Validation of Universal Dependencies by regeneration

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Abstract

We describe the design and use of a web-based system for helping the validation of English or French Universal Dependencies corpora by sentence regeneration. A symbolic approach is used to transform the dependency tree into a constituency tree which is then regenerated as a sentence in the original language. The comparison between regenerated sentences and the original ones from version 2.8 of Universal Dependencies revealed some annotation errors which are discussed and give rise to suggestions for improvement.

1 Introduction

Universal Dependencies (de Marneffe et al., 2021) (UD) have been developed for comparative linguistics and are used in many NLP projects for developing parsers or machine learning systems for training and/or evaluation. The accuracy of these annotations is thus very important. Many of these dependency structure annotations are the result of manual revisions of automatic parses or mappings from other parsing formalisms (e.g. EWT was originally derived from the Penn Treebank annotations). They are often quite difficult to check manually as there are so many details to take into account. This paper describes an alternative way of looking at the UD data, using it to regenerate a sentence that can be compared with the original. As we will show in Section 3, regenerating from the source revealed small mistakes, most often omissions, in quite a few of these structures which are often considered as gold standard. It is indeed much easier to detect errors in a figure or in a generated sentence than in a list of tab separated lines.

This approach for helping detecting potential errors in annotations can be compared with the work of van Halteren (van Halteren, 2000) who compares the result of an automatic part-of-speech tagger with the ones in the corpus and highlights tokens in which disagreement occurs. Wisniewski (Wisniewski, 2018) detects all identical sequences of words that are annotated differently in a corpus. This is achieved by aligning, in Machine Translation parlance, the sentences with their annotation and then displaying both sequences highlighting their differences.

UDREGENERATOR (see Figure 1) is a web-based English and French realizer written in JavaScript, built using JSREALB1. Only the English realizer is shown here, but it is also possible to use it for checking the French corpora of UD. The table at the top shows the token fields of the selected UD in the menu with the corresponding dependency link structure in the middle.

A UD realizer might seem pointless, because most UD annotations are created from realized sentences either manually or automatically. As UD contains all the tokens in their original form (except for elision in some cases), the realization can be obtained trivially by listing the FORM in the second column of each line. Taking into account the tree structure, another baseline generator can be implemented by a recursive traversal of the UD tree by first outputting the forms of the left children, then the form of the head and finally the forms of the right children.

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1http://rali.iro.umontreal.ca/rali/?q=en/jsrealb-bilingual-text-realiser
Universal Dependencies graph/tree display with regeneration using jsRealB

![Table](image)

**Figure 1:** Web page (http://rali.iro.umontreal.ca/JSrealB/current/demos/UDregenerator/UDregenerator-en.html) for exploring UD structures in a local file that is parsed to build a menu of their reference sentences in the middle of the page. Once a sentence is chosen, the fields of its tokens are displayed in the table at the top and the graph of its dependency links is displayed below the menu. A table below the graph shows information about this UD: the line number in the file, its sent_id and reference text (text), the regenerated text by jsREALB (TEXT). When there are differences between the expected text and realized text, they are highlighted (not shown here). The corresponding jsREALB expression is displayed in an editor that allows it to be changed and re-realized. The constituency tree corresponding to the jsREALB expression is displayed at the bottom. Checkboxes are used to limit the sentences in the menu to those for which there are differences between the references text and the generated sentence, those for which jsREALB issued warnings or those with non-projective dependencies.
This method does not work for non-projective dependencies (Kahane et al., 1998) because then, words under a node are not necessarily contiguous. This property is used in our system to detect non-projective dependencies which account for about 4% of the dependencies in our corpora, which roughly corresponds to what was observed by Perrier (Perrier, 2021). But even for projective ones, different trees can be linearized in the same way. However we observed that, quite often, non-projective dependencies are a symptom of badly linked nodes that should be checked.

UDREGENERATOR realizes a sentence from scratch using only the lemmas and the morphological and syntactic information contained in the UD features and relations.

1.1 Constituency structure format

UDREGENERATOR transforms the UDs into a constituency structure format used as input for JSREALB (Molins and Lapalme, 2015), a surface realizer written in JavaScript similar in principle to SIMPLENLG (Gatt and Reiter, 2009) in which programming language instructions create data structures corresponding to the constituents of the sentence to be realized. Once the data structure (a tree) is built in memory, it is traversed to create the list of tokens of the sentence.

