SUMMARY

What is Word Formation Latin (WFL)?

Word Formation Latin (WFL) is a language resource for Classical Latin that connects lexical items on the basis of word-formation rules (WFRs). The scope of WFL is to assign a WFR to each morphologically-complex lexeme (i.e. one word morphologically derived from another word) and to link each complex lexeme to its ancestor. All those lexemes that share a common (not derived) ancestor belong tothe same “word formation family”. For instance, the noun *bellatrix* ‘she who wages war’, the verb rebello ‘to revolt, rebel’, and the adjective *bellicosus* ‘fond of war’ all belong to the word formation family whose ancestor is noun *bellum* ‘war’. The semi-automatic insertion of lemmas into the WFL database establishes input-output relations for a set of lemmas matching the features that characterise each WFR.

WFL has received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 658332-WFL. The project is based at the Centro Interdisciplinare di Ricerche per la Computerizzazione dei Segni dell’Espressione (CIRCSE), at the Università Cattolica del Sacro Cuore, Milan, Italy. The project ran from November 2015 to the end of October 2017, and resulted in the publication of the word formation based lexicon, which is accessible digitally through this website and in connection to the morphological analyser and lemmatiser for Latin Lemlat.

This documentation collects all information regarding how the WFL lexicon was built, together with instructions on how to navigate its site and how and where to find the database for your own personal research.

Last updated:

Methodology

For what the construction of the word formation relationships is concerned, WFL uses a step-by-step morphotactic approach: derivational and compounding rules are modelled as directed one-to-many input-output relations between lexemes, and each word formation process is treated individually. The lexeme resulting from a WFR is usually richer (containing more morphemes) than the input. with the exception of conversion, which only involves a change of PoS. Each output lexeme can only have one source, except in the case of compounds, where it is possible to have two (or three) input lexemes for one output lexeme.

Building the Lexicon

The word formation lexicon is built in two steps. First, word formation rules are detected. Then, they are applied to lexical data.

Detecting Word Formation Rules

Word formation rules (WFRs) are conceived according to the so-calledItem-and-Arrangement model, outlined by Hockett (1954), which considers word forms either as simple morphemes (not derived word forms) or as a concatenation of morphemes (derived word forms). The following conditions on bases and affixes do hold: (1) Baudoin’s assumption that both bases and affixes are lexical elements (i.e. they are both morphemes); (2) as a consequence, they exist in the lexicon (Bloomfield’s “lexical morpheme” theory); (3) they are dualistic, i.e. they have both form and meaning (Bloomfield’s “sign-base” morpheme theory). The first two conditions motivate the fact that in our word formation lexicon affixes are recorded with the same status of lexical bases; the third condition concerns the semantic properties of WFRs.

In Latin, WFRs fall into two main types: (1) derivation and (2) compounding. Derivation rules are further organised into two subcategories: (a) affixal, in its turn split into prefixal and suffixal, and (b) conversion, a derivation process that changes the PoS of the input word without affixation.

Compounding and conversion WFRs are automatically detected, by considering all the possible combinations of main PoS (verbs, nouns, adjectives), regardless of their actual instantiations in the lexical basis. For instance, there are four possible types of conversion WFRs involving verbs: V-To-N (claudo > clausa; 'to close' > 'cell'), V-To-A (eligo > elegans; 'to pick out' > 'accustomed to select, tasteful'), N-To-V (magister > magistro; 'master' > 'to

rule'), A-To-V (celer > celero; 'quick' > 'to quicken'). Each compounding and conversion WFR type is further specified by the inflectional category of both input and output. For instance, A1-To-V1 is the conversion WFR from first class adjectives to first conjugation verbs.

Affixal WFRs are found both according to previous literature on Latin derivational morphology (Jenks, 1911; Fruyt, 2011; Oniga, 1988) and in semi-automatic fashion. The latter is performed by extracting from the list of lemmas of Lemlat the most frequent sequences of characters occurring on the left (prefixes) and on the right (suffixes) side of lemmas. The PoS for WFR input and output lemmas as well as their inflectional category are manually assigned. Further affixal WFRs are found by confrontation with data.

