Semantic annotation and key domains

Lancaster Summer Schools in Corpus Linguistics #LancsSS24

27th June 2024

Slides at https://ucrel.lancs.ac.uk/paul/

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A myriad of NLP and CL methods ...

NER

Content analysis

Semantic tagging

Topic modelling

CDA

KWIC

Network analysis

Linguistic style matching

Text reuse

Qualitative analysis

Summarisation

Sentiment analysis

Stylistic profiling

Collocation

Keywords

Geographic text analysis

N-grams

A session of three parts

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1. Semantic annotation (tagging)
   - a little bit computational
2. Key semantic tags (key domains)
   - a little bit of statistics
3. Wmatrix software
   - Hands on practical

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WHAT IS CORPUS ANNOTATION?

Annotation layers

- Pragmatic
- Discourse
- Semantic
- Syntactic
- Lexical
- Morphological
- Phonetic or phonological

- Grammatical (POS tagging)
  - Otherwise known as POS tagging or morphosyntactic annotation: assigning word-class labels for not only major parts of speech (noun, verb, preposition, etc.) but also values defining sub-classes, such as singular and plural nouns, positive, comparative and superlative adjectives, and so on.
  - Origin_NN of_IN state_NN automobile_NN practices_NNS ._. The_DT practice_NN of_IN state-owned_JJ vehicles_NNS for_IN use_NN of_IN employees_NNS on_IN business_NN dates_VVZ back_RP over_IN forty_CD years_NNS ._.

What is Semantic Tagging?

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- Semantic field annotation has applications for conceptual or topic tagging:
  - *Last_T1.1.1 year_T1.1.1* was_A3+ the_Z5 UK_Z2 's_Z5 second_N4 warmest_O4.6+++ *on_A11.2+ record_A11.2+* ,_PUNC *according_Z5 to_Z5* provisional_T1.3- data_X2.2 from_Z5 the_Z5 Met_S3.1 Office_I2.1/H1c ._PUNC This_Z8 *puts_X2.2-* it_Z8 just_A14 *behind_X2.2-* 2022_N1 ,_PUNC which_Z8 recorded_Q1.2 an_Z5 average_A6.2+ temperature_O4.6 of_Z5 only_A14 0.06C_Z99 higher_N3.7++ ._PUNC

- A3+ = being; A6.2 = comparing; A11.2 = importance; A14 = exclusivisers; H1 = architecture, buildings; I2.1 = business; N1 = numbers; N3.7 = measurement; N4 = linear order; O4.6 = temperature; Q1.2 = documents, writing; S3.1 = relationship; T1.1.1 = Time past; T1.3 = time period; X2.2 = knowledge; Z2 = geographical names; Z5 = grammatical bin; Z8 = pronouns etc; Z99 = unmatched

Multiword expressions: plain sailing?

- Phrasal verbs
  - *Stubbed out*
- Noun phrases
  - *Riding boots*
  - *Pony nuts*
- Proper names
  - *United States of America*
- *Named entities*
  - *23rd November 1963*
  - *British Broadcasting Corporation*
- Multiword prepositions
  - *In terms of*
  - *As soon as*
- Idiomatic expressions
  - *Spill the beans*
  - *A pain in the neck*

UCREL Semantic Analysis System (USAS)

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- Full text tagging, not just selected words (c.f. Diction, LIWC, RID)
- Tagging the coarse-grained sense in context, not just the word
- Not task specific categories
- Flexible category set with hierarchical structure
- Words and multi-word expressions (MWE) e.g. phrasal verbs (stubbed out), noun phrases (riding boots), proper names (United States of America), true idioms (living the life of Riley)

- https://ucrel.lancs.ac.uk/usas/
- Lexicons available free for academic use:
  - https://github.com/UCREL/Multilingual-USAS

The work of many hands ...

