleAI/**HC3-Chinese** ♡ like 34

Tasks: Text Classification Question Answering Sentence Similarity +1 Languages: English Chinese Size Categories: 10K<n<100K ArXiv: arxiv:2301.0

Tags: ChatGPT SimpleAI Detection +1 License: cc-by-sa-4.0

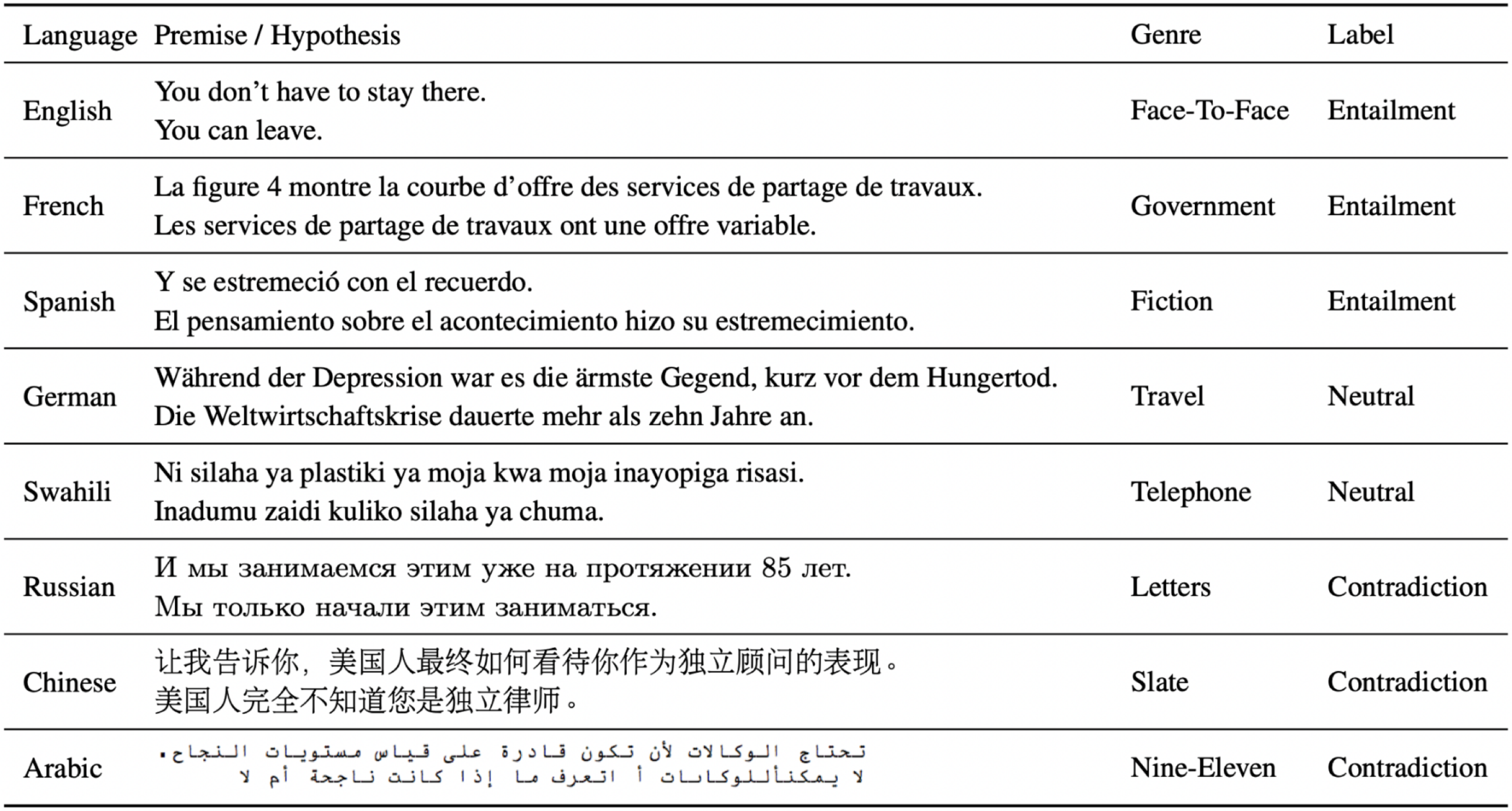


Datasets: **german_legal_entity_recognition** ♡ like 0

Tasks: Token Classification Sub-tasks: named-entity-recognition Languages: German Multilinguality: monolingual Size Categories: n<1K Language Creators: found

Annotations Creators: expert-generated Source Datasets: original License: cc-by-4.0