We recorded the rules in a table of a MySQL relational database where each WFR is classified by type and it is assigned the required PoS, inflectional category and gender for its input and output.

Applying Word Formation Rules

Each morphologically derived lemma is assigned a WFR. All those lemmas that share a common (not derived) ancestor belong to the same “word formation family”. For instance, lemmas *formatio* 'formation', *formo* 'to form' and formosus (“beautiful”, lit. “finely formed”) all belong to the word formation family whose ancestor is the lemma forma(“form”).

WFL uses a morphotactic approach. Each word formation process is treated individually, and the lexeme resulting from a WFR is usually richer (containing more morphemes) than the input. with the exception of conversion, which only involves a change of PoS. Each output lexeme can only have one source, except in the case of compounds, where it is possible to have two (or three) input lexemes for one output lexeme.

Lemmas and WFRs are paired by using a MySQL relational database whose main tables are the les archive of Lemlat, the list of its lemmas (each assigned its PoS, inflectional category and, for nouns only, gender) and the list of WFRs.

A number of MySQL queries provide the candidate lemmas for each WFR. Some of these queries run on the list of lemmas, while others on thelesarchive. In particular, most candidate lemmas of prefixal WFRs are found by running queries on the list of lemmas, as such rules tend to just add the characters of the prefix to the input lemma, like in the case ofaccuso→sub+accuso(“to blame” → “to blame somewhat”). Instead, suffixal WFRs are mostly assigned to their candidate input and output lemmas by running queries on thelesarchive, because suffixes attach tolesinstead of modifying full lemmas, like inamo→amabilis(“to love” → “lovable”) where suffix–bil–attaches tolesam(plus the thematic vowel –a–, used for first conjugation verbs) instead of full lemmaamo. Also, there are suffixal WFRs whose input is the basis of the irregular perfect participle of the input verb, like

induco→ductilis(“to lead” → “that may be led”) where suffix–il–attaches to the basis of the irregular perfect participle of the verbduco(duct). Such irregular bases are recorded explicitly in the les archive with a specific codles.

Making Choices

paro: to furnish, supply, provide

pario V5: to give birth

pario V1 (from par): to pair

The lexical basis for WFL is the same as that of the morphological analyser and lemmatiser for Latin **Lemlat** which has been collated from three Classical Latin Dictionaries: *Oxford Latin Dictionary* (Glare 1982); *Ausführliches lateinisch-deutsches Handwörterbuch* (Georges and Georges 1913-18); *Laterculi vocum latinarum* (Gradenwitz 1904). It contains 40,014 lexical entries and **43,432 lemmas** (as more than one lemma can be part of the same lexical entry). Additionally, the lexical basis of Lemlat has recently been enriched with the integration of most of the *Onomasticon* (26,250 lexemes out of 28,178) contained in the Forcellini lexicon (Budassi and Passarotti 2016).

Lemlat contains every string of characters required in the inflectional paradigm of each lexeme, like the uninflected parts of irregular supines (*duc-*, *duct-* for *duco* ‘to lead’), or the stem of the genitive of imparisyllaba nouns and adjectives (*crimen*, *crimin-* ‘accusation’), fundamental for the automatic processing of WFRs, as well as including graphical variants, like *obf-*/*off-* in *offero* ‘to put oneself forward, cause to be encountered’ (Passarotti and Mambrini, 2012).

