We describe the process of creating NUDAR, a Universal Dependency treebank for Arabic. We present the conversion from the Penn Arabic Treebank to the Universal Dependency syntactic representation through an intermediate dependency representation. We discuss the challenges faced in the conversion of the trees, the decisions we made to solve them, and the validation of our conversion. We also present initial parsing results on NUDAR.

1 Introduction

Parsers have been used in many Natural Language Processing (NLP) applications, such as automatic summarization, question answering, and machine translation. This motivates the creation of treebanks on which these parsers can be trained. Treebanks have two main different syntactic representations. On one hand, there are phrase structure (constituency) treebanks such as the Penn Treebank (Marcus et al., 1993), and its sister treebanks such as the Penn Arabic Treebank (PATB) (Maamouri et al., 2004) and the Penn Chinese Treebank (Xue et al., 2005). On the other hand, there are dependency treebanks, such as Columbia Arabic Treebank (CATiB) (Habash and Roth, 2009), and the Prague Dependency Treebank (PDT) (Hajič et al., 2001). Other treebanks that followed the style of PDT are the Slovene (Džeroski et al., 2006) and the Croatian (Berović et al., 2012) treebanks, as well as the Prague Arabic Dependency Treebank (PADT) (Smrž et al., 2002; Hajič et al., 2004; Smrž et al., 2008).

Having these different syntactic representations makes it difficult to compare treebanks, and parsing results (Nilsson et al., 2007). This motivated the creation of the Universal Dependency (UD) syntactic representation, that aims to create cross-linguistically consistent annotation guidelines that facilitate the creation of treebanks that are built with the same label sets and structural basis (Nivre, 2014; Pyysalo et al., 2015). In this paper, we present the New York University Abu Dhabi Universal Dependency Arabic Treebank, a UD treebank for Arabic, which we dub NUDAR.  

2 Related Work

In this section we present the Universal Dependency syntactic representation, as well as some of the most prominent previous efforts on Modern Standard Arabic (MSA) treebanks.

2.1 Universal Dependencies

UD is an open community effort. It builds on the existing treebank structure of the Stanford dependencies (De Marneffe et al., 2006; De Marneffe and Manning, 2008; De Marneffe et al., 2014), as well as the universal Google dependency scheme (McDonald et al., 2013). In addition, it makes use of the Google Universal Parts-of-Speech (POS) Tagset (Petrov et al., 2011), and the morphosyntactic tag set of the interset interlingua (Zeman, 2008).

The aim of UD is to facilitate the creation of treebanks in different languages that are consistent in their syntactic representation, while still allowing the extension of the relations to accommodate for language-specific constructs. The target of UD is to facilitate the development of multilingual learning systems, and multilingual NLP, as well as allow for comparative linguistic studies and evaluation (Nivre et al., 2016).

In its last release of version 1.4, the UD treebank collection contained 64 different treebanks,

1The noun Nudar /char50/char41/char0b/char09/char92/char0c/char09/char1dnuDAr is Arabic for 'pure gold'.
with over 10 other treebanks scheduled for release in the upcoming version 2.0. The treebanks are in 47 languages, including Swedish (Nivre, 2014), Danish (Johannsen et al., 2015), Finnish (Pyysalo et al., 2015), Estonian (Muischnek et al., 2014), Norwegian (Øvrelid and Höhle, 2016), Croatian (Agić and Ljubešić, 2015), Persian (Seraji et al., 2016), Bulgarian (Osenova and Simov, 2015), Catalan and Spanish (Alonso and Zeman, 2016), as well as the Prague Arabic Universal Dependency Treebank (PAUDT), among others.

2.2 Arabic Treebanks

A number of treebanks exist for MSA. These treebanks vary in terms of their syntactic representation (constituency vs. dependency), richness of annotation, and source of data. We discuss next four treebanks that are relevant to this paper.

PAUDT: The Penn Arabic Treebank (Maamouri et al., 2004; Maamouri et al., 2009) is a Linguistic Data Consortium (LDC) project, for which there are currently 12 parts for MSA. PATB consists of constituency trees, the sources of which are newswire articles from a variety of news sources.

CATIB: Columbia Arabic Treebank (Habash and Roth, 2009) is a dependency treebank effort that allows for faster annotation and uses "intuitive dependency structure representation and relational labels inspired by traditional Arabic grammar" (Habash, 2010). The basic CATIB treebank uses six POS tags, and eight relational labels. It contains 273K tokens that have been annotated directly in the CATIB representation, as well as the entire PATB parts 1, 2, and 3 that were automatically converted into CATIB representation.

