Latin Lemmatization & POS Tagging

Issues, Resources, Tools

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Overview

Lemmatization & Part-of-Speech Tagging

Textual Resources

- Lemmatized Corpora for Latin

Tools and Hands-on

- Tools for lemmatization & POS Tagging
- Try it yourself on the provided text(s)!

Latin in the Semantic Web

- The LiLa Knowledge Base
- The TextLinker

Querying Lemmatized Resources

- Latin Treebanks in Universal Dependencies
- Interlinked Lexical and Textual Resources in LiLa

Goals

Lemmatization and **part-of-speech tagging** (POS-tagging) aim to **abstract** some linguistic properties to allow **form-invariant** reference to types/tokens.

?! How can I retrieve all the occurrences of a word in a text?

?! How can I know which (morphosyntactic) function(s) a word plays in a text?

Lemmatization & Part-of-Speech Tagging

Attaining a standard representation of lexicon and morphosyntax

Different word forms in different contexts…

- …*his rebus cognitis Caesar Gallorum animos* ***verbis*** *confirmavit*…
  → ablative plural (token); dative & ablative plural (type)
- …*quod ego si* ***verbo*** *adsequi possem*…
  → ablative singular (token); dative & ablative singular (type)
- …*ne more iuvencae mugiat, et timide* ***verba*** *intermissa retemptat*…
  → accusative plural (token); nominative, accusative & vocative plural (type)

…but all can be referred to a canonical/standardized citation form (Lemma):

⇒ ***uerbum***
→ nominative singular of neuter II. declension noun

What about *cognitis*, *intermissa* and *timide*?

Lemmatization

Type-based the process of assigning each type (in a text) to one, or more lemma(s)
Token-based the process of assigning each token in a text to a lemma

Different lexicographic criteria:

- inflectional morphology: same paradigm, same lemma? what about participles?
- graphical representation: *voluptas* vs. *uoluptas*
- spelling: *sulphur* vs. *sulfur*
- ending and inflectional type: *diameter* vs. *diametros* vs. *diametrus*
- paradigmatic slot for the lemma: *sequor* vs. *sequo* (see Du Cange: infinitives used)
- homographs: *occido/[caedo|cado]* vs. *occido[1|2]*

Lemmatization & Part-of-Speech Tagging

Attaining a standard representation of lexicon and morphosyntax

Words can play different (morphosyntactic) functions in sentences:

- ⋆ ***supra***
  - ▶ *. . . ager trecentis aut etiam* ***supra*** *nummorum milibus emptus. . .*
    - → adverb (ADV)
  - ▶ *. . . ille qui* ***supra*** *nos habitat. . .*
    - → preposition (ADP)
- ⋆ ***scribo***
  - ▶ *. . . atque in Thesauro* ***scripsit*** *causam dicere prius unde petitur. . .*
    - → verb (VERB)
- ⋆ ***elephantus***
  - ▶ *. . .* ***elephanto*** *beluarum nulla prudentior. . .*
    - → noun (NOUN)

These functions are predictable and come from a rather small set of alternatives.

Part-of-speech tagging

Type-based: the process of assigning each type one, or more morphosyntactic **function(s)**, i. e. parts of speech, from a given set
Token-based the process of assigning each token in a text one morphosyntactic **function**, i. e. part of speech, from a given set

Current standard de facto tagset: **Universal Dependencies**

16+1 classes: ADJ (adjectives), ADP (pre- & postpositions), ADV (adverbs), AUX (auxiliaries), CCONJ & SCONJ (co-ordinating & subordinating conjunctions), DET (determiners), INTJ (interjections), NOUN & PROPN (common & proper nouns), NUM (numerals), PART (particles), PRON (pronouns), VERB (verbs), SYM (symbols), X (other) + PUNCT (punctuation)

`https://universaldependencies.org`

Lemmatization & Part-of-Speech Tagging

Attaining a standard representation of lexicon and morphosyntax

Type-based vs. token-based POS tagging:

- Every ADJ can be NOUN
- Every ADP, CCONJ, SCONJ etc. can be NOUN (like in metalinguistic discourse)
- Every VERB can be NOUN

One or more part-of-speech? Which part-of-speech?

