

# Natural Language Processing for the Classics

## Teacher's Toolkit

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# Outline

- 1 Natural Language Processing
- 2 Lexical Analysis
- 3 Syntactic Analysis
- 4 Semantic Analysis

# Natural vs. Constructed Languages

	<b>Natural</b>	<b>Constructed</b>
<b>used by</b>	humans	machines
<b>purpose</b>	interaction, communication	internal processing
<b>reasoning</b>	joint	isolated
<b>syntax</b>	flexible, evolving <sup>1</sup>	well-defined, strict
<b>ambiguity</b>	is produced	is resolved

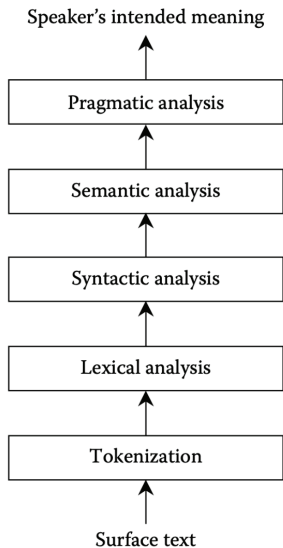
<sup>1</sup>N.B.: This may vary for historical languages like Latin or Ancient Greek.

Further reading. Interaction & communication: Crocker 2013; joint reasoning: Textor 2011; syntax, ambiguity: Ljunglöf et al. 2010, Palmer 2010

## Processing

- stages of NLP (Dale 2010, p.4)

Current  
progress:



**FIGURE 1.1** The stages of analysis in processing natural language.

## Where to perform the search

C. Iulius Caesar (PROIEL): Commentarii  
de bello Gallico 1.1.1 -1.2.1

1

Corpus for the reference  
vocabulary

Bamberg Core Vocabulary (1276 Item) ▾

Take only the  most frequent  
words in the reference vocabulary

Desired number of sentences

Intelligent choice of text passages  
(uncheck for all possibilities)

Sentences	Matching Percentage
<a href="#">52552-52558</a>	80%
<a href="#">52548-52550</a>	75%

2

Highlight unknown vocabulary

Qua de causa Helvetii quoque  
reliquos Gallos virtute praecedunt  
quod fere cotidianis proliis cum  
Germanis contendunt cum aut suis  
finibus eos prohibent aut ipsi in eorum  
finibus bellum gerunt. Apud Helvetios  
longe nobilissimus fuit et ditissimus  
Orgetorix. Is Marco Messala Marco  
Pisone consulibus regni cupiditate  
inductus coniurationem nobilitatis  
fecit et civitati persuasit ut de finibus  
suis cum omnibus copiis exirent.

3

PROIEL: Haug et al. 2008; core vocabularies: Jones et al. 2006,

Robillard et al. 2014; Bamberg Core Vocabulary: Utz 2000;

out-of-vocabulary words: Parada et al. 2010

# Build your own vocabulary exercises...

Matching: Assign the matching elements to each other!

dolore

numerus

sementes

numerus

maximas magnum maximum magno

Check

Cloze: Assign the words from the pool to the correct gaps!





Ita sive casu sive consilio deorum immortalium quae pars civitatis Helvetiae insignem calamitatem populo Romano intulerat ea princeps poenam persolvit. Qua in re Caesar non solum publicas  etiam privatas iniurias ultus est quod eius soceri Lucii Pisonis avum Lucium Pisonem legatum Tigurini eodem proelio quo Cassium interfecerant. Hoc proelio facto reliquas copias Helvetiorum ut consequi posset pontem in Arari faciendum curat  ita exercitum traducit. Helvetii repentino eius adventu commoti cum id quod ipsi diebus viginti aegerrime confecerant ut flumen transirent illum uno die fecisse intellexerent legatos ad eum mittunt. cuius legationis Divico princeps fuit qui bello Cassiano dux Helvetiorum fuerat. Is ita cum Caesare egit.  pacem populus Romanus cum Helvetiis faceret in eam partem ituros  ibi futuros Helvetios ubi eos Caesar constituisset  esse voluisset.

atque si atque sed atque

Check

Interactive exercises: E. C. Schmid 2010, Harecker et al. 2011; indirect learning: Röhr-Sendlmeier et al. 2012; authentic text corpora: Römer 2009; H5P interactive exercises: *H5P. Create, Share and Reuse Interactive HTML5 Content in Your Browser* 2018

... and evaluate your students' performance!

