

# Technology for Minoritized Language Communities

## An Overview of Language and Speech Technology for Kurdish

Sina Ahmadi  
George Mason University  
<https://sinaahmadi.github.io>



University of Toronto  
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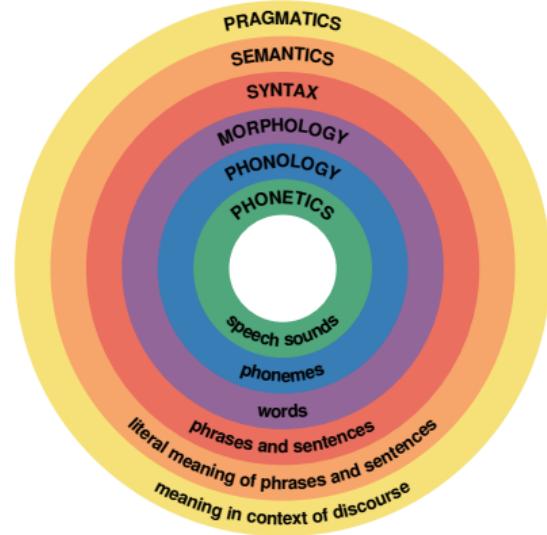
3 Kurdish Language Processing (KLP)

4 Conclusion



# Language and Speech Technology: What Is It?

- **Theoretical Linguistics:** Nature of language  
Phonetics, phonology, morphology, syntax etc



# Language and Speech Technology: What Is It?

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Phonetics, phonology, morphology, syntax etc
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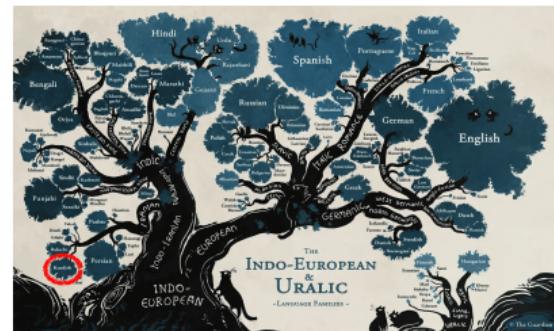
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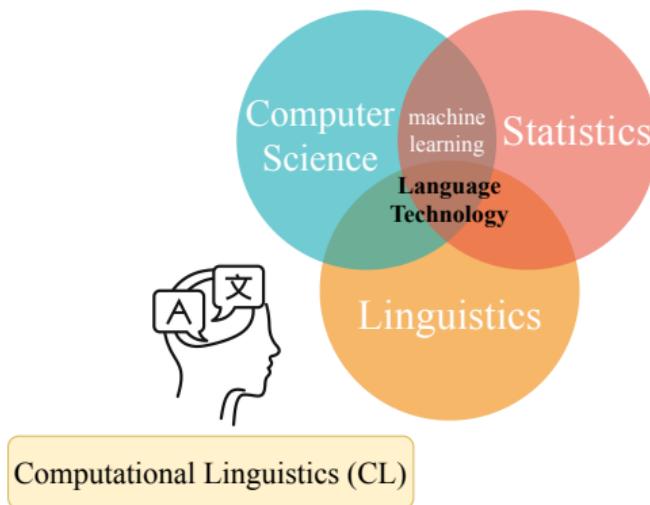
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- **Computational linguistics:** languages and computers ⇒ **our topic today**



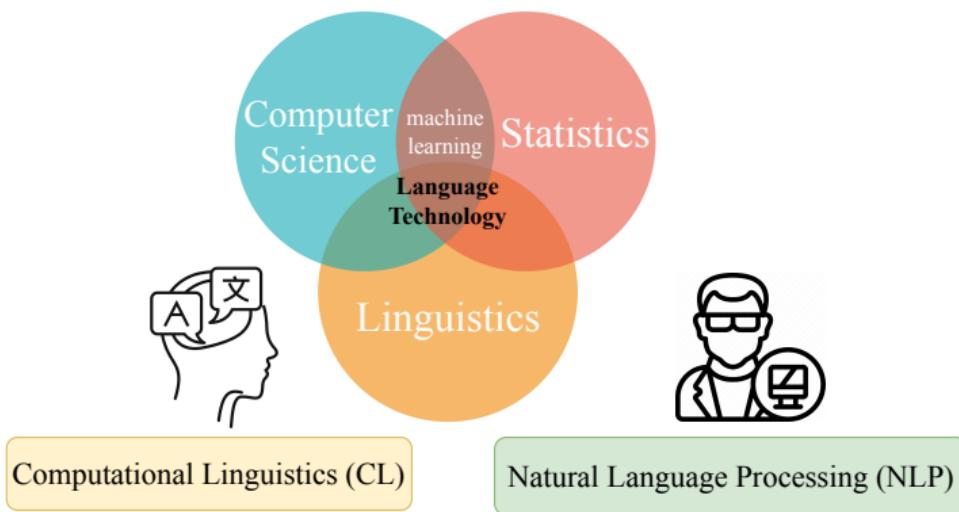
# LST: “understanding” language computationally

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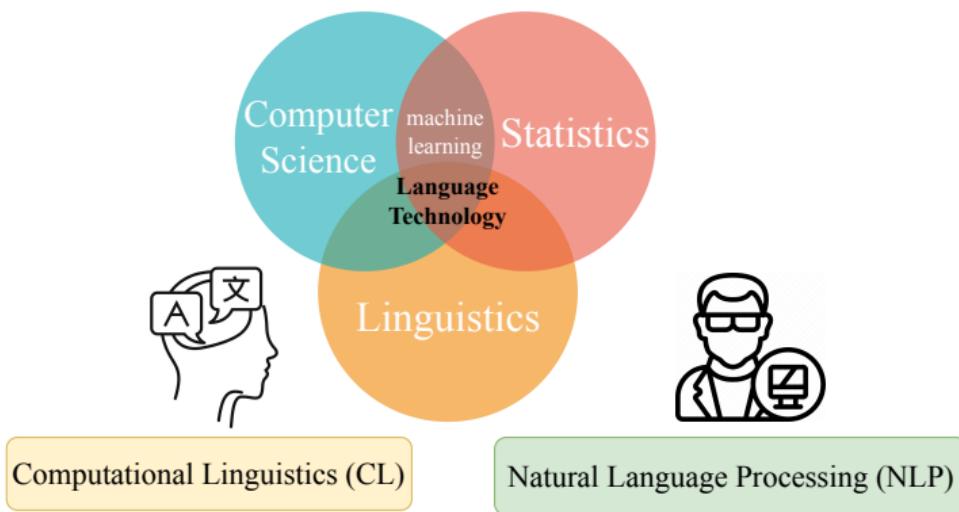
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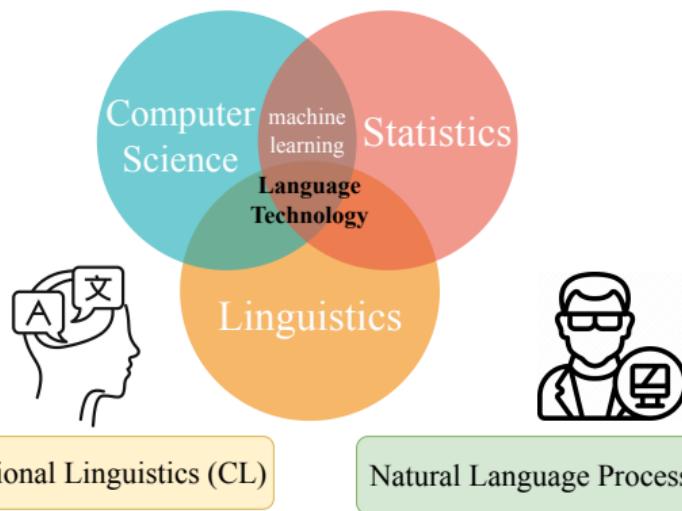
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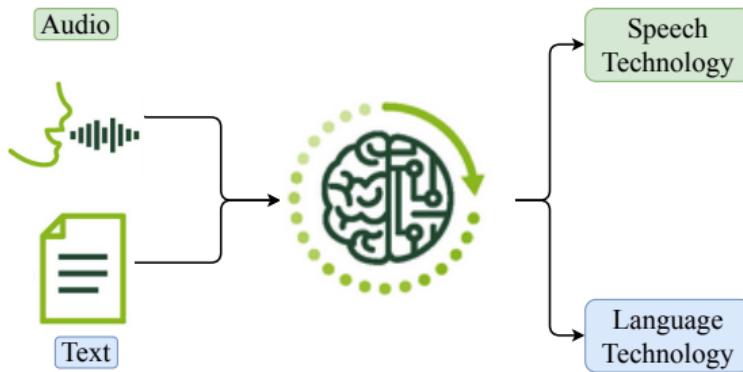
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- Language as text ⇒ **Language technology**

