# Multilingual Language Models: NLP Beyond English


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


Pros:

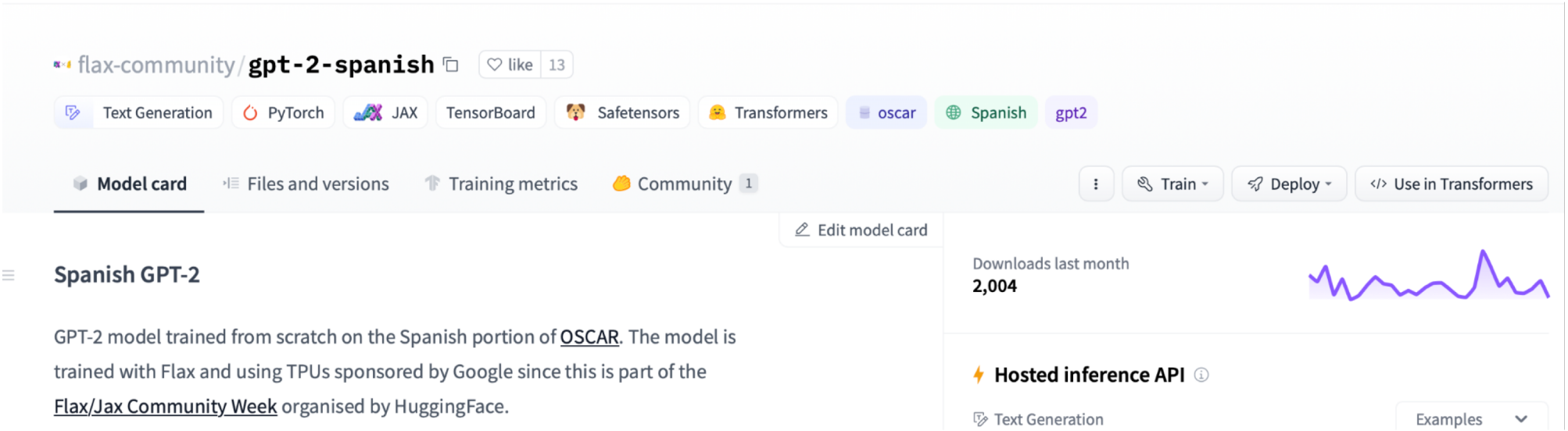
- Straightforward to implement
- Surprisingly strong baseline, especially for classification tasks

Cons:

