CoNLL 2019

Multilingual model using cross-task embedding projection

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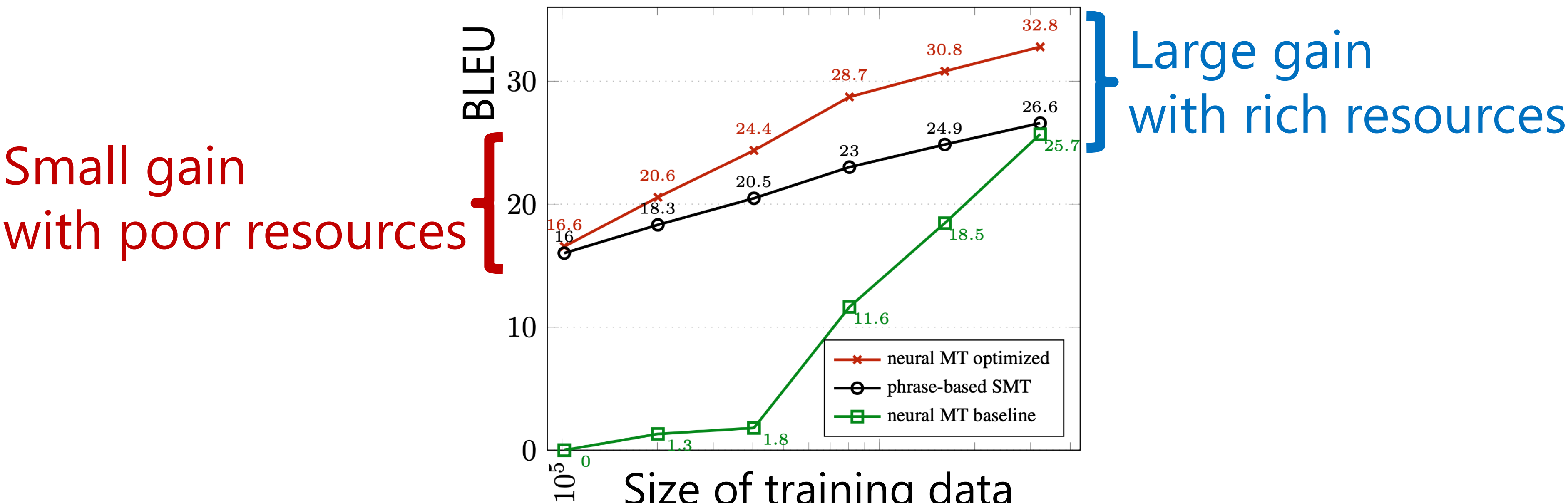
Needs for resources in deep learning

Improvements in various tasks by deep learning

- **Task-specific representation learning** needs more data

Translation performance (DE->EN) [Sennrich+ 2019]



Need massive data for **every pair of task and lang**

Gaps in available resources across langs

Among 7097 languages in the world [Simons+ 2018], massive resources are obtainable only in few

- Universal dependencies project covers only 76 [Nivre+ 201X]

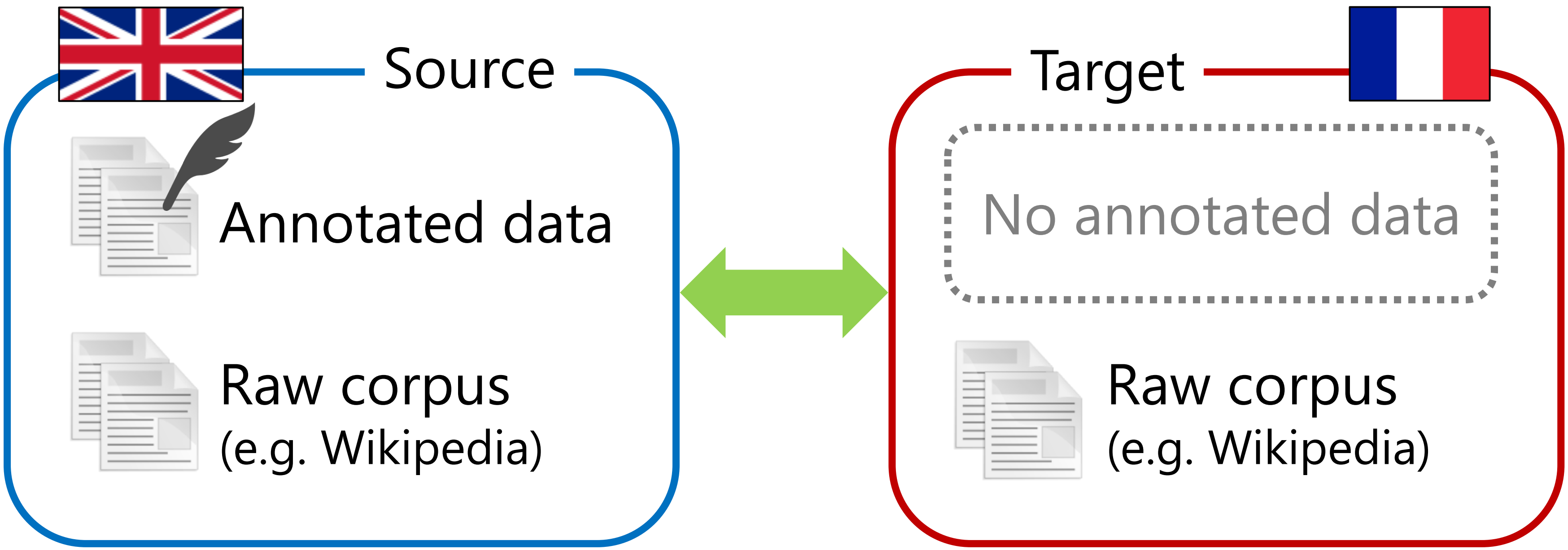
Large gap in model performances among languages

Can we exploit resources of resource-rich languages for training in resource-poor languages?

