CS 784: Computational Linguistics
Lecture 18: Computational Multilingualism (in 2025)

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March 20, 2025

Reading: Ponti et al. 2019. Modeling Language Variation and Universals: A Survey on Typological Linguistics for Natural Language Processing. *Computational Linguistics*.

Pre-Class Survey

Do you think language is a **special** type of time series?

In other words, how do you like the following statement?

Suppose we have a perfect stock price prediction model, it would be a (nearly) perfect language model as well.

Computational Multilingualism before LLMs

Machine Translation

- **Bilingual lexicon induction**: recognize mutually translatable pairs without word-level annotation.
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Cross-Lingual Information Retrieval

- Represent cross-lingual information digitally and retrieve it

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Cross-Lingual Transfer (of Neural Models)

- Pretraining on one language and fine-tuning on another
- Multilingual BERT

Outline

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5. How can typology be harnessed for data selection, rule-based systems, and model interpretation?

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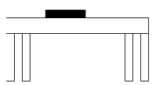
- **Semantic typology**: lexicalization patterns, etc.

[Feist and Gentner, 2003]


English	over	on	in
Spanish	sobre	en	en
Japanese	ue	ue	naka

The World Atlas of Language Structures (WALS)

The online database of typological features of languages `https://wals.info/`.

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- ACL 2016: 24 papers, 24 languages:
  EN: 18, DE: 6, ZH: 5, AR: 1, BG: 1, CA: 1, CS: 1, DA: 1, EL: 1, ES: 1, **EU**: 1, FR: 1, HE: 1, **HU**: 1, IT: 1, JA: 1, KO: 1, ML: 1, NL: 1, PL: 1, PT: 1, SL: 1, SV: 1, TR: 1