- *italicus*: ADJ? NOUN? PROPN?
- *ubi*: ADV? SCONJ?
- *non*: ADV? PART?
- *aliqui*: PRON? DET? ADJ?

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Lemmatized Corpora for Latin

- LASLA Corpus
- Index Thomisticus
- Computational Historical Semantics
- 5 Latin Treebanks in UD
- CLaSSES
- …and others

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LEMLAT

Type-based: https://github.com/CIRCSE/LEMLAT3


```
Analysed wordform : sulphur

============================ANALYSIS    ================================

SEGMENTATION:   sulphur

--------------------morphological feats 1 --------------------------
--nns--

Case:   Nominative
Gender: Neuter
Number: Singular
--------------------morphological feats 2 --------------------------
--ans--

Case:   Accusative
Gender: Neuter
Number: Singular
--------------------morphological feats 3 --------------------------
--vns--

Case:   Vocative
Gender: Neuter
Number: Singular
        ============================LEMMA ================================
        sulpur                          N3B  s3429 n
        ----------------------morphological feats-----------------------
        NcC

        PoS:    Noun
        Type:   Common
        Inflexional Category:   III decl
```

UDPipe

Token-based: `https://lindat.mff.cuni.cz/services/udpipe/`


```
# generator = UDPipe 2, https://lindat.mff.cuni.cz/services/udpipe
# udpipe_model = latin-proiel-ud-2.6-200830
# udpipe_model_licence = CC BY-NC-SA
# newdoc
# newpar
# sent_id = 1
# text = Cui dono lepidum novum libellum arida modo pumice expo
1    Cui    qui    PRON    Pr    Case=Dat|Gender=Masc|Number=Si
2    dono    donum    NOUN    Nb    Case=Abl|Gender=Neut|Nu
3    lepidum    lepidus    ADJ    A-    Case=Acc|Degree=Pos|Gender=
4    novum    novus    ADJ    A-    Case=Acc|Degree=Pos|Gender=
5    libellum    libellus    NOUN    Nb    Case=Acc|Gender=Masc|N
6    arida    aridus    ADJ    A-    Case=Acc|Degree=Pos|Gender=
7    modo    modo    ADV    Df    _    8    advmod    _    TokenR
8    pumice    pumic    NOUN    Nb    Case=Abl|Gender=Masc|Nu
9    expolitum?    expolio    VERB    V-    Case=Nom|Gender=M
SpaceAfter=No|TokenRange=51:61
```

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1	Cui	qui	PRON	_	_	_	_	_	TokenRange=0:3
2	dono	donum	NOUN	_	_	_	_	_	TokenRange=4:8
3	lepidum	lepidus	ADJ	_	_	_	_	_	TokenRange=9:16
4	novum	novus	ADJ	_	_	_	_	_	TokenRange=17:22
5	libellum	libellus	NOUN	_	_	_	_	_	SpacesAfter=\r\n|TokenRange=23:31
6	arida	aridus	ADJ	_	_	_	_	_	TokenRange=33:38
7	modo	modo	ADV	_	_	_	_	_	TokenRange=39:43
8	pumice	pumicus	NOUN	_	_	_	_	_	TokenRange=44:50
9	expolitum?	expolito	VERB	_	_	_	_	_	SpaceAfter=No|TokenRange=51:61
```

TreeTagger

Token-based: HMM + Binary Decision Tree

- Download the tool from `https://www.cis.uni-muenchen.de/~schmid/tools/TreeTagger/`
- Prepare a txt file with a Latin text
- Tokenize the file and prepare the input (one-word-per-line):