	Result Entry test: 5 of 11 tasks were processed correctly.
	Result Vocabulary work on text: 8 of 8 tasks were processed correctly.
	Result Exercise: 22 of 35 words were learned of which indicated as mastered: 9
	Result Final test: 9 of 11 tasks were processed correctly. Change compared to the entry test: 80.00 %

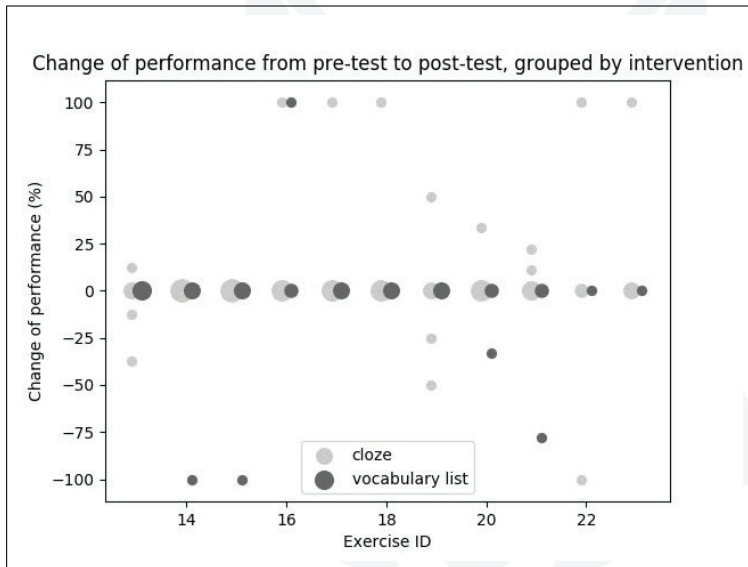
You can do better than that?

Prove it!