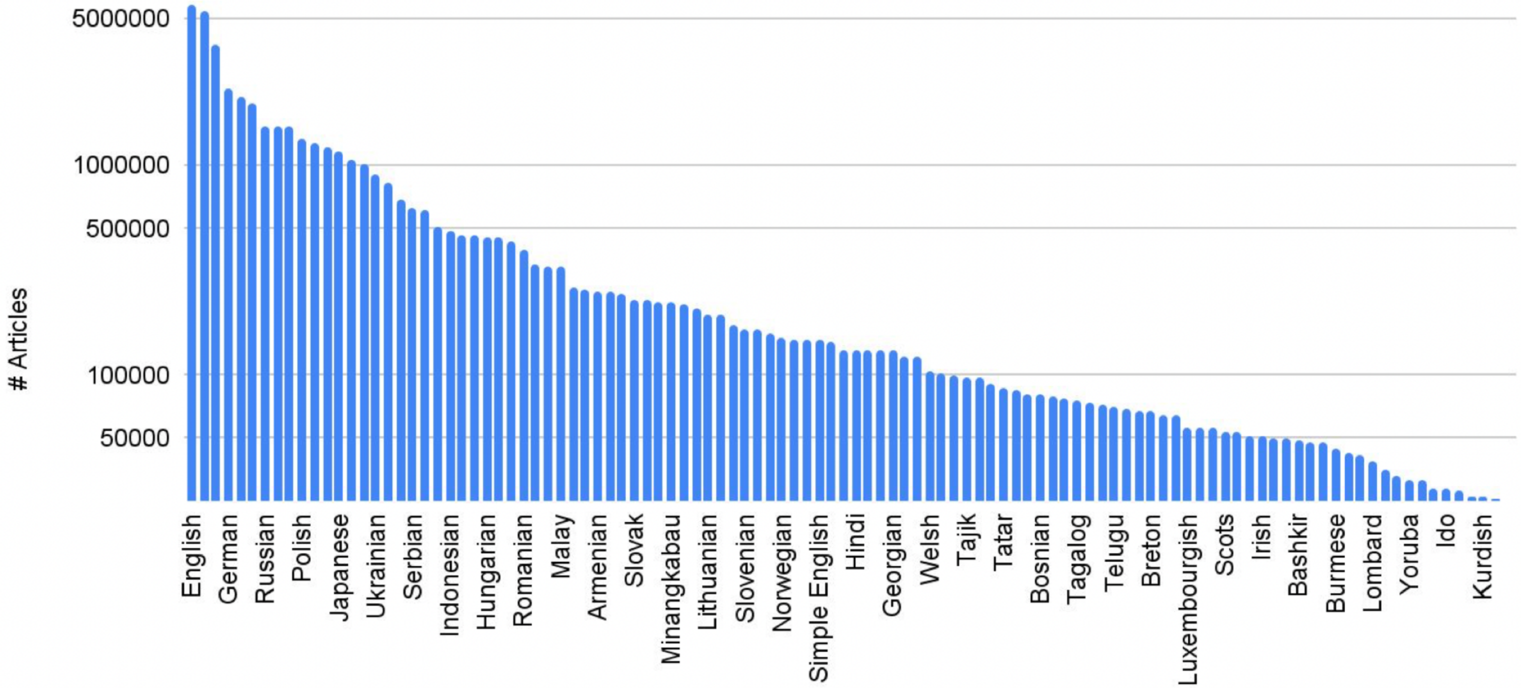
Evaluating LMs in Other Languages



Language	Premise / Hypothesis	Genre	Label
English	You don't have to stay there. You can leave.	Face-To-Face	Entailment
French	La figure 4 montre la courbe d'offre des services de partage de travaux. Les services de partage de travaux ont une offre variable.	Government	Entailment
Spanish	Y se estremeció con el recuerdo. El pensamiento sobre el acontecimiento hizo su estremecimiento.	Fiction	Entailment
German	Während der Depression war es die ärmste Gegend, kurz vor dem Hungertod. Die Weltwirtschaftskrise dauerte mehr als zehn Jahre an.	Travel	Neutral
Swahili	Ni silaha ya plastiki ya moja kwa moja inayopiga risasi. Inadumu zaidi kuliko silaha ya chuma.	Telephone	Neutral
Russian	И мы занимаемся этим уже на протяжении 85 лет. Мы только начали этим заниматься.	Letters	Contradiction
Chinese	让我告诉你，美国人最终如何看待你作为独立顾问的表现。 美国人完全不知道您是独立律师。	Slate	Contradiction
Arabic	تحتاج الوكالات لأن تكون قادرة على قياس مستويات النجاح. لا يمكنأللوكالات أ اتعرف ما إذا كانت ناجحة أم لا	Nine-Eleven	Contradiction

Challenges with Monolingual LMs

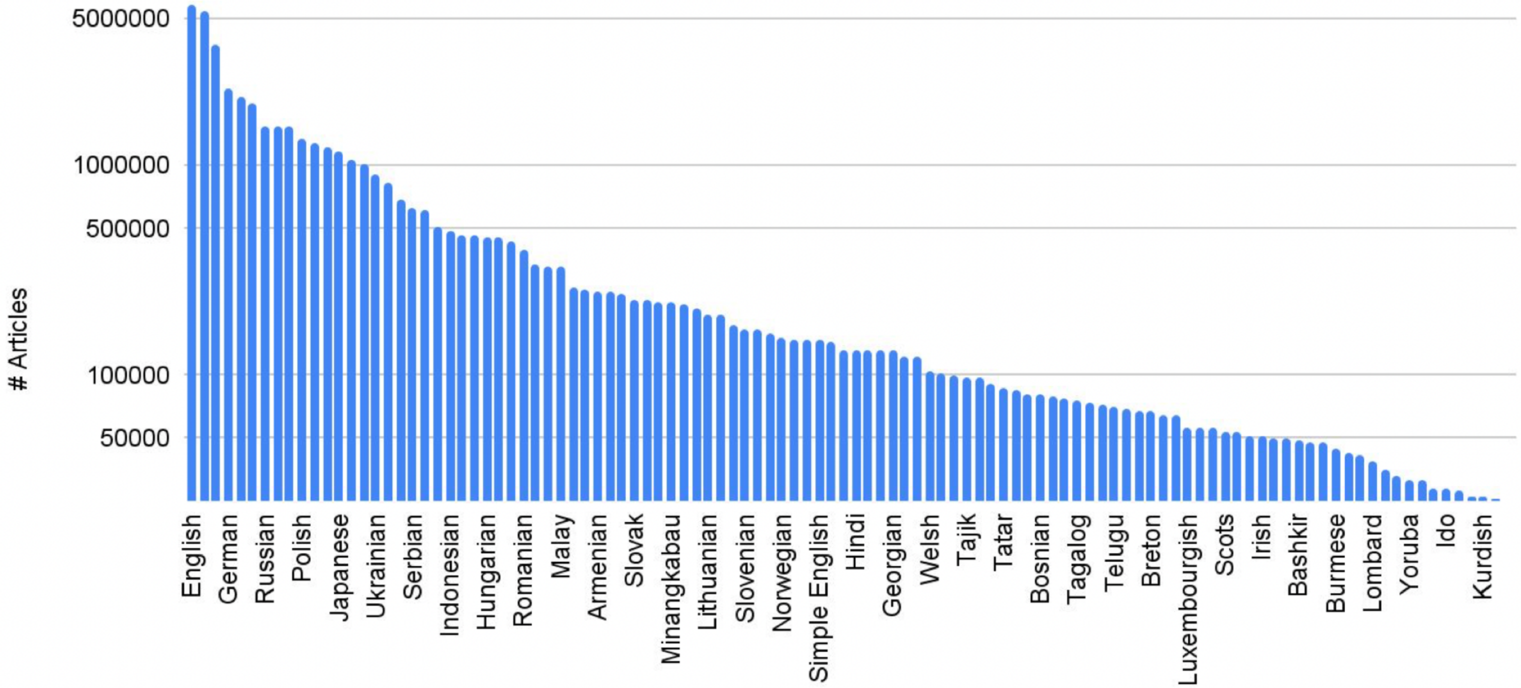
- There is not enough unlabeled data for each language