```
cd treetagger/cmd
perl utf8-tokenize.perl INPUT-FILE.txt >
OUTPUT-FILE.txt
```

TreeTagger

Token-based: HMM + Binary Decision Tree

- `cd ../bin`
- Linux/Mac:
  `./tree-tagger <parameter-file> <input-file> <output-file> -token -lemma`
  Example (download a parameter file for Latin and put it into the 'bin' folder): `./tree-tagger latin.par input.txt output.txt -token -lemma`
- Windows:
  `tag-LANGUAGE.bat <input-file> <output-file>`
  Example: `tag-latin.bat input.txt output.txt`

Further Tools
All Token-based

- Collatinus Web: `https://outils.biblissima.fr/en/collatinus-web/`
- Deucalion: `https://dh.chartes.psl.eu/deucalion/latin`
- Stanza: three models for Latin. `https://stanfordnlp.github.io/stanza/available_models.html`
- Morpheus: `https://github.com/PerseusDL/morpheus`
- Whitaker's Words: `https://latin-words.com`

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- Use web standards to represent/query (meta)data, such as RDF and SPARQL
- Include links to other URIs

Why To Apply LD to Linguistic Resources

J. Gracia: LLD CLARIN Café, 29/4/21

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- Resources disconnected from each other (silos of LRs)
- Proprietary and heterogeneous formats