- Joint research with
  - Geoffrey Leech
  - Roger Garside
  - Jenny Thomas
  - Andrew Wilson
  - Dawn Archer
  - Scott Piao
  - Sheryl Prentice
  - Andrew Moore
  - Daisy Lal

Semantic fields

- AKA concepts, semantic domains
- ‘groups together word senses that are related by virtue of their being connected at some level of generality with the same mental concept’
- Not only synonymy and antonymy but also hypernymy and hyponymy
- E.g. EDUCATION: academic, coaching, coursework, deputy head, exams, PhD, playschool, revision notes, studious, swot, viva

A General and abstract terms	**B** The body and the individual	**C** Arts and crafts	**E** Emotion
F Food and farming	**G** Government and public	**H** Architecture, housing and the home	**I** Money and commerce in industry
K Entertainment, sports and games	**L** Life and living things	**M** Movement, location, travel and transport	**N** Numbers and measurement
O Substances, materials, objects and equipment	**P** Education	**Q** Language and communication	**S** Social actions, states and processes
T Time	**W** World and environment	**X** Psychological actions, states and processes	**Y** Science and technology
Z Names and grammar			

Lexical resources for English

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- Lexicon of 56,316 items
  - presentation NN1 Q2.2 A8 S1.1.1 K4
- MWE list of 18,971 items
  - travel_NN1 card*_NN* M3/Q1.2
- A small wildcard lexicon
  - *kg NNU N3.5
- Unknown words using WordNet synonym lookup

English Disambiguation methods (1)

- 1. POS tag
  - *spring* noun [season sense] [coil sense]
  - *spring* verb [jump sense]
- 2. General likelihood ranking for single-word and MWE tags
  - *green* referring to [colour] is generally more frequent than *green* meaning [inexperienced]
- 3. Overlapping MWE resolution
  - Heuristics applied: semantic MWEs override single word tagging, length and span of MWE also significant

English Disambiguation methods (2)

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- 4. Domain of discourse
  - adjective *battered*
    - [Violence] (e.g. battered person)
    - [Judgement of Appearance] (e.g. battered car)
    - [Food] (e.g. battered cod)
- 5. Text-based disambiguation
  - one sense per text
- 6. Template rules
  - *Auxiliary verbs (be/do/have)*
  - *account* of NP [narrative]
  - balance of xxx *account* [financial]

Evaluation (English data)

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- Hand tagged test corpus of 124,839 words
- Error rate of 8.95%
- Ambiguity ratio 47.73%
- Reduced to 17.06% by disambiguation
- Not all ambiguity is resolved, but 1st choice tag selection gives 91% accuracy.

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KEY SEMANTIC DOMAINS AND FURTHER APPLICATIONS

Wmatrix

Keywords

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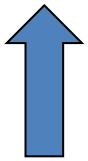
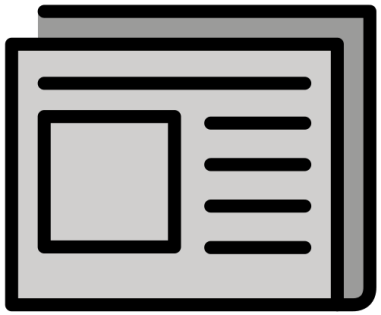
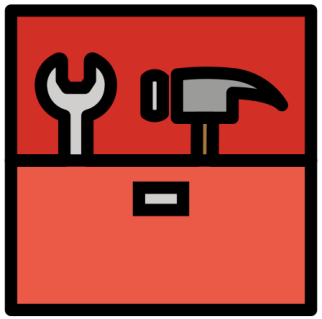
		LibDem manifesto		Labour manifesto			
	Word	Frequency	Rel. freq.	Frequency	Rel. freq.	O/U-use	LL
1	liberal	47	0.23	0	0.00	+	81.41
2	would	70	0.34	10	0.04	+	71.89
3	democrats	40	0.20	0	0.00	+	69.29
4	our	76	0.37	272	0.97	-	63.22
5	labour	33	0.16	152	0.54	-	49.56
6	is	119	0.58	330	1.17	-	47.04
7	which	92	0.45	37	0.13	+	45.13
8	now	8	0.04	76	0.27	-	43.97
9	1997	4	0.02	54	0.19	-	36.76
10	green	26	0.13	2	0.01	+	32.81
11	environmental	47	0.23	14	0.05	+	30.98
12	establish	34	0.17	7	0.02	+	29.06
13	since	2	0.01	38	0.14	-	29.06
14	ten-year	0	0.00	25	0.09	-	27.29
15	also	88	0.43	50	0.18	+	26.30
16	Governments	15	0.07	0	0.00	+	25.98
17	britains	15	0.07	0	0.00	+	25.98
18	long_term	15	0.07	0	0.00	+	25.98
19	new	57	0.28	165	0.59	-	25.91
20	's	29	0.14	106	0.38	-	25.46