Credit: Graham Neubig

Challenges with Monolingual LMs

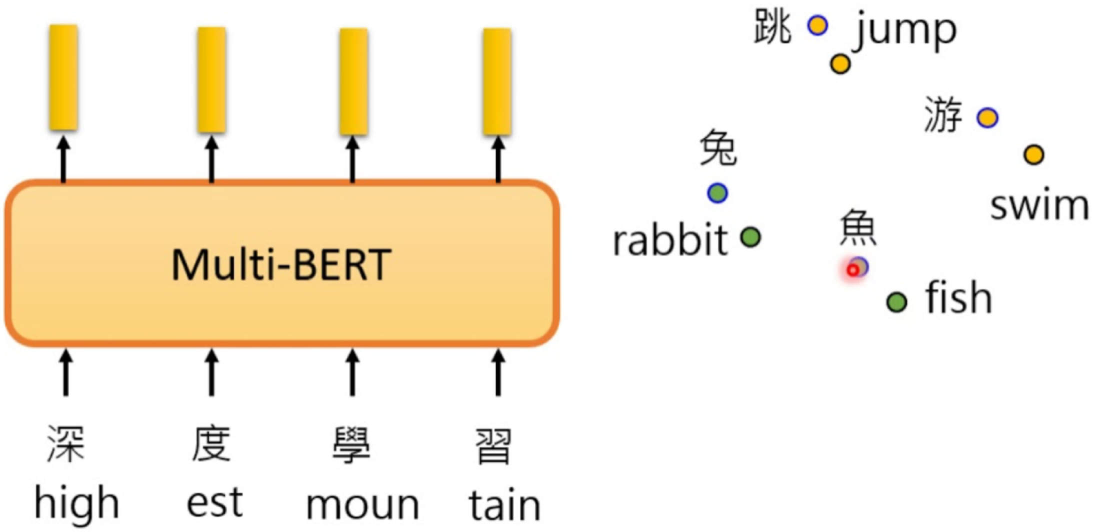
- Compute and complexity of serving 100-1000s of different models



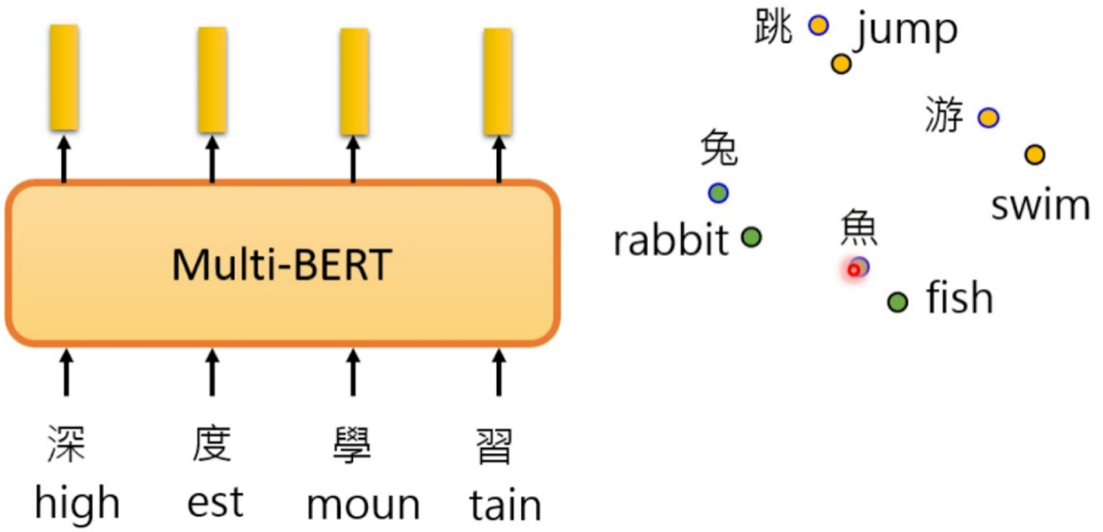
Credit: Graham Neubig

Multilingual Language Models?

Multilingual Language Models?



Multilingual Language Models?



Promises:

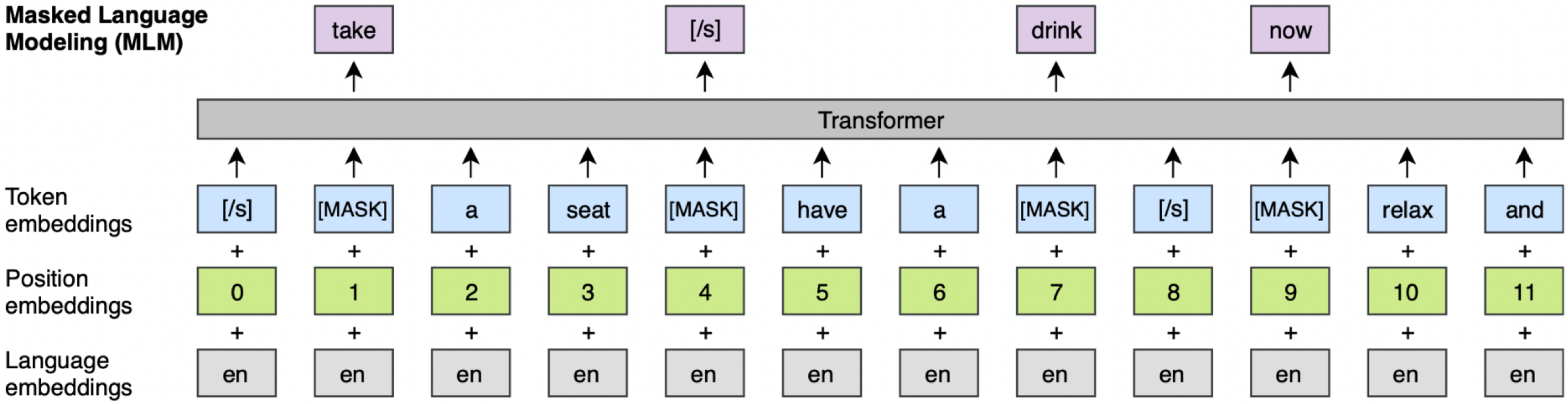
- Share world knowledge, syntax, etc. across languages?
- Use related languages to enhance transfer?

Multilingual BERT

- Simply rerun BERT with 100+ language’s Wikipedia and new BPE

Multilingual BERT

- Simply rerun BERT with 100+ language's Wikipedia and new BPE



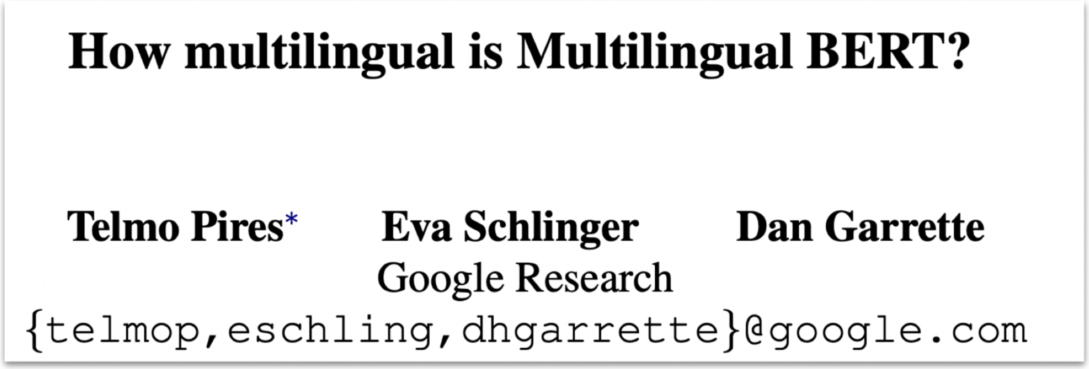
Masked Language Modeling (MLM)		take			[/s]			drink		now		
	Transformer											
Token embeddings	[/s]	[MASK]	a	seat	[MASK]	have	a	[MASK]	[/s]	[MASK]	relax	and
Position embeddings	0	1	2	3	4	5	6	7	8	9	10	11
Language embeddings	en	en	en	en	en	en	en	en	en	en	en	en

Multilingual BERT

- This works surprisingly well!