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

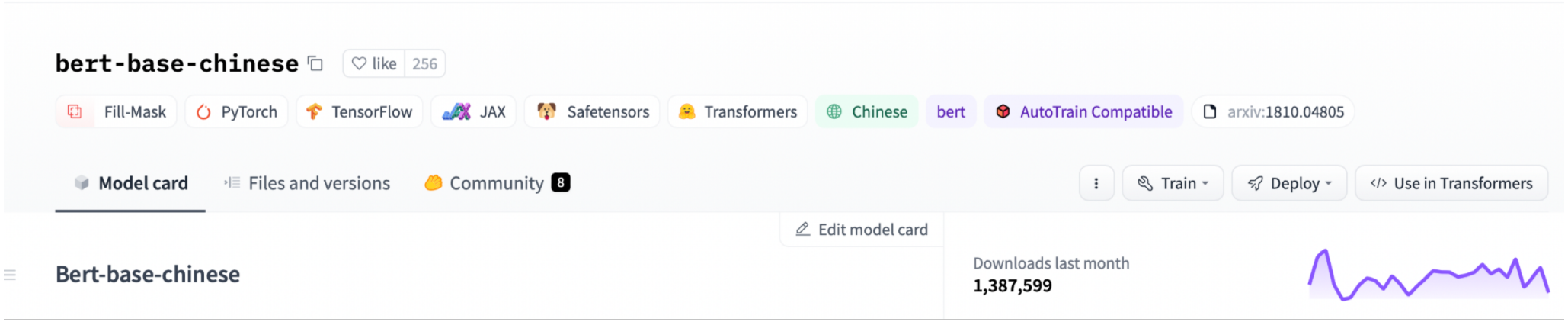
# Monolingual LMs

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



# Monolingual LMs

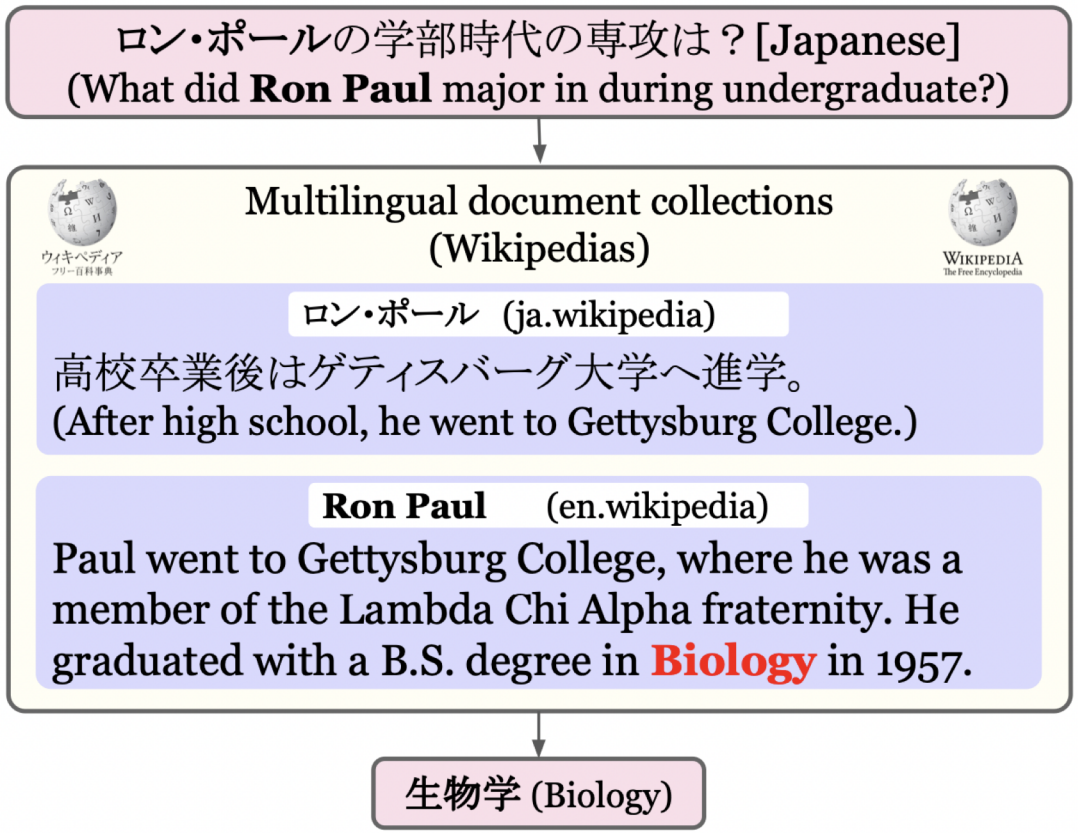
- Can we just repeat the LM pre-training pipeline for other languages?
  - Sort of!