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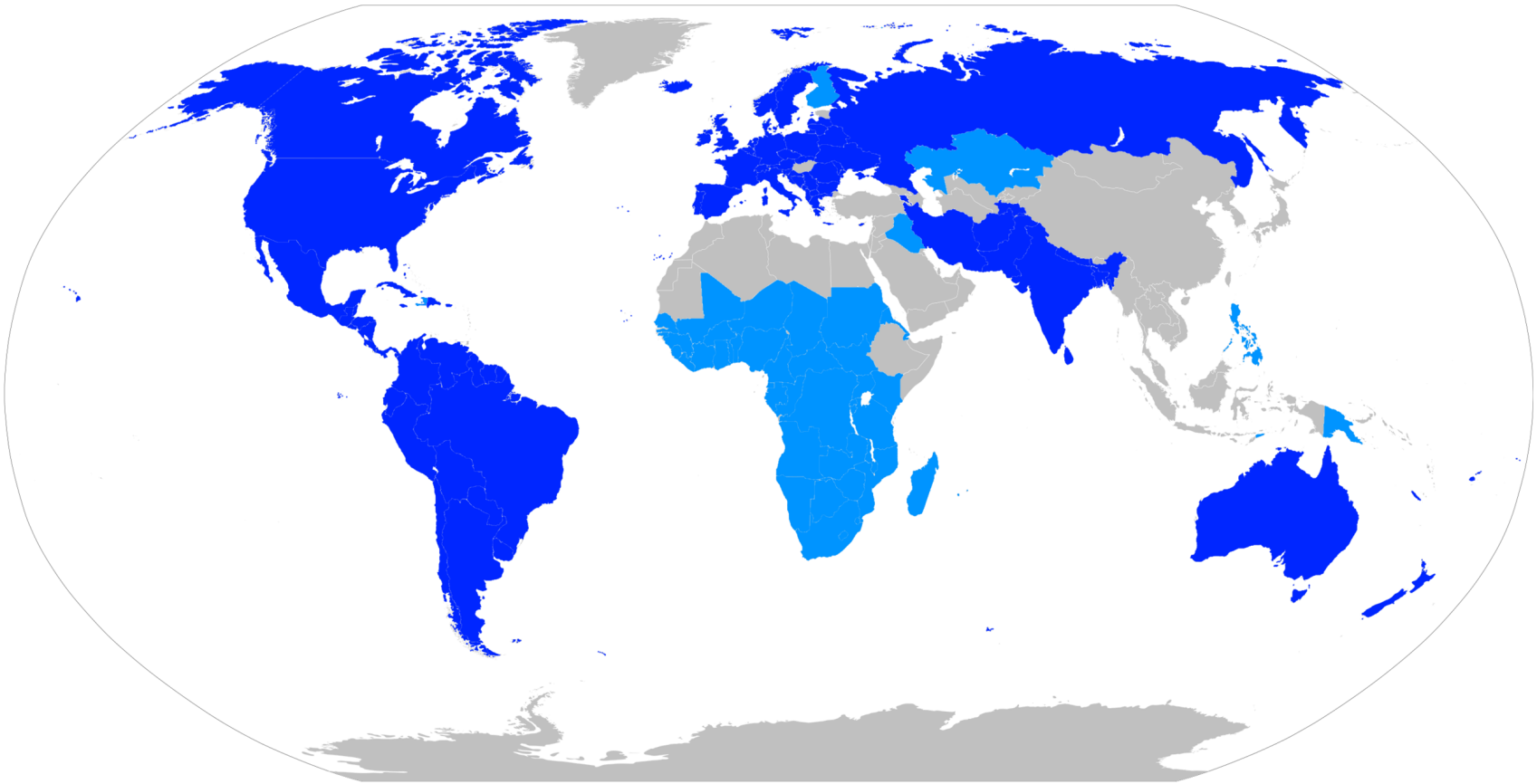
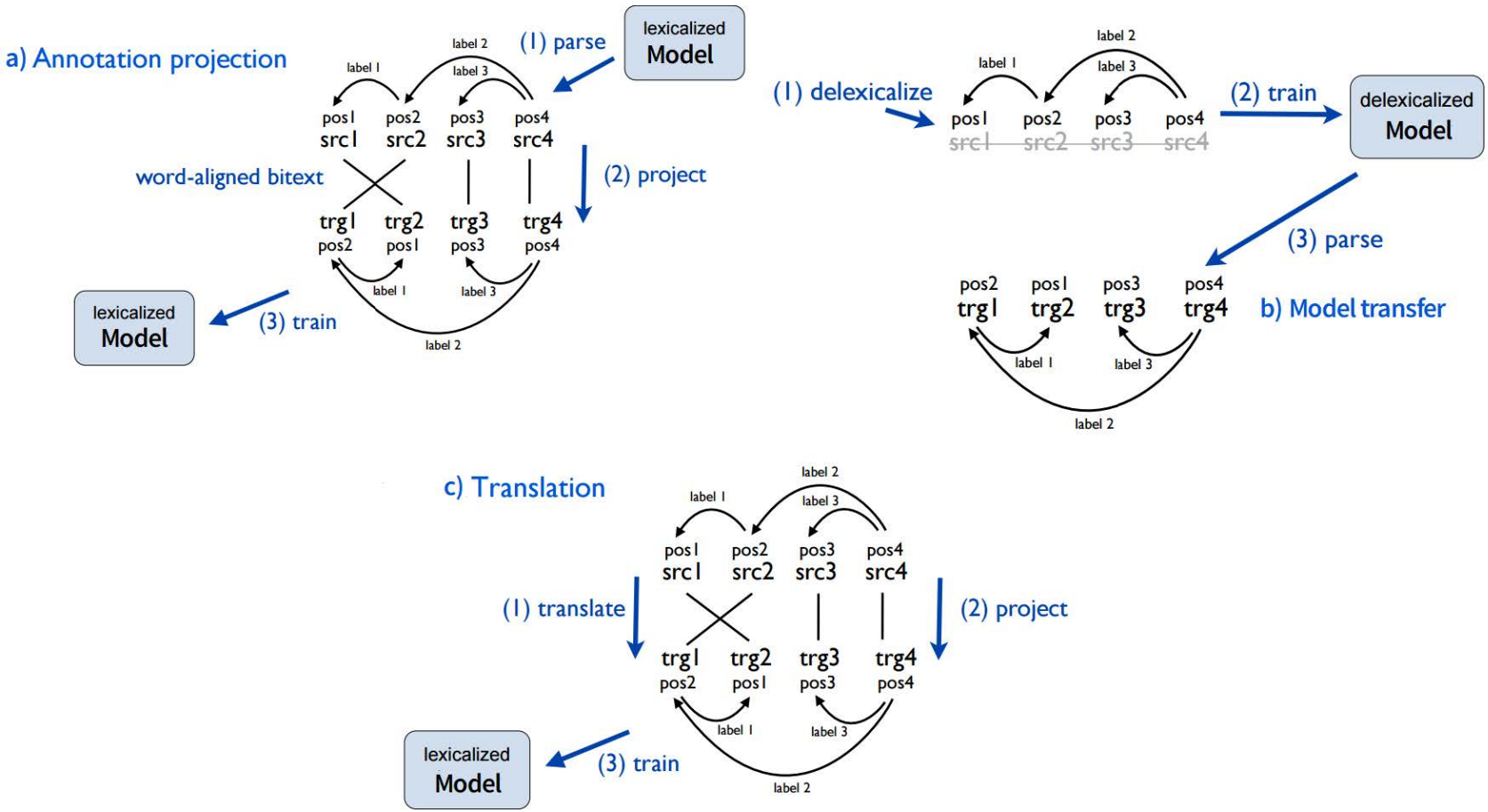
The Indo-European Language Distribution