Problem settings of this study

Available resources:

- Labeled data for training in the source language
- Raw corpora in both languages



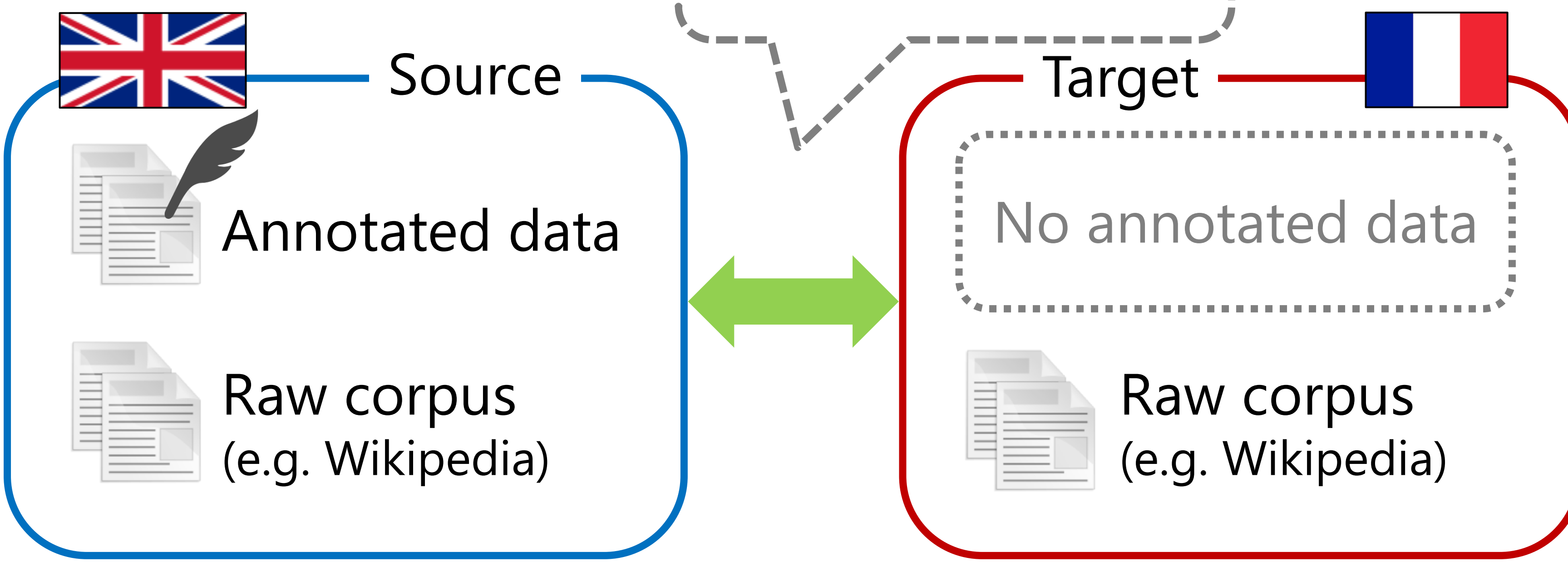
Applicable to various target languages and tasks

Problem settings of this study

Available resources:

- Labeled data for trainin ... ge
- Raw corpora in both lan

No cross-lingual resources

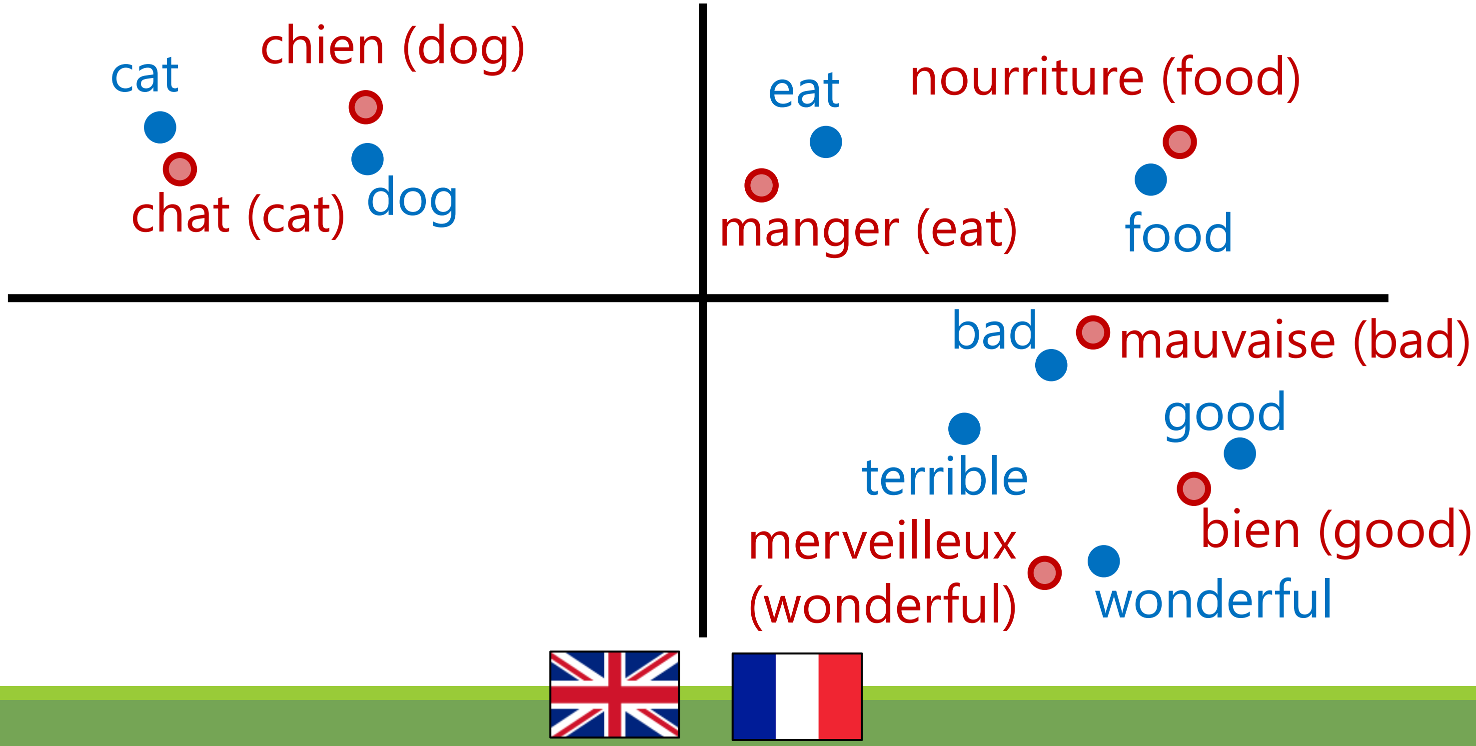


Applicable to various target languages

Preliminary:
Cross-lingual word embeddings (CLWE)

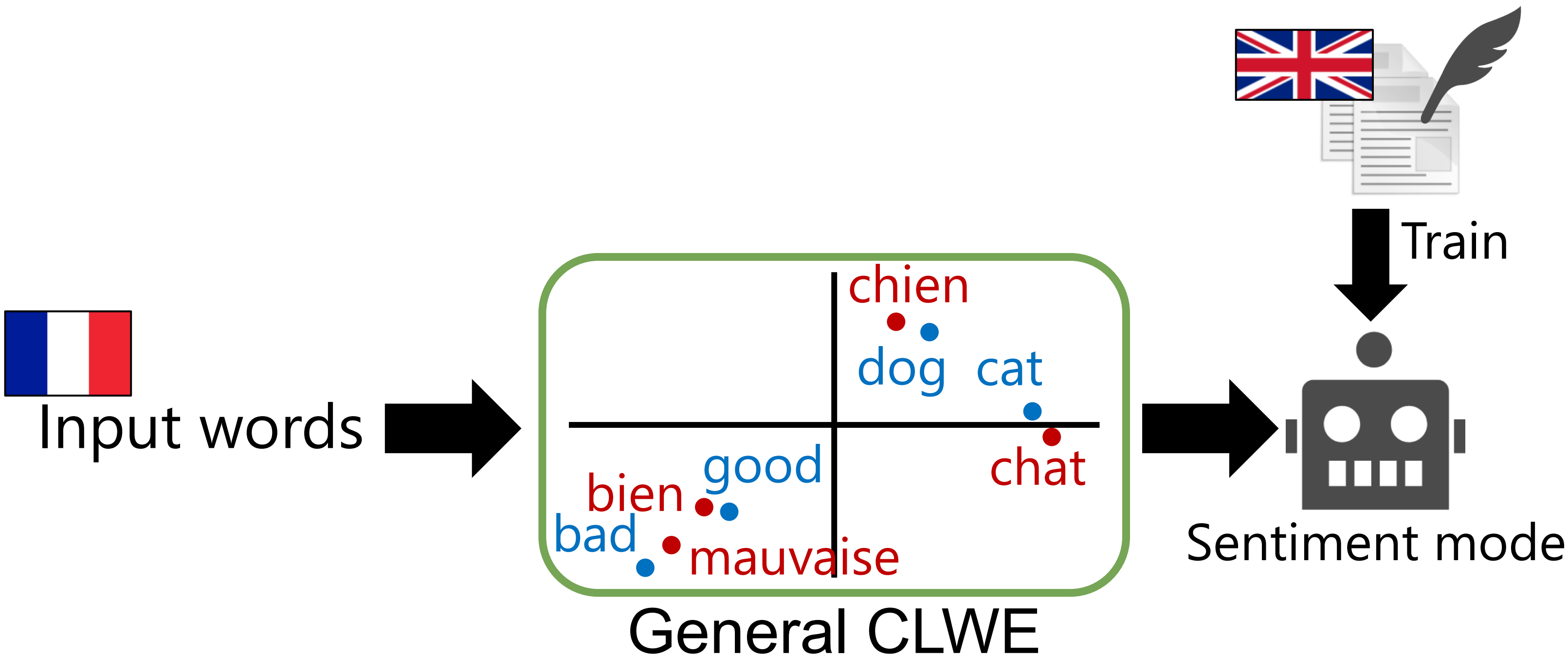
Language-independent representation of words
[Mikolov+ 13]

- Words from two lang. are represented in a shared space
- Similar words from different languages are close



Existing multilingual models

Fix the emb. layer to general CLWE during training
[Duong+ 17, Chen+ 18]