# Few-shot Learning in Other Languages

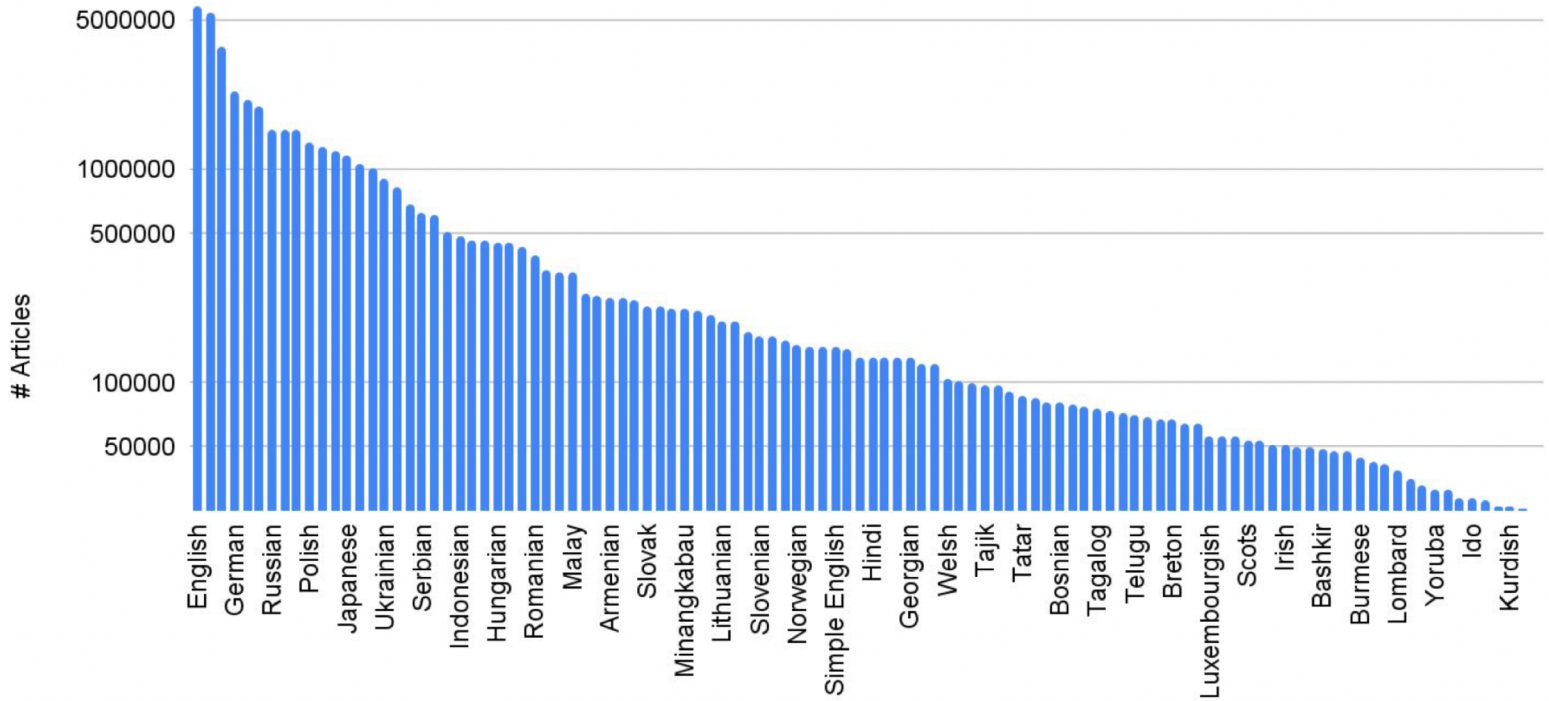
| Language | Premise / Hypothesis | Genre | Label |
|---|---|---|---|
| English | You don't have to stay there.<br>You can leave. | Face-To-Face | Entailment |
| French | La figure 4 montre la courbe d'offre des services de partage de travaux.<br>Les services de partage de travaux ont une offre variable. | Government | Entailment |
| Spanish | Y se estremeció con el recuerdo.<br>El pensamiento sobre el acontecimiento hizo su estremecimiento. | Fiction | Entailment |
| German | Während der Depression war es die ärmste Gegend, kurz vor dem Hungertod.<br>Die Weltwirtschaftskrise dauerte mehr als zehn Jahre an. | Travel | Neutral |
| Swahili | Ni silaha ya plastiki ya moja kwa moja inayopiga risasi.<br>Inadumu zaidi kuliko silaha ya chuma. | Telephone | Neutral |
| Russian | И мы занимаемся этим уже на протяжении 85 лет.<br>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。<br>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.<br>لا يمكنأللوكالات أ اتعرف ما إذا كانت ناجحة أم لا | Nine-Eleven | Contradiction |