Word Alignment

Word alignment used to be the key of multilingual NLP.



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Key idea: if a word e in one language frequently co-occurs with a word f in its bitext counterpart (another language), they are likely to be aligned.

Word Alignment: Evaluation

The alignment error rate (AER):

$$\text{AER} = 1 - \frac{|P \cap A| + |P \cap R|}{|P| + |R|}$$

P :predicted alignment pairs $\langle s, t \rangle$

R :required alignment pairs

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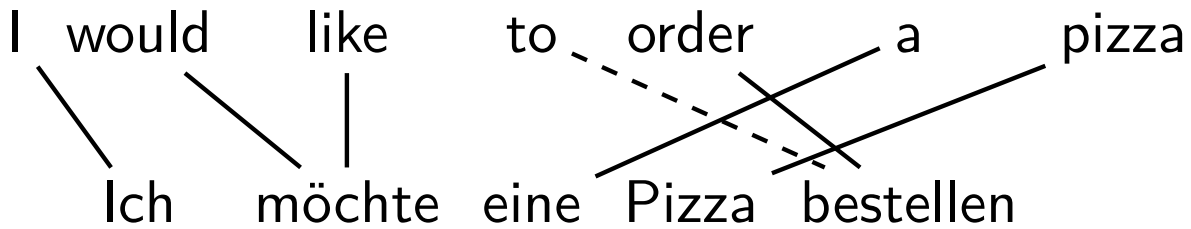

Solid lines: required alignment pairs.
Dashed lines: optional alignment pairs.

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Why?

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- Non-English languages generally take more bytes to represent.

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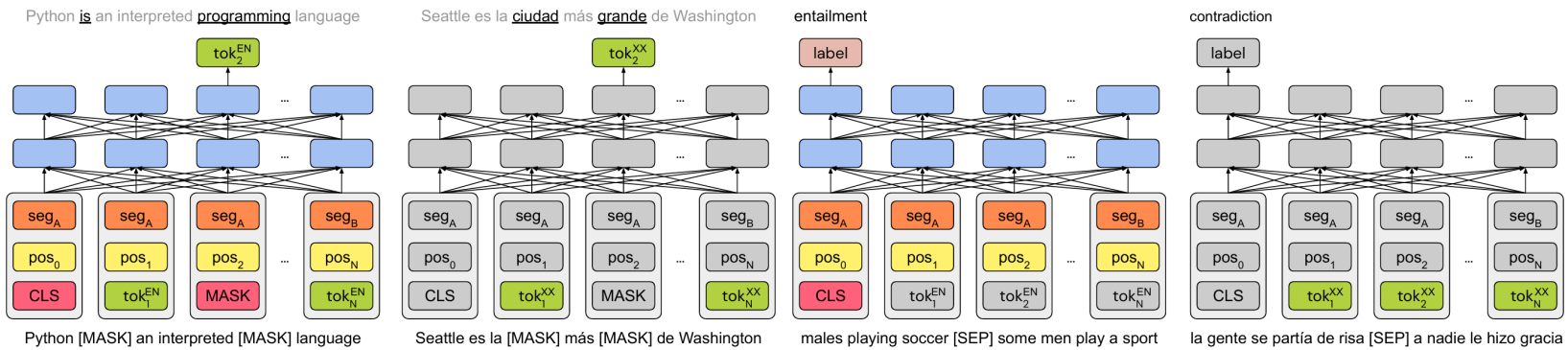
Open problem: why does zero-shot corss-lingual transfer work? Explain scientifically.