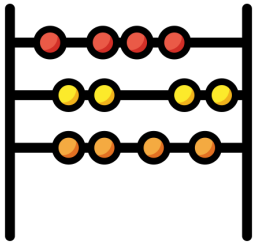
Text

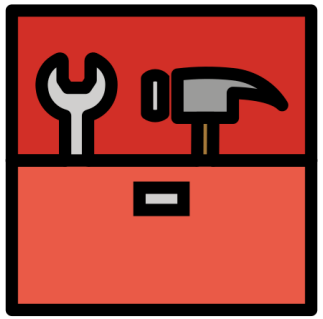


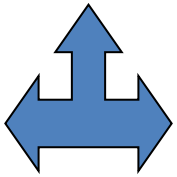
Text or reference corpus











the	351
of	243
a	221
and	153
to	139
in	134
is	123
be	83
for	81
phrase	69
that	67
which	66
are	64
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Word frequency list

Word frequency list

Significance and effect size

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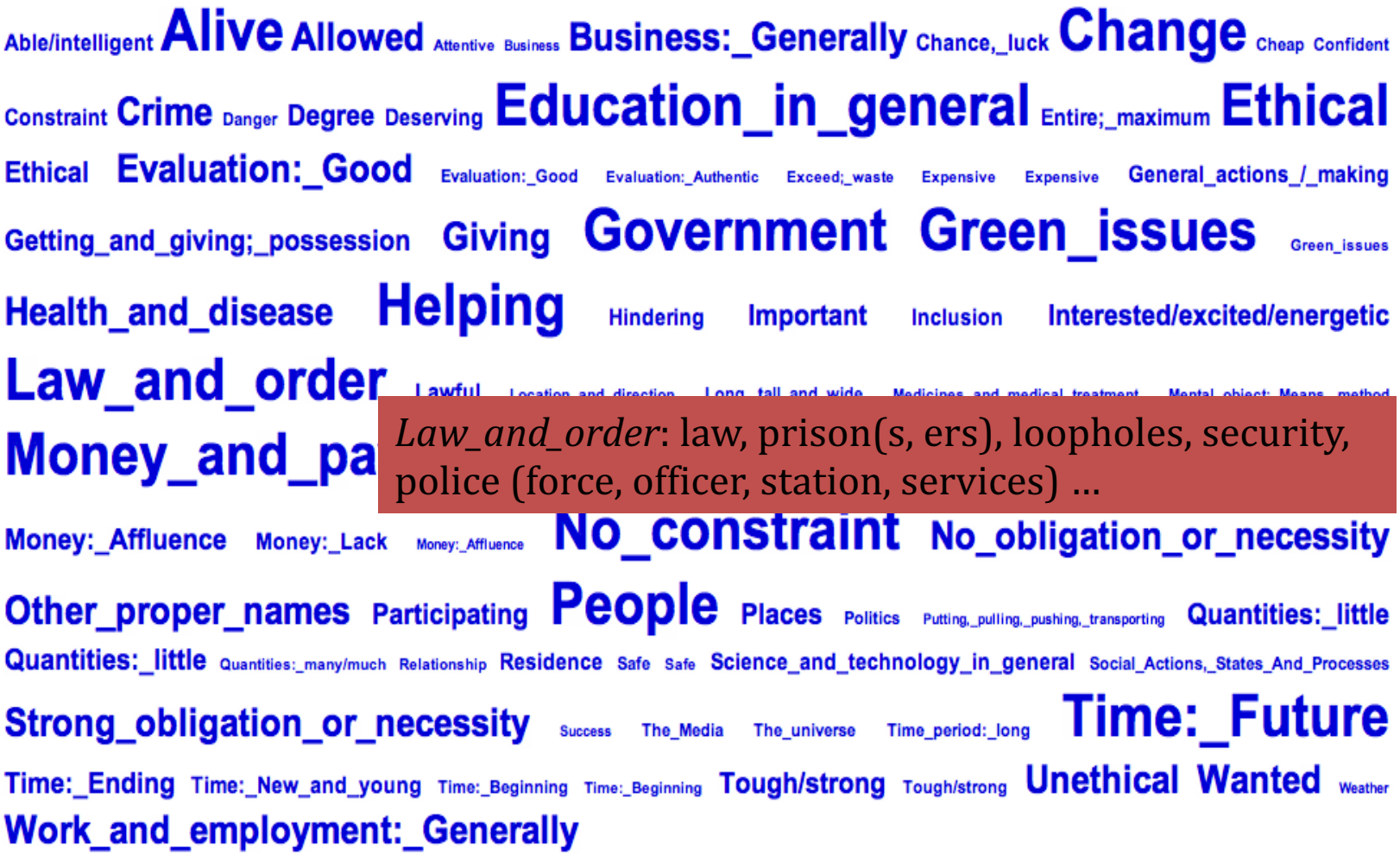
- Log-likelihood (LL) Wizard online at:
  - https://ucrel.lancs.ac.uk/llwizard.html
- Spreadsheet and code also available for download
  - https://github.com/UCREL/SigEff
- Very important to consider dispersion and effect size measures (depending on your corpus) – included in Wmatrix CrossTab feature and keyness measures
  - See the work of Hardie, Gabrielatos, Brezina and others
  - Rayson and Potts (2021)

