

Emoji-Powered Representation Learning for Cross-Lingual Sentiment Classification

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Why Sentiment Analysis?

- A critical component in many applications



Opinion Polling



Recommender Systems



Stock Market Prediction

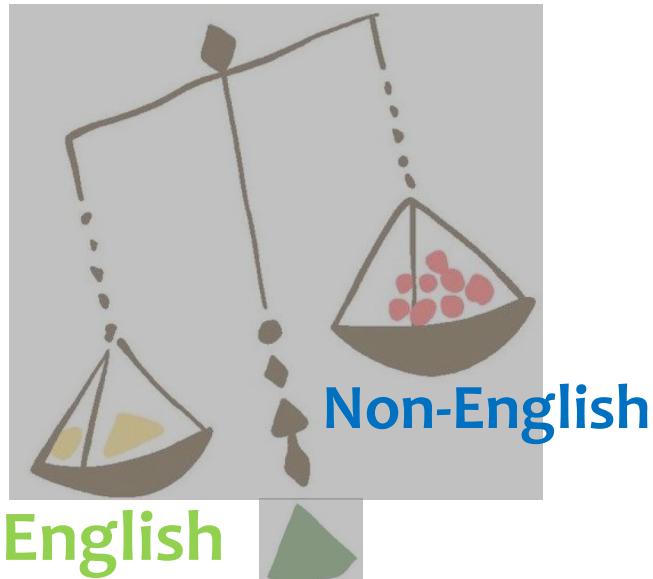


Online Advertising

- NLP
- Social media analysis
- Web mining
-

Considerable Inequality

NLP Research & Results



Accuracy

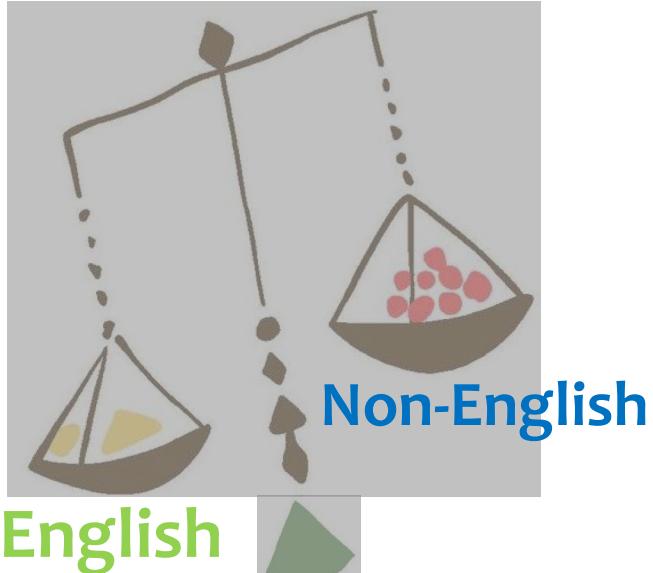
- English: 0.93 [EMNLP'17]
- Russian: 0.72 [1]
- Basque: 0.75 [2]
-

[1]<https://www.kaggle.com/c/sentiment-analysis-in-Russian>, 2018.

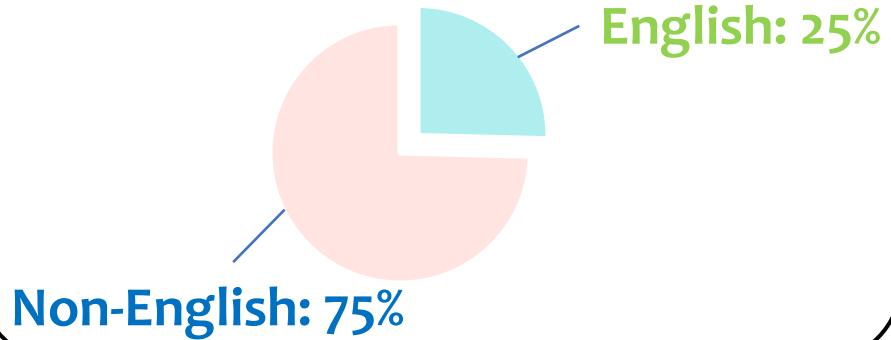
[2]<https://www.kaggle.com/c/basque-sentiment/leaderboard>, 2018.