As is shown in Figure 1, the data structure is built by function calls whose names were chosen to be similar to the symbols typically used for constituent syntax trees:

- **Terminal**: N (Noun), V (Verb), A (adjective), D (determiner) ...
- **Phrase**: S (Sentence), NP (Noun Phrase), VP (Verb Phrase) ...

Features, called options, that modify some properties are added to the structures using the dot notation. For terminals, they are used to specify the person, number, gender, etc. For phrases, the sentence may be negated or set to a passive mode; a noun phrase can be prononomialized. Punctuation signs and HTML tags can also be added.

For example, in the JSREALB structure of Figure 1, plural of treatment is indicated with the option n ("p") where n indicates the number and "p" the plural. Agreements within the NP and between NP and VP are performed automatically, although this feature is not often used in this experiment because features on each token provide, in principle, the appropriate morphological information.

The affirmative sentence is modified to use the permission modal using the property {typ({"mod":"perm"}) to be realized by the verb may. The modification of a sentence structure is an interesting feature of JSREALB. Once the sentence structure has been built, many variations can be obtained by simply adding a set of options to the sentences, to get negative, progressive, passive, modality and some type of questions. For example, the interrogative form What may place the child at risk? could be generated by adding "int":"was" to the object given as parameter to .typ() at the end of the original JSREALB expression. This feature is not needed in this work, but it was used for creating questions from affirmative sentences to build a training corpus for a neural question-answering system or for creating negations for augmenting a corpus of negative sentences for training a neural semantic analyzer.

2 Building the Syntactic Representation

The first step, not described here, is straightforward: the CONLLU input format is parsed into a JavaScript data structure for the tokens. Each token keeps information from the UD fields such as FORM, LEMMA, FEATS, DEPREL and MISC. The HEAD field is used to build a list of pointers to the tokens on its left and an another list for the tokens to the right children. So starting from the root, it is possible to obtain the whole UD tree. Although the position of a node, given its ID, is not taken into account during realization, the positions of the children relative to their parent are kept intact. We do not take into account the absolute node positions, because our goal is to regenerate the sentence from the relative positions indicated by the UD relations.

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2See the documentation http://rali.iro.umontreal.ca/JSrealB/current/documentation/user.html?lang=en for the complete list of functions and parameter types.

3Section 3 will show that, unfortunately, this is not always the case.
We now describe how a parsed UD is transformed into a Syntactic Representation (SR) which is used as input to JSREALB. The principle is to reverse engineer the UD annotation guidelines\(^4\). This is similar to the method described by Xia and Palmer (Xia and Palmer, 2001) to recover the syntactic categories that are projected from the dependents and to determine the extents of those projections and their interconnections.

Although this projection process is theoretically simple, there are peculiarities to take into account when it is applied between two predefined formalisms. In this case, the UD relations with features being associated with each token must be mapped into JSREALB constituents with options that are applied either to a terminal or a phrase. We now give more detail on the mapping process for generating words using the morphological information associated with tokens and for generating phrases from dependency relations.

### 2.1 Morphology

UD Terminals are represented in JavaScript as tokens with no children. They are mapped to terminal symbols in JSREALB. So we transform the JavaScript version of the UD notation to the SR one by mapping lemma and feature names. The following table gives a few examples:

| JavaScript fields                                           | SR                               |
|-------------------------------------------------------------|----------------------------------|
| "upos":"NOUN", "lemma":"treatment", "Number":"Plur"  | N("treatment").n("p")           |
| "upos":"VERB", "lemma":"lean", "Mood":"Ind", "Tense":"Past" | V("lean").t("ps")               |
| "upos":"PRON", "lemma":"its", "Gender":"Neut", "Number":"Sing", "Person":"3", "Poss":"Yes", "PronType":"Prs" | Pro(\"me\").c("gen").pe("3") .g("n").n("s") |

As shown in the last example, we had to normalize pronouns to what JSREALB considers as its base form. In the morphology principles of UD\(^5\), it is specified that *treebanks have considerable leeway in interpreting what canonical or base form means.* In some English UD corpora, the *lemma* of a pronoun is almost always the same as its *form*; it would have been better to use the tonic form. We decided to lemmatize further instead of merely copying the lemma as a string input to JSREALB so that verb agreement could eventually be performed. English UD do not seem to have a systematic encoding of possessive determiners such as *his* which, for JSREALB at least, should be POS-tagged as a possessive determiner. These are defined as pronouns in some sentences or determiners in others, we even found cases of both encodings occurring in the same sentence. As the documentation seems to favor pronouns,\(^6\) we had to adapt our transformation process to deal with these *errors* as they occur quite often. This problem is less acute in the French UD corpora.