- Different representation schemes, query languages, annotation criteria and tagsets

Benefits of Applying LD to Linguistic Resources

Chiarcos et al. (2013)

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- Federation: to combine information from physically separated repositories
- Dynamicity: to provide access to the most recent version of a resource
- Ecosystem: a large and active community with common tools and practices. Initiatives: (1) COST Action *Nexus Linguarum* (COST Action 2019-2023): European network for Web-centred linguistic data science; (2) *Prêt-à-LLOD* (RIA 2019-2022): Ready-to-use Multilingual Linked Language Data for Knowledge Services across Sectors; (3) LD4LT (*Linked Data for Language Technology Community Group*): to create a consolidated LOD vocabulary for web (linguistic) annotation

ERC Consolidator Grant 2018-2023

A collection of multifarious, interoperable linguistic resources described with the same vocabulary for knowledge description (by using common data categories and ontologies)

Interlinking as a Form of Interaction

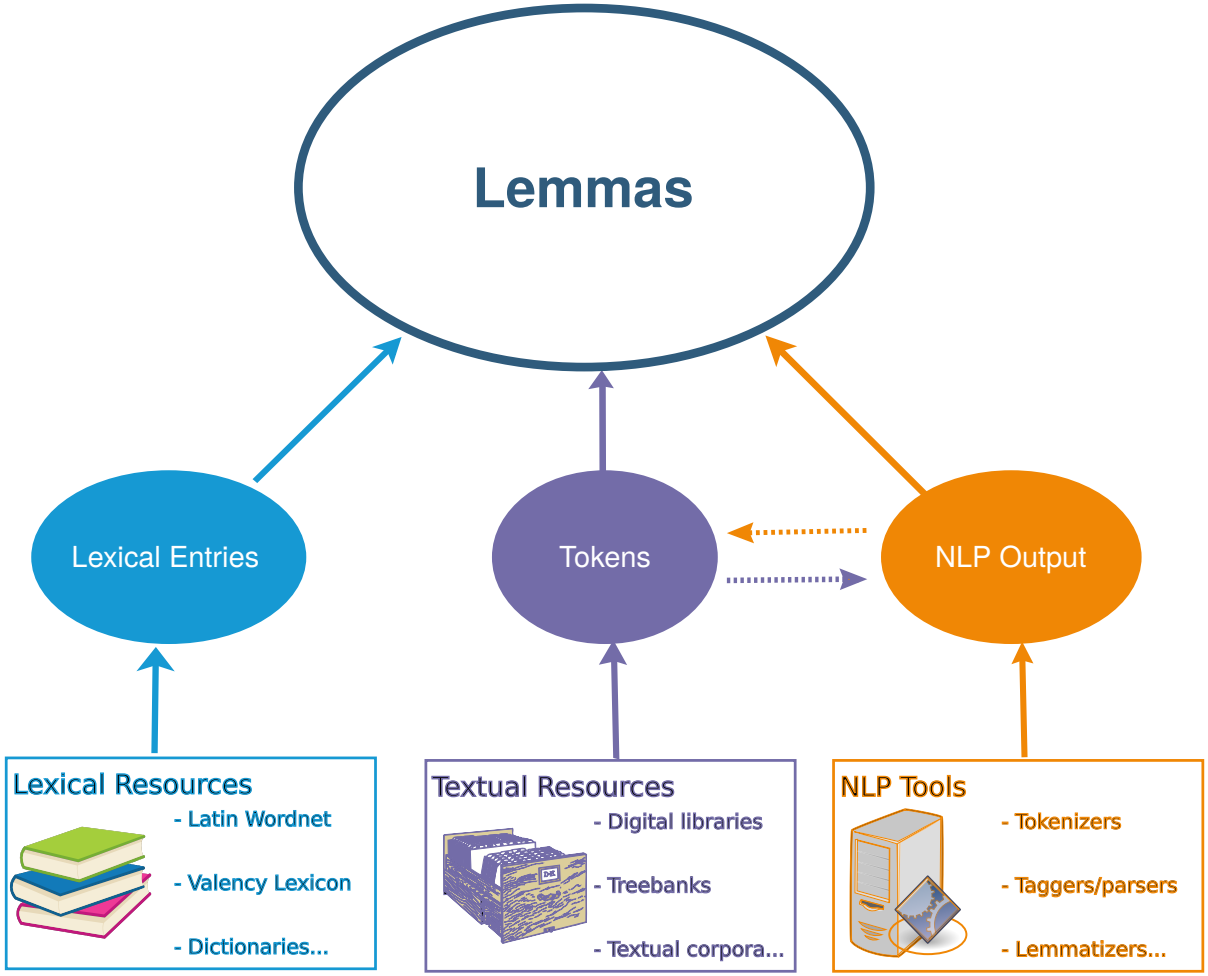
CLARIN
Common Language Resources and Technology Infrastructure

Infrastructure