Considerable Inequality

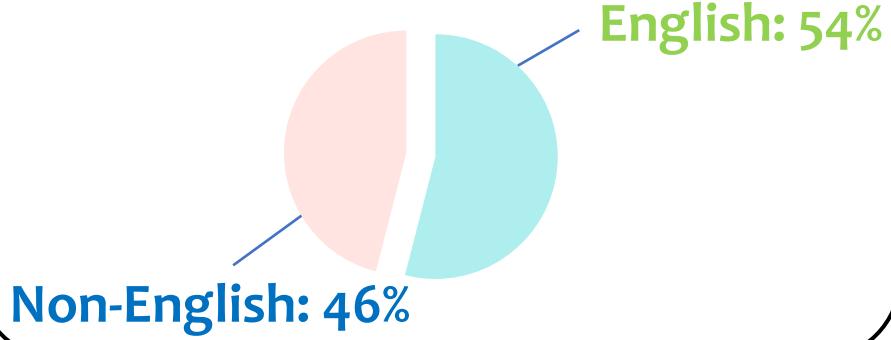
NLP Research & Results



Internet Users

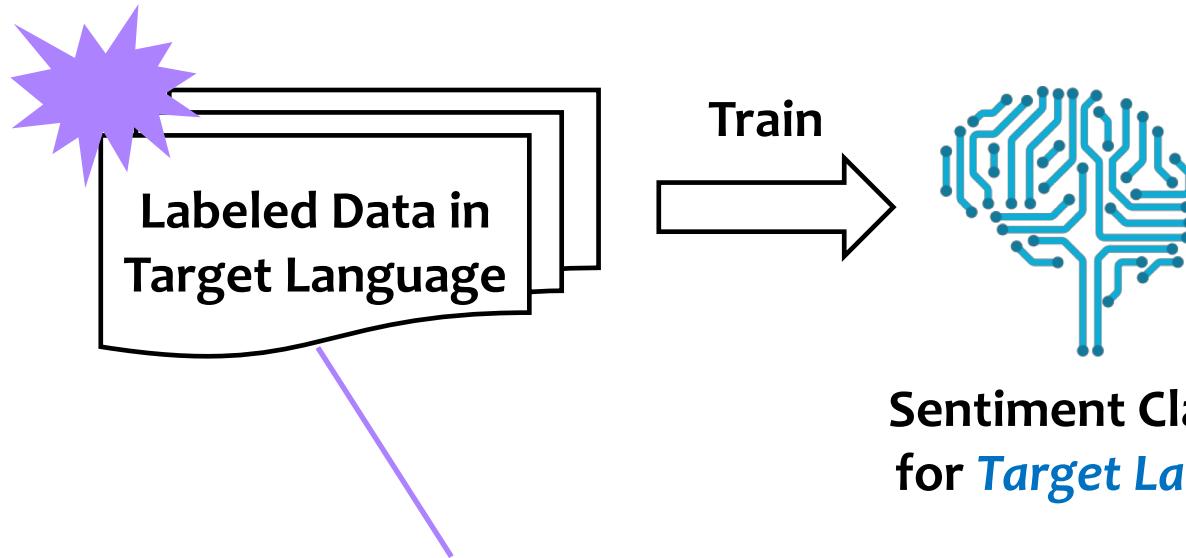


Web Content



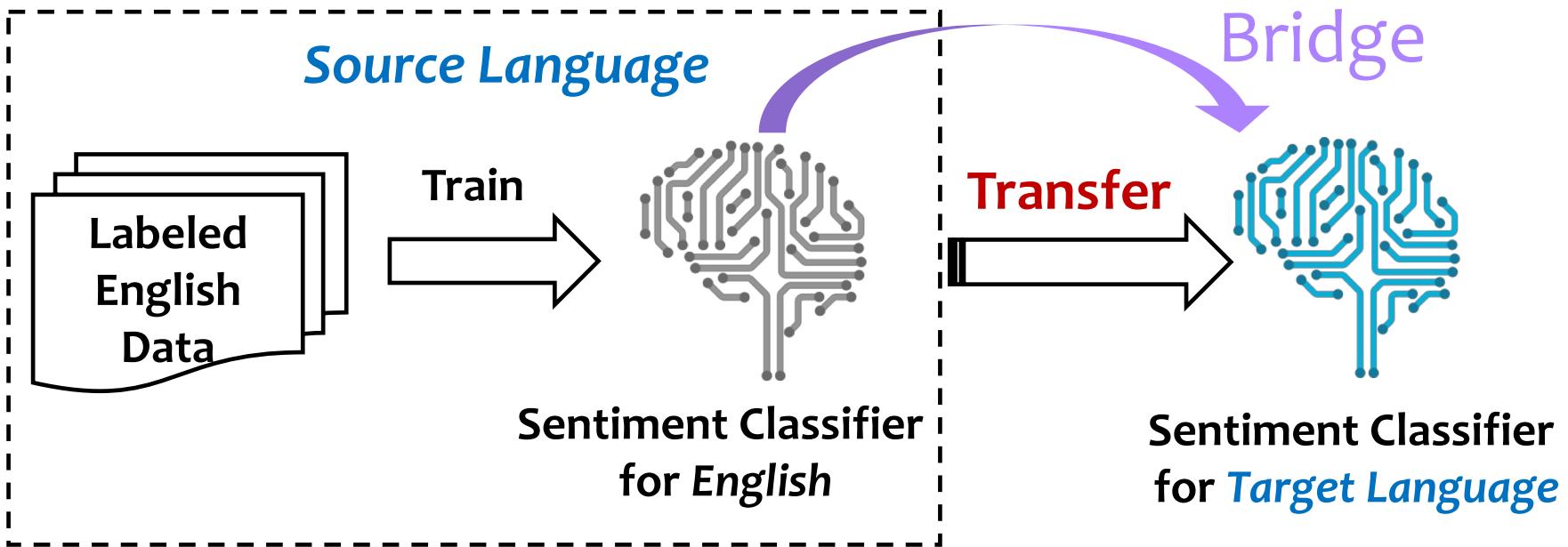
How to Alleviate Such Inequality?

For each non-English language (*target language*),



Challenge: Labels are scarce in non-English languages

Cross-Lingual Sentiment Classification



New Challenges

- Transfer *general* knowledge
 - Sadness.....
- Preserve *language-specific* knowledge

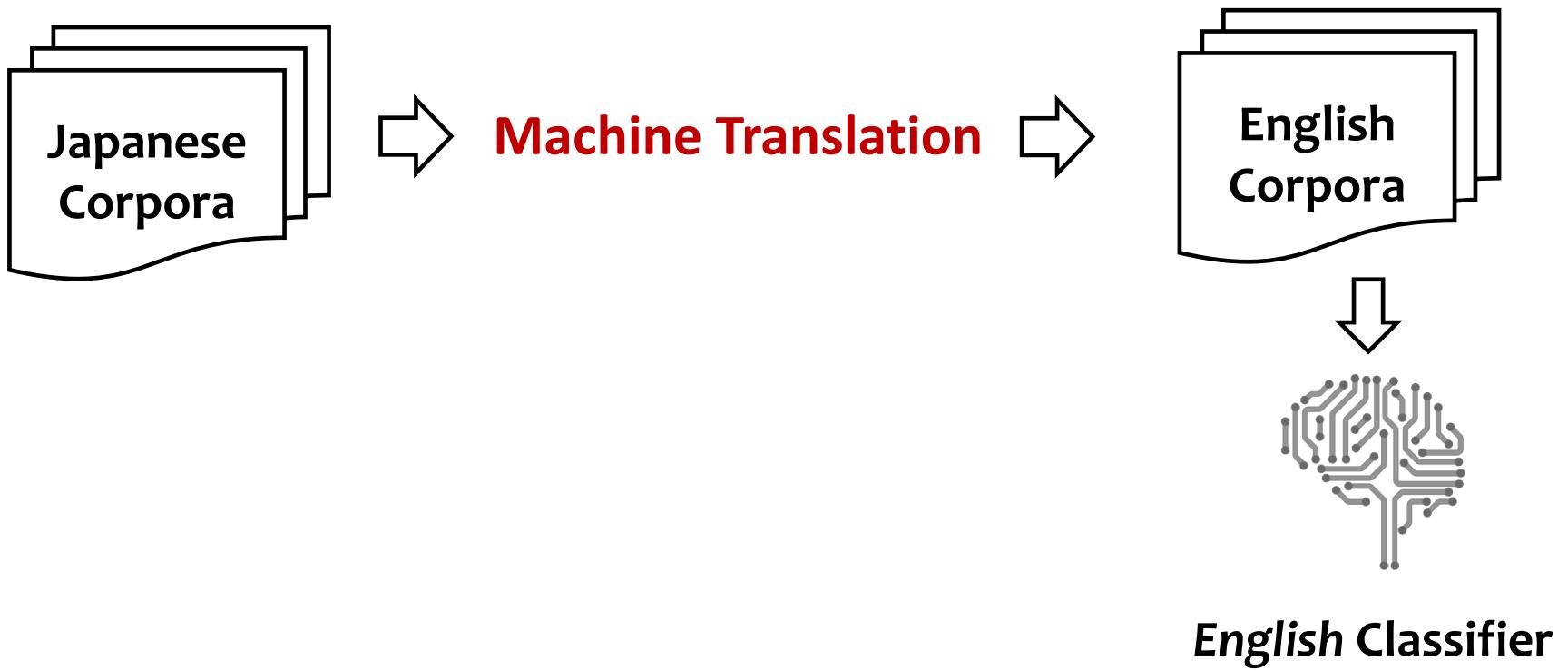
“湯水のように使う”

- **Describe the waste of a resource**
- **Negative**

“Use it like hot water”

- **Neutral**

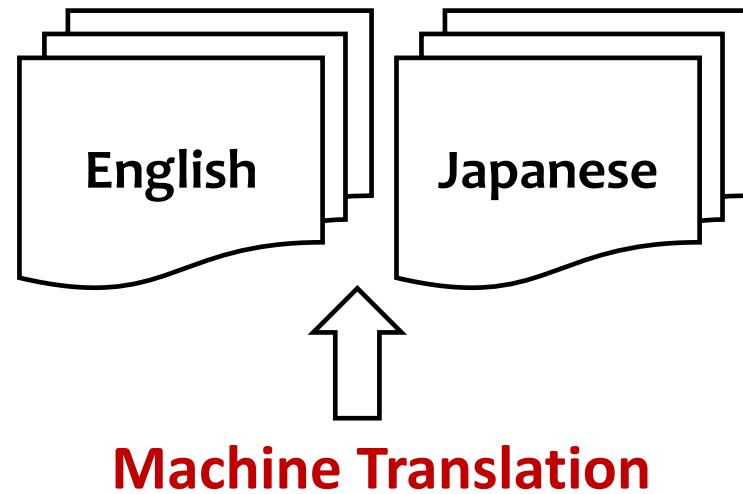
How the Bridge is Built Now



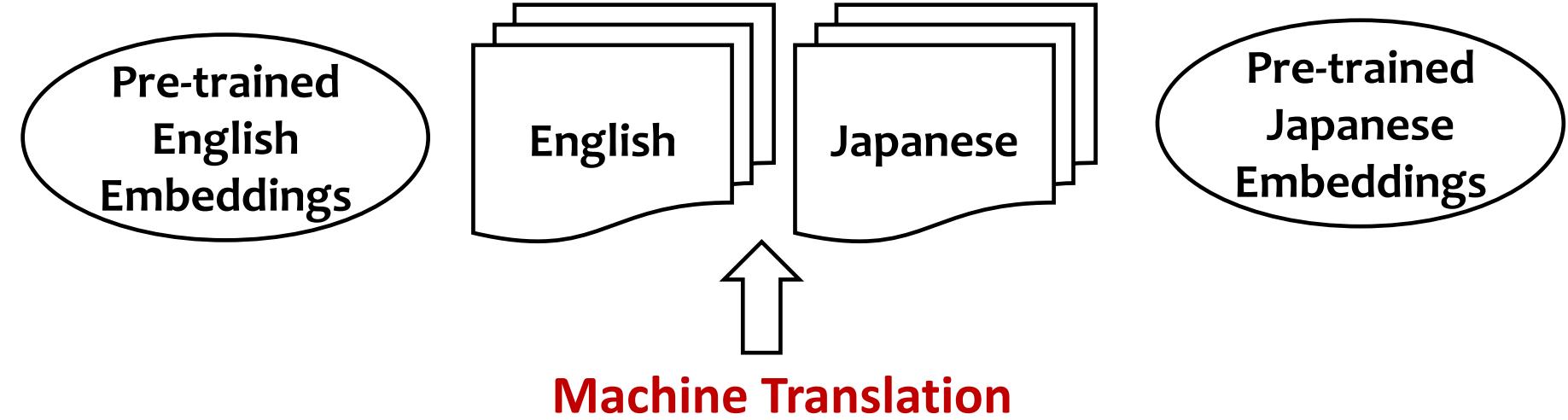
English Classifier

[Wan, ACL'09]