# Few-shot Learning in Other Languages



# Challenges with Monolingual LMs

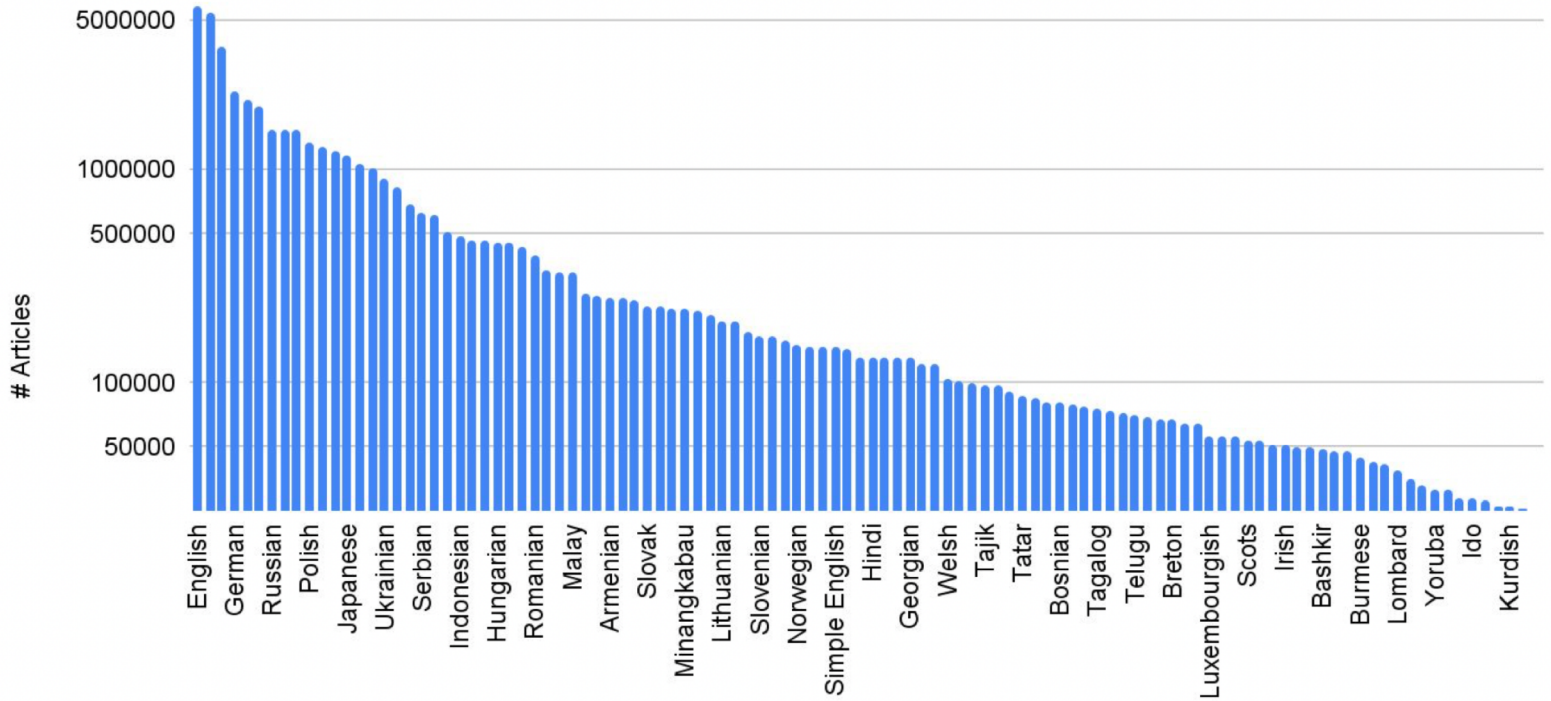
- There is not enough unlabeled data for each language