<https://korpling.org/mc/test>

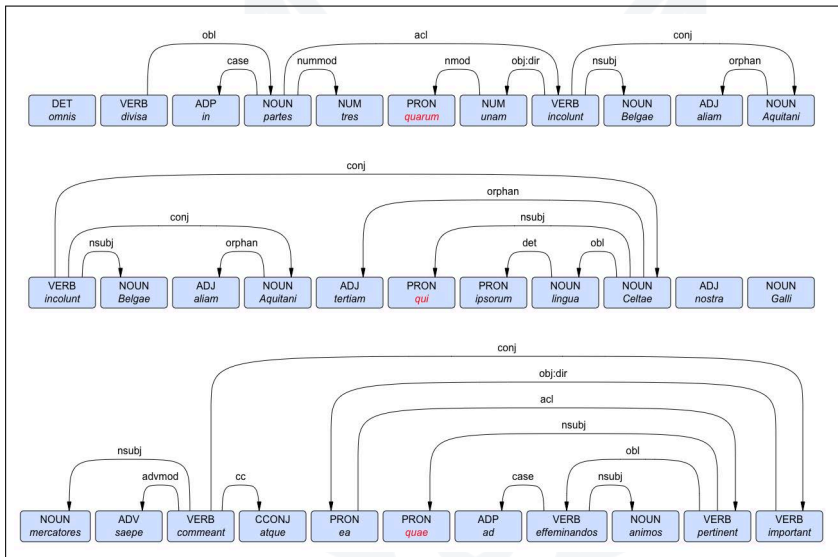


Advanced feedback: Narciss 2008

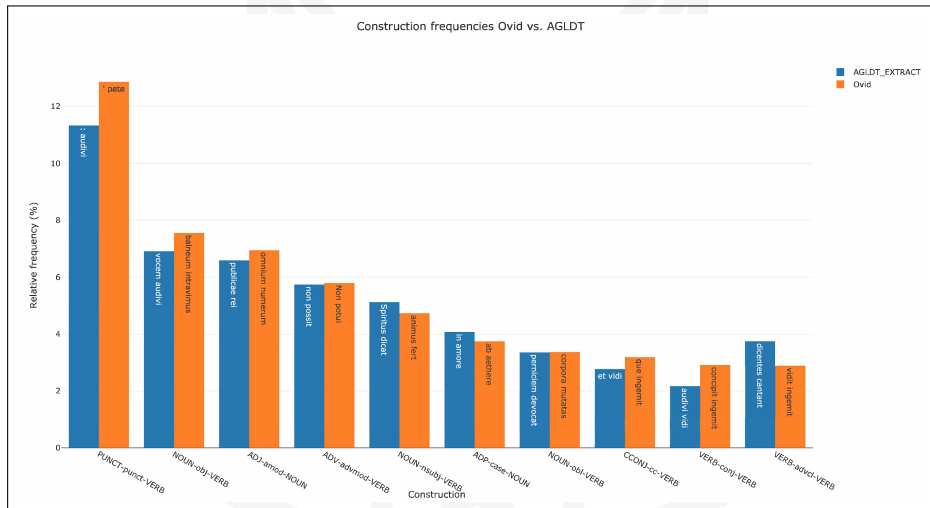


Dataset: Schulz2020; visualized assessment: Ferguson 2012; computer-aided vocabulary learning: Crossley et al. 2010; context-based vocabulary learning: Nation 2012





Keyword in context: Helm 2009; interaction syntax/semantics: Rich et al. 1991, Aijmer 2009, Rei et al. 2014, Lebani et al. 2018; development of syntactic knowledge: Farmer et al. 2011; context as multi-level interaction: Gries et al. 2013



AGLDT: Bamman et al. 2011; learners expect constructions: Ellis 2008, Hahn et al. 2019; constructions attract lexemes: H.-J. Schmid et al. 2013; ANNIS corpus search tool: Krause et al. 2016

Input: **In principio erat verbum et verbum erat apud deum et deus erat verbum.**

Task: Define the meaning of every word by looking at its right and left **neighbor**.

- ① Assign **identifiers** to every unique word form: In: 1, principio: 2, erat: 3, verbum: 4, et: 5, apud: 6, deum: 7, deus: 8
- ② Represent every word as a **sequence** of identifiers: In = [1,2], principio = [1,2,3], erat<sub>1</sub> = [2,3,4], erat<sub>2</sub> = [4,3,6], erat<sub>3</sub> = [8,3,4]
- ③ **Aggregate** representations of the same word form:  

$$\text{erat} = \frac{\text{erat}_1 + \text{erat}_2 + \text{erat}_3}{3}$$
- ④ Formulate a **query**: What is a typical context for 'erat'? → verbum

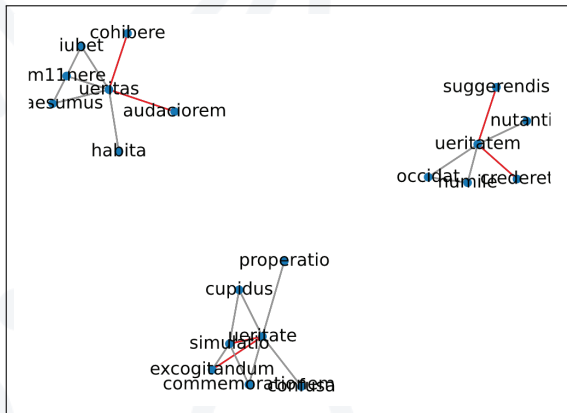
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foundations: Harris 1954, Firth 1957; DS and common knowledge: Bruni et al. 2014; DS and morphology: Gladkova et al. 2016; DS and functional similarity: Gries et al. 2009; DS and polysemy: Hamilton et al. 2016; transformer-based DS: Devlin et al. 2018; optimal parameters for DS: Dobó 2019; limitations of DS: Grigonytė et al. 2010, Karan et al. 2012, Faruqui et al. 2016, Rogers et al. 2017

Task: Using a panegyric from late antiquity, build a word field for "veritas" (*truth*).