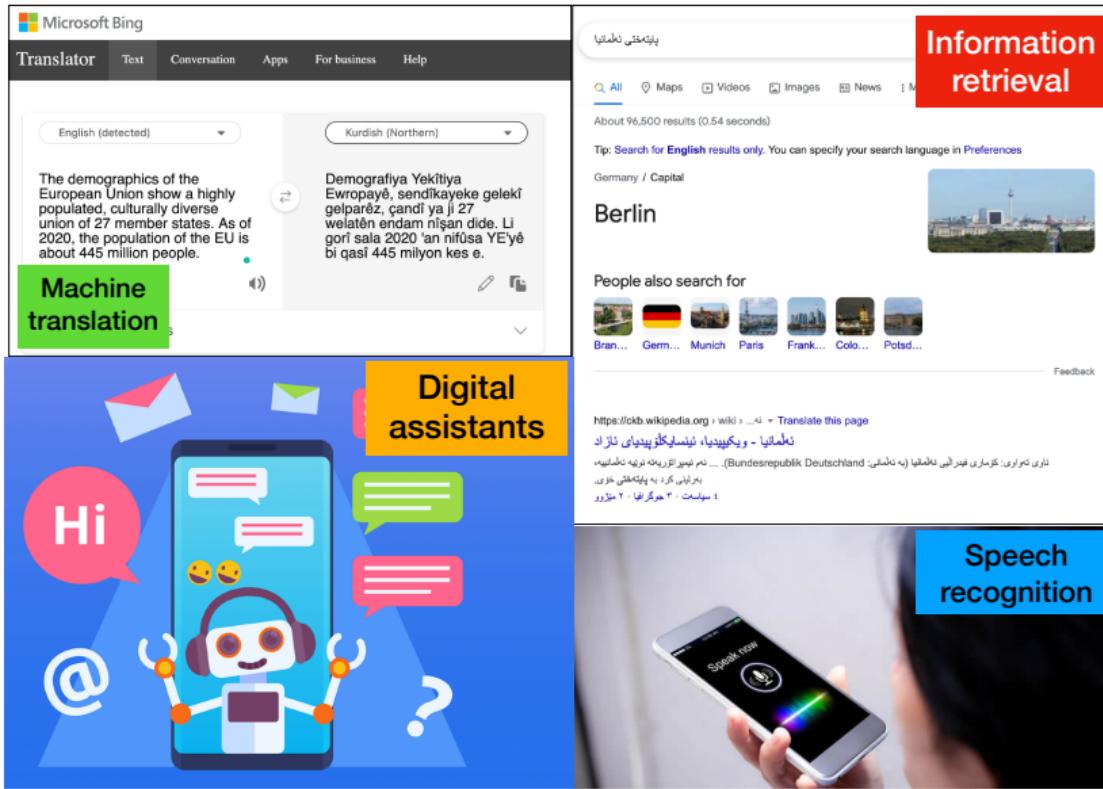


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- Language as text ⇒ **Language technology**
- Language as sound ⇒ **Speech technology**



# Language and Speech Technology: a few applications



# Language and Speech Technology: a few tasks

## ● Machine translation

≡ Translate

Text Images Websites

FRENCH - DETECTED ENGLISH

"Toute faute qu'on fait est un cachot qu'on s'ouvre." X

53 / 5,000

Any mistake we make is a dungeon we open. ☆

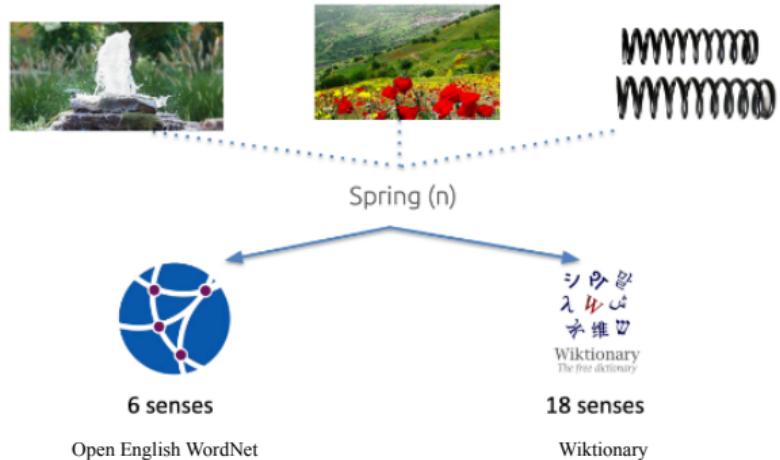
Send feedback



# Language and Speech Technology: a few tasks

- Machine translation
- Word-sense disambiguation

In *spring*, the garden is a feast of blossom.



# Language and Speech Technology: a few tasks

- Machine translation
- Word-sense disambiguation
- Spelling error correction
  - This cake is basicly sugar, butter, and flour. [→ basically]
  - We went to the store and bought new stove. [→ a new stove]
  - i'm entirely awake. [→ {I, wide}]



# Language and Speech Technology: a few tasks

- Machine translation
- Word-sense disambiguation
- Spelling error correction
- Question answering

A screenshot of a search results page from a search engine. The search query "what languages are spoken in switzerland" is entered in the search bar. Below the search bar are navigation links: All, Images, Maps, News, Videos, More, Settings, and Tools. The main result is titled "Switzerland > Official languages" and features a red Swiss flag icon. It lists four languages in a 2x2 grid: German (top-left), French (top-right), Romansh (bottom-left), and Italian (bottom-right).

German	French
Romansh	Italian



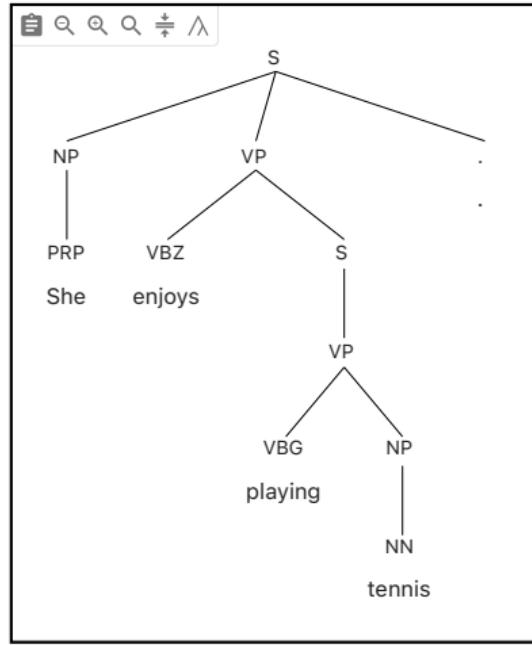
# Language and Speech Technology: a few tasks

- Machine translation
- Word-sense disambiguation
- Spelling error correction
- Question answering
- Syntactic parsing

Sentence:

She enjoys playing tennis.

Parse tree:



# Language and Speech Technology: a few tasks

- Machine translation
- Word-sense disambiguation
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- Syntactic parsing
- Text summarization



# Language and Speech Technology: a few tasks

- Machine translation
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- Question answering
- Syntactic parsing
- Text summarization
- Sentiment & emotion analysis



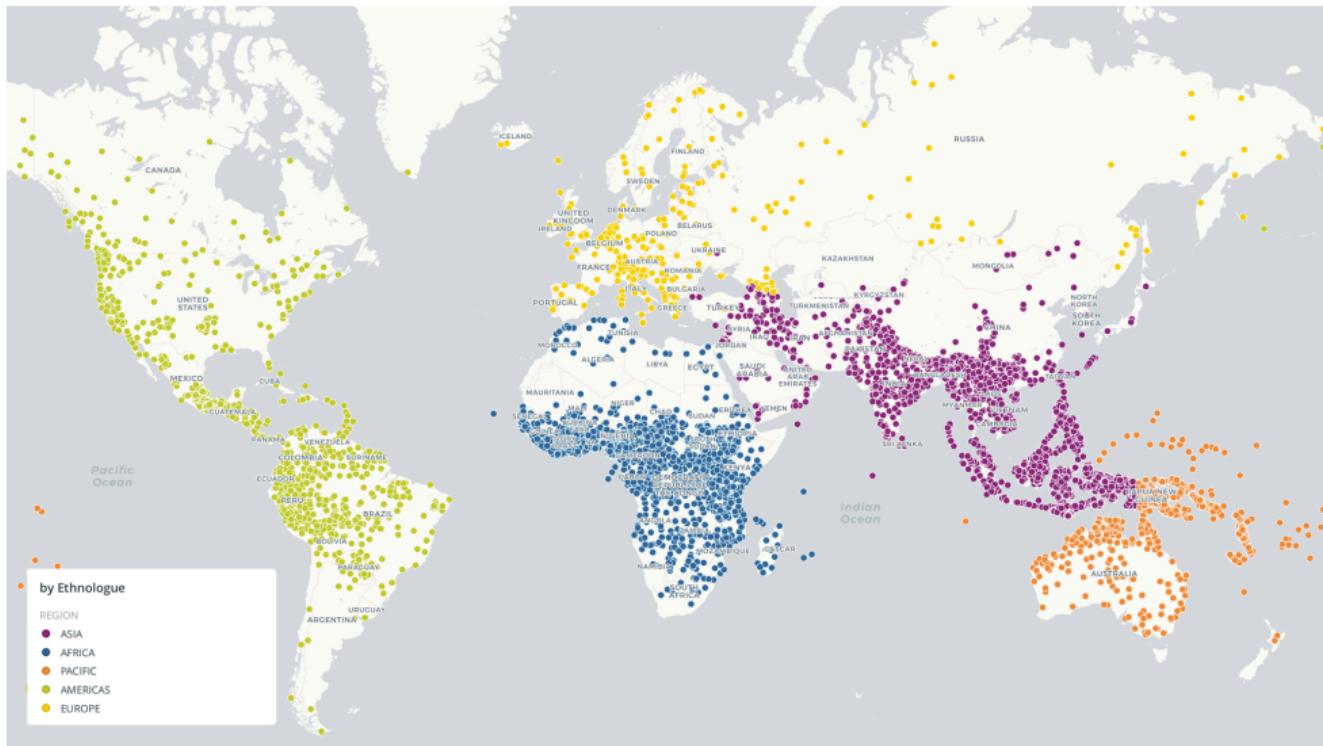
# Language and Speech Technology: a few tasks

- Machine translation
- Word-sense disambiguation
- Spelling error correction
- Question answering
- Syntactic parsing
- Text summarization
- Sentiment & emotion analysis
- And many more...