Figure 1: keywords in LibDem 2010 manifesto

Figure 2: key domains (semantic fields) in LibDem 2010 manifesto



Law_and_order: law, prison(s, ers), loopholes, security, police (force, officer, station, services) …

Applications of semantic analysis

100+ papers listed at https://ucrel.lancs.ac.uk/wmatrix/

- Analysis of market research interview transcripts
- Intelligent dictionaries
- Assistance for human translators
- Software Engineering domain understanding
- Language profiling for online child protection
- Actionability
- Corpus stylistics
- Prediction of real-world events from social media
- Metaphor and end-of-life care
- Pattern analysis of the language of psychopaths
- Political discourse analysis
- Describing the language of extremism and counter-extremism
- UK General Election Manifestos (Rayson 2008)

BRITISH NATIONAL CORPUS

ParlaMint

BNC
BRITISH NATIONAL CORPUS 2014

CorCenCC
Corpws Cenedlaethol Cymraeg Cyfoes
National Corpus of Contemporary Welsh

Metaphor, cancer and end of life care (MELC)

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- Analysis of metaphorical language used to talk about cancer, dying and death: people 'fight' their cancer, 'win' or 'lose' their 'battle' against it, hope for a positive end to their cancer 'journey', and so on.
- 1.5M word corpus of interviews and online forum posts from patients, carers and healthcare professionals
- Methods: Manual analysis (MIP) and Wmatrix (Semantic analysis & concordancing)
- http://wp.lancs.ac.uk/melc/

G3 Warfare (e.g. *fight* as a verb, *battle*)
A1.1.1 General actions, making (e.g. *blast*, *confront*)
A1.1.2 Damaging and destroying (e.g. *destroy*, *shatter*)
E3– Violent/angry (e.g. *hit*, *attack*)
S8+ Helping (e.g. *defend*, *protect*)
S8– Hindering (e.g. *fight* as a noun)
X8+ Trying hard (e.g. *struggle*)

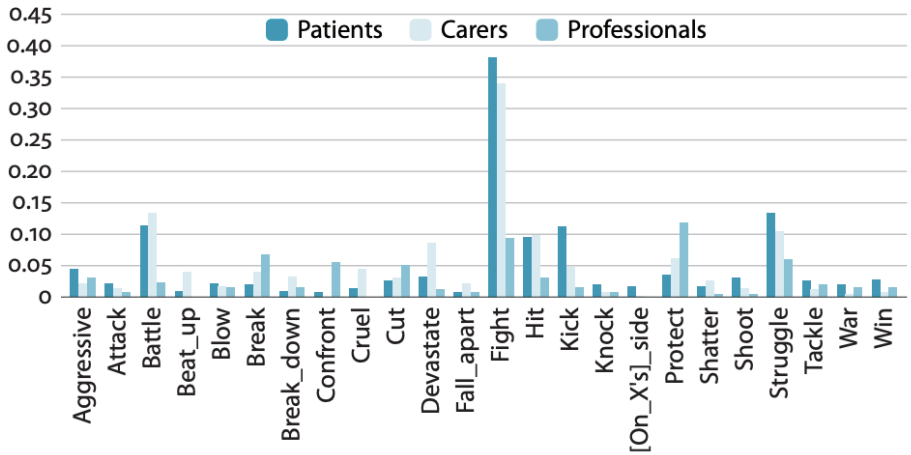

Figure 3. Relative use of most frequent Violence metaphors by each stakeholder group (per 1,000 tokens): Online forum posts