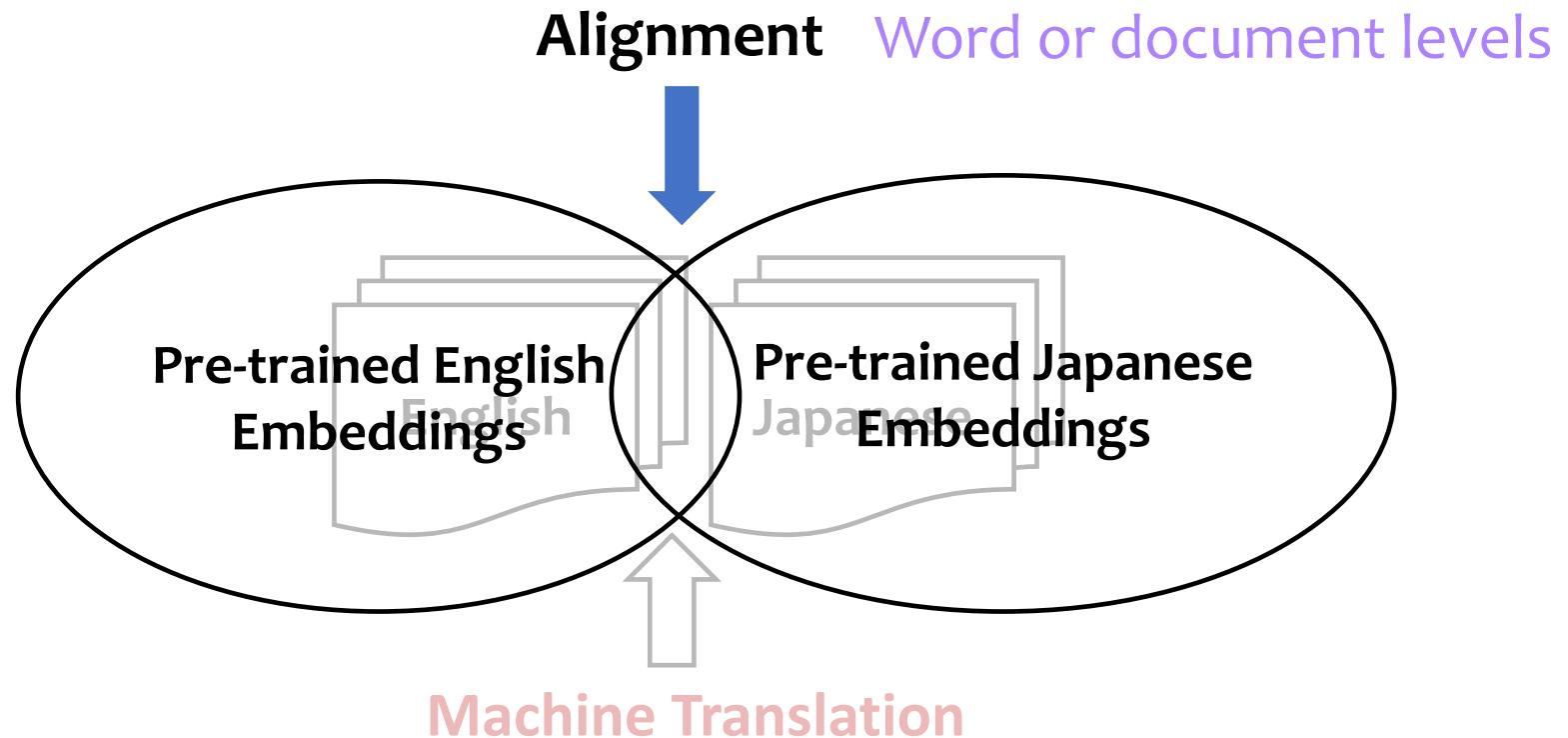
How the Bridge is Built Now



How the Bridge is Built Now

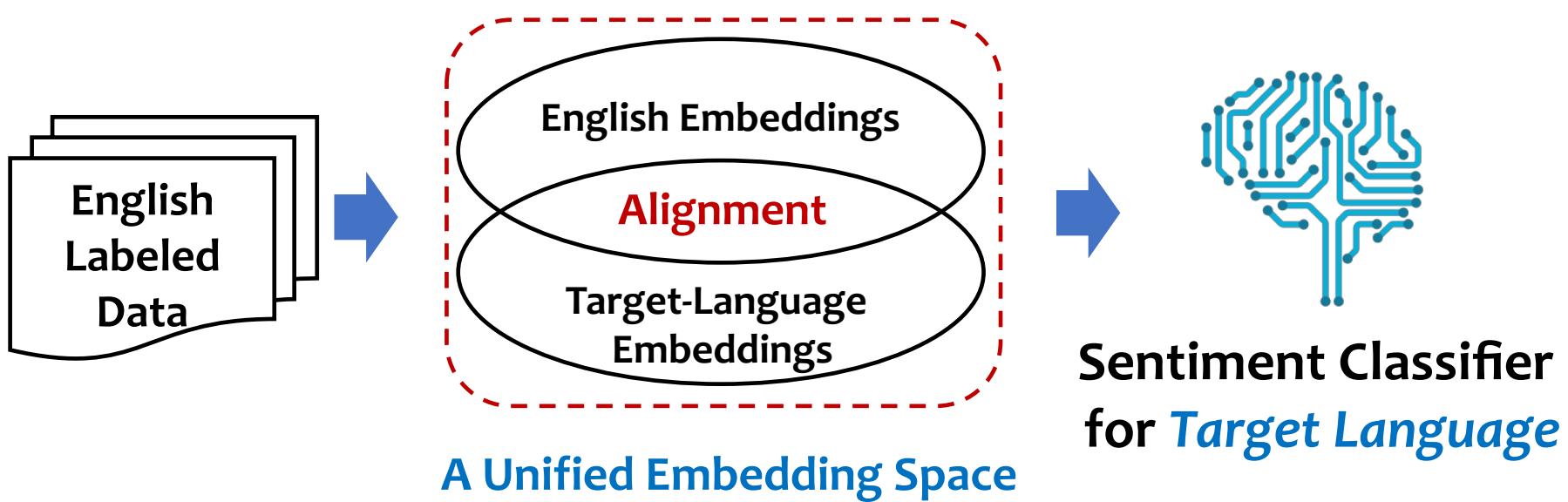


How the Bridge is Built Now

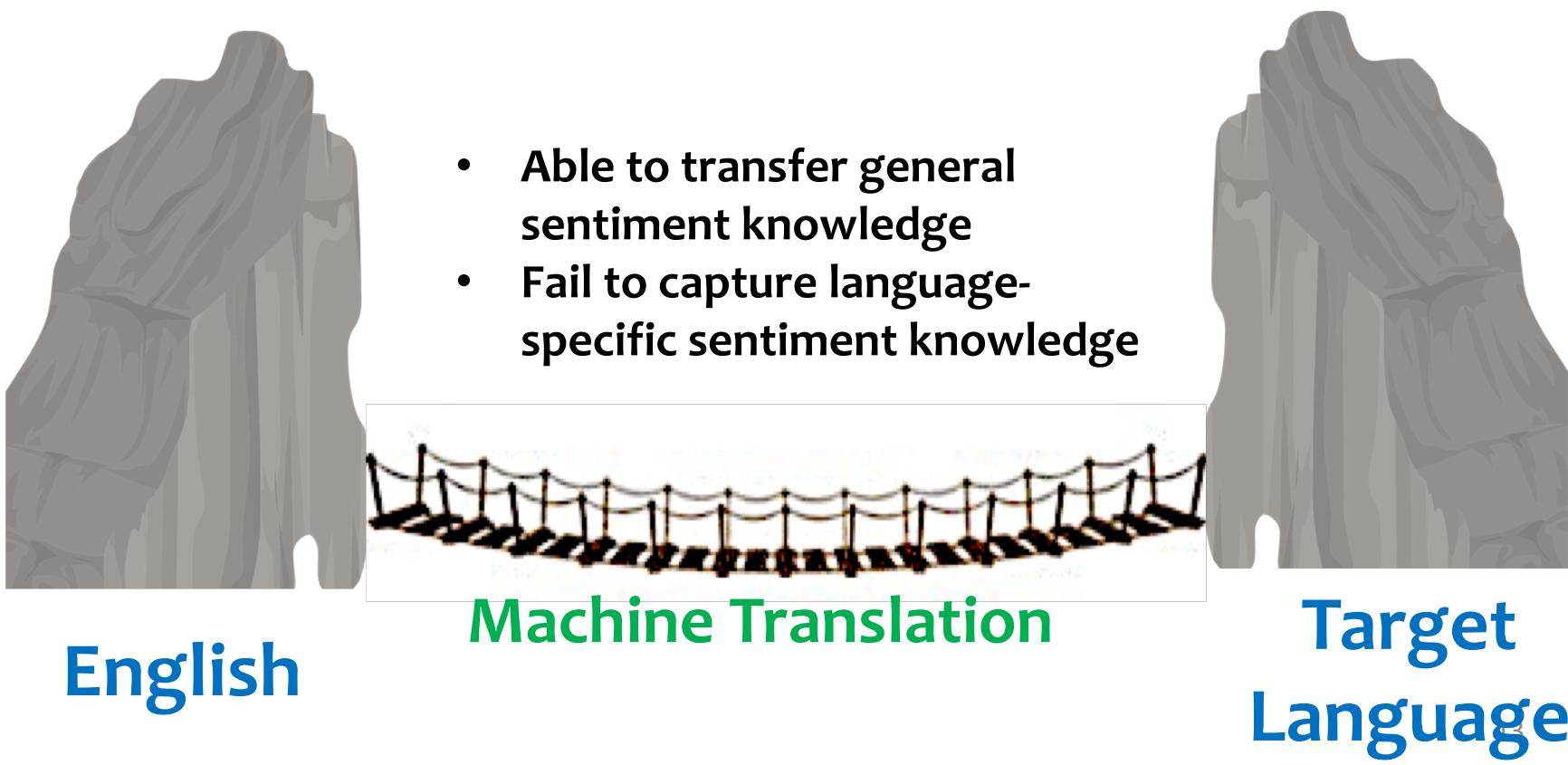


[Xiao and Guo, EMNLP'13]
[Zhou et al., ACL'16]

How the Bridge is Built Now



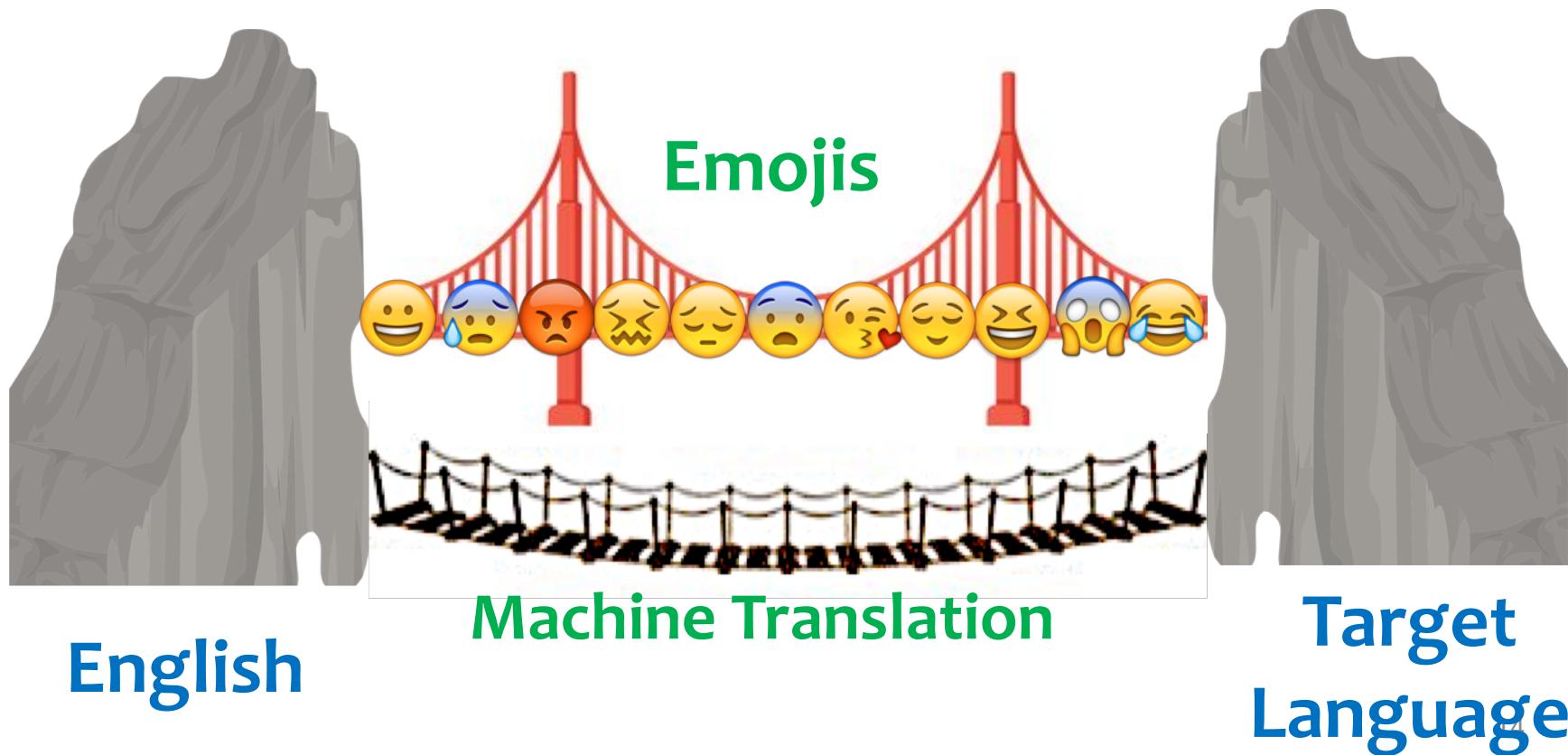
Machine Translation as Bridge



English

Target
Language