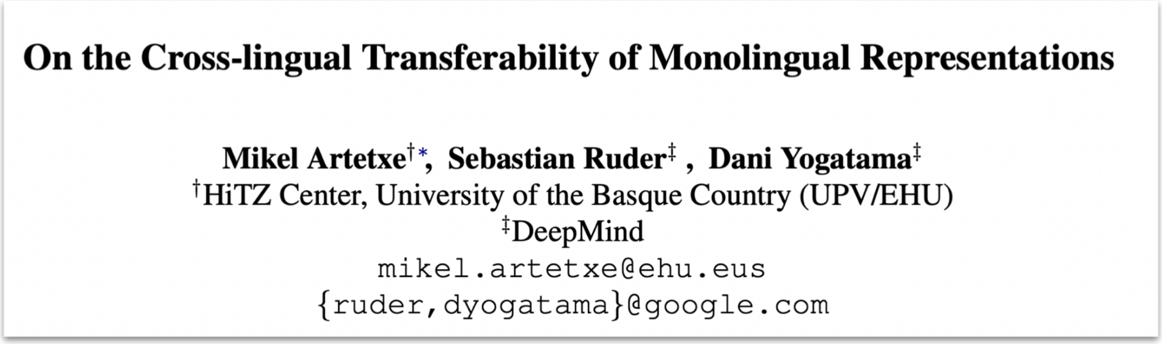
Multilingual BERT

- This works surprisingly well!



How multilingual is Multilingual BERT?

Telmo Pires[*] **Eva Schlinger** **Dan Garrette**
Google Research
{telmop,eschling,dhgarrette}@google.com

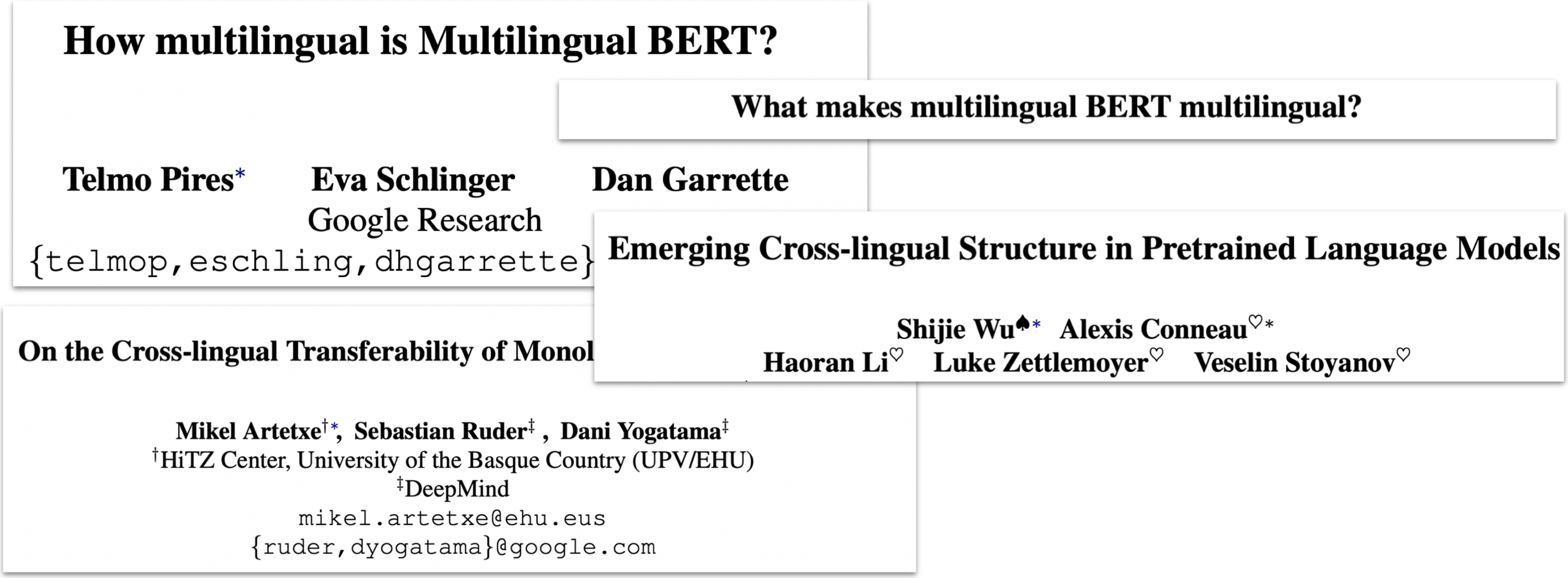


On the Cross-lingual Transferability of Monolingual Representations

Mikel Artetxe[†*], **Sebastian Ruder**[‡], **Dani Yogatama**[‡]
[†]HiTZ Center, University of the Basque Country (UPV/EHU)
[‡]DeepMind
mikel.artetxe@ehu.eus
{ruder,dyogatama}@google.com

Multilingual BERT

- This works surprisingly well!



How multilingual is Multilingual BERT?

Telmo Pires[*] **Eva Schlinger** **Dan Garrette**
Google Research
{telmop,eschling,dhgarrette}

What makes multilingual BERT multilingual?

Emerging Cross-lingual Structure in Pretrained Language Models

Shijie Wu[♠*] **Alexis Conneau**[♡*]
Haoran Li[♡] **Luke Zettlemoyer**[♡] **Veselin Stoyanov**[♡]

On the Cross-lingual Transferability of Monol

Mikel Artetxe[†*], **Sebastian Ruder**[‡] , **Dani Yogatama**[‡]
[†]HiTZ Center, University of the Basque Country (UPV/EHU)
[‡]DeepMind
mikel.artetxe@ehu.eus
{ruder,dyogatama}@google.com

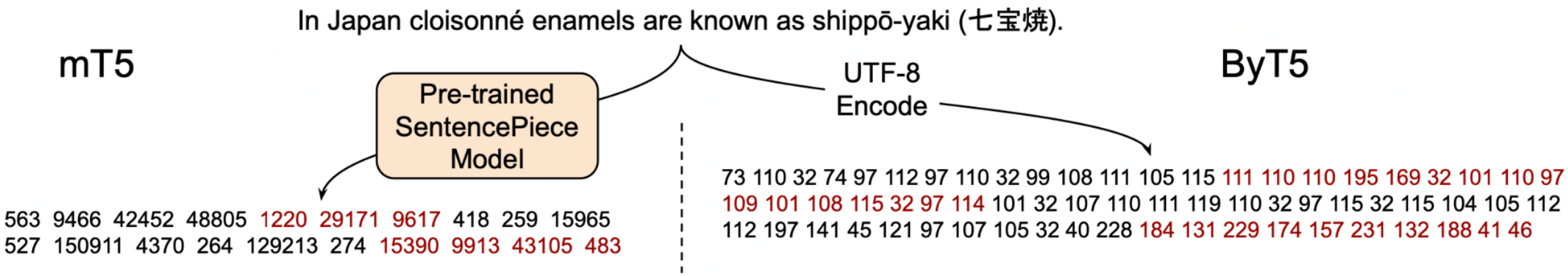
Non-English Tokenizers

- We can use standard BPE tokenizers
  - massively increase vocab size (50k → 250k+)