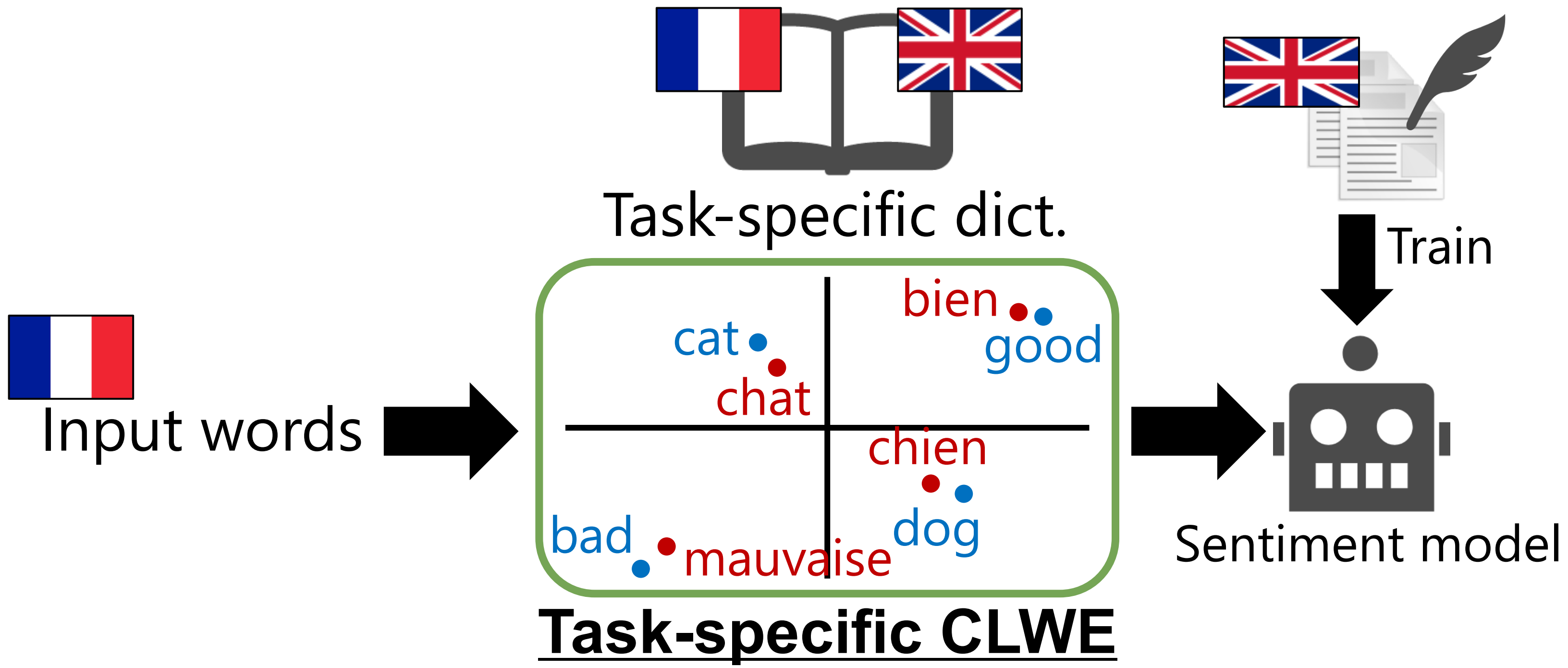


😃 Enables cross-lingual transfer

😰 The embedding layer is not optimized for the task

Related work:
Task-specific CLWE with specialized dict.

Utilize task-specific bilingual dict. to obtain CLWE
[Gouws+ 15]



😃 The embedding layer is optimized for the task

😰 Additional cross-lingual resources are required

Related work:
Task-specific CLWE with specialized dict.

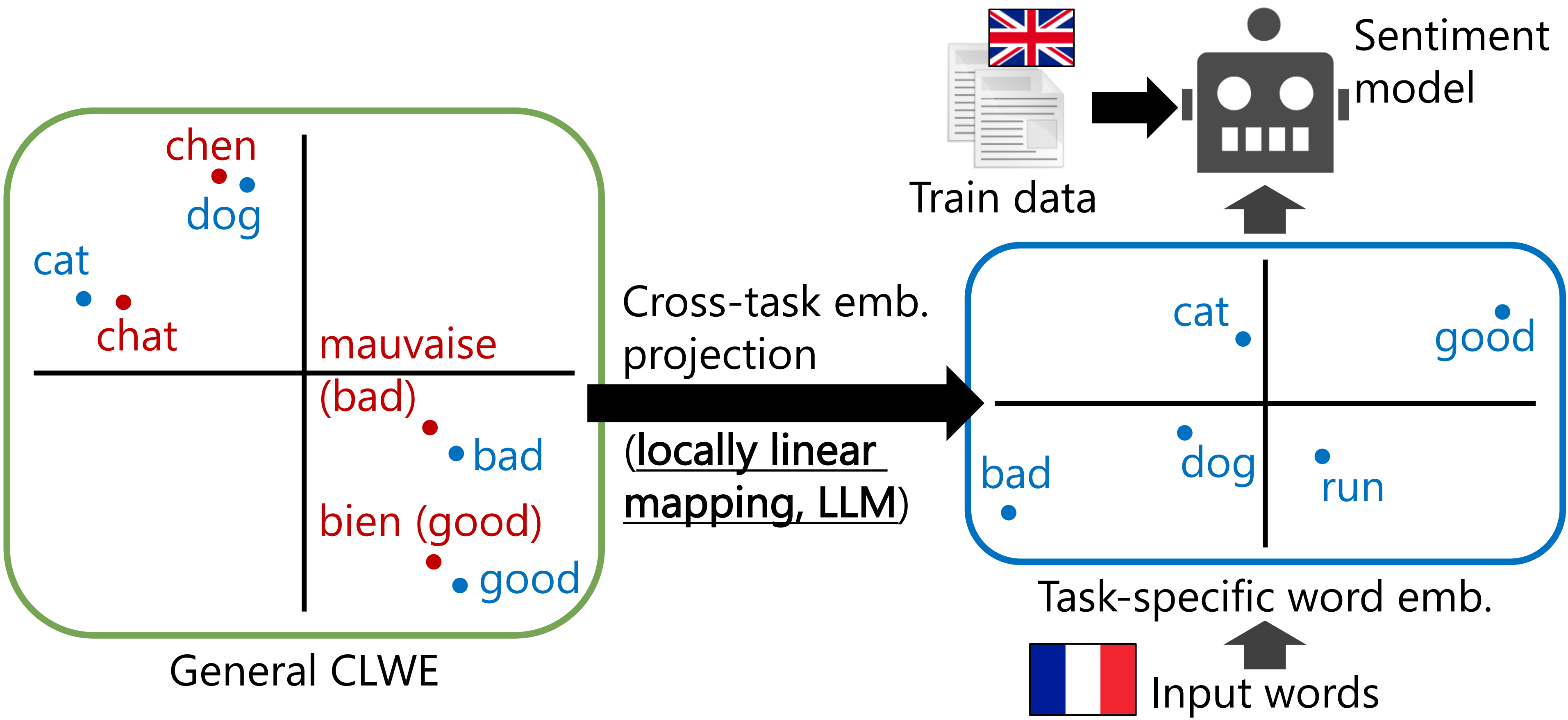
Utilize task-specific bilingual dict. to obtain CLWE [Gouws+ 15]

In this study:
Obtain task-specific CLWE without relying on any cross-lingual resources

- The embedding layer is optimized for the task
- Requires additional cross-lingual resources

Proposal:
Multilingual model with task-spec emb.