# Language and Speech Technology: Linguistic Disparity

- More than 7,000 “languages” are spoken today (Ethnologue, 2023).



# Language and Speech Technology: Linguistic Disparity



# Language and Speech Technology: Linguistic Disparity

## High-resource

- Billions of documents online
- Large annotated datasets
- Large Wikipedia



# Language and Speech Technology: Linguistic Disparity



## High-resource

- Billions of documents online
- Large annotated datasets
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## Medium-resource

- Millions of documents online
- Few labeled datasets
- Decent Wikipedia



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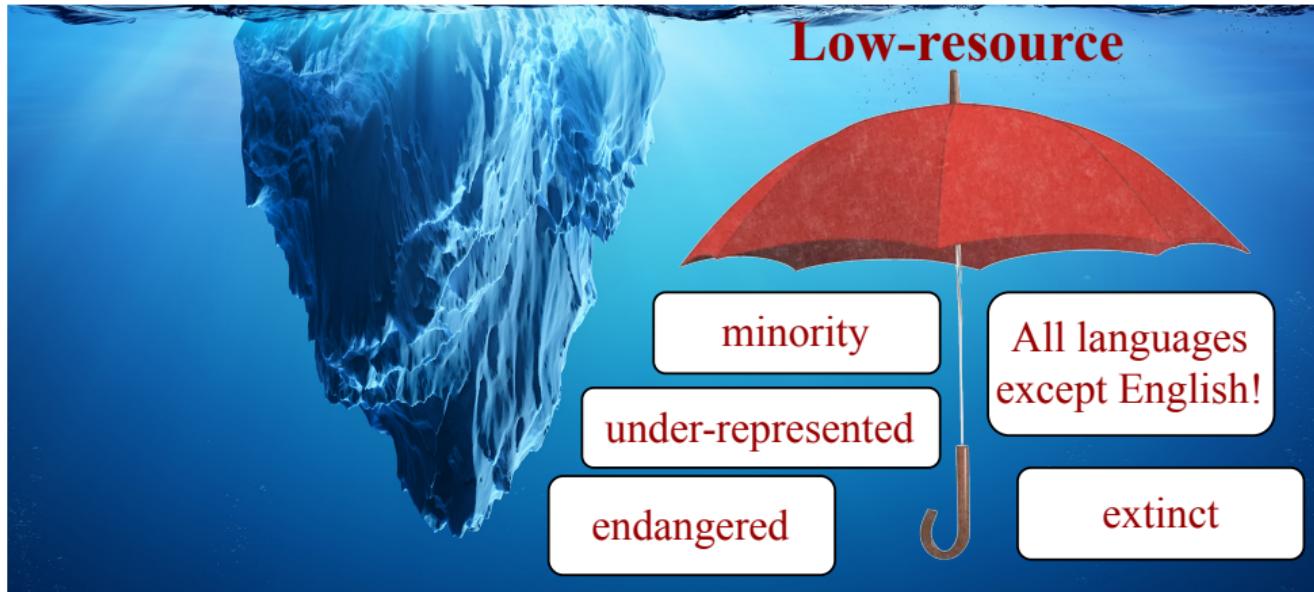
## Medium-resource

- Millions of documents online
- Few labeled datasets
- Decent Wikipedia

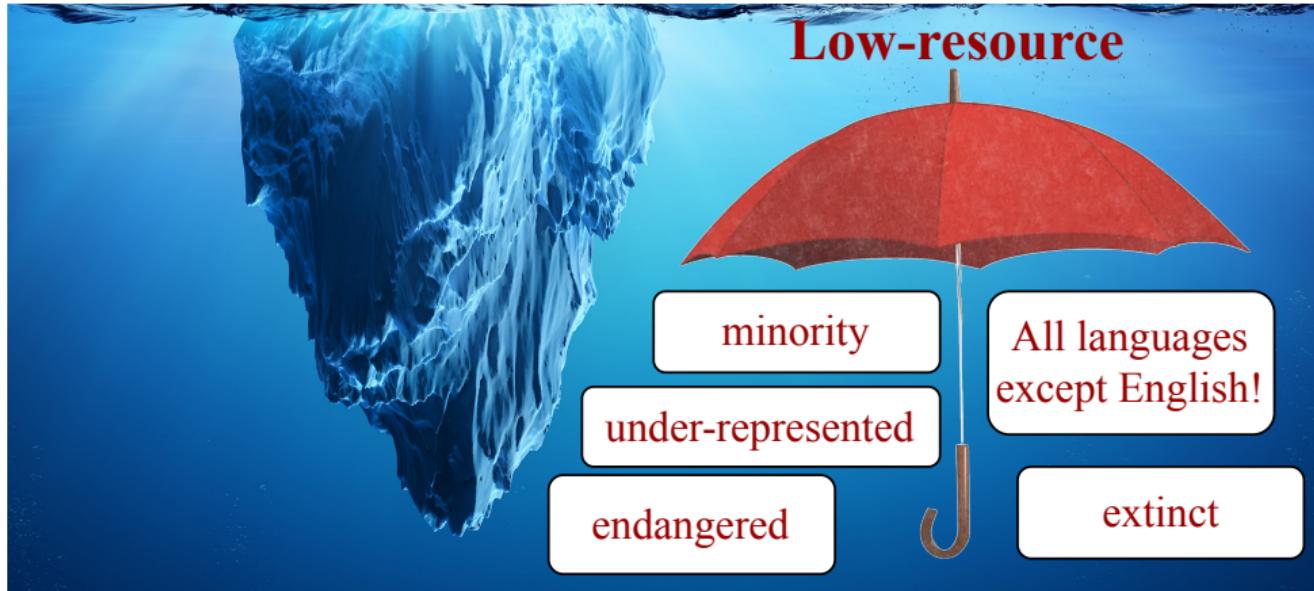
## Low-resource

- Hundreds of documents online
- (almost) No labeled datasets
- Small Wikipedia

# Language and Speech Technology: Linguistic Disparity



# Language and Speech Technology: Linguistic Disparity



- 99% of languages around the globe are low-resourced, including Kurdish!



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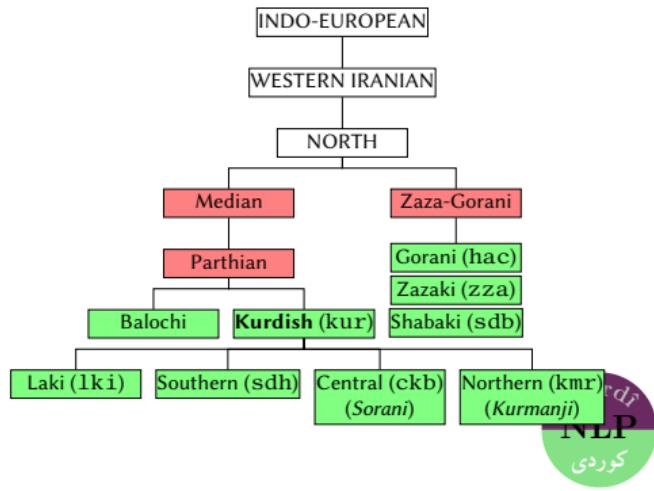