Non-English Tokenizers

- We can use standard BPE tokenizers
  - massively increase vocab size (50k ⟶ 250k+)

- Or use unicode byte-level models



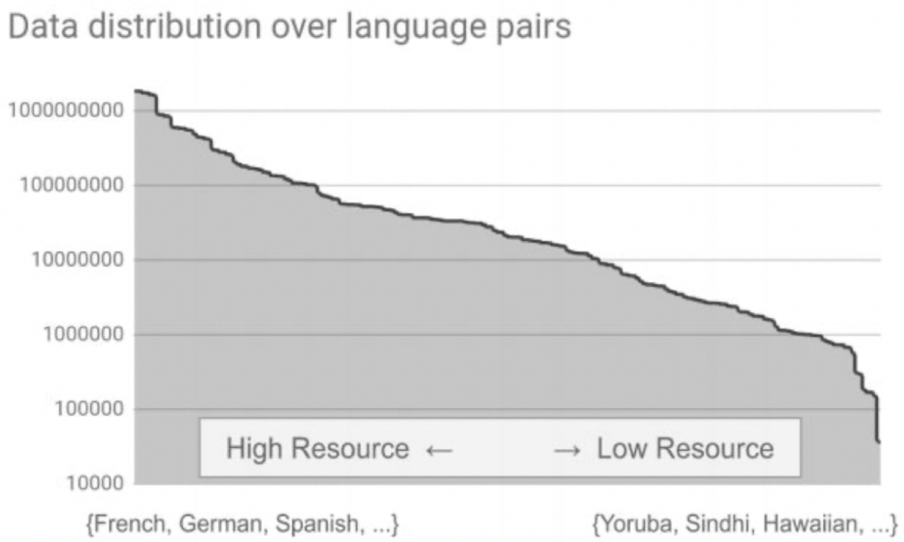
In Japan cloisonné enamels are known as shippō-yaki (七宝焼).

```
563  9466  42452  48805  1220  29171  9617  418  259  15965
527  150911  4370  264  129213  274  15390  9913  43105  483
```

```
73 110 32 74 97 112 97 110 32 99 108 111 105 115 111 110 110 195 169 32 101 110 97
109 101 108 115 32 97 114 101 32 107 110 111 119 110 32 97 115 32 115 104 105 112
112 197 141 45 121 97 107 105 32 40 228 184 131 229 174 157 231 132 188 41 46
```

Data Resampling

Problem: training data highly imbalanced

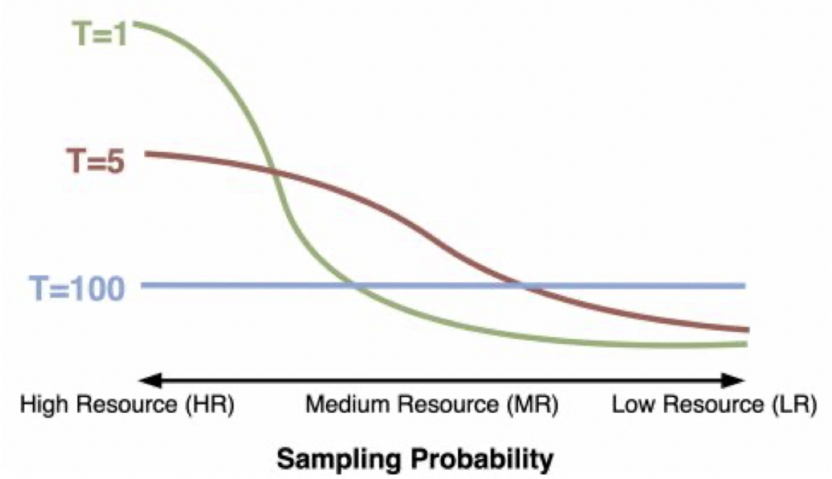


- ➔ High resource languages have much more data than low-resource ones
- ➔ Important to upsample low-resource data in this setting!

Credit: Graham Neubig

Data Resampling

Problem: training data highly imbalanced

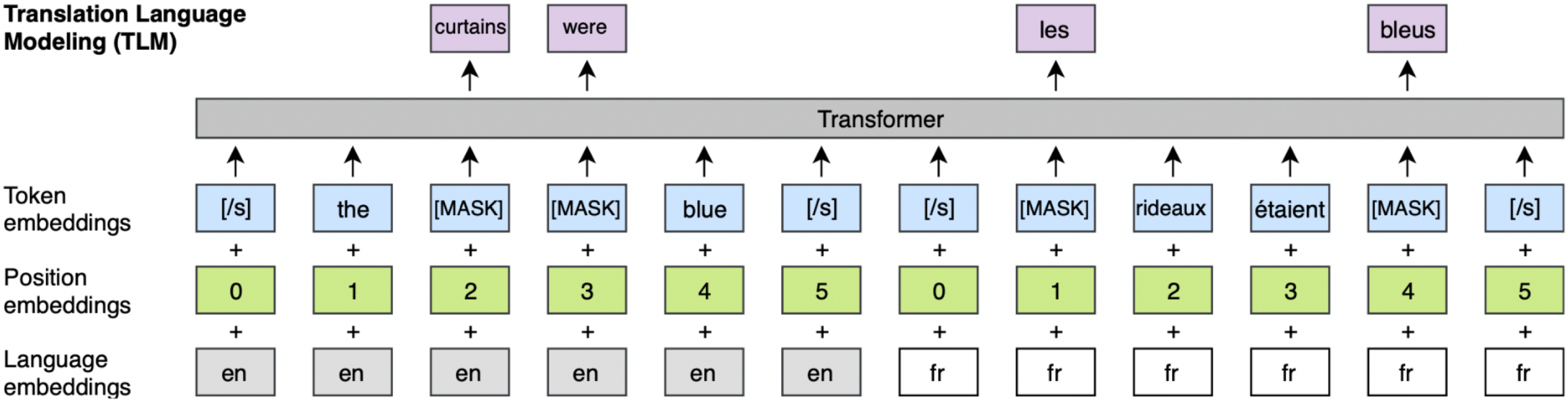


- ➔ Sample data based on dataset size scaled by a temperature term
- ➔ Easy control of how much to upsample low-resource data