Project general CLWE to the emb. layer optimized for the task by **cross-task embedding projection**

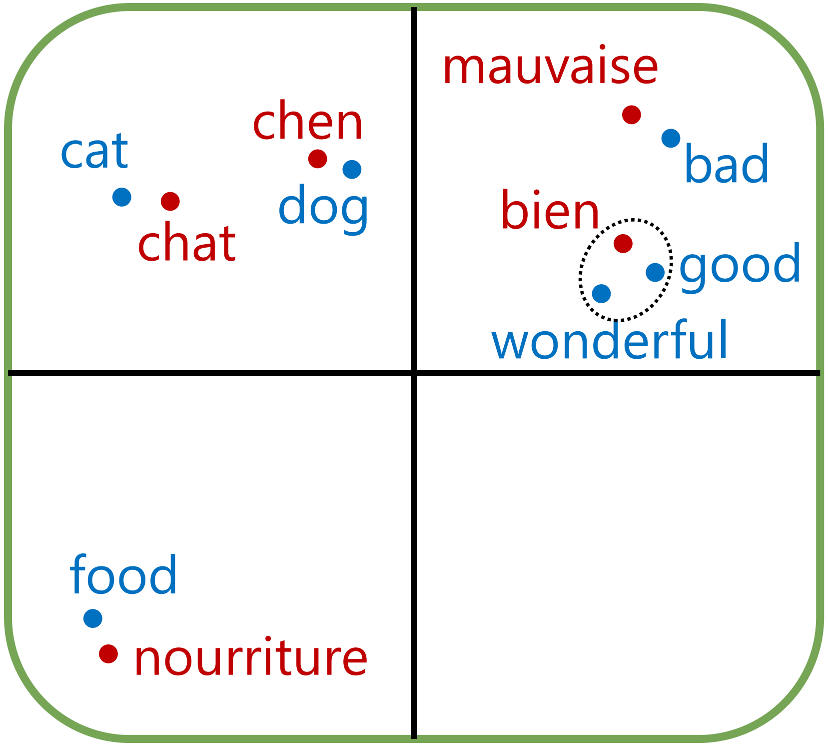


Locally linear mapping:

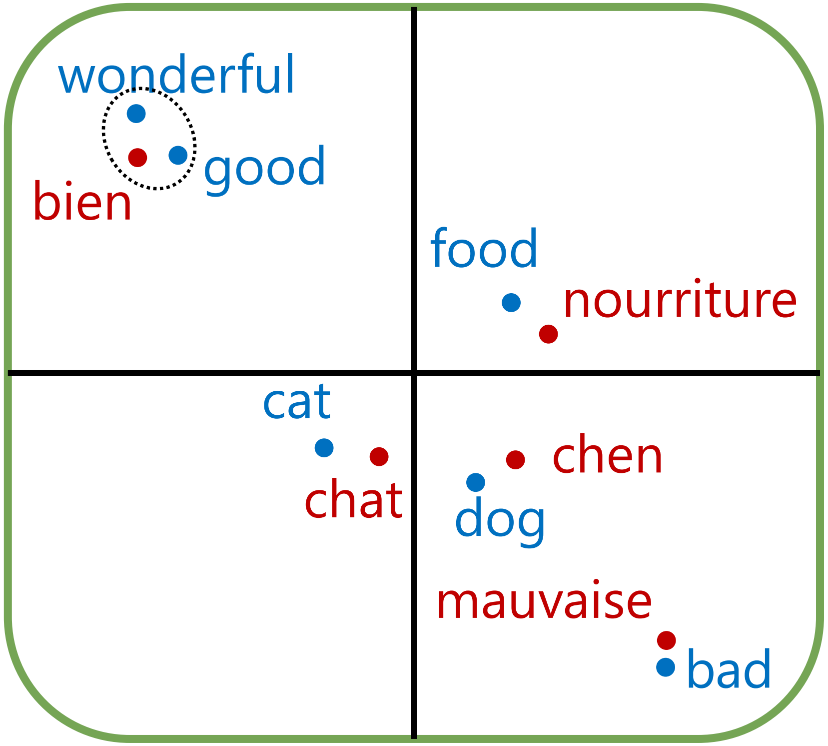
Idea: local topology of embeddings

Assumption:

- Words <u>**adequately close**</u> in the general CLWE are also close in task-specific space