# Kurdish Language

- an Indo-European language



Source: <https://www.britannica.com/topic/Kurd>

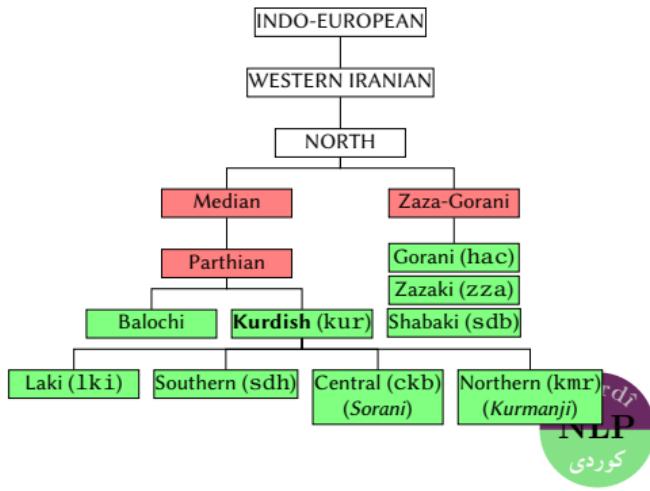


# Kurdish Language

- an Indo-European language
- spoken by 20-30 million speakers



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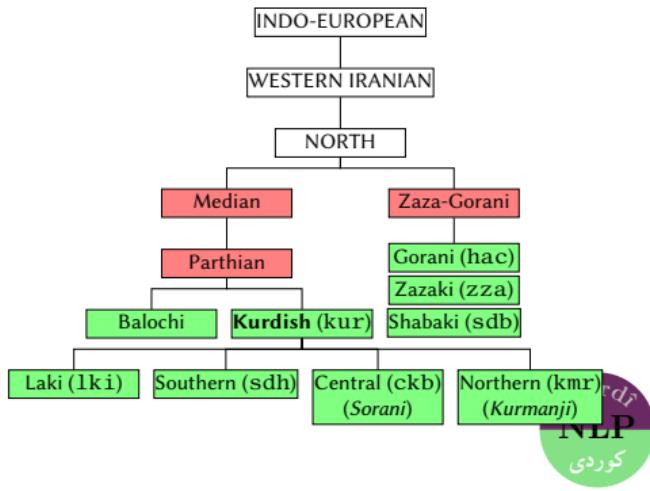


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- an Indo-European language
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- spoken in many dialects and subdialects (*dialects or languages?*)



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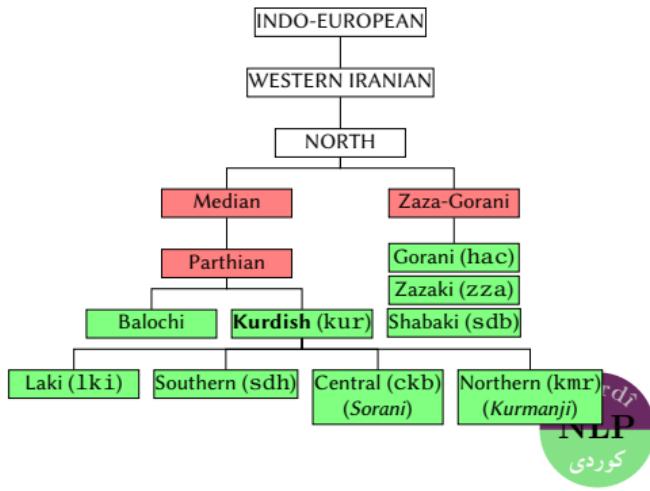


# Kurdish Language

- an Indo-European language
- spoken by 20-30 million speakers
- spoken in many dialects and subdialects (*dialects or languages?*)
- has a longer oral tradition than a written one ⇒ *lack of data*



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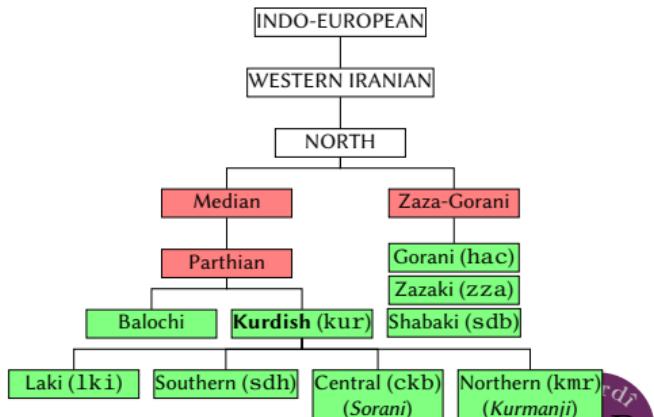


# Kurdish Language

- an Indo-European language
- spoken by 20-30 million speakers
- spoken in many dialects and subdialects (*dialects or languages?*)
- has a longer oral tradition than a written one ⇒ *lack of data*
- written in many scripts: the Latin-based and Arabic-based ones still widely in use



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# Kurdish Language: Issues

- Too many scripts scatter readers and creates further challenges in NLP

ئیمرووز په لاؤنی مەرمکە گرتۆتى خەلکىش بى ھوول ئەز  
کورونا دەوران گرتۆ

فەلسەفە و درجه سۆقرات، چاودىز زانستىپل سرۇوشتى بقىيە  
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لە پاستىدا ئەم كارەكتىرانە سەر بە كۆمەلگائى سۈننەتىي  
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Ji ber barîna berfê li bajarê Wan û navçeya  
Tetwan a Bedlîsê dîmenêن ciwan derketin  
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[lki-ar]

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[kmr-latn] [ckb-latn]



Kurdish

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[lki-ar]	ئیمرووژ په لاؤنی مەرمکە گرتۆتى خەلکىش بى ھول ئەز کورونا دەوران گرتق
[sdh-ar]	فەلسەفە و درجه سۆقرات، چاودیز زانستیل سرۇوشتى بقىيە و کارىكەو كىدار، باوھر، دين و ئايىن خەلک نىاشتىيە
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[ckb-ar]	لە پاستىدا ئەم كارەكتىرانە سەر بە كۆمەلگائى سۈننەتىي كوردستان و جىلەكانى را بىردوون
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Kurdish



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  - variations like *I*, *II* or *†* for *[‡]*

[lki-ar]	ئیمرووز په لاؤنی مەرمکە گرتقى خەلکىش بى ھوول ئەز كورونا دەوران گرتقى
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[kmr-ar]	وەزارەتا ئۇقاقي و كاروبارىن ئايىنى ل ھېرىما كوردستانى دۆر بىنەنەنەك فەرمى ب ھەلکەفتەكى ئايىنى رۇھنكرنەك دەرگىر
[ckb-ar]	لە پاستىدا ئەم كارەكتىرەنە سەر بە كۆمەلگەسى سۈننەتىيە كوردستان و جىلەكانى را بىردوون
[kmr-latn] [ckb-latn]	Ji ber barîna berfê li bajarê Wan û navçeya Tetwan a Bedlîsê dîmenêن ciwan derketin holê.
[ckb-latn]	Bergirî lem bwareda her le yekemîn rojekanî damezrandinî komarî Turkyawe hate goře.

Kurdish



# Kurdish Language: Issues

- Too many scripts scatter readers and creates further challenges in NLP
- Written in various orthographies following different conventions
- Even though, still written *unconventionally*
  - *di sala 2020'an* | *2020-an* | *2020an de*  
“in the year 2020”
  - *hêviya*, *hêviya* or *hêvi ya* “hope of”?
  - ١٢٣٤٥٦٧٨٩, • ١٢٣٤٥٦٧٨٩ or  
0123456789?
- Kurdish orthographies are phonemic, but not always:
  - double-usage characters: *ى* for *î/y* and *و* for *u/w*
  - variations like *I*, *II* or *I* for *[i]*
  - vowel *i* missing in the Arabic-based

ئیمرووز په لاؤنی مەرمکە گرتۆتى خەلکىش بى ھولل ئەز  
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دەرك

لە پاستىدا ئەم كارەكتىرانە سەر بە كۆمەلگائى سۈننەتىي  
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Kurdish



# Kurdish Language: Unconventional Writing

- Almost 300 writing systems exist (and many adopted ones)



# Kurdish Language: Unconventional Writing

- Almost 300 writing systems exist (and many adopted ones)
- Less than 4,000 languages have a written form



# Kurdish Language: Unconventional Writing

Most countries are X-lingual, but not all officially!