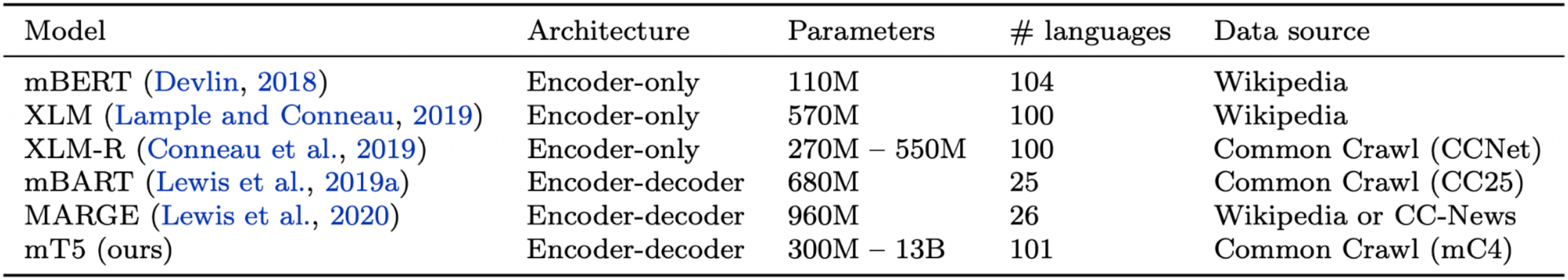
Credit: Graham Neubig

Translation MLM

- If I have translation data, can use it to enhance masked LM training



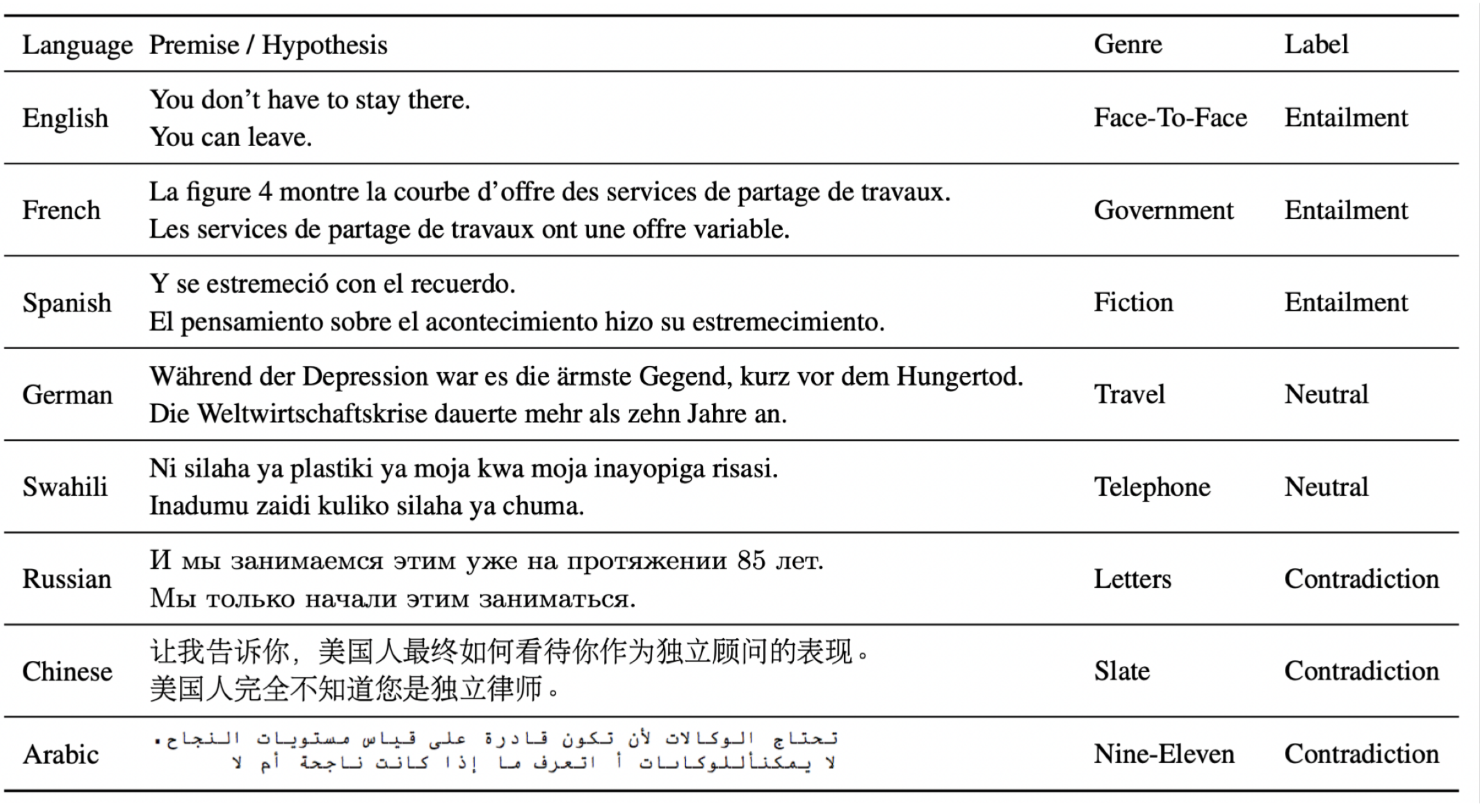
Existing Multilingual Language Models



Model	Architecture	Parameters	# languages	Data source
mBERT (Devlin, 2018)	Encoder-only	110M	104	Wikipedia
XLM (Lample and Conneau, 2019)	Encoder-only	570M	100	Wikipedia
XLM-R (Conneau et al., 2019)	Encoder-only	270M – 550M	100	Common Crawl (CCNet)
mBART (Lewis et al., 2019a)	Encoder-decoder	680M	25	Common Crawl (CC25)
MARGE (Lewis et al., 2020)	Encoder-decoder	960M	26	Wikipedia or CC-News
mT5 (ours)	Encoder-decoder	300M – 13B	101	Common Crawl (mC4)