A New Bridge for Cross-Lingual Sentiments



Two Roles of Emojis

- As surrogate labels of sentiments

I am happy ✓ Widely available sentiment signal

- As bridge between languages

I am happy ✓ Carrying common sentiment
私は幸せです knowledge

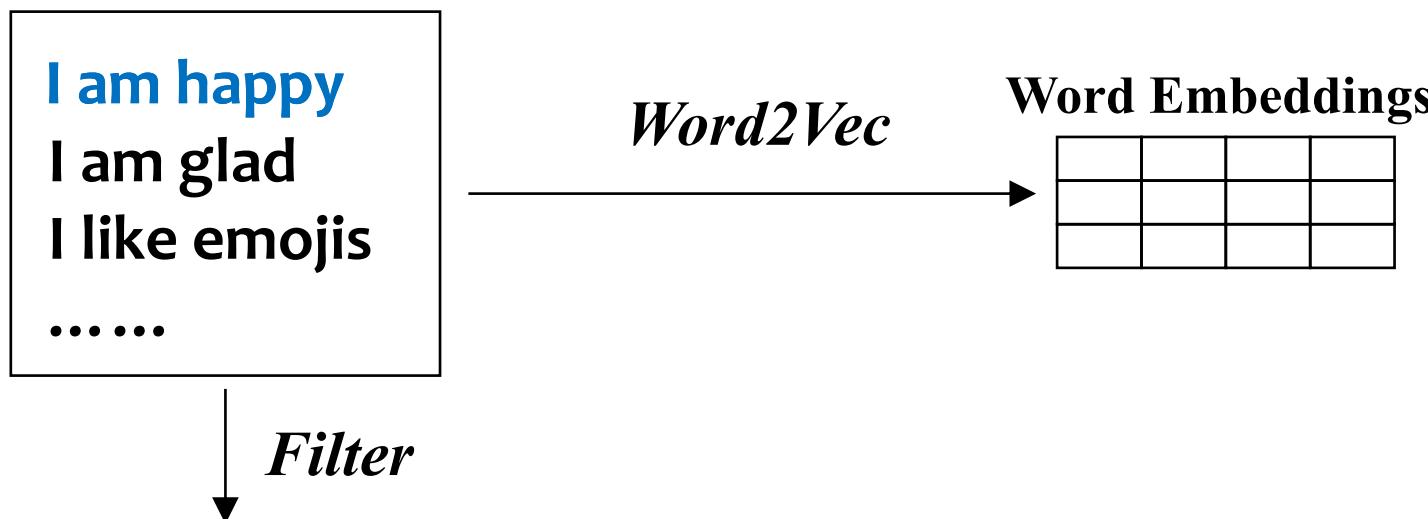
I am sad 😢 ✓ Carrying language-specific
私は眠い 😴 sentiment knowledge

How to Capture Language-Specific Knowledge?