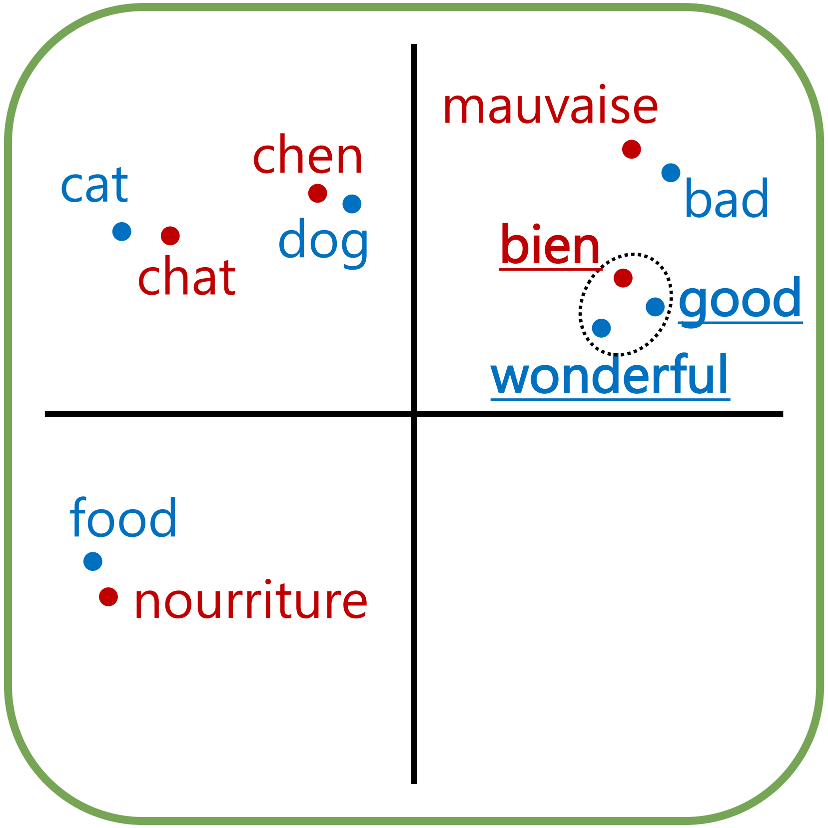
General CLWE



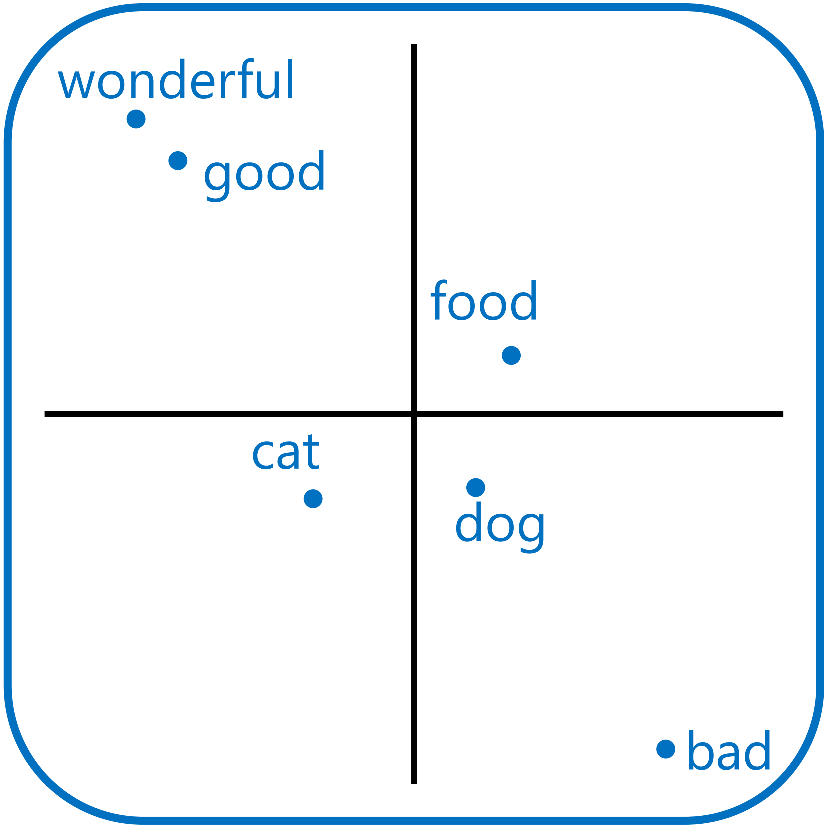
(Ideal) task-specific CLWE

Locally linear mapping:
Step 1: selecting nearest neighbors

For each **target word (bien)**, select ***k*-nearest neighbors** in the general CLWE



General CLWE

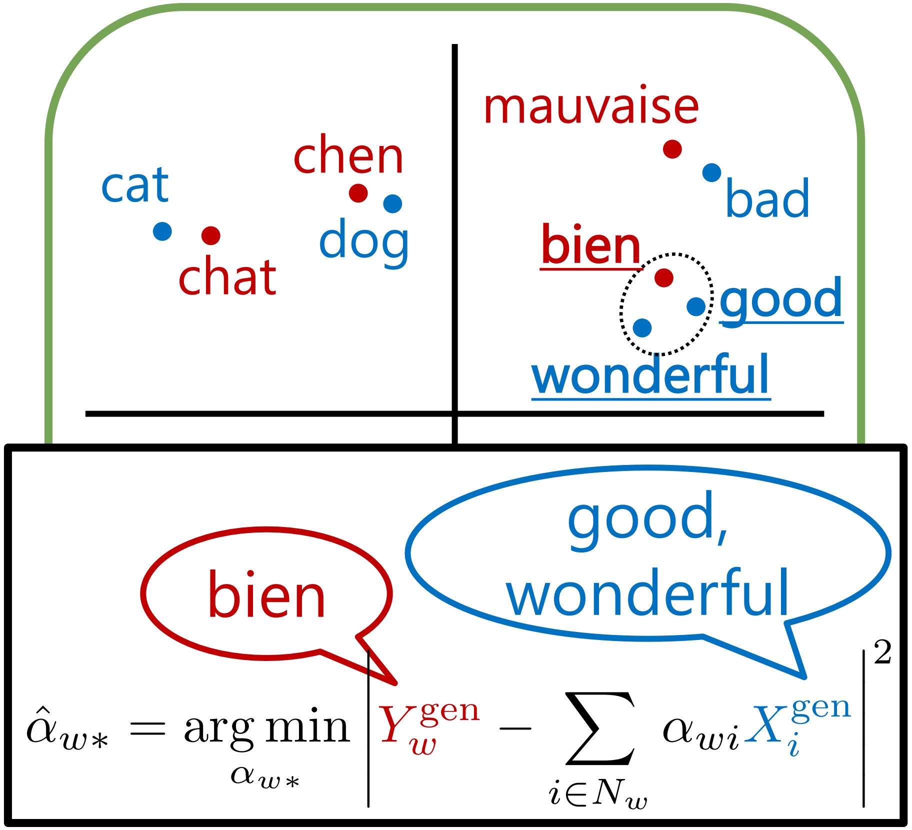


Task-specific word emb.