What should be a *lemma* is a hotly discussed subject on the UD GitHub\(^7\), but there are still many debatable lemmas such as *an*, *n’t*, plural nouns, etc. In one corpus, lowercasing has been applied to some proper nouns, but not all. We think it would be preferable to apply a more aggressive lemmatization to decrease the number of base forms to help further NLP processing that is often dependent on the number of different types. The lexica for JSREALB being sufficiently comprehensive for most current uses (34K lemmas for English and 53K lemmas for French), there are still unknown lemmas for specialized or informal contexts. Our experience shows that, most often, unknown lemmas are symptoms of errors in the lemma or the part of speech fields. Section 3.1 shows examples encountered in the corpora.

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\(^4\) [https://universaldependencies.org/guidelines.html](https://universaldependencies.org/guidelines.html)

\(^5\) [https://universaldependencies.org/u/overview/morphology.html](https://universaldependencies.org/u/overview/morphology.html)

\(^6\) [https://universaldependencies.org/en/feat/Poss.html](https://universaldependencies.org/en/feat/Poss.html) indicates that *his* can be marked as a possessive pronoun.

\(^7\) [https://github.com/UniversalDependencies/docs/docs/labels/lemmatization](https://github.com/UniversalDependencies/docs/docs/labels/lemmatization)
2.2 Translating the JavaScript notation of UD to Syntactic Representation

The goal is to map the JavaScript tree representation of the dependencies to a constituency tree that can be used by JSREALB to realize the sentence. According to the UD annotation guidelines, there are two main types of dependents: nominals and clauses, which themselves can be simple or complex.

The head of a Syntactic Representation is determined by the terminal at the head of the dependencies. The system scans dependencies to determine if the sentence is negative, passive, progressive or interrogative depending on whether combinations of aux, aux:pass with proper auxiliaries (possibly modals) or interrogative advmod are found. When such a combination is found, then those relations are removed before processing the rest. The appropriate JSREALB sentence typ will be added to the resulting Universal Dependencies. For example, in Figure 1, the auxiliary may is removed from the tree and the sentence is marked to be realized using the permission modal.

All dependencies are transformed recursively; as each child is mapped to a SR, children list are mapped to a list of SR. Before combining the list of Syntactic Representations into a JSREALB constituent, the following special cases are taken into account, for English sentences:

1. a UD with a copula is most often rooted at the attribute (e.g., mine in Figure 2). The constituency representation must be reorganized so that the auxiliary is used as the root of a verb phrase (VP): This reorganization could probably be simplified with the use of the Surface Syntactic Universal Dependencies formalism (SUD) as input as it emphasizes syntax over semantics.

2. A verb at the infinitive tense is annotated in UD as the preposition to before the verb, so this preposition is removed before processing the rest of the tree, it is reinserted at the end;

3. An adverb (from advmod relation) is removed from processing the rest and added to the resulting VP at the end;

4. If the head is either a noun, an adjective, a proper noun, a pronoun or a number, it is processed as a nominal clause mapped to a NP enclosing all its children UD.

5. If the head is a verb: check if the auxiliary will is present, then a future tense option will be added to the verb; in the case of the do auxiliary, feature information (tense and person) is copied into the JSREALB options.

6. Otherwise, bundle Syntactic Representations into a sentence S, the subject being the first child and the VP being the second child.

7. Coordinate VPs and NPs must also be dealt in a special way because the way that JSREALB expects the arguments of a CP is different from the way coordinates are encoded in UD (see Figure 3) where the elements are joined by conj relations. in JSREALB, all these elements must be wrapped in a global CP, the conjunction being indicated once at the start.

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Figure 2: On the left, the dependency tree corresponding to the sentence The car is not mine; the center shows the constituency tree after transformation with its JSREALB encoding on the right to realize the original sentence.

