On the Current State of Kurdish Language Processing

Sina Ahmadi

Insight Centre for Data Analytics
National University of Ireland Galway

https://sinaahmadi.github.io

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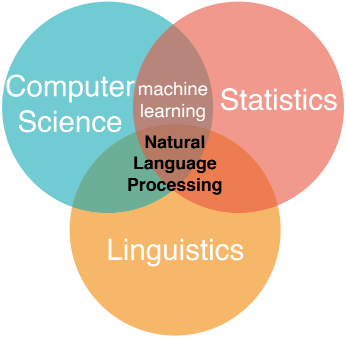
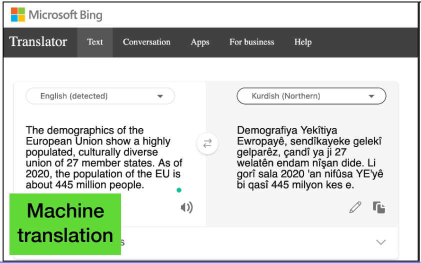
Understanding Human Language “computationally”

- **Computational linguistics**: the study of languages using computational techniques. It is about linguistics.
- **Natural language processing**: the creation of tools, algorithms and resources to solve tasks related language processing. It is about engineering.
- **Computational linguistics** (CL), **natural language processing** (NLP) and **human language technology** are often conflated and used interchangeably.



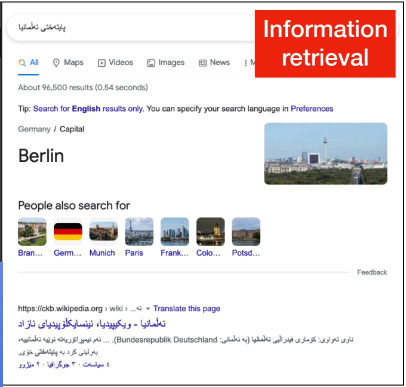
Language Technology: a few applications



The demographics of the European Union show a highly populated, culturally diverse union of 27 member states. As of 2020, the population of the EU is about 445 million people.

Demografiya Yekîtiya Ewropayê, sendîkayeke gelekî gelparêz, çandî ya ji 27 welatên endam nîşan dide. Li gorî sala 2020 'an nifûsa YE'yê bi qasî 445 milyon kes e.

Machine translation



About 96,500 results (0.54 seconds)

Tip: Search for **English** results only. You can specify your search language in Preferences

Germany / Capital

Berlin

People also search for

Bran... Germ... Munich Paris Frank... Colo... Potsd...

https://ckb.wikipedia.org › wiki › ...ئە Translate this page

ئەڵمانیا - ویکیپیدیا، ئینسایکلۆپیدیای ئازاد

ناوی تەواوی: کۆماری فیدراڵیی ئەڵمانیا (بە ئەڵمانی: Bundesrepublik Deutschland). ... ئەم ئیمپراتۆریەتە نوێیە ئەڵمانییە، بەرلینی کرد بە پایتەختی خۆی.

٤ سیاسەت · ٣ جوگرافیا · ٢ مێژوو

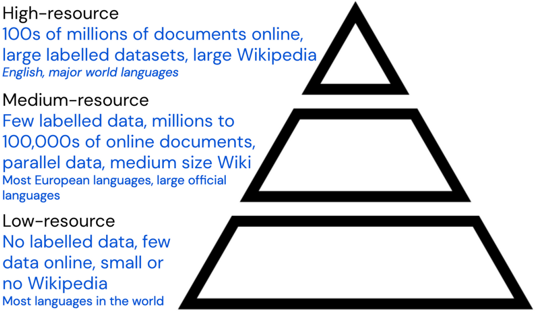
Information retrieval

Digital assistants

Speech recognition

Languages around the Globe

- 7,117 languages are spoken in the world[1]
- a big proportion of these languages are endangered, minority or **less-resourced**
- recent focus on applying language-independent approaches to various tasks in natural language processing (NLP) and computational linguistics using artificial intelligence
- language-specific tools are still essential to process a language in a viable way