Interoperability

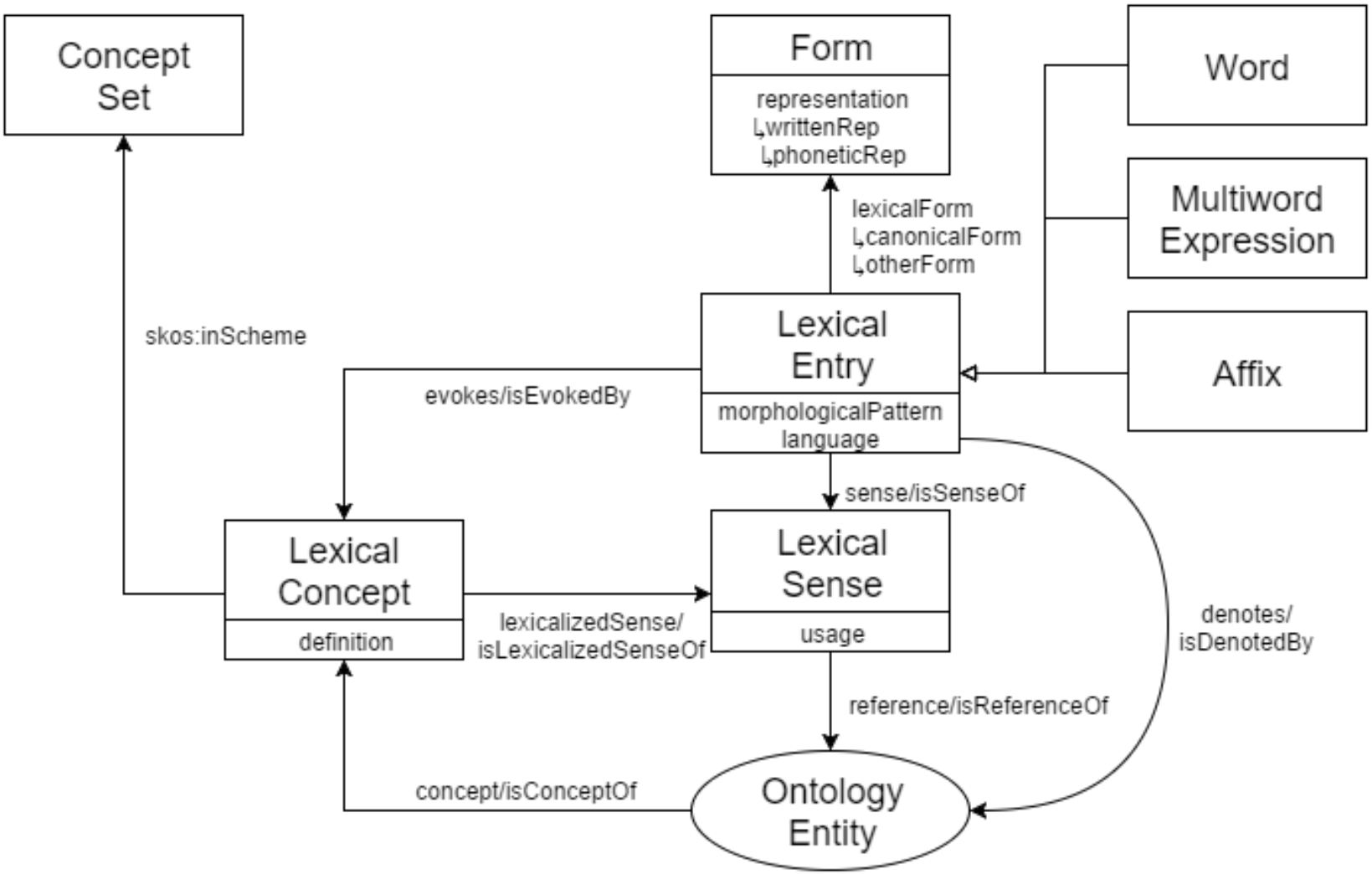
The LiLa Knowledge Base

Lexically-based architecture and (meta)data sources



LiLa and Ontolex Lemon

A *de facto* W3C standard for publishing lexical data as LLOD



Lemma *admiror* 'to admire, to respect'

`http://lila-erc.eu/data/id/lemma/87541`

- Lemma Bank
- A bilingual dictionary (Lewis & Short)
- A derivational lexicon (Word Formation Latin)
- A polarity lexicon (LatinAffectus)
- An etymological dictionary (De Vaan)
- A Valency Lexicon (Latin Vallex)
- A manually checked subset of the Latin WordNet

Lemma Bank Query Interface

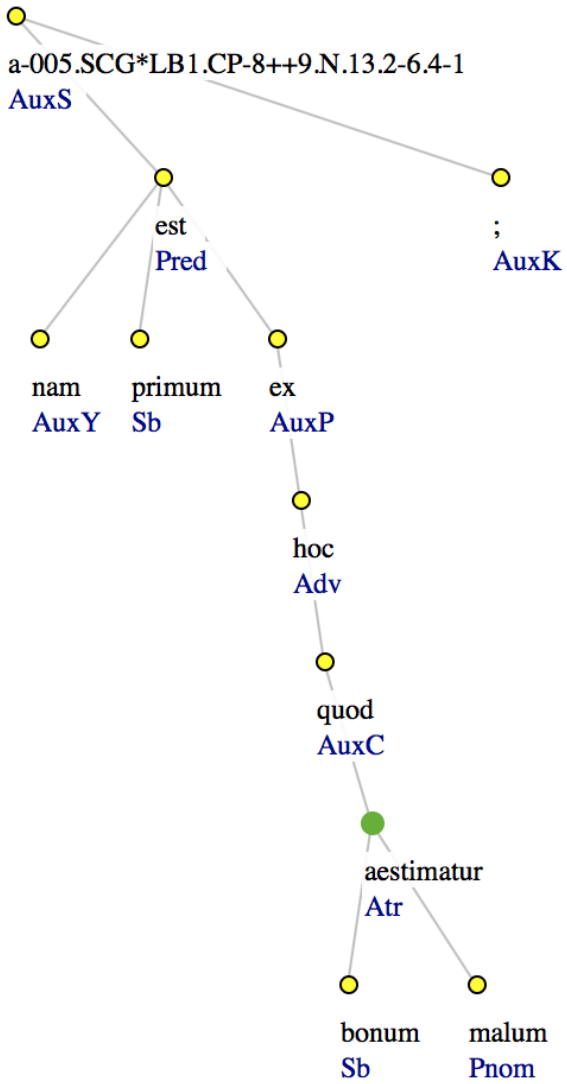
https://lila-erc.eu/query/

Textual Resources

Source: the *Index Thomisticus* Treebank (original scheme)

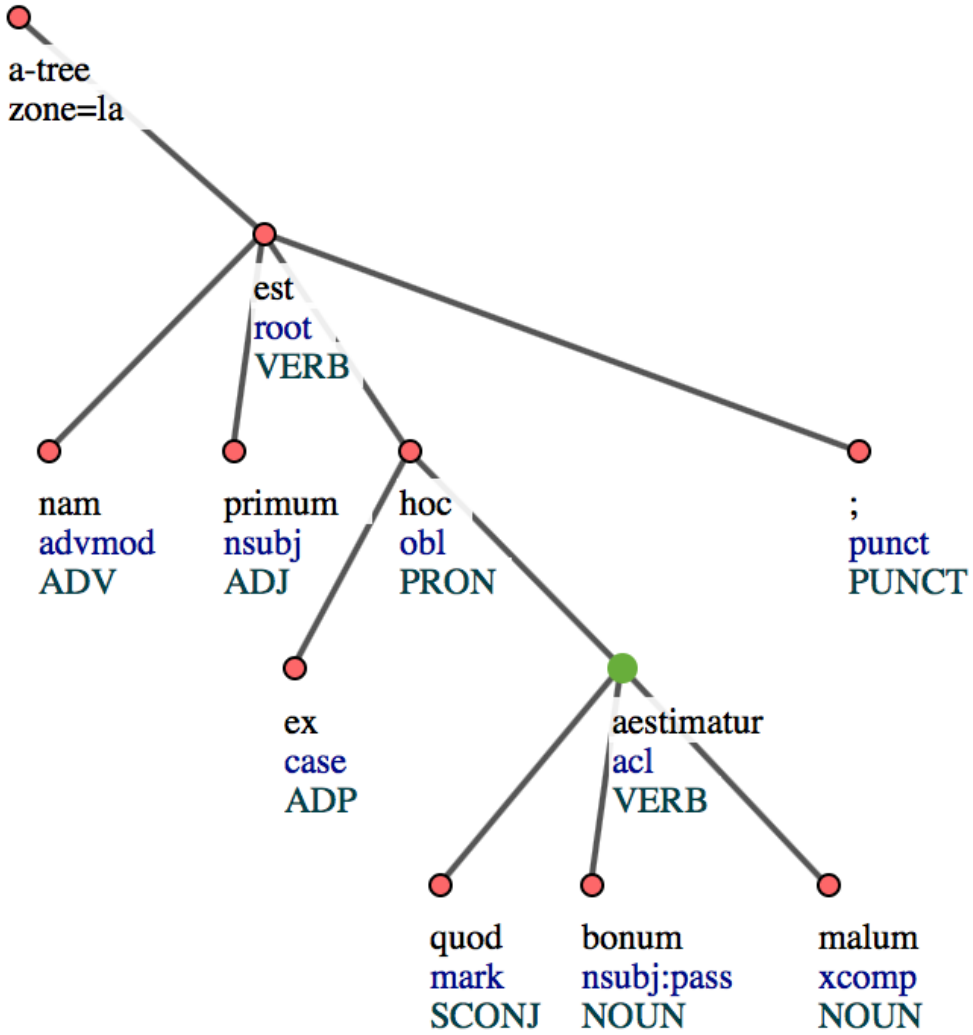
nam primum est ex hoc quod bonum ***aestimatur*** *malum*; (IT-TB: SCG, lib. 1, cap. 89, n. 13)

for the first arises because the good ***is judged*** *to be evil*; (Trans. Anton C. Pegis)



Textual Resources

Source: the *Index Thomisticus* Treebank (UD scheme)



Textual Resources

A token from the *Index Thomisticus* Treebank in LiLa

Token *aestimatur*

http://lila-erc.eu/lodview/data/corpora/ITTB/id/token/005.SCG*LB1.CP-8++9.N.13.2-6.4-1W8