Dependences formalism (SUD) as input as it emphasizes syntax over semantics.
This exercise in transforming UD structures to JSREALB revealed an important difference in their level of representation. By design UD stays at the level of the form in the sentence, while JSREALB works at the constituent level. For example, in UD, negation is indicated by annotating `not` and the auxiliary elsewhere in the sentence, while in JSREALB the negation is given as an option for the whole sentence. So as shown above, the structure is checked for the occurrence of `not` and an auxiliary to generate the `.typ({neg:true})` option for JSREALB (see Figure 2); these dependents are then removed for the rest of the processing. Similar checks must also be performed for passive constructs, modal verbs, progressive, perfect and even future tense in order to abstract the UD annotations into the corresponding structure for JSREALB. It would be interesting to check if working with SUD (Gerdes et al., 2018) would simplify the transformation process into the dependency structure.

2.3 Working with French

As JSREALB can also be used for realizing sentences in French and that many UD are available in French, we adapted for French the methodology described in the previous section. For morphology, we changed the lemmas for pronouns and numerals. Fortunately, the ambiguity between pronouns and determiners seldom occurs in the French UD corpora, so this step was more straightforward. The transformation for clauses stays essentially the same as for English, except that there is no need to cater for the special cases for modals, future tense and infinitives.

3 Experiments

UDREGENERATOR can be used interactively, but it can also be used as a NODE.JS module to process a corpus and print the differences between the original text and the regenerated one. We ran the NODE.JS version on the French and English corpora of UD (Version 2.8), the most recent at the time of writing. UDREGENERATOR handled all sentences and is quite fast: about 1 millisecond per sentence on a commodity Mac laptop.

When all lemmas of UD structure appear in the JSREALB lexicon and are used with the appropriate features, UDREGENERATOR creates a tree and realizes the corresponding sentence. In other cases, JSREALB emits warnings so that the unknown words can either be corrected or added to the lexicon of JSREALB; in those cases, JSREALB inserts the `lemma` verbatim in the generated string which works out all right in English which is not too morphologically rich. But in many cases, these erroneous lemmata should be more closely checked. The tokens of the generated sentence are then compared with the tokens of the original text using the Levenshtein distance ignoring case and spacing. When there are differences, they are highlighted in the output or the display; the number of UD with differences are called `#diff` in the following tables. Differences can come from limitations of JSREALB (e.g., contractions, special word ordering that cannot be generated verbatim, non-projective dependencies) or from errors or underspecification of the part-of-speech, features or head field in the UD.

For this experiment, we consider generated sentences with non-projective dependencies as errors. In

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9 [http://rali.iro.umontreal.ca/JSrealB/current/demos/UDregenerator/UDregenerator-en.html](http://rali.iro.umontreal.ca/JSrealB/current/demos/UDregenerator/UDregenerator-en.html)

10 Using a previous version of this tool, we detected errors in Version 2.7 that were then corrected by the maintainers of the corpora once we raised the issues to them.
Table 1: Statistics for the English UD corpora: for each corpus and type, it shows the numbers of sentences (#sent), tokens (#toks) and non-projective dependencies (#nPrj); the number of sentences that had at least one difference with the original (#diff); the number of tokens that had at least one lexical error (#lerr); the percentages of sentences regenerated exactly (%regen), of tokens in error (%terr) and of non-projective sentences (%nPrj). The next-to-last line displays the total of these values and the mean percentages over all sentences of the corpora. The last line shows the statistics for the sample that is studied more closely in Section 3.3.

As we use a symbolic approach, we do not distinguish between the training, development and test splits of a corpus, we consider them as different corpora. This allows an overall judgment on what we feel to be the precision of the information in the UD. The last subsection provides a more detailed analysis of a representative sample of the corpora.

3.1 English corpora

Table 1 shows statistics on the 14 English corpora that comprise 32,641 sentences, of which 1,408 (4.1%) have non-projective dependencies and gave rise to 17,984 warnings. We did not use the three English ESL corpora because they do not provide any information about the lemma and the features of tokens, they only give the form and relation name.