Parameter-Efficient Cross-Lingual Transfer

Key assumption: the Transformers have learned some language-agnostic processing protocols, so we can only fine-tune the non-contextualized (layer 0) word embeddings.

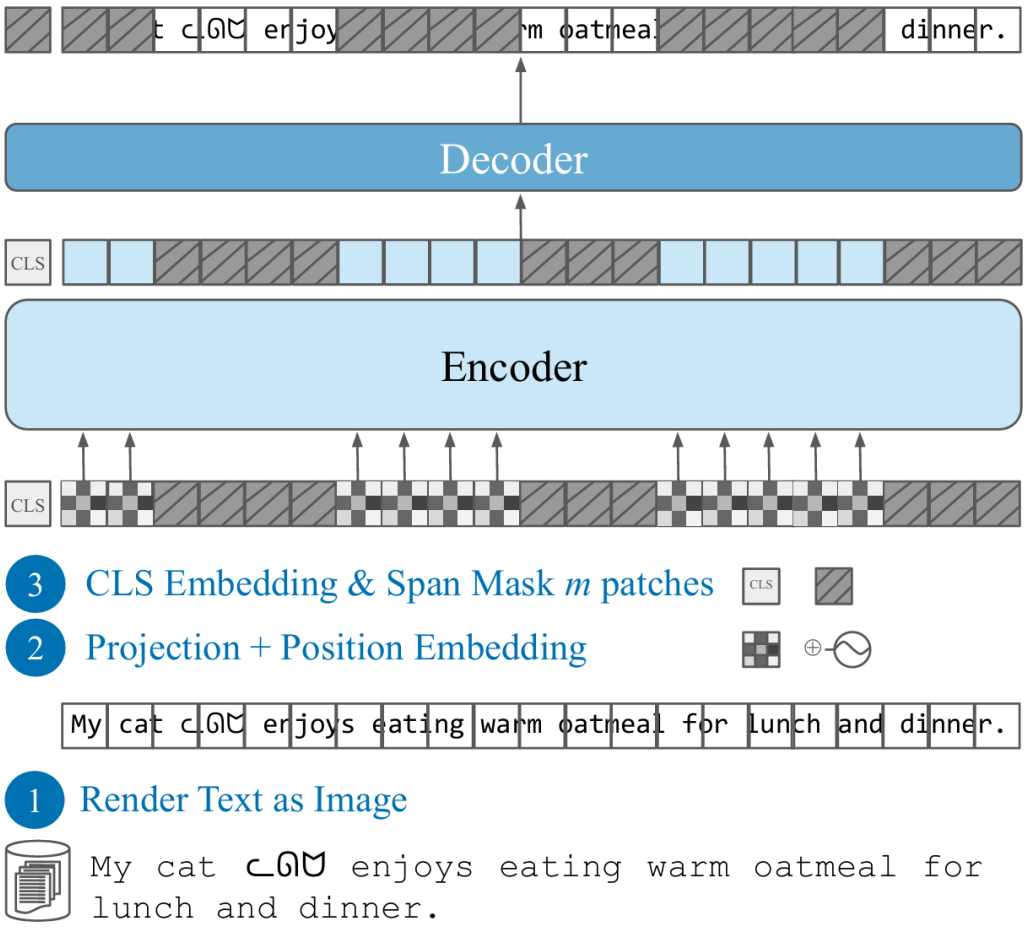


(a) English pre-training (b) L_2 embedding learning (c) English fine-tuning (d) Zero-shot transfer to L_2

[Artetxe et al. 2020. On the Cross-lingual Transferability of Monolingual Representations. ACL]

Pixel Language Models

Predict next pixel patch, instead of next word, in a sequence.



[Rust et al. 2023. Language Modelling with Pixels. ICLR]

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  Possible issue(s): this will not directly improve the model; there may be shortcuts in experimental designs.

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- LLM assisted language documentation?

Any more ideas?

Next

Language models as human cognitive models