Multilingual Few-shot Learning

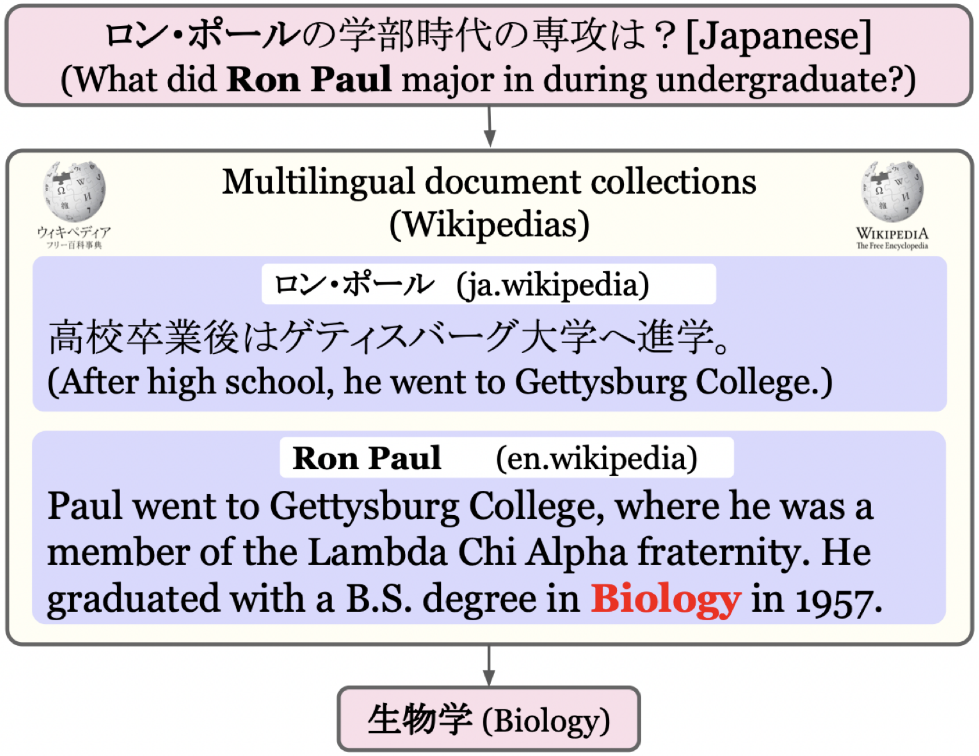
- Can use LMs out of the box for few-shot learning in different languages



Language	Premise / Hypothesis	Genre	Label
English	You don’t have to stay there. You can leave.	Face-To-Face	Entailment
French	La figure 4 montre la courbe d’offre des services de partage de travaux. Les services de partage de travaux ont une offre variable.	Government	Entailment
Spanish	Y se estremeció con el recuerdo. El pensamiento sobre el acontecimiento hizo su estremecimiento.	Fiction	Entailment
German	Während der Depression war es die ärmste Gegend, kurz vor dem Hungertod. Die Weltwirtschaftskrise dauerte mehr als zehn Jahre an.	Travel	Neutral
Swahili	Ni silaha ya plastiki ya moja kwa moja inayopiga risasi. Inadumu zaidi kuliko silaha ya chuma.	Telephone	Neutral
Russian	И мы занимаемся этим уже на протяжении 85 лет. Мы только начали этим заниматься.	Letters	Contradiction
Chinese	让我告诉你，美国人最终如何看待你作为独立顾问的表现。 美国人完全不知道您是独立律师。	Slate	Contradiction
Arabic	تحتاج الوكالات لأن تكون قادرة على قياس مستويات النجاح. لا يمكنأللوكالات أ اتعرف ما إذا كانت ناجحة أم لا	Nine-Eleven	Contradiction

Multilingual Few-shot Learning

- Can use LMs out of the box for few-shot learning in different languages



ロン・ポールの学部時代の専攻は？[Japanese]
(What did **Ron Paul** major in during undergraduate?)

Multilingual document collections
(Wikipedias)

ロン・ポール (ja.wikipedia)

高校卒業後はゲティスバーグ大学へ進学。
(After high school, he went to Gettysburg College.)

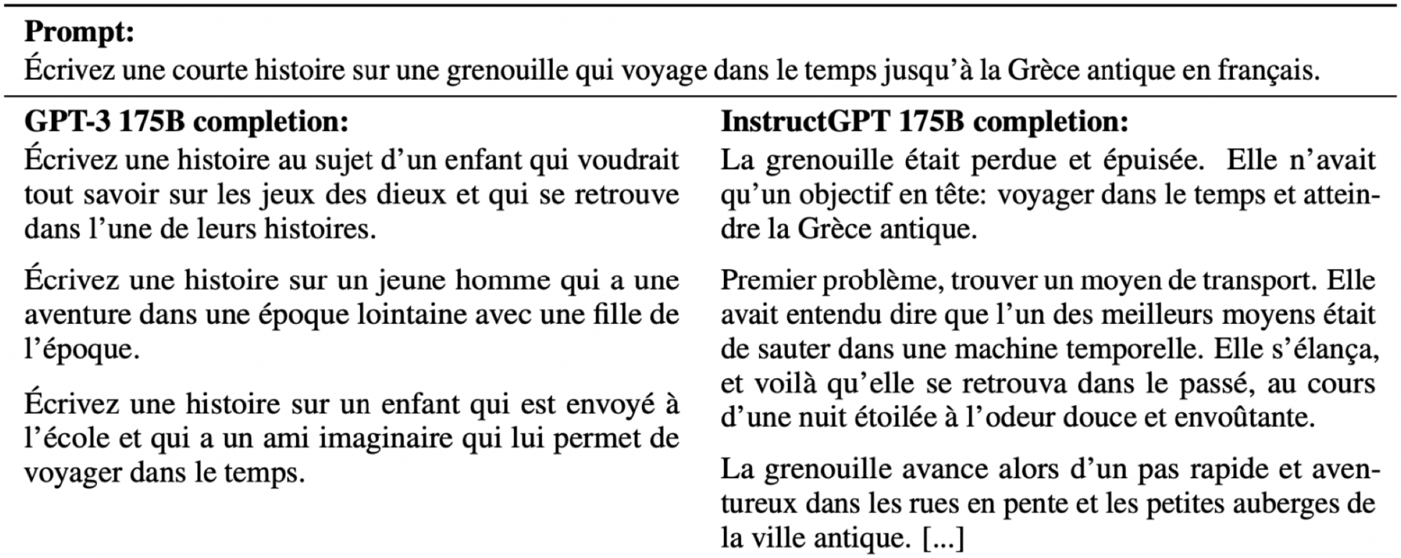
Ron Paul (en.wikipedia)

Paul went to Gettysburg College, where he was a member of the Lambda Chi Alpha fraternity. He graduated with a B.S. degree in **Biology** in 1957.

生物学 (Biology)

Cross-lingual Supervised Transfer

- If I have supervised data, can transfer to languages w/o supervised data



Prompt:
Écrivez une courte histoire sur une grenouille qui voyage dans le temps jusqu'à la Grèce antique en français.

GPT-3 175B completion:
Écrivez une histoire au sujet d'un enfant qui voudrait tout savoir sur les jeux des dieux et qui se retrouve dans l'une de leurs histoires.

Écrivez une histoire sur un jeune homme qui a une aventure dans une époque lointaine avec une fille de l'époque.

Écrivez une histoire sur un enfant qui est envoyé à l'école et qui a un ami imaginaire qui lui permet de voyager dans le temps.