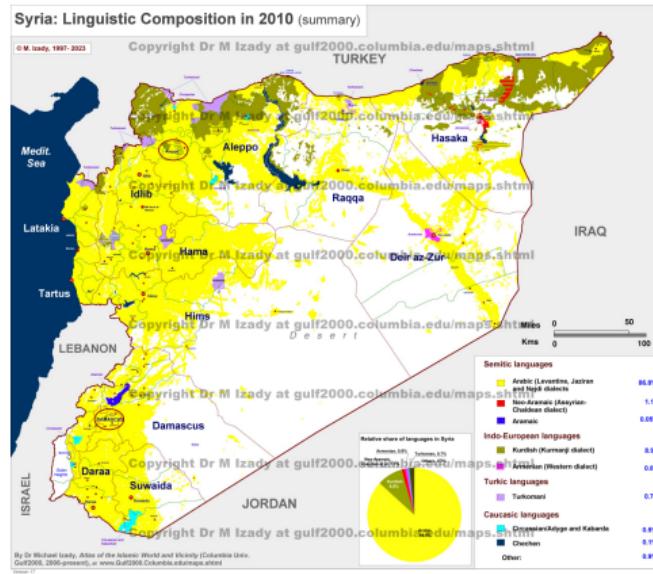
- Turkey:  
→ Turkish



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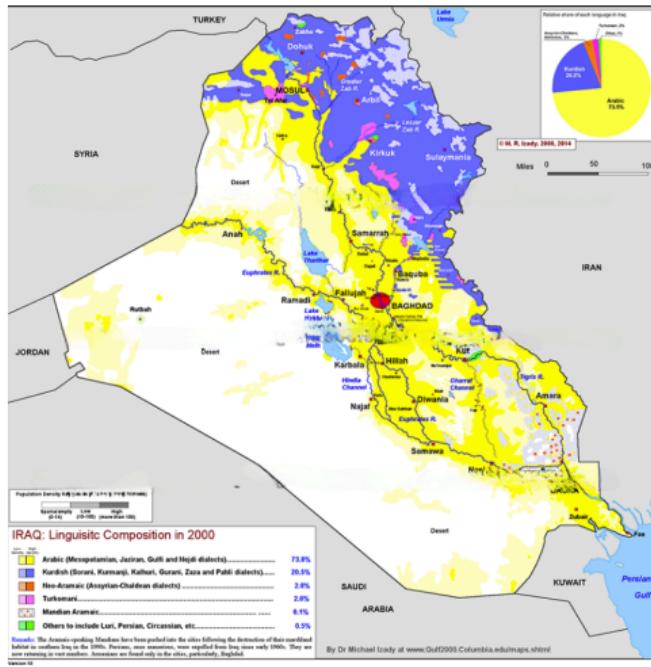
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  - Syria:  
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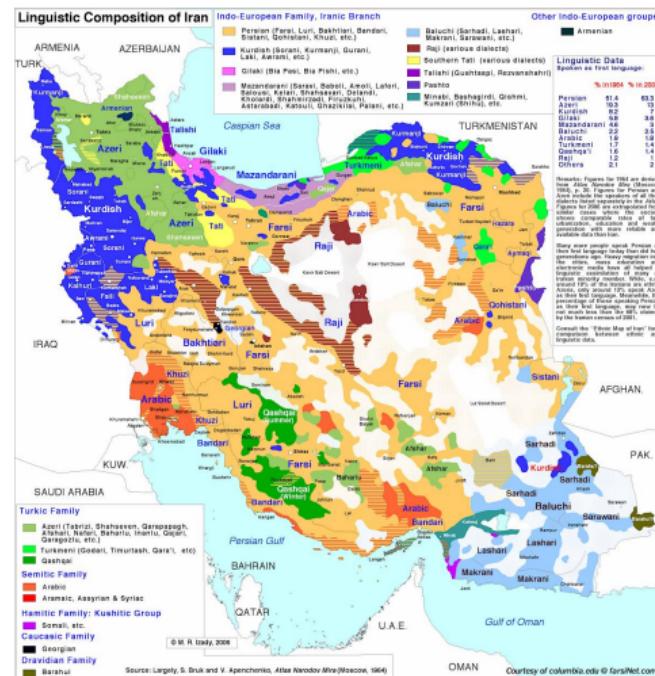
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- Iraq:  
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# Kurdish Language: Unconventional Writing

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Unconventional writing refers to the usage of the **script of another language**, presumably that of a dominant language.

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- *mer6 pr tn mess pr mn anif* (French SMS language)



# Kurdish Language: Unconventional Writing



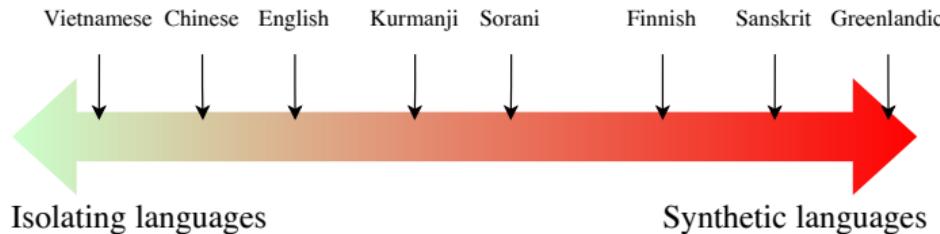
# Kurdish Language: Complex Morphology

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# Kurdish Language: Complex Morphology

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POS	Morpheme per form		
	pre-stem	post-stem	average
Noun	0	3.63	3.63
Adjective	0	4.30	4.30
Verb	INTR	1.05	2.32
	TR	1.65	2.46
Average	1.35	3.1	<b>2.22</b>

## Degree of synthesis in inflectional morphology of Central Kurdish based on our datasets

# Kurdish Language: Complex Morphology

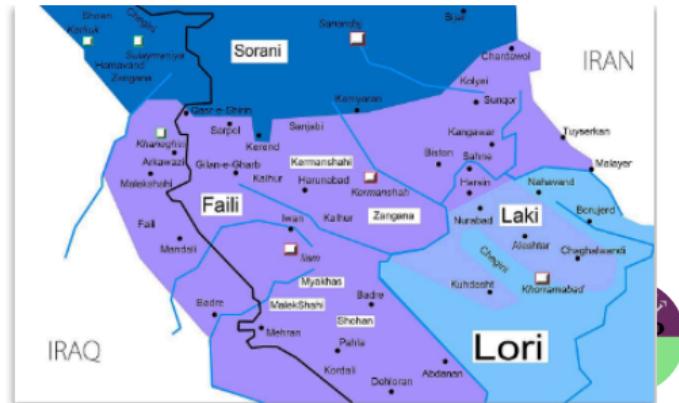
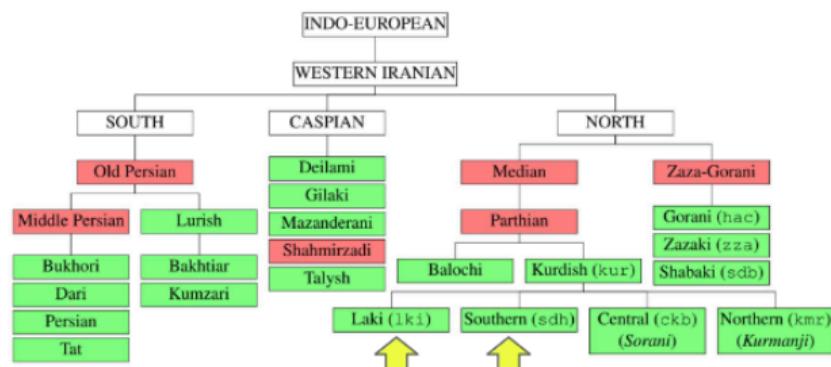
- Kurdish has a synthetic morphology: > 2000 noun forms from a stem!
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  - Complex morphotactics due to split-ergativity

The placement of the endoclitic  $=i\$$  (in green boxes) and agent marker  $=im$  (in blue boxes) with respect to the base and each other in a verb form. Note that Sorani Kurdish is a null-subject language.

# Kurdish Language: Underrepresented Varieties

Not too many resources available for Southern Kurdish and Laki:

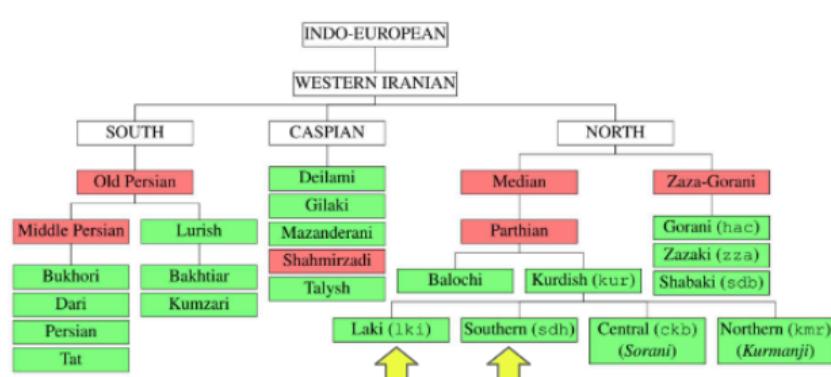
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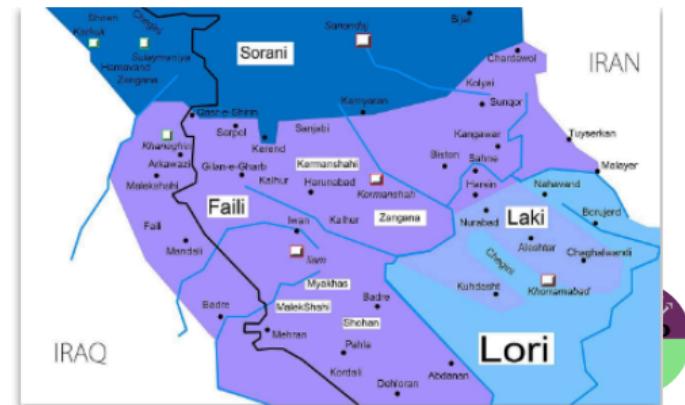
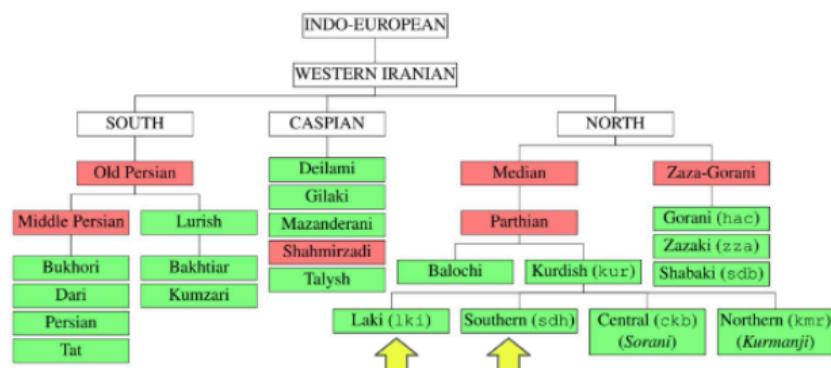
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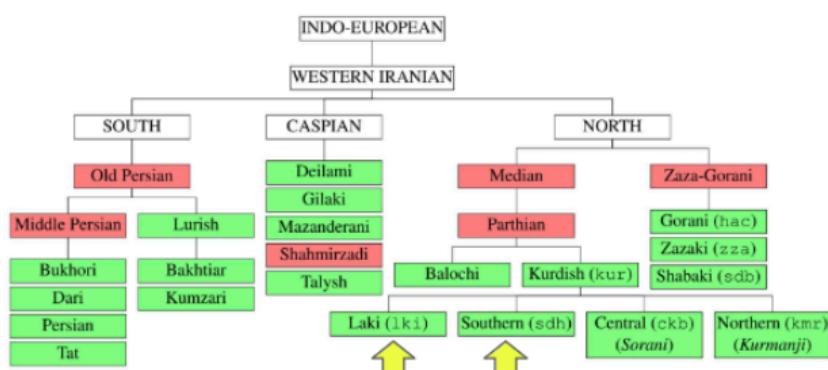
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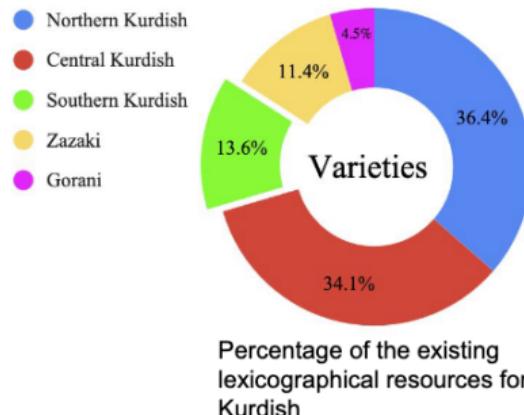
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- Few available digital resources available [Ahmadi et al., 2019]