Locally linear mapping:

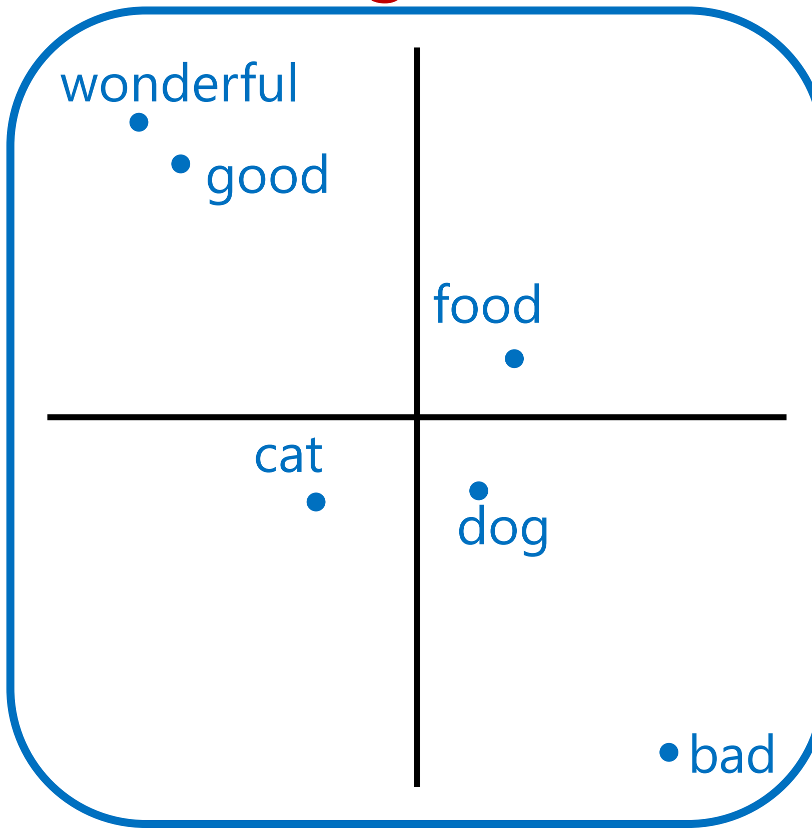
Step 2: local topology in general space

In general CLWE, learn linear combination of **nearest neighbors** that reconstructs the **the target word**



$$\hat{\alpha}_{w*} = \arg\min_{\alpha_{w*}} \left| Y_w^{\text{gen}} - \sum_{i \in N_w} \alpha_{wi} X_i^{\text{gen}} \right|^2$$

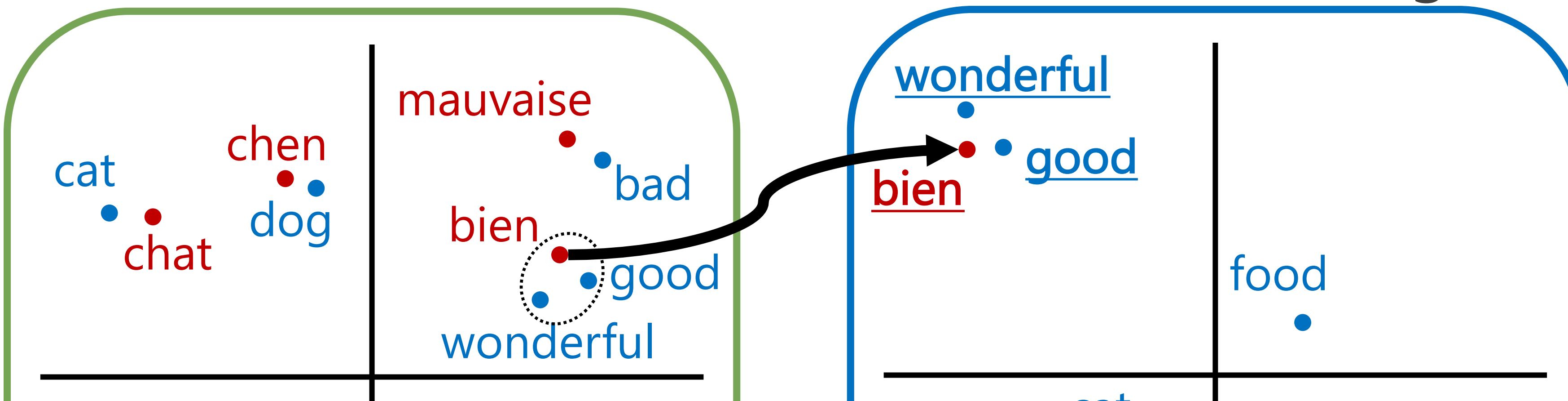
General CLWE



Task-specific word emb.

Locally linear mapping:
Step 3: task-specific word embeddings

Compute **task-specific word emb. of the target word** as the linear combination with the induced weights



bien

good, wonderful

$$\hat{\alpha}_{w*} = \underset{\alpha_{w*}}{\arg\min} \left| Y_w^{\text{gen}} - \sum_{i \in N_w} \alpha_{wi} X_i^{\text{gen}} \right|^2$$

General CLWE

bien

good, wonderful

$$Y_w^{\text{spec}} = \sum_{i \in N_w} \hat{\alpha}_{wi} X_w^{\text{spec}}$$

Task-specific word emb.