Credit: Graham Neubig

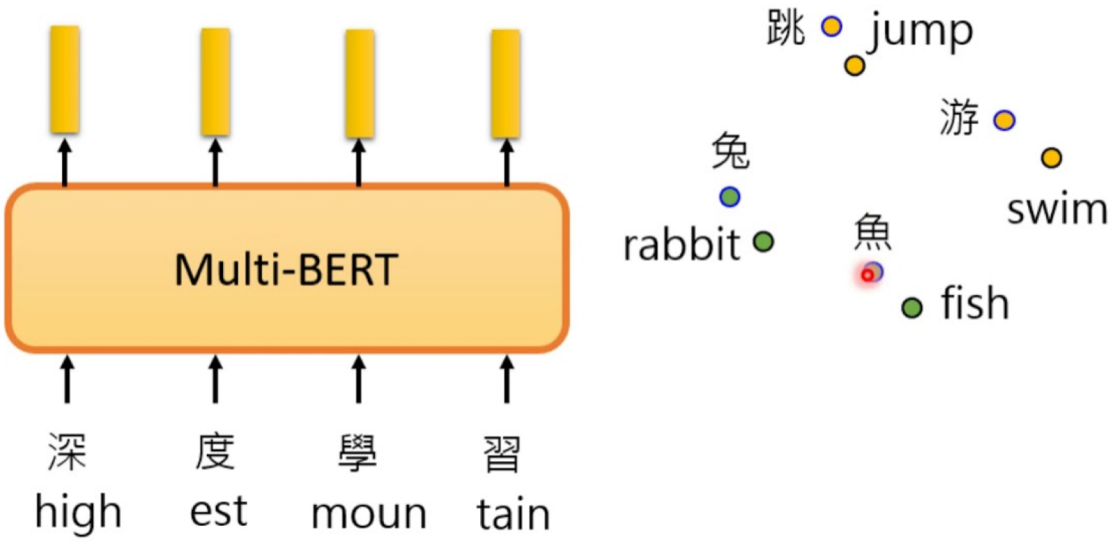
# Challenges with Monolingual LMs

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



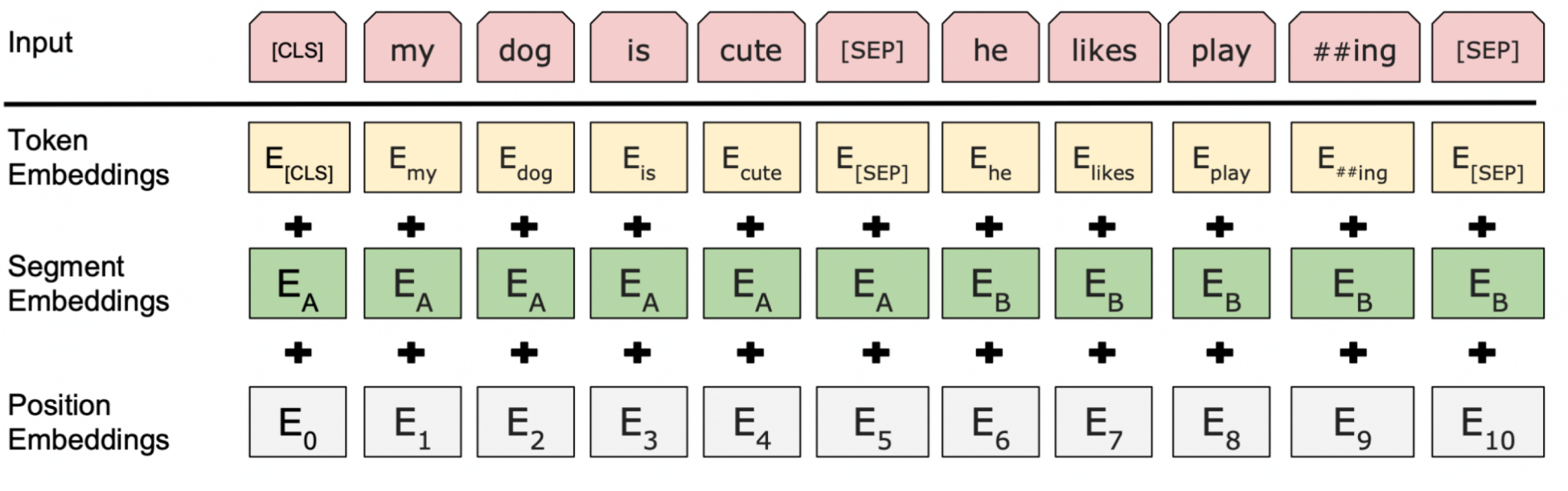

Credit: Graham Neubig

# Multilingual Language Models?



# Multilingual BERT

- Simply rerun BERT, except use 100+ Wikipedias and new BPE