Qualitative survey analysis: FreeTxt/TestunRhydd project (2022-3)

- Surveys are widely used in many areas of professional practice, e.g. staff development, professional training, product design, testing as well as for many types of hotel, movie and product reviews
- Very little support for bilingual free-text survey and questionnaire data analysis in English and Welsh
- Follow on funding impact project building on CorCenCC project (National Corpus of Contemporary Welsh), we will develop an open access user friendly online interface
- Partners: National Trust Wales, Cadw and National Museum Wales
- https://ucrel.lancs.ac.uk/freetxt/

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1990-6

English semantic tagger
(C version)

2002-5

Finnish semantic tagger
(Java version)

2005-7

Russian semantic tagger

2013-

onwards: Extension to 10+ languages

2014-5

Historical Thesaurus Semantic Tagger (utilising HTE after 40 years of development at Glasgow University and 150+ years for the OED

2016–2021

Specialisation for genetics discourse (extension with a pre-existing Gene Ontology)

2021-2

Python code released open source (pymusas)

- https://ucrel.github.io/pymusas/
- https://pypi.org/project/pymusas/

2023

PyMUSAS integrated into Wmatrix6 (Chinese, Dutch, Finnish, French, Italian, Portuguese, Spanish, Welsh)

Recipe for creating a tagger in a new language

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1. re-evaluate USAS semantic tagset for new language context
2. find freely available (open source if possible) POS tagger & lemmatiser
3. integrate these into USAS Multilingual software framework (PyMUSAS)
    a. consider whether other new components are needed e.g. tokeniser or compound tool
4. develop single-word semantic lexicon and MWE dictionary
    a. bilingual dictionary
    b. parallel aligned corpus (Moses / Giza)
    c. machine translation / translation memory
    d. crowdsourcing by non-experts
    e. named entity recognition and gazetteers
    f. vector-based approaches
    g. multi-task & deep learning
    h. manual checking and editing by experts
5. extend disambiguation routines
6. release lexicons with CC-BY-NC-SA licence
7. release software as REST API and/or open-source licence

PyMUSAS

https://pypi.org/project/pymusas/

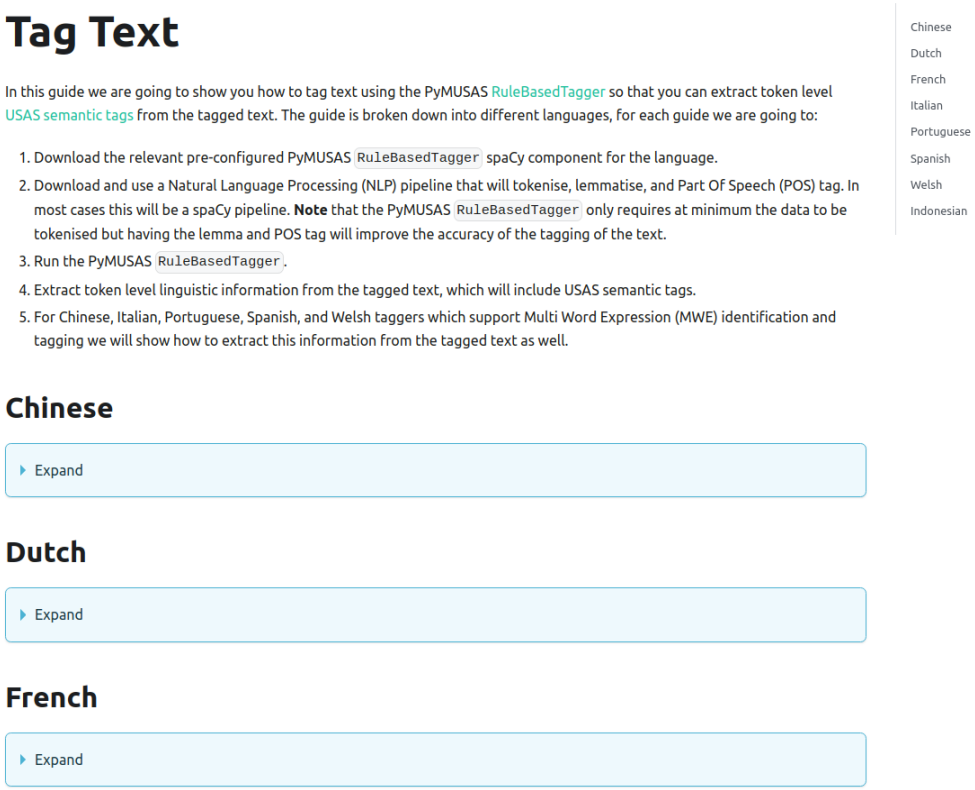
- Open source – Apache License Version 2.0
- Open resources – Creative Commons licence version 4
- Rule based tagger
- Identify and tag Multi Word Expressions (MWE)
- Supports multiple languages through downloadable spaCy pipelines
- Supports Indonesian and Welsh via other POS taggers (TreeTagger for Indonesian and CyTag for Welsh)