# Table of Contents

1 Language and Speech Technology

2 Kurdish Language

3 Kurdish Language Processing (KLP)

4 Conclusion



# Kurdish Language Processing: Scientific Contributions

Less than 100 publications address a task in Kurdish language technology.

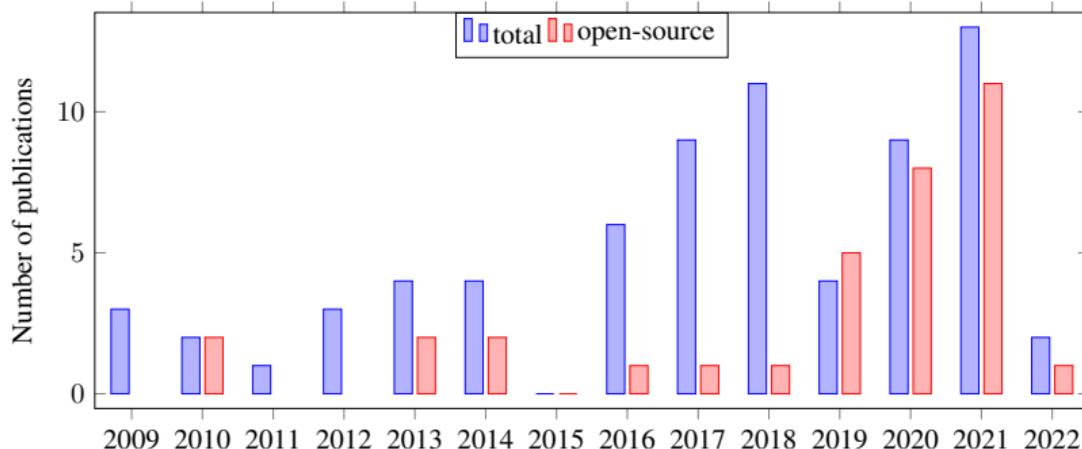
- the earliest works in the field of KLP date back to 2009  
except a work in 1995 [Baban and Husein, 1995] – Why such an interval?!)
- thus far, a total number of **87** publications are published in a field directly related to KLP, including non-peer-reviewed ones
- all varieties have not equally received attention

## Open-source

Does the paper provide the discussed resource or tool under an open-source license?



# Kurdish Language Processing: Scientific Contributions

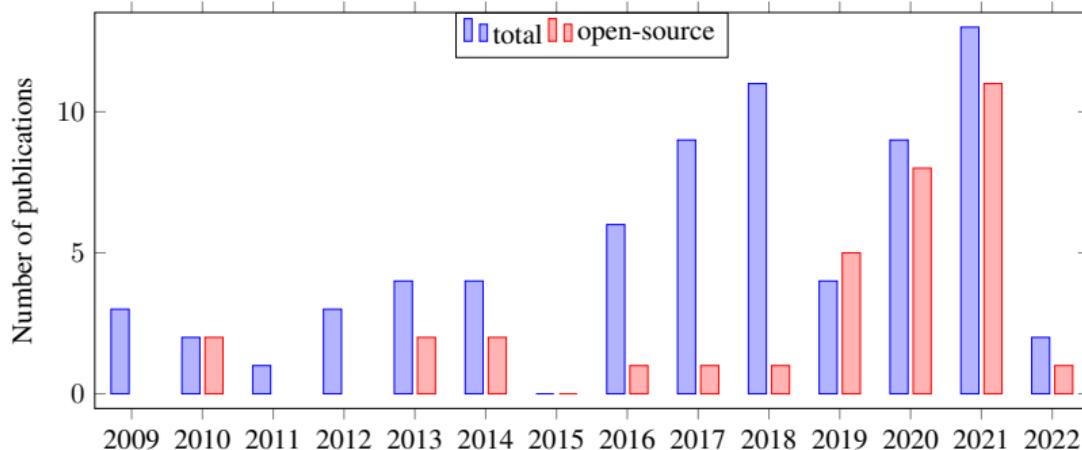


Number of scientific publications directly related to KLP per year and field

- Roughly a third provide their resources or tools under an open-source license



# Kurdish Language Processing: Scientific Contributions

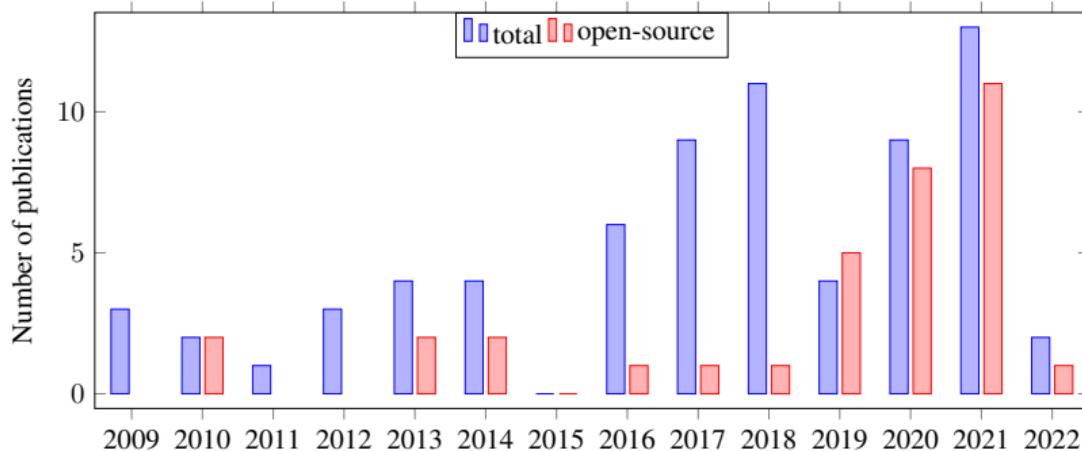


Number of scientific publications directly related to KLP per year and field

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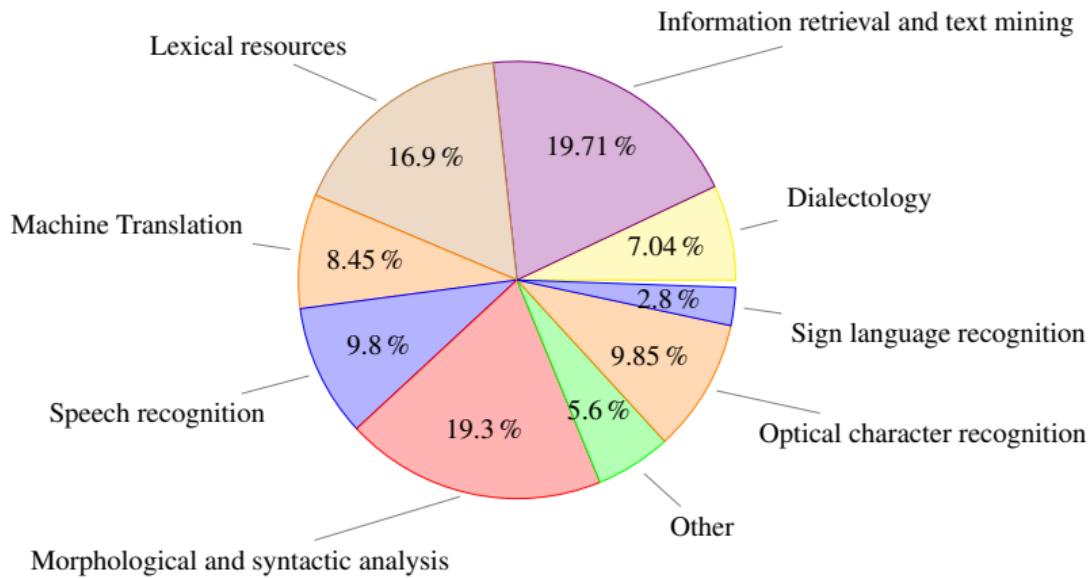
Number of scientific publications directly related to KLP per year and field