LiLa: Overview

Resources connected and upcoming connections

- **Textual Resources**
  - [x] Index Thomisticus Treebank (*Summa contra Gentiles*): ca. 400,000 nodes
  - [x] UDante Treebank: ca. 46,000 tokens
  - [x] *Querolus sive Aulularia*: ca. 17,000 tokens
  - [x] *Liber Abbaci* (ch. VIII) by Leonardo Fibonacci: ca. 30,000 tokens
  - [x] LASLA Corpus: ca. 1.7 million tokens
  - [ ] PROIEL and LLCT treebanks, CompHistSem, CroALa, Musisque DeoQue
- **Lexical Resources**
  - [x] Lemma Bank: ca. 200,000 canonical forms
  - [x] Word Formation Latin: ca. 36,000 lemmas (Classical Latin)
  - [x] Etymological Dict. of Latin & the Other Italic Langs.: ca. 1,500 entries
  - [x] LatinAffectus: ca. 3,300 entries
  - [x] Index Graecorum Vocabulorum in L. Latinam Transl.: ca. 1,800 entries
  - [x] Latin WordNet: ca. 2,500 manually checked entries
  - [x] Latin Vallex 2.0: ca. 2,000 entries
  - [x] Lewis & Short Dictionary: ca. 50,000 entries
  - [ ] Lexikon der Indogermanischen Verben (LIV). Wiktionary, BabelNet

TOTAL: approximately 33 million triples

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TextLinker

Welcome screen: `http://lila-erc.eu:8080/LiLaTextLinker/`