Language (BCP 47 language code)	MWE Support	Size
Mandarin Chinese (cmn)	✔	1.28MB
Welsh (cy)	✔	1.09MB
Spanish, Castilian (es)	✔	0.20MB
French (fr)	×	0.08MB
Indonesian (id)	×	0.24MB
Italian (it)	✔	0.50MB
Dutch, Flemish (nl)	×	0.15MB
Portuguese (pt)	✔	0.27MB

PyMUSAS – Language Support

Each language that we support has a guide on how to semantically tag text for that language:

https://ucrel.github.io/pymusas/usage/how_to/tag_text



Tag Text

Chinese
Dutch
French
Italian
Portuguese
Spanish
Welsh
Indonesian

In this guide we are going to show you how to tag text using the PyMUSAS RuleBasedTagger so that you can extract token level USAS semantic tags from the tagged text. The guide is broken down into different languages, for each guide we are going to:

1. Download the relevant pre-configured PyMUSAS `RuleBasedTagger` spaCy component for the language.
2. Download and use a Natural Language Processing (NLP) pipeline that will tokenise, lemmatise, and Part Of Speech (POS) tag. In most cases this will be a spaCy pipeline. **Note** that the PyMUSAS `RuleBasedTagger` only requires at minimum the data to be tokenised but having the lemma and POS tag will improve the accuracy of the tagging of the text.
3. Run the PyMUSAS `RuleBasedTagger`.
4. Extract token level linguistic information from the tagged text, which will include USAS semantic tags.
5. For Chinese, Italian, Portuguese, Spanish, and Welsh taggers which support Multi Word Expression (MWE) identification and tagging we will show how to extract this information from the tagged text as well.