Table 1 shows that on average about 47% of the sentences are regenerated exactly ignoring capitalization and spacing. Many of the differences are due to contractions (e.g. ain’t or he’ll) for which JSREALB realizes the long form (is not or he will). There are two outliers: the pronouns corpus which uses a limited vocabulary and was manually designed to illustrate many variations of pronouns; in fact, we used it to design our pronoun transformations; the lines corpus has a high ratio of unknown lemmata, some of which are dubious: (collapsible|expandable), & course as an adverb, smile’ and even wrote, which occurs 11 times or opened, 21 times.

Looking at the results, we found that one important source of differences was the fact that in many English corpora, person and number were not given as features of verbs except for the third person
Table 2: This table shows the different, and inconsistent across English corpora, part of speech, lemma and features associated with two common English words used in proper nouns. The second column gives the number of occurrences in each English corpus.

| Corpus | #occ | upos | lemma | feats        |
|--------|------|------|-------|-------------|
| EWT    | 93   | ADJ  | United| Degree=Pos  |
| GUM    | 80   | VERB | Unite | Tense=Past, VerbForm=Part |
| Lines  | 9    | PROPN| United| Number=Sing |
| Partut | 11   | PROPN| United|             |
| PUD    | 6    | PROPN| United| Number=Sing |

| New    | #occ | upos | lemma | feats   |
|--------|------|------|-------|---------|
| EWT    | 95   | ADJ  | New   | Degree=Pos |
| GUM    | 80   | PROPN| New   | Number=Sing |
| Lines  | 21   | PROPN| New   | Number=Sing |
| Partut | 3    | PROPN| New   |         |
| PUD    | 7    | PROPN| United| Number=Sing |

singular. There are about 11.5K instances of these in the EWT corpus\(^\text{11}\), but none in the GUM corpus and about 9K in all other English corpora. As \textsc{JsRealB} uses the third person singular as default, the generated sentence comes out right most of the time, except when the subject is a pronoun at the first or second person or is plural.

We also discovered some inconsistencies between English corpora even for very common words. Table 2 shows occurrences of \texttt{United} used in \texttt{United States}, \texttt{United Nations} or \texttt{United Kingdom} and of \texttt{New} such as in \texttt{New York}, \texttt{New England}, \texttt{New Delhi}... In the previous version (2.7) of UD, all \texttt{United} had been tagged as \texttt{PROP}. Given the fact that the \textsc{JsRealB} lexicon does not include the adjective \texttt{United} (with a capital U) or the verb \texttt{Unite} also with a capital, this raised warnings. A similar problem occurred for the adjective \texttt{New} used in \texttt{New Year}, \texttt{New Left} for which some occurrences are adjectives and others are part of a proper noun. \textsc{JsRealB} lexicon does not contain these lemmata with a capital. This may seem anecdotal, but it occurs quite frequently and is typical of inconsistency problems.

Another source of warnings is the fact that some words are tagged dubiously: there are strange conjunctions such as: of (264 occurrences), in (181), by (162), with (142), on (99) ...

Although POS tags are consistent most of the time within a corpus, this is not the case between corpora of the same language, especially for a non-low resource language such as English, so some care should be used when combining these corpora in a learning scheme for a given language, unless the learning scheme does not care about number, person and POS tags.

In order to limit the number of warnings, we decided to add a few dubious lemmas\(^\text{12}\):

- \texttt{best} and \texttt{better} were added as lemmas, although we think that the appropriate lemma should be \texttt{good} or \texttt{well} specifying the Degree feature: superlative (Sup) or comparative (Cmp).

- \texttt{&} was added as a lemma for a conjunction, but it should be \texttt{and}.

- in formal English, adjective and nouns corresponding to nationalities start with a capital letter (e.g. \texttt{American} or \texttt{European}), but we also had to accept the lowercase form as lemma for these.

\(^{11}\)Following our suggestion, most of these features have been added to EWT in version 2.9

\(^{12}\)Many of these cases, have been corrected in version 2.8 of some corpora, namely EWT, following our remarks about this problem on version 2.7
Table 3: Statistics for the French UD corpora: for each corpus and type, it shows the numbers of sentences (#sent), tokens (#toks) and non-projective dependencies (#nPrj); the number of sentences that had at least one difference with the original (#diff); the number of tokens that had at least one lexical error (#lerr); the percentages of sentences regenerated exactly (%regen), of tokens in error (%terr) and of non-projective sentences (%nPrj). The next-to-last line displays the total of these values and the mean percentages over all sentences of the corpora. The last line shows the statistics for the sample that is studied more closely in Section 3.3.