Figure: LiLa's Text Linker

TextLinker

Processed output: `http://lila-erc.eu:8080/LiLaTextLinker/`

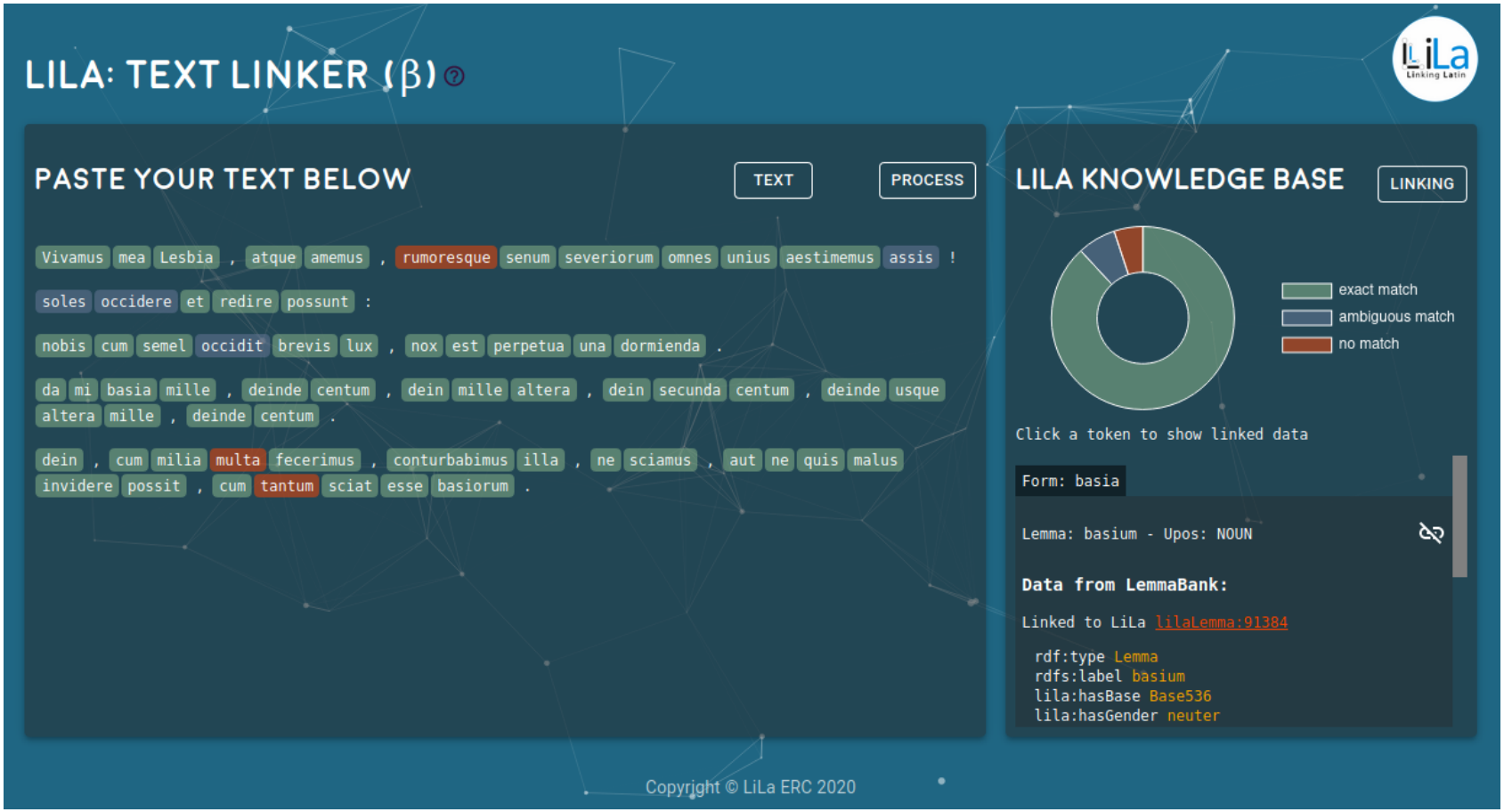

Figure: Text processed against the LiLa Knowledge Base

TextLinker

Hands-on: `http://lila-erc.eu:8080/LiLaTextLinker/`

Try the TextLinker yourself on the provided text(s)!

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SETS Treebank Search

http://depsearch-depsearch.rahtiapp.fi/ds_demo/

Select one UD Latin treebank from the list

- `dicitur`
- `L=dico`
- `NOUN`
- `L=dico & Number=Sing`
- `L=dico &!  Number=Sing`
- `L=dico | L=materia`
- `L=dico >nsubj L=commentator` (ITTB)

KonText

https://lindat.mff.cuni.cz/services/kontext/corpora/corplist

Select collection, language (Latin) and corpus

- Basic: worform (`hominem`) or, if the query is a lemma (`homo`), all the forms of that lemma
- Lemma: `homo`
- Phrase: `forma de`
- Word part: `hom`
- CQL: `[upos="NOUN" & (lemma="homo" | lemma="forma")]`

You can always specify the context
(lemmas co-occurring with query results in a specified window size)

Grew-match

http://match.grew.fr

Select language (Latin) and corpus

- `pattern {N [lemma="homo"]}`
- `pattern {N [upos="NOUN"]}`