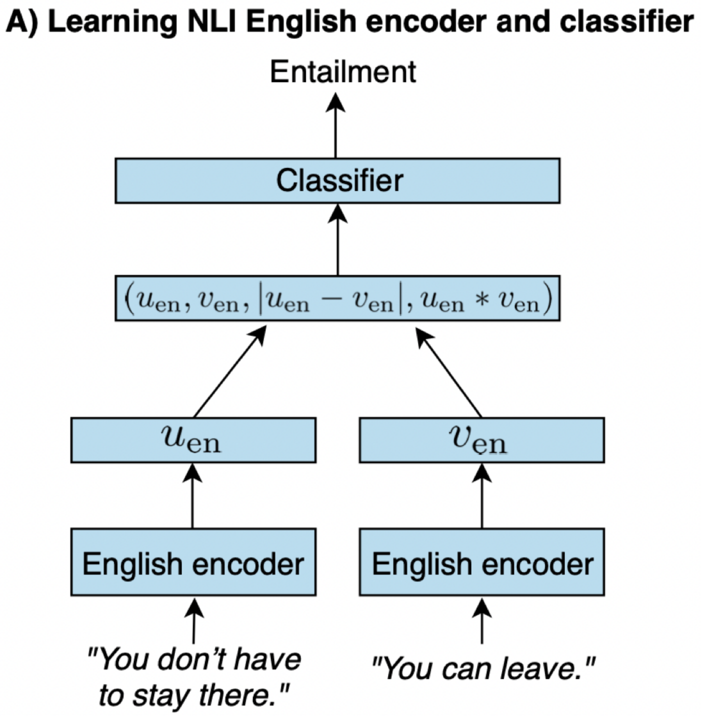
InstructGPT 175B completion:
La grenouille était perdue et épuisée. Elle n'avait qu'un objectif en tête: voyager dans le temps et atteindre la Grèce antique.

Premier problème, trouver un moyen de transport. Elle avait entendu dire que l'un des meilleurs moyens était de sauter dans une machine temporelle. Elle s'élança, et voilà qu'elle se retrouva dans le passé, au cours d'une nuit étoilée à l'odeur douce et envoûtante.

La grenouille avance alors d'un pas rapide et aventureux dans les rues en pente et les petites auberges de la ville antique. [...]

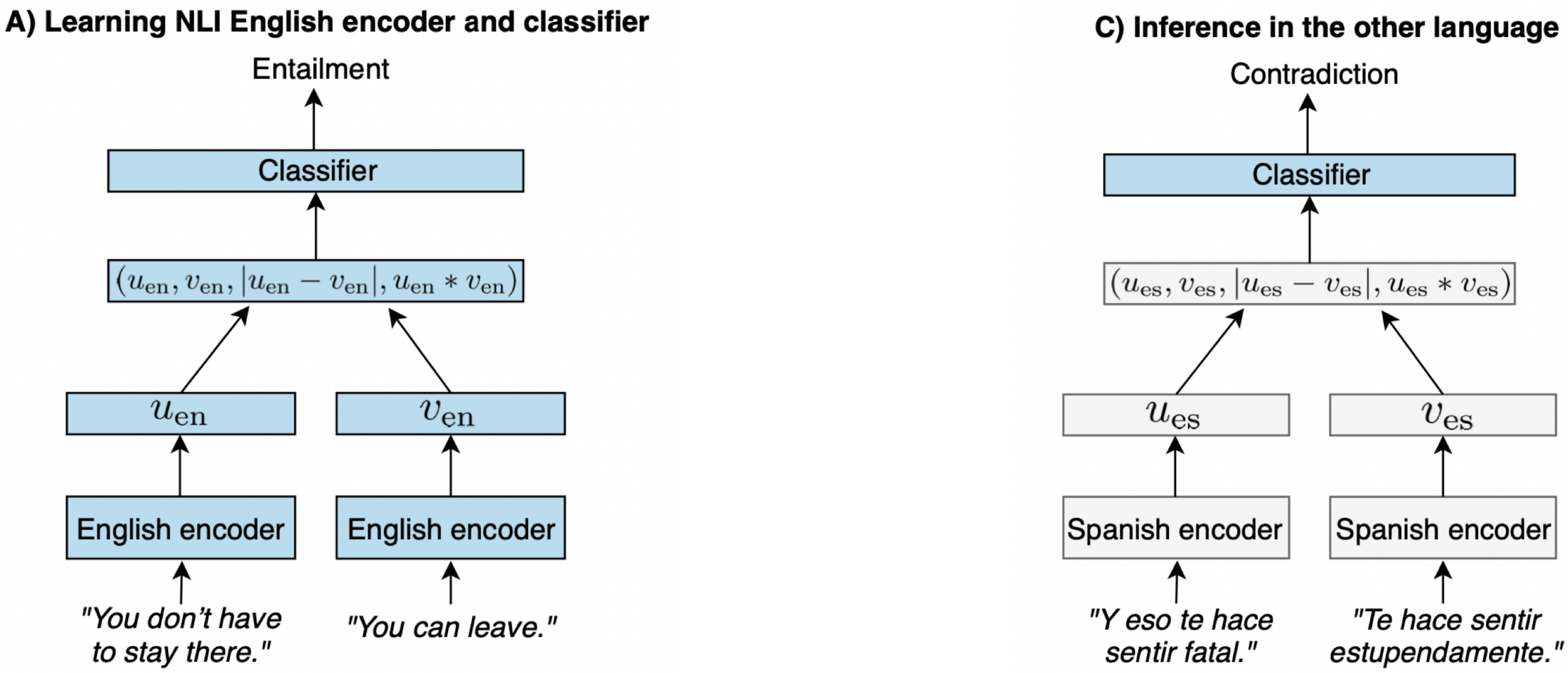
Cross-lingual Supervised Transfer

- If I have supervised data, can transfer to languages w/o supervised data


A) Learning NLI English encoder and classifier
Entailment
Classifier
$(u_{\text{en}}, v_{\text{en}}, |u_{\text{en}} - v_{\text{en}}|, u_{\text{en}} * v_{\text{en}})$
u_{en}
v_{en}
English encoder
English encoder
"You don't have to stay there."
"You can leave."

Cross-lingual Supervised Transfer

- If I have supervised data, can transfer to languages w/o supervised data



A) Learning NLI English encoder and classifier

Entailment

Classifier

$(u_{\mathrm{en}}, v_{\mathrm{en}}, |u_{\mathrm{en}} - v_{\mathrm{en}}|, u_{\mathrm{en}} * v_{\mathrm{en}})$

u_{en}

v_{en}

English encoder

English encoder

"You don't have to stay there."

"You can leave."

C) Inference in the other language

Contradiction

Classifier

$(u_{\mathrm{es}}, v_{\mathrm{es}}, |u_{\mathrm{es}} - v_{\mathrm{es}}|, u_{\mathrm{es}} * v_{\mathrm{es}})$

u_{es}

v_{es}

Spanish encoder

Spanish encoder

"Y eso te hace sentir fatal."

"Te hace sentir estupendamente."