High-resource
100s of millions of documents online, large labelled datasets, large Wikipedia
English, major world languages

Medium-resource
Few labelled data, millions to 100,000s of online documents, parallel data, medium size Wiki
Most European languages, large official languages

Low-resource
No labelled data, few data online, small or no Wikipedia
Most languages in the world

[1] Source: `https://www.ethnologue.com/guides/how-many-languages`

* Image source: `https://ruder.io/unsupervised-cross-lingual-learning`

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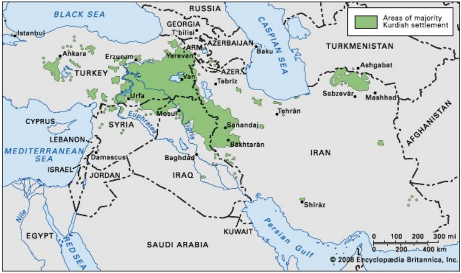
Kurdish Language

- an Indo-European language
- spoken by 20-30 million speakers
- spoken in many dialects and subdialects (*dialects* or *languages*?)
- written in many scripts, among which the Latin-based and Arabic-based ones are still widely in use



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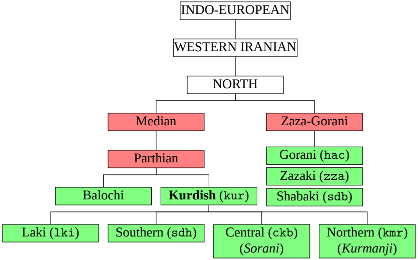


INDO-EUROPEAN

WESTERN IRANIAN

NORTH

Median

Zaza-Gorani

Parthian

Gorani (hac)

Zazaki (zza)

Balochi

Kurdish (kur)

Shabaki (sdb)

Laki (lki)

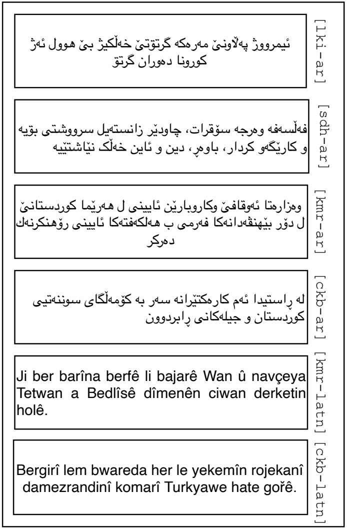
Southern (sdh)

Central (ckb) (*Sorani*)

Northern (kmr) (*Kurmanji*)

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

- using more than one script for a language, not only scatters readers but also creates further challenges in text processing
- written in various orthographies following different conventions
  - *di sala 2020’an* | *2020-an* | *2020an de* “in the year 2020”
  - *hêv**i**ya*, *hêv**î**ya* or *hêvî ya* “hope of”?
  - ٠١٢٣٤٥٦٧٨٩, ۰۱۲۳۴۵۶۷۸۹ or 0123456789?
- although Kurdish orthographies are phonemic, there is not always a one-to-one relation between graphemes, particularly due to:
  - double-usage characters: ی for î/y and و for u/w
  - variations in some orthographies such as l, ll or ł for [ɫ]
  - vowel i has no equivalent in the Arabic-based orthography



ئیمرووژ پەڵاونیٚ مەرەکە گرتوتیٚ خەڵکیژ بیٚ هوول ئەژ
کورونا دەوران گرتو

[lki-ar]

فەڵسەفە وەرجە سۆقرات، چاودێر زانستەیل سرووشتی بۆیە
و کارێگەو کردار، باوەڕ، دین و ئاین خەڵک نیاشتێیە

[sdh-ar]

وەزارەتا ئەوقافێ وکاروبارێن ئایینی ل هەرێما کوردستانێ
ل دۆر بێهنڤەدانەکا فەرمی ب هەلکەفتەکا ئایینی رۆهنکرنەك
دەرکر

[kmr-ar]

لە ڕاستیدا ئەم کارەکتێرانە سەر بە کۆمەڵگای سوننەتیی
کوردستان و جیلەکانی ڕابردوون

[ckb-ar]

Ji ber barîna berfê li bajarê Wan û navçeya Tetwan a Bedlîsê dîmenên ciwan derketin holê.