3.2 French corpora

The 14 French UD corpora (see Table 3) provide 26,586 sentences of which 1,130 (4.3 %) have non-projective dependencies. UDREGENERATOR regenerates about 53% of the sentences, which is slightly more than for the English corpora, but the overall statistics are similar between French and English.

As for English, many of the warnings were generated by strange part of speech tags: comme tagged as a preposition instead of adverb or conjunction (796 occurrences), puis as conjunction instead of adverb (225 occurrences). There were a number of incomplete or erroneous lemmata. Here are a few examples across all French corpora:

- **bad part of speech**: certain (343 times) is a determiner instead of an adjective; comme (796 times) is a preposition instead of a conjunction;

- **orthographic error in lemma**: region (14 times) instead of région, inégalité (4 times) instead of inégalité, publicitaire (5 times) instead of publicitaire;

- **bad lemma**: humains (6 times), performances (5 times), normes (4 times), financements, intacts or ressources whose lemma should be singular.

This is a good illustration of how UDREGENERATOR can help improve UD information.

In both French and English corpora, we found a few instances of bad head links for which regeneration produces words in the wrong order. We noticed that most often this occurs in non-projective dependencies, the tree representation is particularly useful for checking these as there are crossing arcs. This is why the system flags these so that they can be identified more easily and checked.

3.3 Sample corpora

In order to get a more precise appraisal of the quality of the UD information, we studied in detail a sample of 10 sentences from the 6 English and French test corpora for which we used UDREGENERATOR to
recreate the original sentences. The percentages on the last line of Tables 1 and 3 show that these samples have roughly the same characteristics as the whole corpus from which they were taken, except for the fact that there are no non-projective dependencies in the English sample.

This experiment shows that JSREALB has an almost complete coverage of English and French grammatical constructs found in the corpora, except for some specialized terminology which can be easily added to the lexicon or given as quoted words that will appear verbatim in the output. We encountered only 12 unknown tokens over 1,086 in English (e.g. shippeddate, luncheonette as noun, related or numismatic as adjective) and 4 unknown tokens over 1233 in French (e.g. boxeuse as noun or déclassifier as verb). In some cases (7 for English and 5 in French) JSREALB could not reproduce the exact order of some of the words in a sentence: e.g., when an adverb is inserted within a conjugated modal (e.g. would never use) or because of non-projective dependencies. In all cases, the sentences kept their original meaning.

In English, 24 sentences were reproduced verbatim, without any modification either to the UD coding or the generated JSREALB expression. There were 5 cases of contractions (e.g., doesn’t instead of does not, I’ve instead of I have) that JSREALB does not generate. Three cases of limitations of JSREALB because of modals being applied to noun phrases because of the transformation process limits. But we found 23 tokens (over 1,086) for which there were errors or omissions in either the part of speech tags (UPOS), features or lemma (e.g. follow as adjective, Sir or Council as noun, with or of as conjunction). Those are very small numbers computed over only 60 sentences, the whole corpus being 490 times greater.

We also experimented with 60 sentences sampled from French corpora with the following results: 26 were regenerated verbatim without any intervention. 48 tokens (over 1233) had errors or omissions in either the part of speech tags (UPOS), features or lemma (e.g. mot as adjective, octobre and expire as a feminine noun, but voile (in the sense of sail) as a masculine noun even though the attribute is feminine). There were 5 cases of word ordering in some part of a sentence, most because of non-projective dependencies, a case of an incomplete sentence and an unusual encoding of coordination. The encoding of pronouns is especially delicate because different corpora do not use the same conventions. A case of JSREALB limitations was encountered for the verb pouvoir: je peux at interrogative form should be realized as puis-je and not peux-je.

This is an experiment over a very small sample (0.23%) of sentences from the French and English corpora, but it shows the need to recheck the information in UD as it is often used as a gold standard and sometimes even used as a mapping source for other lower-resourced languages. We also showed that UDREGENERATOR it can be a useful tool for pointing out some eventual problems in the annotation of tokens and relations.