Chinese

Expand

Dutch

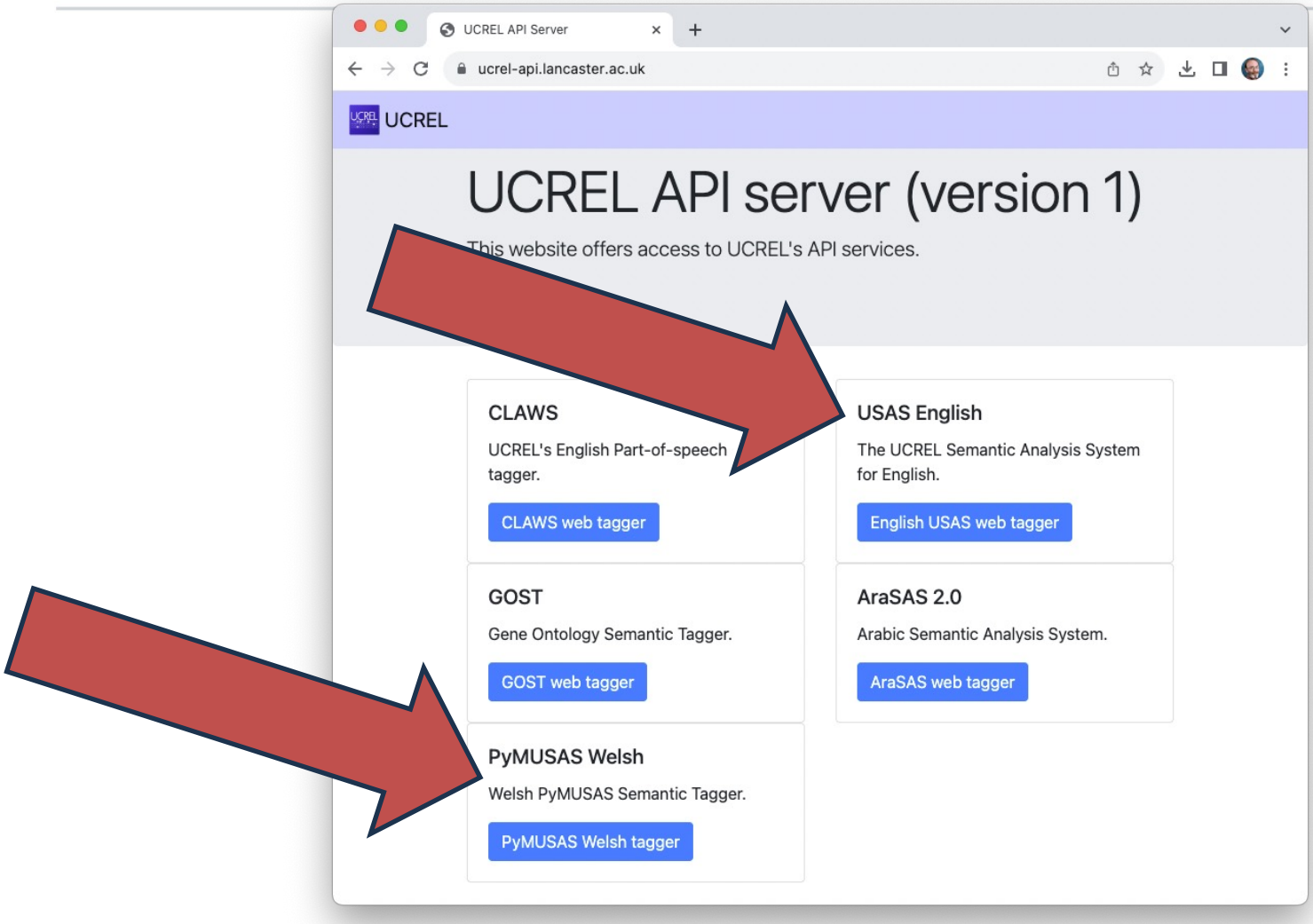
Expand

French

Expand

https://ucrel-api.lancaster.ac.uk/

You can also test USAS without a login for Wmatrix



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WMATRIX VERSIONS 5 AND 6

Key points

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- Web-based (c.f. BNCweb, CQPweb, SketchEngine)
- Dedicated server, Secure HTTPS access
- You can load your own data (English in v5, Multilingual in v6)
- Incorporates main methods in corpus linguistics toolbox
  - frequency lists, concordances, key words, collocations, n-grams
- Adds two levels of linguistic annotation (NLP methods)
  - POS tagging, Semantic field tagging
- Novelty
  - key domain analysis, semantic collocations

Hands on practical

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- 2005 UK general election
  - Liberal Democrat party manifesto
  - Labour party manifesto
- 2010 UK general election
  - manifestos for all three main parties
- 2015, 2017, 2019 and 2024 UK general elections
  - manifestos for seven parties
- Aims:
  - To help you understand the basic Wmatrix features and key domains method
  - To give you some awareness of the semantic tagset

Version 5 or version 6?