[kmr-latn]

Bergirî lem bwareda her le yekemîn rojekanî damezrandinî komarî Turkyawe hate gořê.

[ckb-latn]

Kurdish

Current state of Kurdish language processing (KLP)

- the earliest works in the field of KLP date back to 2009
- thus far, a total number of **53** publications are published in a field directly related to KLP
- a couple of volunteer-based projects
- a few number of non-scientific contributions

Open-source

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

Applicability

Does the paper, implicitly or explicitly, propose an approach or methodology that can be applied to solve the same problem in the other dialects of Kurdish?

Current state of KLP

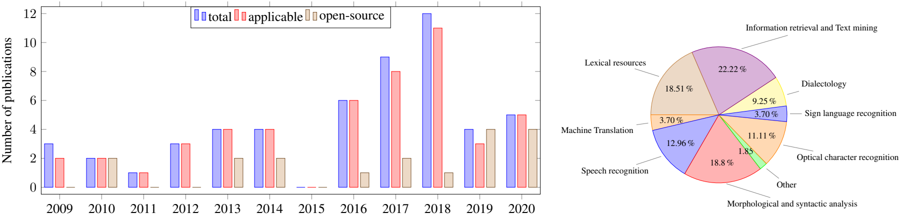


Figure: Number of scientific publications directly related to KLP per year and field

- most of these publications are applicable
- only **18** provide their resources or tools under an open-source license
- Sorani makes up a predominant proportion of almost 90% of publications
- no publication addresses the processing of Southern Kurdish, Laki or Zazaki
- Kurdish still lacks basic language processing tools such as part-of-speech tagger, stemmer, lemmatizer and so on

Current state of KLP: What is wrong?

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

*

- Some are hardly integrable or inter-operable
  - A large-scale morphological lexicon and a part-of-speech tagger for Kurdish within the Alexina framework [Walther and Sagot, 2010, Walther et al., 2010]
- Released in an unorganized manner for individual tasks
  - Example: a transliteration tool for Kurdish [Ahmadi, 2019a]
- **A lack of involvement of the Kurdish linguistic communities in using computational formalisms**
- **Kurdish *is* still a less-resourced language**

* Image source: `https://www.aic.cuhk.edu.hk/web8/Reinventingthewheel.htm`

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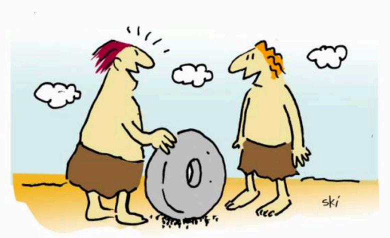
Kurdish Language Processing Toolkit (KLPT)

- 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**



KLPT Packages: Preprocess

Goal: Handle diversities in scripts and orthographies in an automatic and formalized way

1. `normalize()`: normalize text by unifying character encodings
   - Example: the grapheme ی (U+06CC, î/y), may be represented as ي (U+064A), ى (U+0649), ﻲ (U+FEF2) or ﻱ (U+FEF1)
2. `standardize()`: standardize scripts and orthographies by using writing conventions based on dialects and scripts
3. `unify_numeral()`: convert Farsi, Eastern and Western Arabic numerals

Example

```
>>> from klpt.preprocess import Preprocess
>>> preprocessor = Preprocess("Sorani", "Arabic", numeral="Latin")
>>> preprocessor.normalize("لە ســـــاڵەکانی ١٩٥٠دا")
لە ساڵەکانی 1950دا
>>> preprocessor.standardize("راستە لەو ووڵاتەدا")
ڕاستە لەو وڵاتەدا
```