4 Conclusion

This work made us realize that UD corpora, while being a source of useful linguistic information, would benefit from a check by trying to regenerate the sentences from the provided annotation. We are not aware of any previous attempt to perform such an experiment. Sentence regeneration is not foolproof because different feature combinations can produce the same sentences, but we showed that in some cases it helps to pinpoint discrepancies between what is specified and the expected outcome. UDREGENERATOR is far from perfect, but it proved to be a convenient tool for doing some sanity checking on the lemma, part of speech, features and head fields. We hope that this work will help improve the precision of the wealth of useful information contained in UD corpora.

We only experimented with the French and English UD corpora because the text realizer we used only deals with these languages, but it showed the potential of detecting errors even in so-called high resource languages whose annotation is often considered as golden. It would be interesting to apply the same technique using a text realizer in other languages. Should a full-text realizer not be available for this target language, we conjecture that already checking the tokens with a conjugation or declension

13These sample corpora including the equivalent JSREALB expressions are available at http://rali.iro.umontreal.ca/JSRealB/current/demos/UDregenerator/UD-2.8/sample/
tool might already be useful to detect some interesting or dubious cases. The appendix describes briefly a language independent UD exploration tool that we used to pinpoint recurrent patterns that might be symptoms of errors.

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Appendix: Searching for combinations of tokens

UDREGENERATOR can identify some errors or missing features in a given UD, but we found interesting to search in a file of UD if this combination exists in others UD. Many researchers use grep or string searching of a text editor or even special purpose scripts to check for specific combinations of features for a given token. None of these combinations are foolproof, but they can easily be checked once they are identified and they can then be modified in the original file if needed. To help identify these types of feature combinations, we have set up a web page\textsuperscript{14} to search in local UD files. Each UD field can be matched for a regular expression or its negation. It is also possible to check if a FORM is the same or different from the LEMMA. All tokens in the file that match these conditions are displayed in a table, in which it is possible to select one to get the sentence in which it occurs, the identification of the sentence (sent_id) and the line number in the file. This tool is not as sophisticated as Grew-match\textsuperscript{15} which defines a pattern language to allow also searching for combinations of links.

As UDGREP does not use any language specifics, it can be used to find patterns on UD in any language. Patterns entered by the user are, of course, language specific.

Search tokens in a Universal Dependency file

| ID   | FORM    | LEMMA | UPOS | XPOS | FEATS | HEAD | DEPREL | DEPS | MISC      |
|------|---------|-------|------|------|-------|------|--------|------|-----------|
| 16   | Systems | NOUN  | NN   | NOUN | Number=Sing | 20 | compound | 20 | compo... |
| 11   | mechanic | NOUN  | NN   | NOUN | Number=Sing | 7 | nomod | 7 | nomod_to Entity=abstract-13_lab... |
| 15   | mechanics | NOUN  | NN   | NOUN | Number=Sing | 11 | parataxis | 11 | parataxis Entity=abstract-145_lab... |
| 25   | statistics | statistic | NOUN  | NN   | Number=Sing | 23 | conj | 21 | nomod... Entity=abstract-17_lab... |
| 19   | metaphysics | metaphor | NOUN  | NN   | Number=Sing | 16 | conj | 14 | nomod... Entity=abstract-91_lab... |
| 18   | counter-meas... | counter-meas... | NOUN  | NN   | Number=Sing | 15 | obj | 15 | obj Entity=object-85 |
| 2    | hours    | hour  | NOUN  | NN   | Number=Sing | 7 | subj | 7 | subj_pass Entity=time-173_lab... |
| 1    | shorts   | short | NOUN  | NN   | Number=Sing | 4 | nssubj_pass 4 | nssubj_pass Discourse=background... |

Figure 4: Identification of curious English nouns that end with s, but not their lemma and that do not contain Plur in their features. A colored field name shows a regular expression that should match the field, a complemented name (with an overbar) shows a regular expression that should not match. The identified tokens are shown in a table in which it is possible to select a cell to show the context of this token: sentence with the token highlighted, the id of the sentence and its line number in the file. The dependency graph of the sentence is also shown.

\textsuperscript{14}Available at http://rali.iro.umontreal.ca/JSrealB/current/demos/UDreurator/UDgrep.html

\textsuperscript{15}http://match.grew.fr