These strings of characters are used by Lemlat while morphologically analysing and lemmatising input word forms, which are automatically segmented into formative elements. Among these, the lexical element is called **les** (for “LExical Segment”). This is the invariable part of the inflected forms, i.e. the sequence – or one of the sequences – of characters that remains the same in the inflectional paradigm of a lexeme. The **les** does not necessarily match the word stem. For example, *poetis* the **les** for the lexeme *poeta* ‘poet’, as it is the sequence of characters that does not change in the different forms of the lexeme *poeta*: *poet-a*, *poet-ae*, *poet-am*, *poet-ae*, *poet-arum*, *poet-as*, *poet-is*. Lemlat includes a **les** archive, in which each **les** is assigned a number of inflectional features. Among these, there is a tag for the gender of the lexeme (for nouns) and a code (**codles**) for its inflectional category. For instance, the **codles** for the **les** *poet* is **n1e** (first declension irregular nouns) and its gender is **m** (masculine). In the case of irregular nouns, as for *poeta*, there is also a field (**lem**) containing information on how to recognise an irregular ending (*poeta* can sometimes appear with nom. sg. *poetes*) during the lemmatisation.

WFL makes use of the **les** archive together with a list of **43,432 lemmas** automatically extracted from the Lemlat dataset. Both lists were added as tables to the relational database used while building WFL.

For more details about Lemlat and its lexical basis please refer to Passarotti et al. 2017 (in bibliography).

In the WFL lexical basis, there are three codes for three different kinds of lemmas:

1. B for "basic": lemmas taken from the original Lemlat lexical basis.
2. O for "onomastic": lemmas added from the Forcellini onomastic lexicon. These have not been used to build word formation relations, unless they are the input for a non

onomastic lemma, e.g. *antonius* 'Anthony' > *antonesco* 'to behave like Anthony'.

3. F for "fictional": fictional lemmas that have been added during the building of WFL to account for relationships that are otherwise difficult to fit in the WFL morphotactic database (see Budassi and Litta 2017). Fictional entries are marked with a preceding asterisc ('*') that indicates a "reconstructed" lemma, although the lemma does not necessarily need to have ever existed, but it only acts as a *trait d'union* between two attested lemmas.

Parts of Speech (PoS)

Legenda of PoS codes used in the resource

A: adjectives. A is followed by a number indicating the class of the adjective, i.e. 1 for adjectives of the first class and 2 for adjectives of the second class. For example, A2 means adjective of the second class.

N: nouns. The number following the initial letter indicates the declension, e.g. N1, N2, N3 etc. The small letter following the declension number indicates the gender of the noun, i.e. m for masculine, f for feminine, n for neuter. For example, N2m means masculine noun of the second declension. N on its own means uninflected nouns, such as numerals, letters (*beta*) and unassimilated borrowings.

V: verbs. V is followed by a number indicating the conjugation, or by A to indicate an auxiliary verb, e.g. V1, V3, VA, etc. V5 means e/i conjugation verbs e.g. *capio* 'to take'.

I: invariable lemmas, i.e. adverbs, interjections, conjunctions.

PR: pronouns

Where to find participial nouns or adjectives

adulescens> per-adulescens

Which Word Formation Rules?

Word Formation Rules (**WFRs**) were conceived according to the **Item-and-Arrangement** (IA) model, which considers word forms either as simple (non-derived) morphemes or as a **sequence of morphemes** (**base** and **affixes**) having both form and meaning (Hockett 1954). IA was chosen as the theoretical model supporting WFL for two main reasons: first, it emphasises the **semantic significance** of affixal elements as they are found in the lexicon; secondly, IA was the model adopted by other derivational lexica like *Word Manager* (Domenig and ten Hacken, 1992), after which WFL was designed.

There are two types of word formation processes in Latin: **derivation** and **compounding**.

Derivation can be further split into:

1) **Affixation**, where one or more morphemes, called affixes, can be attached to the base of a word. Affixation can be of two types, and can involve (or not) a change of part of speech:

- **Prefixation**: where the affix is attached **before** the base.
- **Suffixation**: where the affix is attached **after** the base.

2) **Conversion**, where the derived word incurs only in a change of part of speech without the addition of any affix.

Compounding is the formation of a new lexeme from two or more lexemes.