- For each language, learn its specific representations through emoji prediction

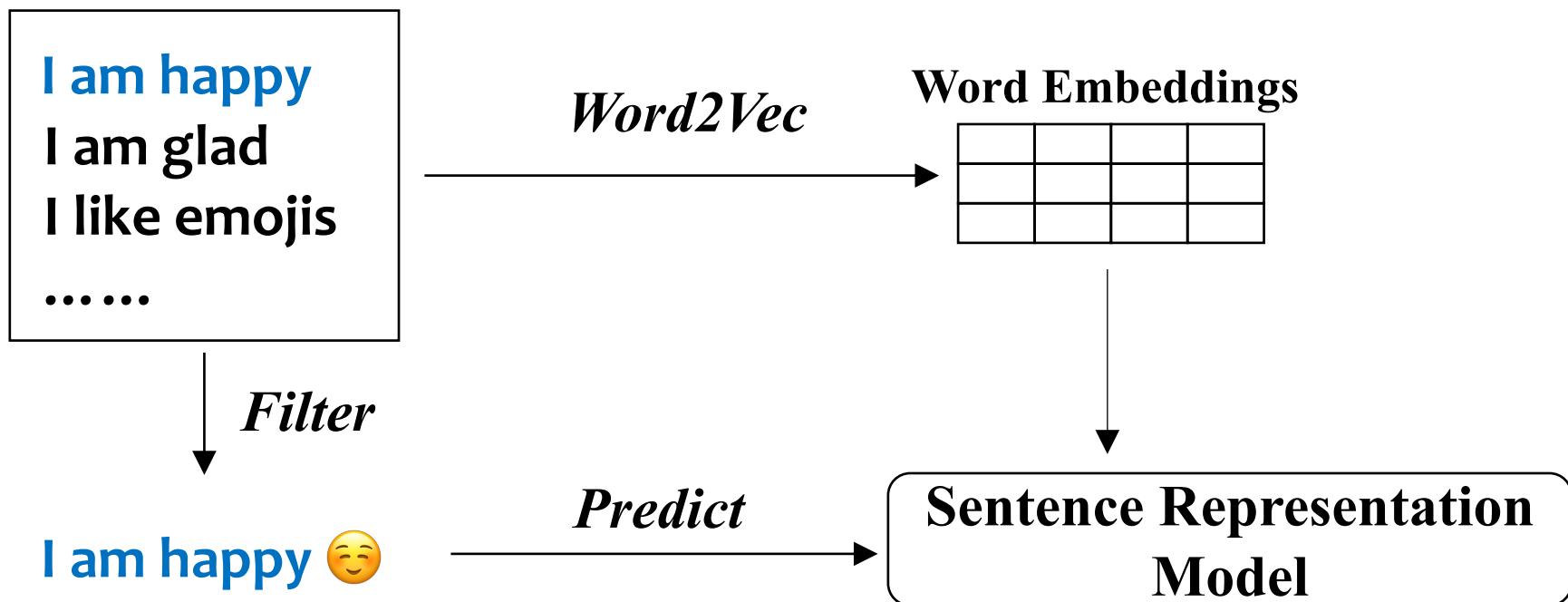
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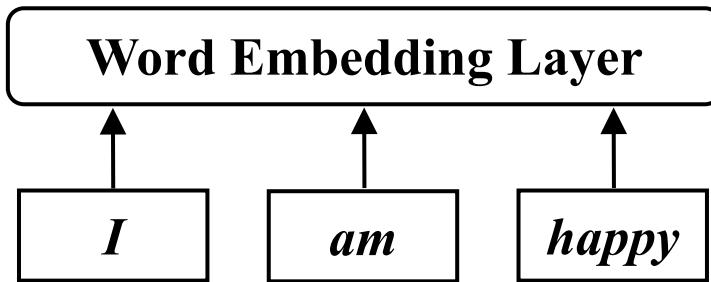


How to Capture Language-Specific Knowledge?

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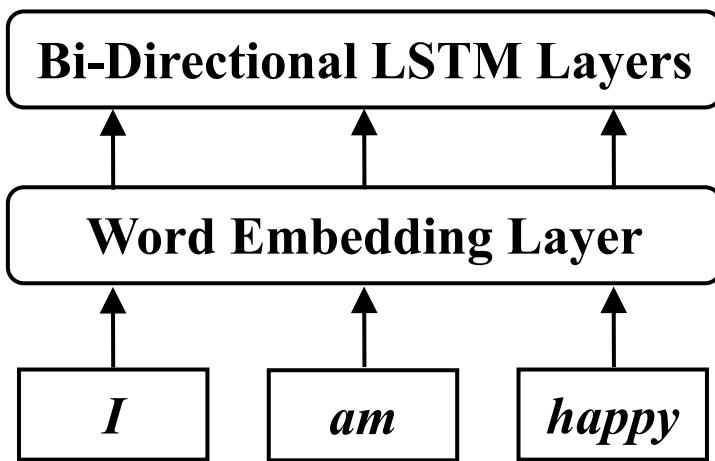


Sentence Representation through Emoji Prediction



Step 1: represent every single word as a vector

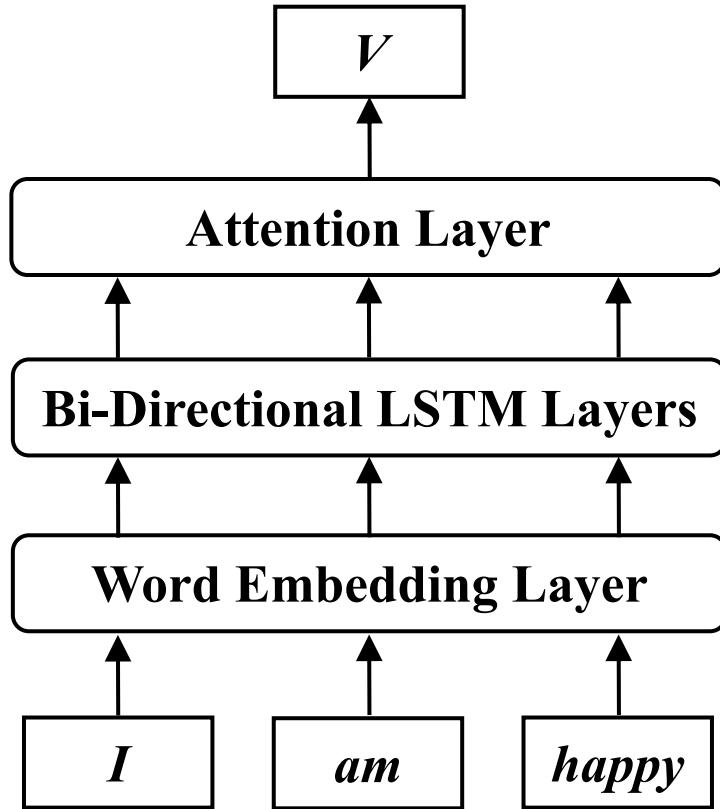
Sentence Representation through Emoji Prediction