- Roughly a third provide their resources or tools under an open-source license
- Central Kurdish makes up a predominant proportion of almost 90% of publications
- Only one publication addresses the processing of Southern Kurdish, Laki or Zazaki



# Kurdish Language Processing: Scientific Contributions

A range of topics have been addressed:



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- Creation of lexical resources and corpora [Ahmadi et al., 2023]

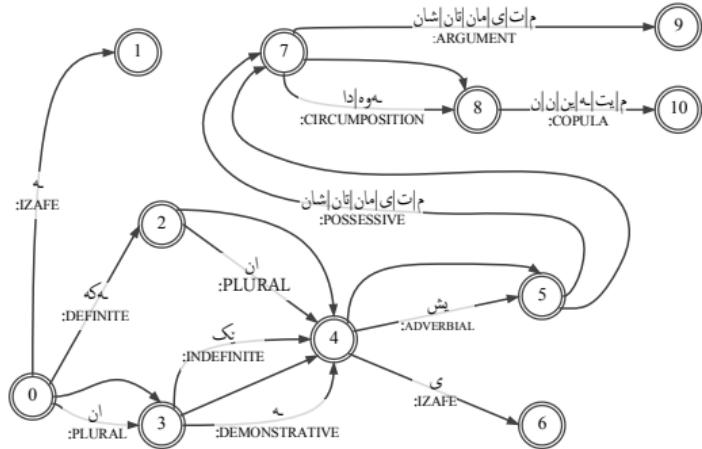
Language	639-3	Wikipedia	Common Scripts	Corpora
Northern Kurdish (Kurmanji)	kmr	ku	Latin, Central Kurdish	(Esmaili and Salavati, 2013; Ataman, 2018; Matras, 2019)
Central Kurdish (Sorani)	ckb	ckb	Central Kurdish, Latin	(Esmaili et al., 2013; Abdulrahman et al., 2019; Veisi et al., 2020; Ahmadi et al., 2020; Matras, 2019)
Southern Kurdish Gorani	sdh hac	- -	Central Kurdish, Persian Central Kurdish	(Fattah, 2000) (Ahmadi, 2020a)
Zazaki	zza	dīq	Latin	(Ahmadi, 2020a)



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- Morphological and syntactic analysis [Ahmadi, 2020c]



A finite-state transducer for generating nouns in Central Kurdish



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- Morphological and syntactic analysis [Ahmadi, 2020c]
- Sentiment analysis [Hameed et al., 2023]

Reference	Prediction	Tweet
Negative	Negative	تاخ منالی سپزیل و هیچ نهدیو چەن تینەگەشتوو چەن ناشیرین چەن بى سوود. Oh, how ugly, useless and fool (is) a spoiled and bad-mannered kid. يادى به خىر 😊 به منالى خونەكانمان چەند گوره بىوون 💔💔💔💔😊😊
Neutral	Negative	Those were the days 😊 How big our childhood dreams were 😅😅💔💔💔
Neutral	Positive	عەشقى راستەقينە وک و نويز وايە، دواى ئەوهى نىھەت هىننا نابى سەيرى دور و بەرت بکەي. Real love is like prayer. You should not get distracted when doing it.
Negative	Negative	بە درۆي پياوه گورەكان ئەلئىن سىاسەت The big lies of big men (people) are called politics



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```
# Southern Kurdish
>>> model.predict("چەس نمروو چە قوومیاس؟")
((__label__sdh,), array([1.00003743]))
```

```
# Gorani
>>> model.predict("داستانێ فرهەن و درێژترەن و دەسی سەر پەی")
((__label__hac,), array([0.99998134]))
```