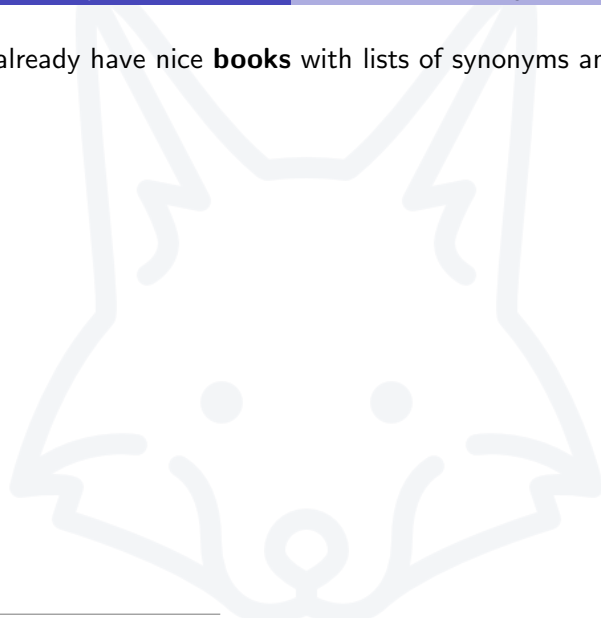
→

- simulatio (*pretense*)
- crederet (*to trust*)
- suggerendis (*to suggest*)
- excogitandum (*to contrive*)
- cohibere (*to restrain*)
- audaciorem (*bold*)





"But we already have nice **books** with lists of synonyms and word fields!"



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Distributional semantics and synonymy: Divjak et al. 2009, Hagiwara et al. 2009, Weale et al. 2009, Ono et al. 2015; explainable artificial intelligence: Doran et al. 2017

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🤔 "The underlying algorithm is a **black box**. We do not know how it works!"

🧐 True, but that is a **research** problem, not an educational one. In school, it is more important that the materials are suitable for a specific learning context.

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# Task: Find contexts where factuality is discussed.

haec pro imperatore nostro in quae 5 sint uerba suscepta ope1-ae pretium est adnotare : rsi bene rem publicam et ex utilitate omnium ' \* ' digna uota quae semper suscipiantur semper -que soluantur .

ut haec esse uera credamus quae mendacilis uatum in plausus aptata cauearum .

merito necne , neutram in partem decernere audeamus , quia nec fas est affirmationi tuae derogare et onerosum confiteri uera esse quae de nobis , praesertim tam magnifica , dixisti .

scis enim uhi uera principis , ubi sempiterna sit gloria .

quae perpetuae et constantis benit1olentiae prima fiducia est , certissima ui1-tut11m et max.ima principis , 11eritas , numquam in animo esse suspicacem te audiui .

dico enim magna certa -que fiducia : digna est hac quoque glo1-ia uestra pietas , et potest eam praestare felicitas .

o tego properationem militum iuui , ego fugam hostium praepediui , ego Maximt1m in muros coegi et quem uos cogebatis mori uiuum domino reseruau' : non uideo quod possit esse iudicium quin , cum ista pars imputet tyranni fugam , illa custodiam , res publica

20 legii religionem uererer , si is , qui semper 1-es a numine tuo gestas praedicare solitus essenii , haec tanto maiora pristinis silentio praeterirem , per quae non pars aliqua seruata , sed uniuersa sibi est res publica

neque enim parui negotii est imperatorem totius or bis pro se peculiariter rogare , sub tantae maiestatis aspectu perficere frontem , uultum componere , 20 confirmare animum , uerba concii pere , intrepidante1: dicere , apte desinere , expectare responsum .

quibus enim m11neribus aequari 20 haec cura principis , haec patientia potest , qua meruisti ut ille sibi nimium fortis ac p1-ope durus uideretur ?

est enim haec demum uera felicitas ao

haec est uera pietas , haec uoluptas conseruandi generis humani , exemplum dare gentibus ad matrimonia studiosius expetenda et liberos educandos , ut substituendis so successioneibus singulorum nihil obsit unumquemque esse mortalem , cum immortalis sit omnium posteritate res publica .