- `pattern {V [upos=VERB];} without {V [lemma="sum"]}`
- `pattern {N1 [lemma="forma"]; N2 [lemma="materia"]; N1 < N2 }`
- `pattern {N1 [upos=VERB]; N2 [upos=NOUN]; N1 < N2 }`
- `pattern {GOV -> DEP; DEP [upos=NOUN]}`
- `pattern {N [upos = AUX]}`

PML Tree Query

http://lindat.mff.cuni.cz/services/pmltq/#!/home

Select collection (UD), language (Latin) and corpus

- `a-node $n1:= [ lemma = "homo" ]`
- `a-node $n1:= [ conll/cpos = "NOUN" ]`
- `a-node $n1:= [ conll/cpos = "NOUN" ]`
  `» for $n1.lemma give $1, count(), sort by $2 desc, $1`
- `a-node $n1:= [ conll/cpos = "NOUN", child $n2:= [ conll/deprel = "amod"] ]`
  `» for $n2.lemma give $1, count(), sort by $2 desc, $1`
- `a-node $n1:= [ lemma = "forma", child $n2:= [ conll/deprel = "amod"] ]`
  `» for $n2.lemma give $1, count(), sort by $2 desc, $1`

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SPARQL Access Point

`https://lila-erc.eu/sparql/`

Thanks!
Get in touch

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Università Cattolica del Sacro Cuore
CIRCSE Research Centre

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https://github.com/CIRCSE

https://lila-erc.eu

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