```
# Kurmanji
>>> model.predict("ئەگەر بیشەم ئاز فەرھادم")
((__label__ku,), array([0.93445575]))
```

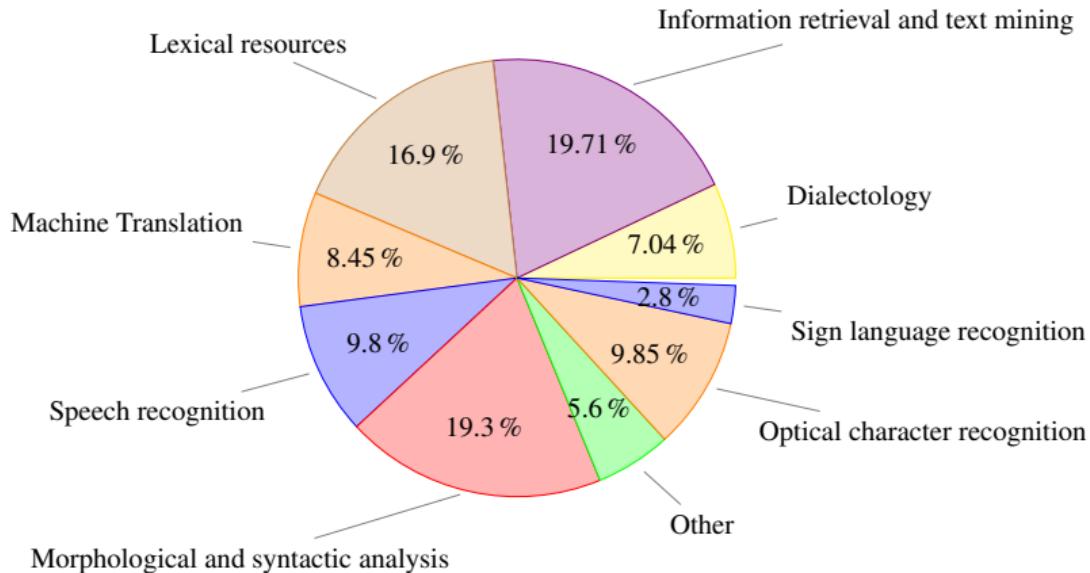
```
# Zazaki
>>> model.predict("Seba naye zî ganî ma rayîr û metodanê xo xurtêr bikerê.")
((__label__zza,), array([1.00003004]))
```



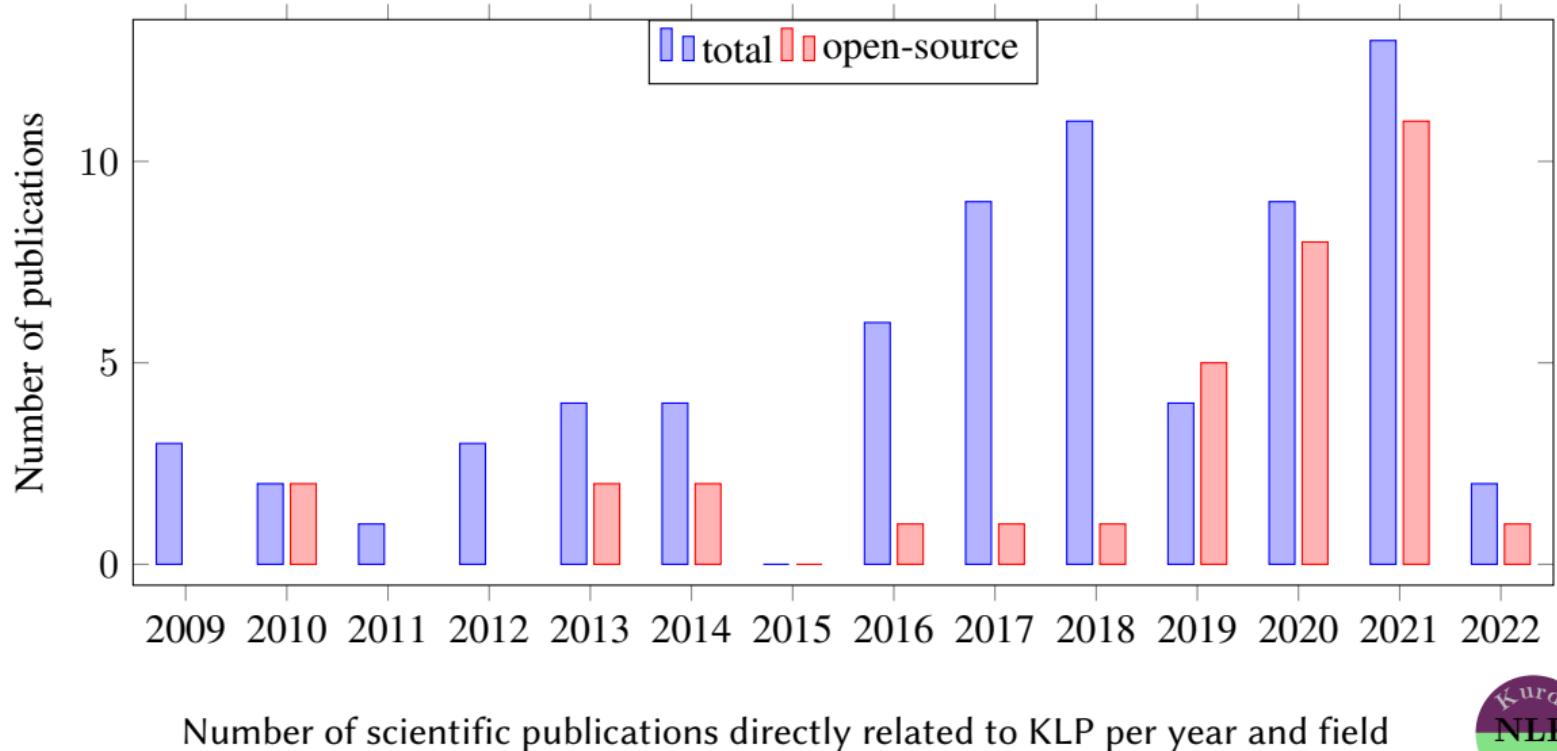
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  - And many more ⇒ <https://github.com/sinaahmadi/awesome-kurdish>



# Kurdish Language Processing: What is wrong?



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- Many projects overlap significantly, yet none of them provide a solution under any open-source license
  - Stemming is addressed at least *six* times [Jaff, 2014, Salavati and Ahmadi, 2018, Mustafa and Rashid, 2018, Saeed et al., 2018, Hawezi et al., 2019, Ahmadi, 2020e]
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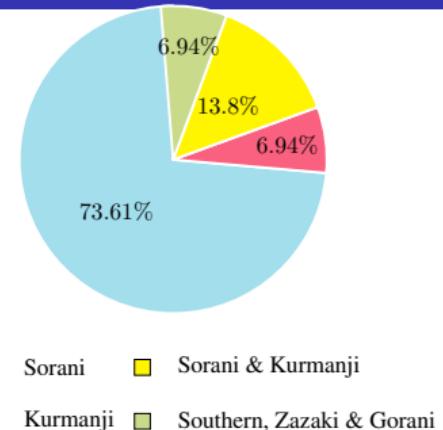
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- **Kurdish is still a less-resourced language**



# Kurdish Language Processing: a few projects

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WÎKÎPEDIYA

Ensiklopediya azad



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Wîkîferheng  
[wîki:fər'həŋg]  
pirzimani  
Ferhenga azad  
ویکیفرهنج  
پرسنلی  
فرهنجگا نازاد



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  - Meta:  
<https://ai.facebook.com/research/no-language-left-behind>



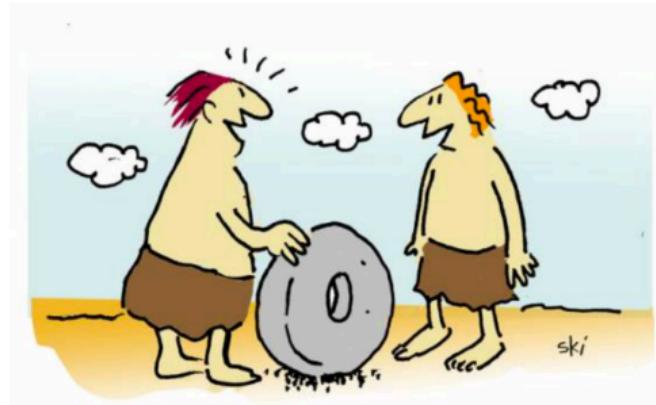
# Kurdish Language Processing: a few projects

- Wîkîferheng: <https://ku.wiktionary.org>
- Wîkipediya kurdî: <https://ku.wikipedia.org>
- VejînLex: <https://lex.vejin.net/en>
- Importance of Kurdish for the Tech Giants
  - Google: <https://translate.google.com>
  - Microsoft: <https://www.bing.com/translator>
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<https://ai.facebook.com/research/no-language-left-behind>
- Kurdish Computational Linguistics Course:  
<https://sinaahmadi.github.io/KurdishCL>



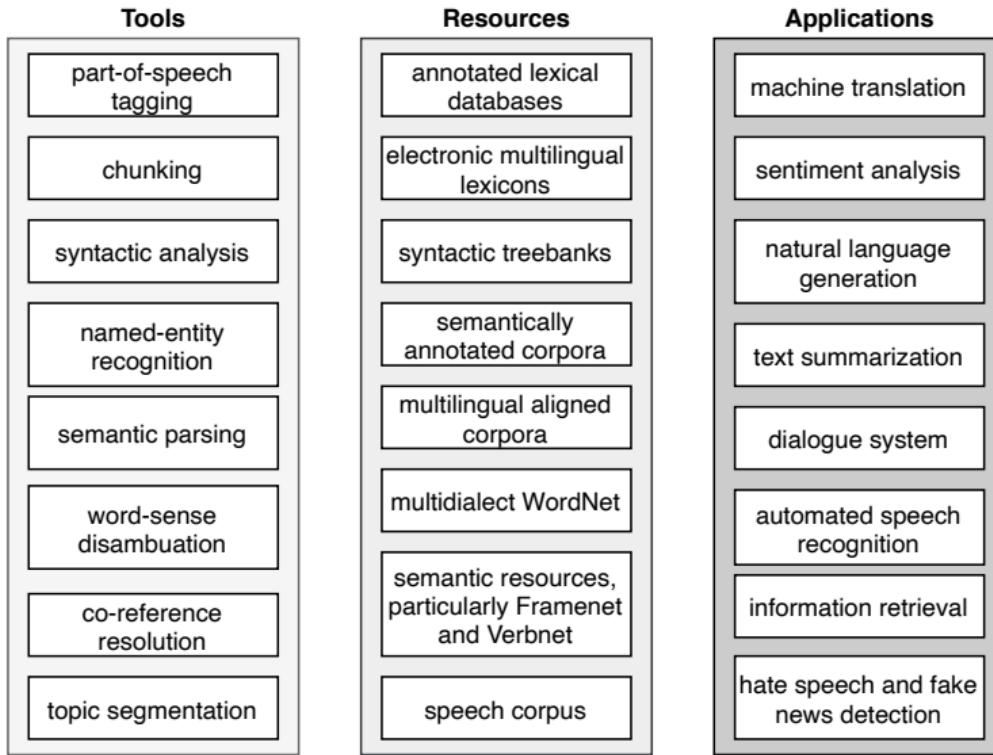
# KLP: Kurdish Language Processing Toolkit

- a basic but extendable language processing toolkit
- an effort to standardize Kurdish language with all its dialects and scripts
- implemented in Python
- inspired by the functionality of relevant NLP toolkits, e.g. NLTK and spaCy
- no external NLP library is used in this toolkit
- composed of core modules for Sorani and Kurmanji for the following tasks:
  - text preprocessing
  - stemming
  - lemmatization
  - spelling error detection and correction
  - transliteration
  - morphological analyzer and generator
  - tokenization
- **it is open-source!**  
→ <https://github.com/sinaahmadi/klpt>



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# KLP: Which tasks to be addressed next?



# Table of Contents

1 Language and Speech Technology

2 Kurdish Language

3 Kurdish Language Processing (KLP)

4 Conclusion



# Conclusion

- **Lessons learned:**

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<sup>1</sup><https://en.wiktionary.org>

<sup>2</sup><https://www.wikipedia.org/>



# Conclusion

- **Lessons learned:**

- **release your project under an open source license** → essential to ensure gradual but efficient progress in resource and technology development for a less-resourced language

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- promote and extend technology for KLP
- create a community of developers and linguists for KLP
- train future professors and researchers in the field ⇒ needs \$\$\$

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# And, the takeaway point is ...

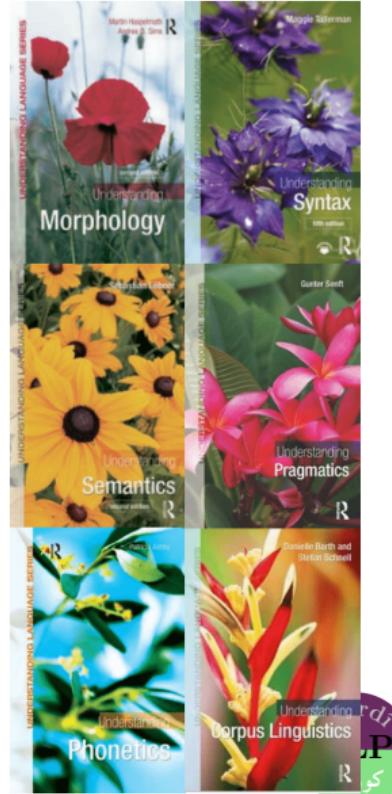
*“An endangered language will progress if its speakers can make use of electronic technology.”*

*– David Crystal (Language death, p.13)*



# Recommended readings

- Linguistics
  - Routledge book series on linguistics ([link](#))
- Computational Linguistics
  - Speech and Language Processing ([link](#))
  - The Handbook of CL & NLP ([link](#))
- Kurdish Linguistics
  - Sorani & Kurmanji reference grammars (W. M. Thackston) ([link](#))
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  - Natural Language Processing with Python ([link](#))



# Thanks!



Spas!

<https://github.com/sinaahmadi/klpt>



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