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	Wmatrix5	Wmatrix6
Indexing system	Bespoke from 1990s	SQLite
Folders / Corpus	Single file, up to 1M words	Multiple files (zip), tested up to 30M words
Concordances	Corpus order	Various sort options
N-grams and collocations	NSP and Java code	SQLite
Language	USAS English, Spanish beta	PyMUSAS for Chinese, Dutch, Finnish, French, Italian, Portuguese, Spanish, and Welsh
MWEs	Tagged, displayed in frequency lists	Tagged but not yet displayed in frequency lists
Optional features	Domain and My Tag Wizard, Metaphor features, folder sharing	

Open two web-browser windows or tabs

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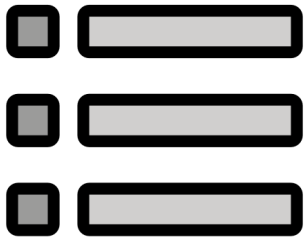
- All URLs linked from Wmatrix home page:
  - https://ucrel.lancs.ac.uk/wmatrix/

1. Wmatrix tutorials
   - https://ucrel.lancs.ac.uk/wmatrix/tutorial/
   - https://ucrel.lancs.ac.uk/wmatrix/tutorial6/

1. Wmatrix tool:
   - https://ucrel-wmatrix5.lancaster.ac.uk/
   - https://ucrel-wmatrix6.lancaster.ac.uk/
   - Apply for login now if you haven't already got one

Your tasks!!



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- https://ucrel.lancs.ac.uk/wmatrix/tutorial/
- https://ucrel.lancs.ac.uk/wmatrix/tutorial6/
- On your own or in small groups ...
  - **Do** tutorials A and B (you can either upload the manifesto documents yourself into Wmatrix, or use the ones I made earlier in the corpus library)
  - **Do** tutorial C (key words, key domains and concordances)
  - For the keen ones amongst you, move on to the other tutorials
  - You can use your own data if you wish
  - Ask questions any time!

Thanks for listening!

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- Questions and comments?
- PyMUSAS collaboration for existing and new languages welcome!!
- Contact:
  - Email: p.rayson@lancaster.ac.uk
  - Twitter/X: @perayson
- Icons from https://openmoji.org/

Key papers

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- Rayson, P., Archer, D., Piao, S. L., McEnery, T. (2004). The UCREL semantic analysis system. In proceedings of the workshop on Beyond Named Entity Recognition Semantic labelling for NLP tasks in association with 4th International Conference on Language Resources and Evaluation (LREC 2004), 25th May 2004, Lisbon, Portugal, pp. 7-12.
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Key papers

- Piao, Scott Songlin; Rayson, Paul; Archer, Dawn; Bianchi, Francesca; Dayrell Gomes Da Costa, Maria Carmen; El-Haj, Mahmoud; Jiménez, Ricardo-María; Knight, Dawn; Křen, Michal; Lofberg, Laura; Nawab, Rao Muhammad Adeel ; Shafi, Jawad; Teh, Phoey Lee; Mudraya, Olga / Lexical Coverage Evaluation of Large-scale Multilingual Semantic Lexicons for Twelve Languages. 2016. In proceedings of the 10th edition of the Language Resources and Evaluation Conference (LREC2016), Portorož, Slovenia, pp. 2614-2619.
  - http://www.lrec-conf.org/proceedings/lrec2016/pdf/257_Paper.pdf
- El-Haj, M., Rayson, P., Piao, S., & Wattam, S. (2017). Creating and validating multilingual semantic representations for six languages: expert versus non-expert crowds. In Proceedings of the 1st Workshop on Sense, Concept and Entity Representations and their Applications: Proceedings of the 15th Conference of the European Chapter of the Association for Computational Linguistics. (pp. 61-71). Association for Computational Linguistics.
  - http://aclweb.org/anthology/W17-1908

References ...

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  - https://ucrel.lancs.ac.uk/wmatrix/
  - https://ucrel.lancs.ac.uk/claws/
  - https://ucrel.lancs.ac.uk/usas/
- Semantic lexicon expansion
  - Sheryl Prentice, Paul Rayson, Jo Knight, Mahmoud El-Haj, Solly Elstein (2021) A Domain Based Approach to Semantic Lexicon Expansion, International Journal of Lexicography. https://doi.org/10.1093/ijl/ecab028
- Useful background reading (keyness, annotation and MWE):
  - Rayson, P., Archer, D., Piao, S. L., McEnery, T. (2004). The UCREL semantic analysis system. In proceedings of the workshop on Beyond Named Entity Recognition Semantic labelling for NLP tasks in association with 4th International Conference on Language Resources and Evaluation (LREC 2004), 25th May 2004, Lisbon, Portugal, pp. 7-12. http://www.lancaster.ac.uk/staff/rayson/publications/usas_lrec04ws.pdf
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