PADT and PAUDT: The Prague Arabic Dependency Tree 1.0 (Smrž et al., 2008) was published in the LDC in 2004 (Hajič et al., 2004) and consisted of about 114K tokens. The data in PADT comes from part of the PATB parts 1 and 2, and the Arabic Gigaword (Graff et al., 2006). Variants of that dataset were released for the CoNLL 2006 (60K tokens) and CoNLL 2007 (116K tokens, improved morphology) shared tasks. An extended dataset (282K tokens) was incorporated in the HamleDT collection, where 30 treebanks were first harmonized in the Prague annotation style, later in Stanford dependencies (Rosa et al., 2014). Finally, this dataset was converted to Universal Dependencies and it has been part of UD releases since UD 1.2, labeled simply “UD Arabic”.

The annotation guidelines of PADT 1.0 were derived from the Prague Dependency Treebank (Czech), with some necessary adjustments to account for the differences between Arabic and Czech. The original morphological and syntactic disambiguation was done manually but the subsequent conversion steps were automatic.

Word forms in PADT are fully diacritized; in PAUDT we preserve the diacritized as a useful extra attribute, but the main form is undiacritized, to provide more natural training material for parsers. Morphological tags were converted to the UD tags and features, dependency relation types were translated to the UD label set. Occasionally the translation of labels relied on other sources such as part of speech or even lemma. For example, the PADT relation `AuxM` (modifying expression) is used for prepositions (which are attached as `case` or `mark` in PAUDT), for negative particles `lā, lam, lān` (which ended up as `neg` in UD v1 and as `advmod` in UD v2), for future particles `sa, sawfa` (which are `aux` dependents in PAUDT) and also for the negative copula `laysa` (cop in PAUDT).

Unlike UD, the Prague treebanks do not distinguish whether the dependent is a nominal or a clause (nsubj vs. subj, obj vs. ccomp etc.) Heuristics have to be used here. At present, only phrases headed by verbs are considered clause; clauses with non-verbal predicates without a copula are attached as if they were bare nominals. On the other hand, when a copula is involved, we re-attach it as a dependent of the non-verbal predicate (in PADT, if the copula is present, it heads the clause). Similarly, prepositions head prepositional phrases in the Prague style but they are attached as modifiers of their nouns in PAUDT.

Finally, coordination in the Prague style is not...
ways headed either by a conjunction, or, if no con-
junction is present, by a punctuation symbol. All
conjuncts are at the same tree level. In PAUDT
these structures are transformed so that the first
conjunct is the head and all subsequent conjuncts
are attached to it.

Why Another Arabic Universal Dependency
Treebank? PAUDT is based on PADT, which is
a small treebank, compared to the existing PATB
treebank. Our aim is to make use of the automatic
conversion of PATB, parts 1, 2, and 3, into a richer
version of CATiB, and use it to create NUDAR.
This would allow us in the future to convert the
remaining parts of PATB, both in MSA and dia-
lectal Arabic (such as Egyptian (Maamouri et al.,
2012)), as well as extend the existing CATiB tree-
bank that has no parallel in PATB’s constituency
representation.

3 NUDAR: NYUAD Universal
Dependency Arabic Treebank

In this section we describe the creation of
NUDAR, starting with the PATB. The conversion
strategy we adopt is to transform the constituency
PATB trees into the rich CATiB++ dependency
representation (Section 3.2). We then apply mor-
phological and syntactic transformations on these
trees – Section 3.3, and Section 3.4 respectively.

3.1 A Note on Tokenization and Datasets

The datasets that are currently included in
NUDAR are the PATB part 1, v4.1 (Maamouri et
al., 2010a), part 2, v3.1 (Maamouri et al., 2011),
and part 3, v3.2 (Maamouri et al., 2010b). The
tenkenization followed in NUDAR is the same to-
ktenization scheme followed in PATB, which tok-
enizes all the clitics, with the exception of the def-
inite article +ال ‘the’ (Pasha et al., 2014). The
treebank contains 19K sentences, containing 738K
tokens. For our parsing experiment, we followed
the guidelines detailed by Diab et al. (2013), to
split the treebanks into TRAIN, DEV, and TEST.
The details of the sizes of the different datasets are
shown in Table 1.

3.2 From Constituency to Dependency

Our conversion pipeline starts from PATB, con-
verting it to a richer version of the Columbia Ara-
bic Treebank which we refer to as CATiB++. We
use the Columbia Arabic Conversion Tool v0.7
(Habash and Roth, 2009), that converts PATB
trees to the CATiB representation, with the ad-
dition of the semantic hashtags and the PATB
complete morphological tags (BW) (Buckwalter,
2004). We supplement the trees with additional
feature-value pairs representation in the style used
in the MADAMIRA morphological analyzer and
disambiguator (Pasha et al., 2014).