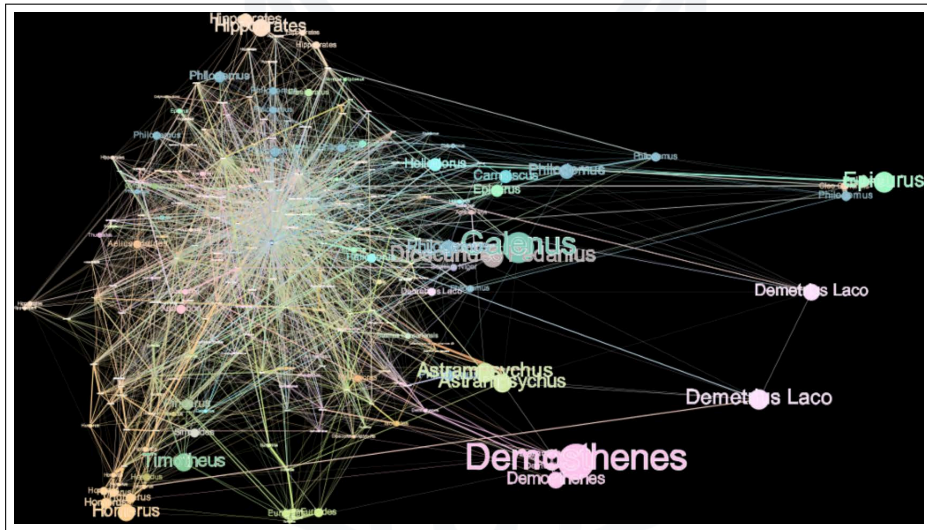
etenim ceterae uirtutes et bona cetera processu aetatis eueniunt , fortitudo a.nnis accedentibus roboratur , continentia disciplinae praeceptis traditur , iustitia cognitio -ne iuris addiscitur , 6 ipsa denique illa quae uidetur rerum omnium domina esse sapientia perspectis homin11m moribus et exploratis rerum docetur euentis : solae cum nascentibus pariter oriuntur pietas atque felicitas ; naturalia sunt enim animorum bona et praemia fatorum .

ibi adulescentes optimi discant , nobis quasi sollemne carmen praefantibus , maximorum principun1 facta celebrare ( quis enim melior usus est eloquentiae ?

neque enim fabula est de licentia poetarum nec opinio de fama ueterum saeculorum , sed manifesta res et probata , 20 sicut hodie -que testatur Herculis ara maxima et Herculei sacri custos familia Pinaria , principem illum tui generis ac nominis Pallantea moenia adisse ui

magnus uterque honor uester , sit1e eosdem maxime diligit quos scit uobis esse carissimos siue illis neminem praefert , quamuis aliquem magis amet : proposita sunt senioribus p1-aemia , iuuenib1s exempla : adeant , 20 frequentent securas tandem ac patentes domos : quisquis probatos senatui uiros suscipit , hic maxime principem promeretur .

etenim ut nomj -ne Augusti admonemur eius cui primum dicatum est , ita haec optimi appellatio numquam memoriae 11ominum sine te recurret , quotiensque posterii nostri optimum aliquem uocare cogentur , so totiens recordabuntur quis me1-uerit uocari .



Source: Ochab et al. 2019, p.141; effects of text length and topic in stylometry:  
Golcher et al. 2011

# Take Home Message

NLP can ...

- improve and **assess** your students' vocabulary knowledge
- **visualize** syntactic structures to help students break down complex sentences
- **retrieve** relevant text passages for a given topic

NLP cannot (yet) ...

- provide advanced **feedback** beyond 'correct/incorrect'
- reliably **discover syntactic** structures all by itself
- pin down **ambiguous** contexts to a specific meaning

## Useful resources

- interactive exercises: [H5P](#)
- Latin vocabulary exercises: [Machina Callida](#)
- visualization for linguistic annotations: [CONLLU Viewer](#)
- annotated ancient texts: [AGLDT](#) & [PROIEL](#)
- corpus search and visualization: [ANNIS](#)

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