Proposal:
Hyperparameter search

Dev. set in the target language is required to tune the hyperparameter k (size of nearest neighbors)

Tuning to the task (no additional resources)

Assume the best k is **independent of language**

Apply LLM to the embeddings of the source language and evaluate on the dev. set of the source language

(Tuning to the task/language)

Utilize small development set (100 examples) of the target language

Experimental setup (1/2)

Goal:

- Does out task-specific word embeddings improve the multilingual model?

Task:

- Topic classification task (and sent. analysis)

Languages:

- Source language: English (en)
- Target languages:
  - Danish (da), Italian (it), French (fr), Swedish (sv)

Datasets:

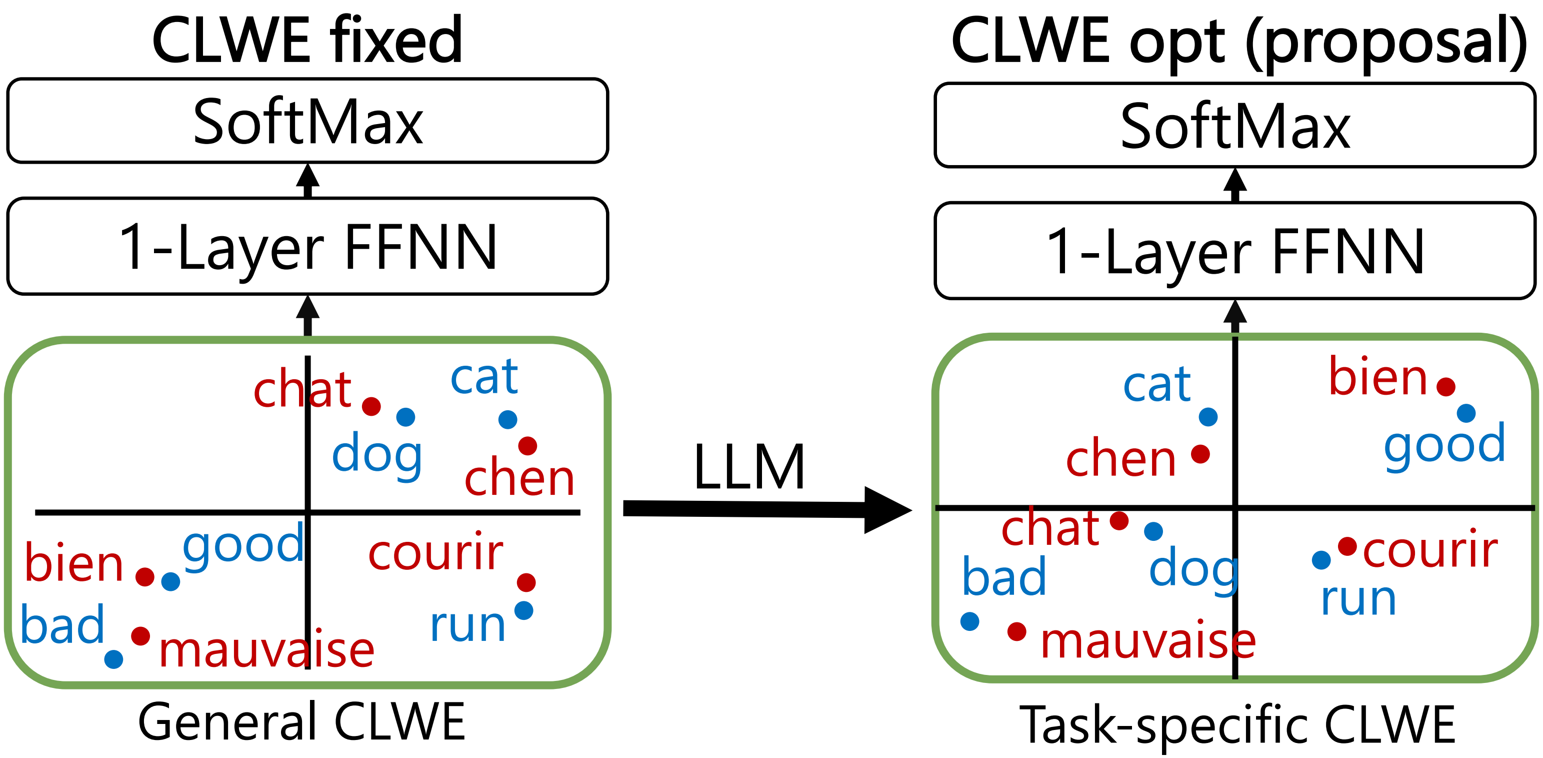
- RCV1/2 dataset (four topics)

Experimental setup (2/2):

Models to compare

Compare the following two models to evaluate the effect of task-specific CLWE

- Experiments on more models on the paper



Results:

Topic classification task

Classification accuracies in four languages

Method	k-tuning	en-da	en-it	en-fr	en-sv
CLWE fixed	-	0.621	0.535	0.772	0.816
CLWE opt (Proposed)	task	0.672	**<u>0.623</u>**	**<u>0.885</u>**	**<u>0.831</u>**
CLWE opt (Proposed)	task/lang	**<u>0.687</u>**	0.615	0.879	0.830

- CLWE opt outperforms the baseline
- Tuning k for task and language is not necessary

Conclusion and future work

Conclusion

- Proposed a method to build a multilingual model with <u>task-specific word embeddings</u>
- Evaluated our method on real tasks and <u>confirmed its effectiveness</u>

Future work

- Evaluate this method on wider range of tasks, languages, and models
- Further improve the quality of locally linear mapping