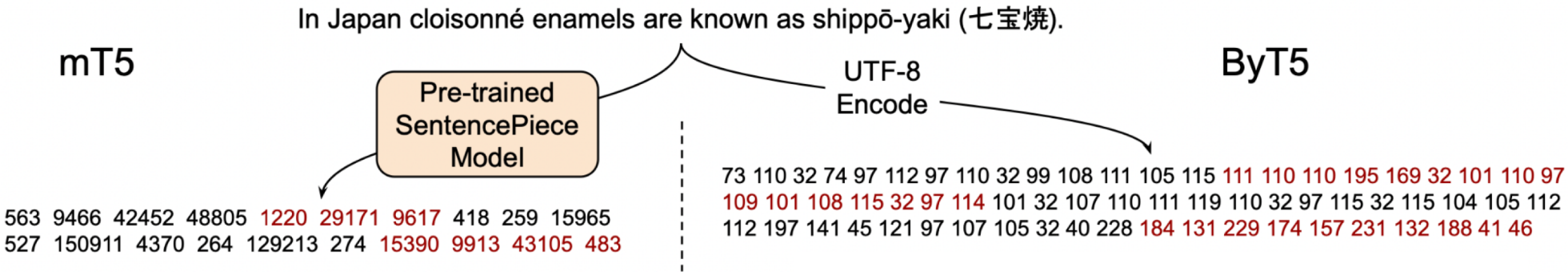


# Non-English Tokenizers

- We can use either standard BPE tokenizers or byte-level models
  - massively increase BPE size (50k ⟶ 250k+)

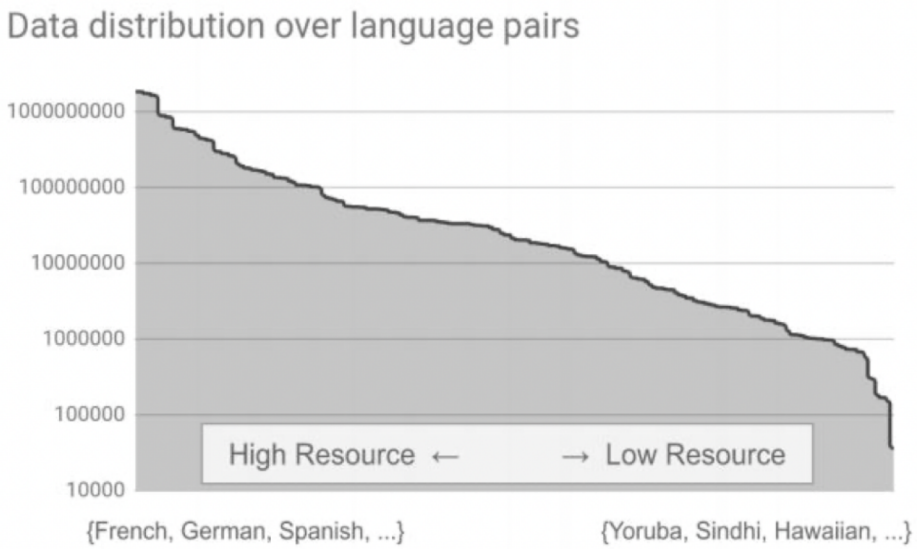
# Non-English Tokenizers

- We can use either standard BPE tokenizers or byte-level models
  - massively increase BPE size (50k ⟶ 250k+)