Step 2: Capture the context information of individual word

Step 1: represent every single word as a unique vector

Sentence Representation through Emoji Prediction

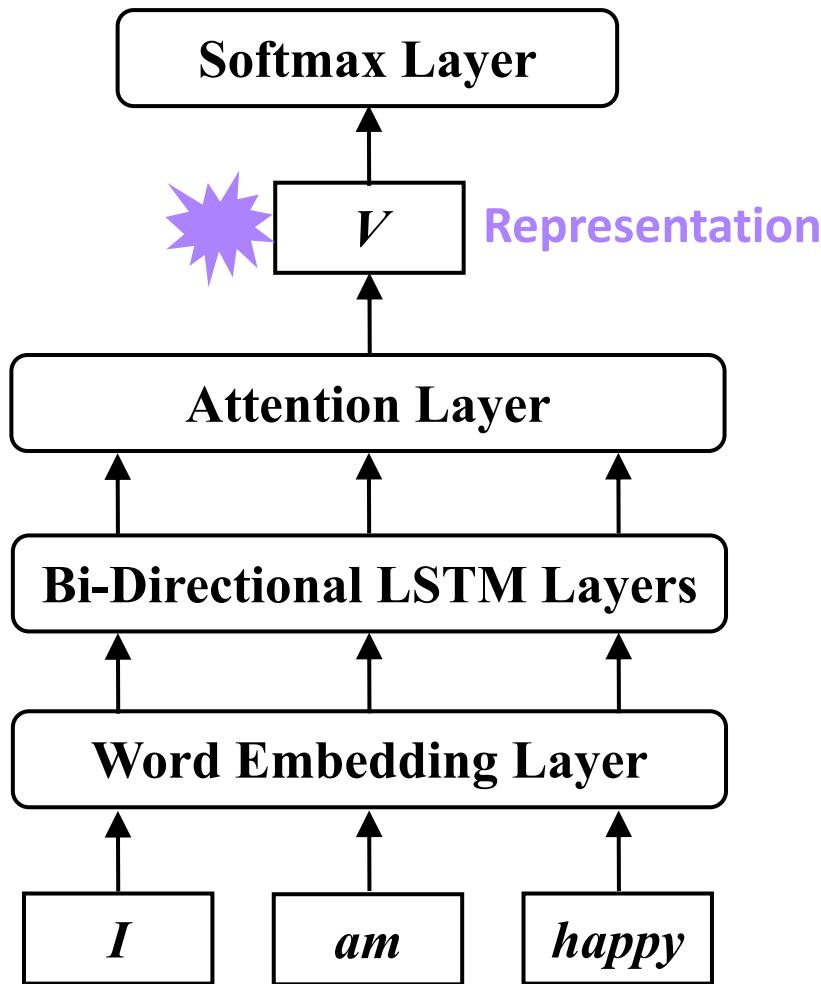


Step 3: Determine the importance (attention score) of each word

Step 2: Capture the context information of each word

Step 1: represent every single word as a unique vector

Sentence Representation through Emoji Prediction



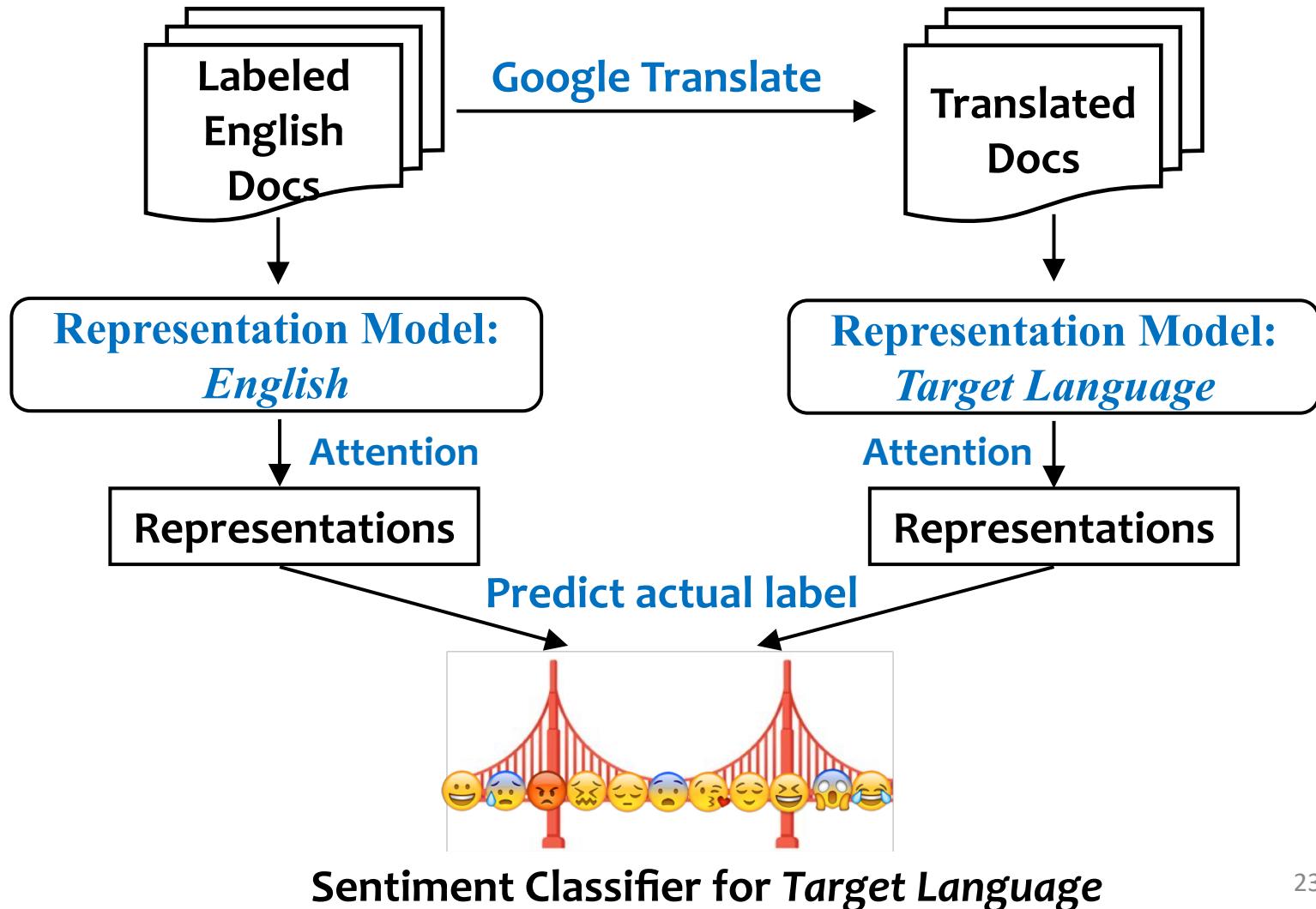
Step 4: Predict

Step 3: Determine the importance (attention score) of each word

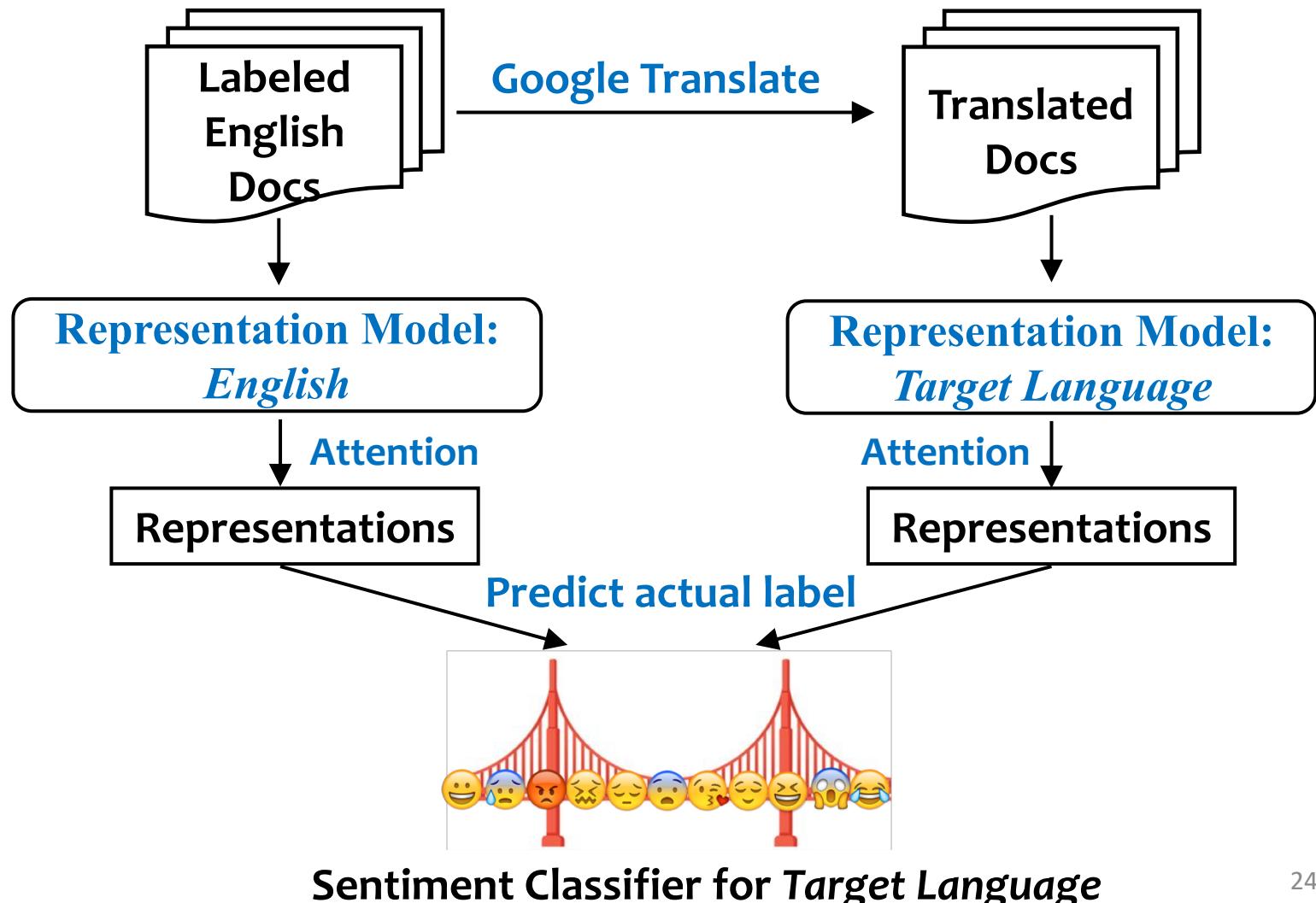
Step 2: Capture the context information of each word