Prefixation

In general, we consider prefixes those morphemes that are often equivalent to a preposition, which are attached to the beginning of a word, e.g. ad, ab, ex, prae etc. as indicated by Oxford Latin Dictionary.

Moreover, we have included among prefixes all those numeral affixes that are considered prefixes by the Oxford Latin Dictionary. These are bi-, tri-, quadri-.

The following is a list of prefixes that can be found in WFL:

- a(b)-
- ad-
- am(b)(i)-
- ante-
- archi-
- bi-
- circum-

- con-
- contra-
- de-
- dis-
- e(x)-
- ec-
- extra-
- in (entering)-
- inter-
- intro-
- multi-
- ne-
- ob-
- per-
- post-
- prae-
- praeter-
- pro-
- quadri-
- re-
- retro-
- se-/sed-/so-
- semi-
- sub-
- subter-
- super-
- tra(ns)-
- tri-

Suffixation

A suffix is an affix that is placed after the stem of a word, to form another word.

A list of suffixes that can be found in WFL:

- (at)im
- (i)cul
- (i/a)n
- (i/e)ll
- (t)io(n)
- (t)iu

- (t)or
- (t)ric
- (t)ur
- ac
- ace
- al
- an
- ar
- at
- atil
- bil
- bund
- cell/cill
- cr
- cul
- e
- edo/edin
- el
- et
- far
- fex
- go/gin
- i
- ic
- ici
- id
- il
- iss
- ist
- it
- iti
- itud/itudin
- men/min
- ment
- n
- ol
- or
- os
- ri
- sc

- str
- tas/tat
- tori
- tr
- udo/udin
- ul
- uncul
- ur

Conversion

We have included change of inflection class, or gender, such as masculine to feminine, or 3rd declension to 1st declension, among N-to-N conversions.

examples: aera N1 < aes N3:n

Conversions in WFL are of the following kind:

- V-To-V
- V-To-N
- V-To-A
- V-To-I
- N-To-V
- N-To-N
- N-To-A
- N-To-I
- A-To-V
- A-To-N
- A-To-I
- I-To-A
- PR-To-N

Compounding

Compound words collected in WFL are created through 59 WFRs.

- A+A=A
- A+A=N
- A+I=I
- A+N=A
- A+N=I
- A+N=N

- A+PR=PR
- A+V=A
- A+V=N
- A+V=V
- I+A=A
- I+A=I
- I+I=I
- I+N=A
- I+N=I
- I+N=N
- I+N=N
- I+PR=A
- I+PR=I
- I+PR=PR
- I+V=A
- I+V=I
- I+V=N
- I+V=V
- N+A=A
- N+A=N
- N+I=I
- N+N=A
- N+N=N
- N+V=A
- N+V=I
- N+V=N
- N+V=V
- PR+A=A
- PR+A=N
- PR+A=PR
- PR+I=I
- PR+I=PR
- PR+N=A
- PR+N=I
- PR+PR=I
- PR+PR=PR
- PR+V=N
- PR+V=PR
- PR+V=PR
- PR+V=V

- V+A=A
- V+N=A
- V+N=I
- V+N=N
- V+PR=PR
- V+V=A
- V+V=N
- V+V=V

Accessing the Data

Important caveats:

1) WFL only contain derived and compounded lemmas and their input lemmas. You will not find a lemma that is not derived, or that does not have a derived output.

2) Type 'u' instead of 'v'.

The word formation lexicon can be accessed on-line through a visualisation query system (http://wfl.marginalia.it). The lexicon can be browsed either by WFR, affix, or input and output PoS or lemma. Drop down menus provide the available options for each selection, like for instance the list of affixes and lemmas.