# Multilingual Language Models

## Problem: training data highly imbalanced



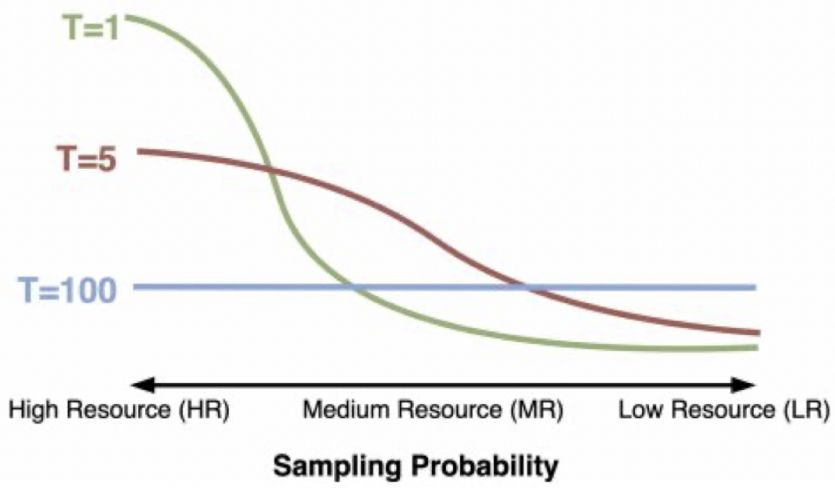

➔ High resource languages have much more data than low-resource ones

➔ Important to upsample low-resource data in this setting!

Credit: Graham Neubig

# Multilingual Language Models

## 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

# 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

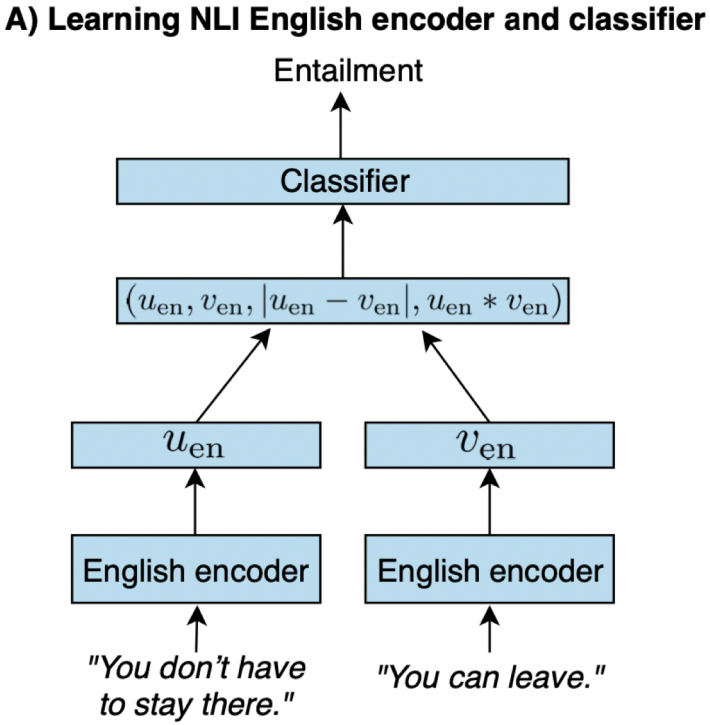
| Language | Premise / Hypothesis | Genre | Label |
|---|---|---|---|
| English | You don't have to stay there.<br>You can leave. | Face-To-Face | Entailment |
| French | La figure 4 montre la courbe d'offre des services de partage de travaux.<br>Les services de partage de travaux ont une offre variable. | Government | Entailment |
| Spanish | Y se estremeció con el recuerdo.<br>El pensamiento sobre el acontecimiento hizo su estremecimiento. | Fiction | Entailment |
| German | Während der Depression war es die ärmste Gegend, kurz vor dem Hungertod.<br>Die Weltwirtschaftskrise dauerte mehr als zehn Jahre an. | Travel | Neutral |
| Swahili | Ni silaha ya plastiki ya moja kwa moja inayopiga risasi.<br>Inadumu zaidi kuliko silaha ya chuma. | Telephone | Neutral |
| Russian | И мы занимаемся этим уже на протяжении 85 лет.<br>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。<br>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.<br>لا يمكنأللوكالات أ اتعرف ما إذا كانت ناجحة أم لا | Nine-Eleven | Contradiction |

# Cross-lingual Transfer

- If I have English supervised data, can transfer to low-resource language

# Cross-lingual Transfer

- If I have English supervised data, can transfer to low-resource language



# Cross-lingual Transfer

- If I have English supervised data, can transfer to low-resource language