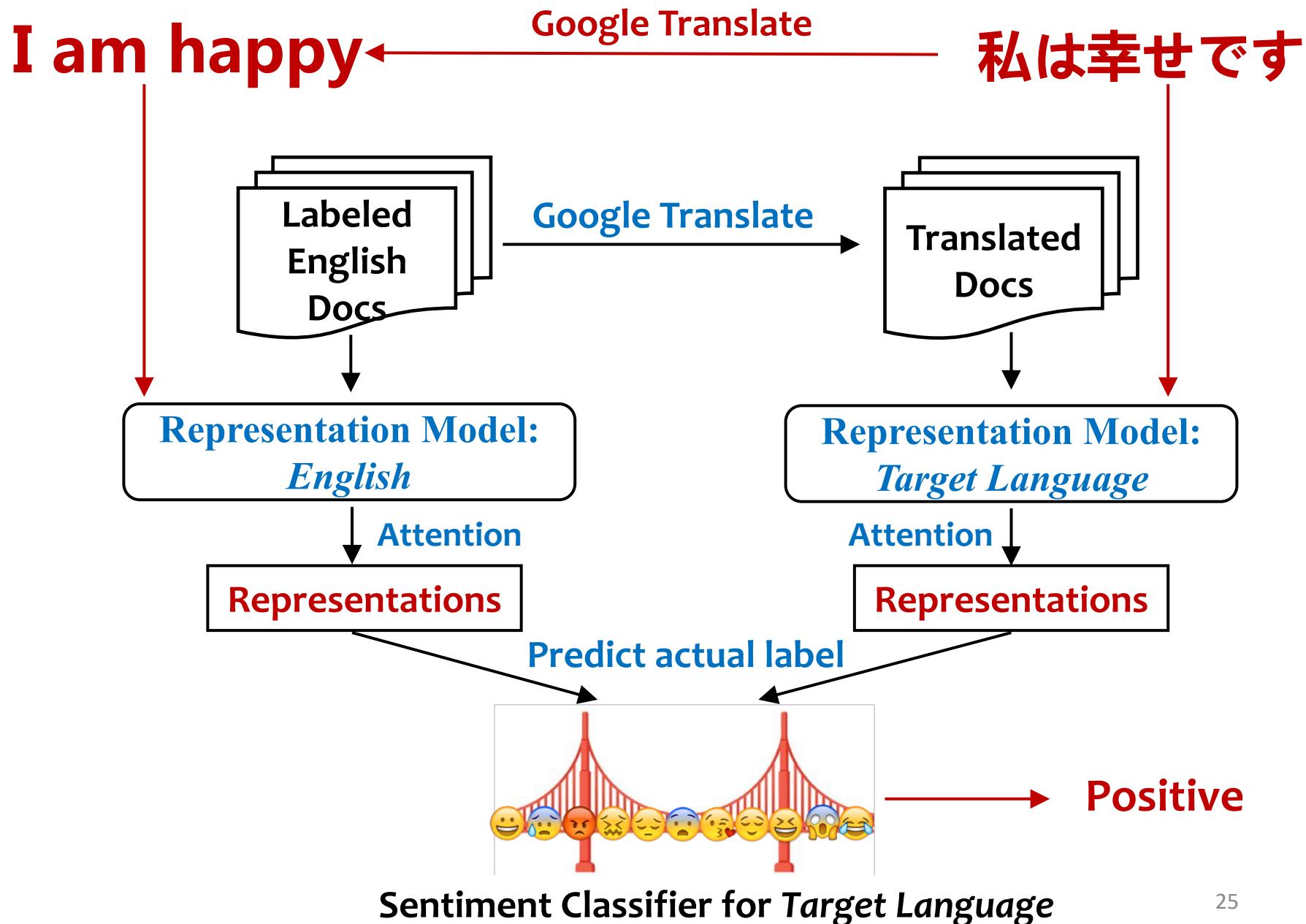
Step 1: represent every single word as a unique vector

ELSA for Cross-Lingual Sentiment Classification



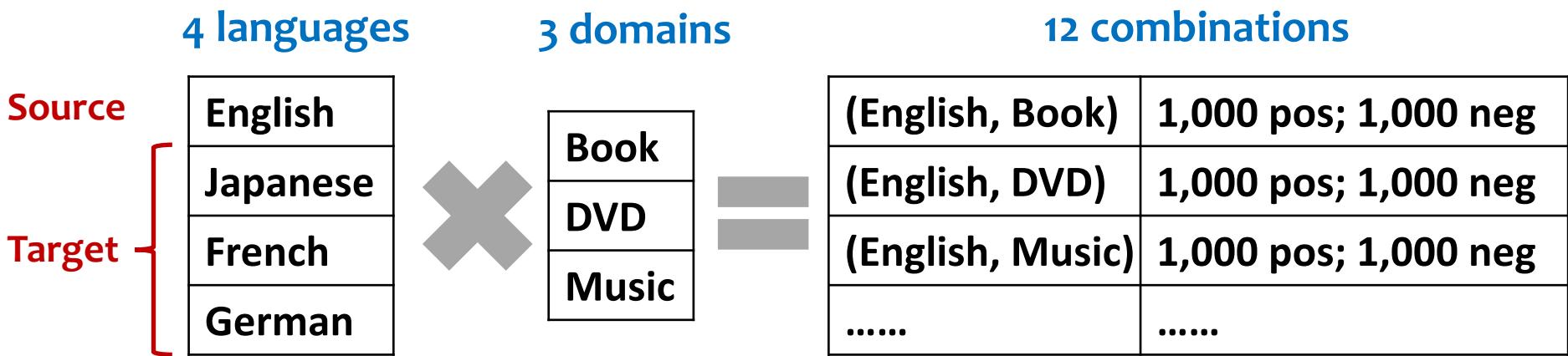
I am happy ← Google Translate → 私は幸せです



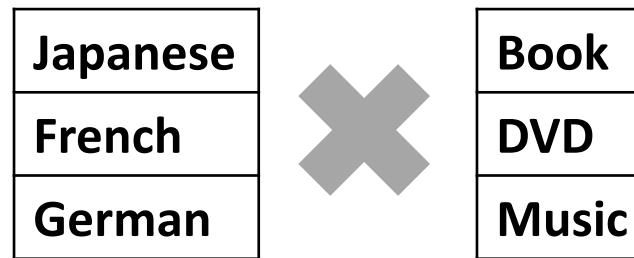


Evaluation Setup

- Benchmark: Amazon Review Dataset



- 9 tasks in total:



Text for Representation Learning

- For each language
 - Tweets: train word embeddings
 - Tweets containing emojis: predict emoji