Results are visualised as tree graphs, whose nodes are lemmas and edges are WFRs. Trees are interactive. Clicking on a node shows the full derivation tree (“word formation cluster”, which is calculated dynamically) for the lemma reported in that node. For example, Figure 1 shows part of the word formation cluster for the lemma *amo* 'to love'. One can see that *amabilis* 'lovable' derives from *amo* and it is in turn the input for two other derived lemmas: *amabilitas* 'loveliness' and *inamabilis* 'unlovely'. Clicking on an edge shows the lemmas built by the WFR concerned in that edge. Lemmas are provided both as a derivation graph and as an alphabetical list. For instance, clicking on the edge going from amo to *amabilis* in Figure 1 shows the lemmas built by the derivation WFR that builds second class adjectives (A2) from first conjugation verbs (V1) with suffix *–bil–*.

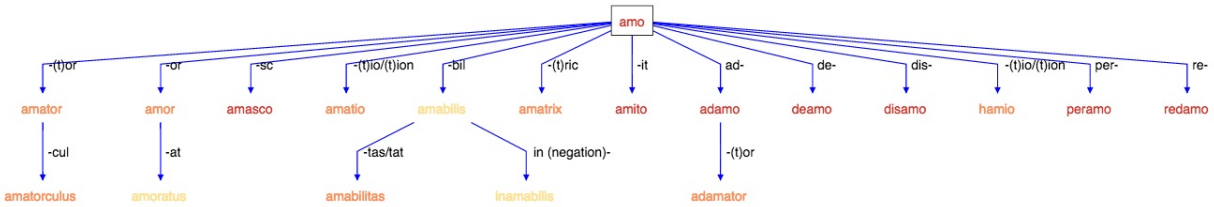

Figure 1: partial word formation family for *amo*.

Figure 2 presents a portion of the derivation graph for this rule.

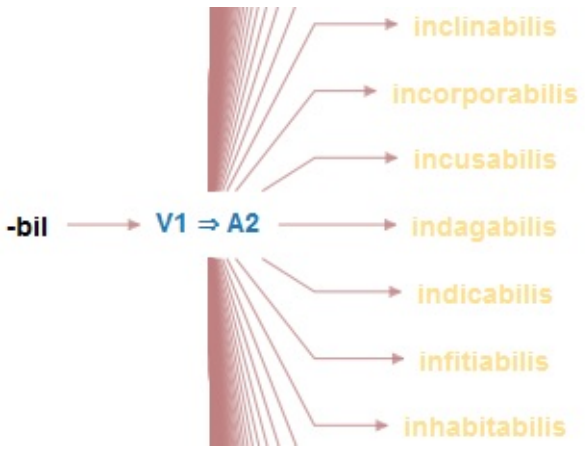

Figure 2. Derivation graph for a WFR.

Deeper searches: how to use regular expressions to look into thematic vowels.

Project Publications

The present documentation on WFL is covered partly by the following publications that were prepared during the MSCA Fellowship:

- paper clic -io
- paper clic composti

- Budassi, Marco, and Eleonora Litta. 2017. ‘In Trouble with the Rules. Theoretical Issues Raised by the Instertion of -sc- verbs into *Word Formation Latin*’. In *Proceedings of the Workshop on Resources and Tools for Derivational Morphology (DeriMo)*, 15–26. Milan: Educatt.

- Litta, Eleonora, Marco Passarotti, and Paolo Ruffolo. 2017. ‘Node Formation: Using Networks to Inspect Productivity in Affixal Derivation in Classical Latin’. In *Proceedings of the 2Nd International Conference on Digital Access to Textual Cultural Heritage*, 103–8.DATeCH2017. New York, NY, USA: ACM. doi:10.1145/3078081.3078092.

- Passarotti, Marco, Marco Budassi, Eleonora Litta, and Paolo Ruffolo. 2017. ‘The Lemlat 3.0 Package for Morphological Analysis of Latin’. In *Proceedings of the NoDaLiDa 2017 Workshop on Processing Historical Language*, 24–31. Linköping University Electronic Press. http://www.ep.liu.se/ecp/article.asp?issue=133&article=006&volume=.

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