KLPT Packages: Transliterate

- transliterating the Arabic-based and Latin-based scripts of Kurdish to one another, e.g. برا → *bira* ‘brother’
- based on the rule-based approach of [Ahmadi, 2019a] which
  - detects double usage characters
  - predicts the presence of the missing i, a.k.a *Bizroke*
  - finds the syllabic pattern of a given word based on Kurdish phonetics
- beneficial to many NLP tasks such as named-entity recognition

Example

```
>>> from klpt.transliterator import Transliterate
>>> transliterator = Transliterate("Kurmanji", "Latin", target_script="Arabic")
>>> transliterator.transliterate("rojhilata navîn")
'رۆژهلاتا ناڤین'
```

KLPT Packages: Stem

- an annotated lexicon + morphological rules using **Hunspell**[2] for:
  - spelling error detection and correction → also usable in text editors such as LibreOffice
  - morphological analyzer and generator
  - stemmer
- a rule-based lemmatization system
- based on [Ahmadi, 2020c, Ahmadi, 2020e]

Example

```
>>> from klpt.stem import Stem
>>> stemmer = Stem("Sorani", "Arabic")
>>> stemmer.check_spelling("سوتاندبووت")
False
>>> stemmer.correct_spelling("سوتاندبووت")
('سووتاندبووت', 'سووتاندت', 'سووتاندن', 'سووتاند')
>>> stemmer.stem("سووتاندبووت")
('سووت',)
>>> stemmer.analyze("دیتبامن")
{'pos': 'verb', 'is': 'past_intransitive', 'stem': 'دی', ‘verb_stem': 'دیت',
'terminal_suffix': 'بامن'}
```

[2] http://hunspell.github.io

KLPT Packages: Tokenize

- detect word and sentence boundaries → a non trivial task:
  - **orthographic inconsistencies**, e.g. how compounds words are separated?
  - **excessive concatenation**, e.g. لەوێشدایە (*lewêşdaye*) “(it) is also there” is written as a word but is composed of five tokens *le*, *wê*, *ş*, *da*, *ye*
- split a text into sentences or tokens
- identify compound forms such as *kar-û-bar* (word-and-load) “affaires”
- based on the [Ahmadi, 2020b]’s approach using a morphological analyzer and a lexicon

Example

```
>>> from klpt.tokenize import Tokenize
# Tokenize module
>>> tokenizer = Tokenize("Kurmanji", "Latin")
>>> tokenizer.word_tokenize("endamên encûmena wezîrên")
['_endam_ên', '_encûmen_a', '_wezîr_ên']
```

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Which tasks to be addressed next?

Tools

- part-of-speech tagging
- chunking
- syntactic analysis
- named-entity recognition
- semantic parsing
- word-sense disambuation
- co-reference resolution
- topic segmentation

Resources

- annotated lexical databases
- electronic multilingual lexicons
- syntactic treebanks
- semantically annotated corpora
- multilingual aligned corpora
- multidialect WordNet
- semantic resources, particularly Framenet and Verbnet
- speech corpus

Applications

- machine translation
- sentiment analysis
- natural language generation
- text summarization
- dialogue system
- automated speech recognition
- information retrieval
- hate speech and fake news detection

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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
  - **community-driven initiatives** → bring together users, developers, researchers, language activists and policy makers
  - **raise awareness** by promoting good practices in content creation on the Web, particularly collaboratively-curated resources such as Wiktionary[3] and Wikipedia[4]
  - every single user is a contributor too
  - **time to reconcile linguistics with computational methods for Kurdish**
- **Future directions**:
  - promote the usage of KLPT in the Kurdish communities
  - create a community of developers and linguists for KLP
  - extend the current version of KLPT to include further advanced tasks

[3] https://en.wiktionary.org

[4] https://www.wikipedia.org/

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)

Join KLPT

*

https://github.com/sinaahmadi/klpt

KLPT

* Image credit: Milad Ghaderpanah

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