	<i>Sentence</i>	<i>Label</i>
I love you ❤️❤️💋	1 I love you	❤️
	2 I love you	💋

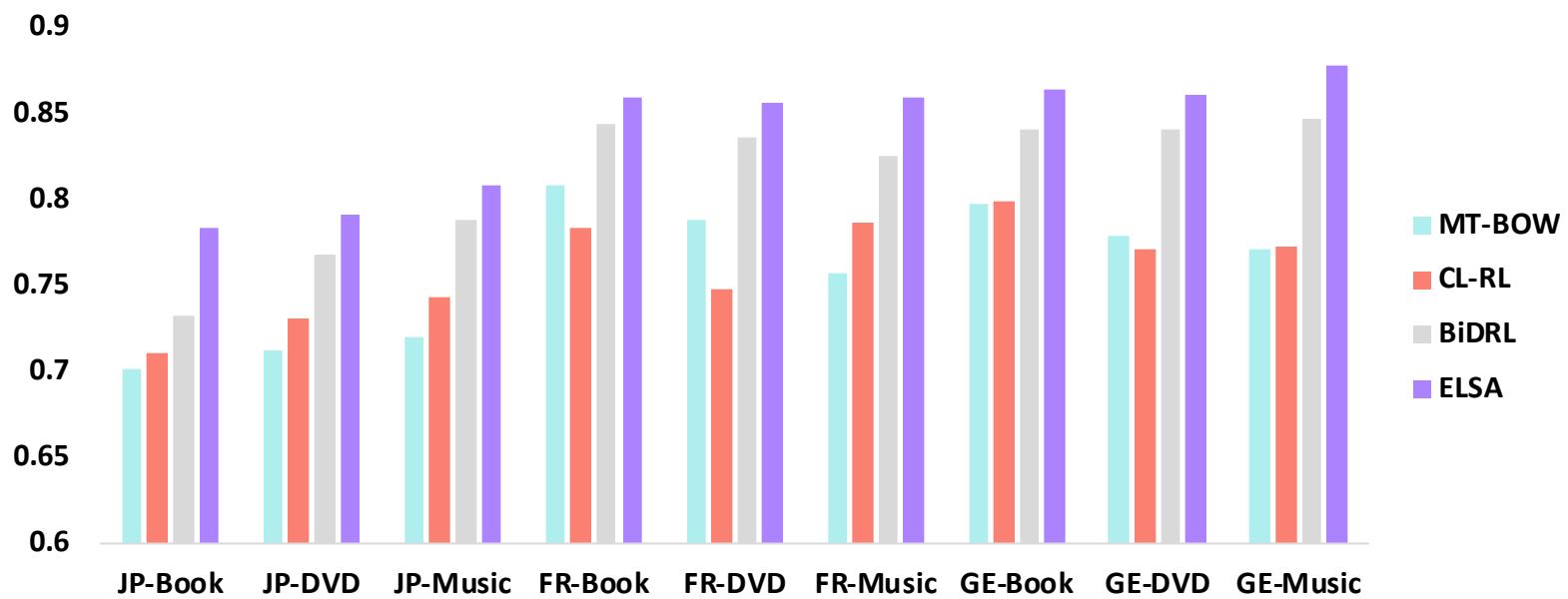
	English	Japanese	French	German
Raw Tweets	39.4M	19.5M	29.2M	12.4M
Emoji Tweets	6.6M	2.9M	4.4M	2.7M

Baseline Methods

- **MT-BOW** [Prettenhofer and Stein, ACL'10]
 - English classifier: bag-of-words
 - Classify translated documents
- **CL-RL** [Xiao and Guo, EMNLP'13]
 - A unified embedding space: word-level aligned
- **BiDRL** [Zhou *et al.*, ACL'16]
 - A unified embedding space: document-level aligned

Results

The accuracy of ELSA and baselines



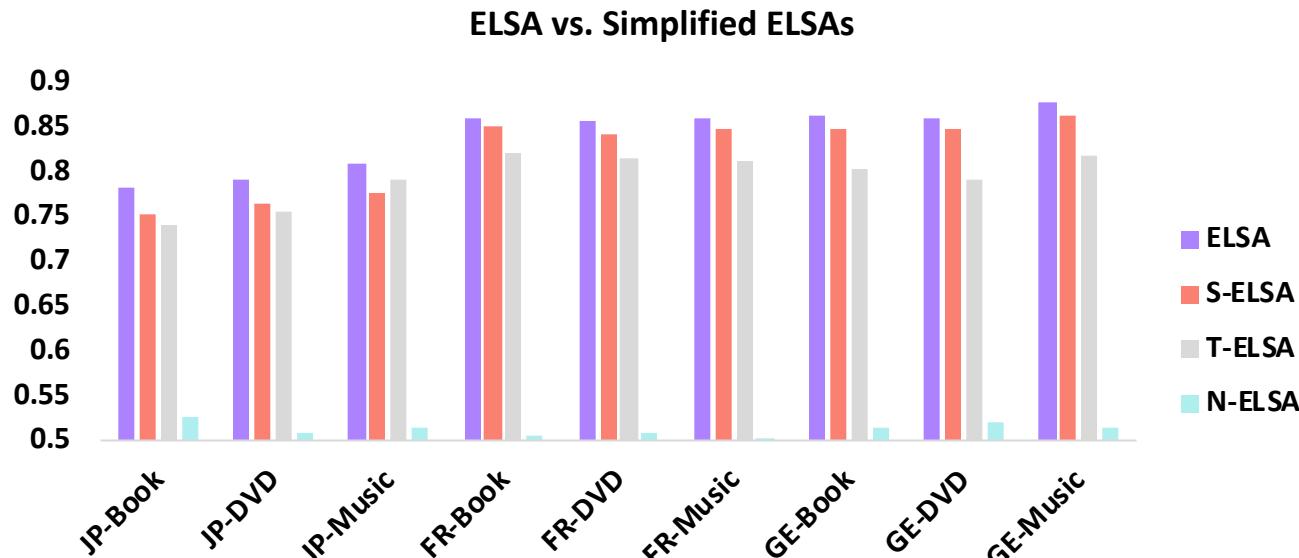
- ELSA outperforms all three baselines on all nine tasks

To What Extent do Emojis Contribute to ELSA?

Remove the emoji-prediction phase to make comparisons!

Evaluation of Emoji Power

- Remove emoji-prediction phase of
 - target language **S-ELSA**
 - English **T-ELSA**
 - both languages **N-ELSA**



- ELSA outperforms S-ELSA, T-ELSA, and N-ELSA on all tasks

An Illustrating Example

- The translation of a Japanese sample that expresses dissatisfaction with an album

It was not interesting at all until I saw them at samasonon last year

the first song I listened live after sumasoni did not leave my head so it was my first

I bought an album and asked, but it was a very good one

Seems to be positive

however, this album does not come with an honest pin

there is a feeling that it is quietly gathered, and it is different from the first album

i think that it is not possible to do

In fact, a negative example

An Illustrating Example

N-ELSA: Without Emoji Incorporation

Sentence Attention

Sentences in the example review

0.0	it was not interesting at all until i saw them at samasonon last year
0.0	the first song listened live after sumasoni did not leave my head so it was my first
0.0	i bought an album and asked , but it was a very good one
0.074	however , this album does not come with an honest pin
0.851	there is a feeling that it is quietly gathered , and it is different from the first album
0.001	i think that it is not possible to do

- Neutral words: “song”, “album”
- The 5th sentence

Emojis Benefit Text Comprehension

With Emoji Incorporation

Predicted emojis	Sentence Attention	Sentences in the example review
😂 😢 😭	0.001	it was not interesting at all until i saw them at samasonon last year
😂 😢 😭	0.001	the first song i listened live after sumasoni did not leave my head so it was my first
😂 😊 🤗	0.054	i bought an album and asked , but it was a very good one
😂 😢 😭	0.384	however , this album does not come with an honest pin
😂 🎵 😭	0.042	there is a feeling that it is quietly gathered , and it is different from the first album
🤔 😂 😭	0.49	i think that it is not possible to do

- **Adjectives:** “not interesting”, “not possible”
- **Disjunctives:** “however”
- **The 4th and 6th sentence**

Take Away

- Emojis as a new bridge beyond machine translation for cross-lingual sentiment analysis
- Capture both general and language-specific sentiment knowledge
- Actionable insights for other web mining applications that also suffer from inequality among languages



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