We chose to convert the treebanks through this
methodology to allow for the conversion of the
existing CATiB treebank that has no parallel in
PATB’s constituency representation. In the future,
we envision enriching the CATiB treebank with
the morphosyntactic features it lacks, using tech-
niques described by Alkuhlani et al. (2013).

3.3 Morphological Transformation

The mapping of the morphological features from
CATiB++ to NUDAR includes mapping the
NUDAR POS tag, as well as the set of features
that appear with each token. The mapping of POS
tags is done through a lookup that takes the CATiB
POS tag and the gold BW tag of the token stem,
and maps them to the equivalent NUDAR POS
tag. The lookup map is shown in Table 2. The
mapping of the morphological features uses an-
other lookup map, that is shown in Table 3.

3.4 Syntactic Transformation

UD and CATiB representations share a number
of similarities, both being dependency representa-
tions. However there are differences between them
that primarily arise from the basic focus on what a
dependency is, and affect the structure of the trees.
CATiB tries to represent a structure closer to tradi-
tional Arabic grammar analysis, which is more in-
terested in modeling the assignment of case. This
results in function words tending to head their
phrase structures more. In contrast, UD tends to
get closer to the meaning, and minimize differ-
ences between different languages that have dif-
frent morphosyntactic structures (Nivre, 2016).

The CATiB and NUDAR representations use a
different set of labels that refer to very similar
concepts, although they use different forms. This
results in having a number of similar constructs
where we only need to map the labels without
modifying the structure.

4For more information on this tool, contact the second au-
thor.
Table 1: The tokens and sentences in the current NUDAR Treebank, based on PATB parts 1, 2, and 3

|       | DEV | TRAIN | TEST | ALL |
|-------|-----|-------|------|-----|
|       | Tokens | Sentences | Tokens | Sentences | Tokens | Sentences | Tokens | Sentences |
| PATB1 | 16,881 | 447 | 16,586 | 487 | 133,813 | 3,585 | 167,280 | 4,519 |
| PATB2 | 16,972 | 264 | 17,128 | 228 | 135,219 | 2,099 | 169,319 | 2,591 |
| PATB3 | 40,092 | 1,275 | 40,411 | 1,248 | 321,787 | 10,105 | 402,290 | 12,628 |
| Total  | 73,945 | 1,986 | 74,125 | 1,963 | 590,819 | 15,789 | 738,889 | 19,738 |

3.4.1 Verbal Constructs

Verbal constructs representation in CATiB and NUDAR are the same, except for the choice of label. The verb heads the optional subject, zero or more objects, and other modifiers. The label used for the attachment between the subject and the verb is SBJ in CATiB, and nsubj in NUDAR. Any object is attached to the verb using the OBJ relation in CATiB. In NUDAR, the first object takes the label obj, and any other objects take the label iobj. An example of a verbal sentence is demonstrated in Figure 1.

In the case of passive verbs, the subject of the passive verb takes the relation nsubj:pass. CATiB marks passive verbs using the POS tag VRB-PASS, and uses the relation SBJ for the subject.

![Figure 1: Verb-Subject-Object Construct](image)

3.4.2 Adjectival Constructs

A noun followed by an adjectival modifier maintains the same structure in both CATiB and NUDAR, with the noun heading the adjectival modifier. The label that this relation takes in NUDAR is amod, as in the example in Figure 2.

![Figure 2: Adjectival Modifier Construct](image)

3.4.3 Idafa Constructs

The Idafa construct can be used to mark the genitive possessor, objects of preposition-like nominal adverbs, and some quantification constructs (Habash et al., 2009). Each of these cases is treated differently. For the case of possessive constructs, such as in Figure 3, we extend the existing nmod UD label to the language-specific nmod:poss label.

![Figure 3: Idafa Construct: the genitive possessor](image)

3.4.4 Number Constructs

Number constructs take different relational labels in the CATiB representation. A number

^The numbers we discuss in this section are three and above. The number *one* in Arabic (١ واحد wAHd) is an ad-
Table 2: Part-of-Speech mapping from CATiB POS and BW POS to NUDAR. BW’ denotes the complete or partial match of the full BW tag set. Entries marked with !! under BW’ POS means that the relevant information is taken from the CATiB POS tag only. Entries starting with * under the BW means that there are multiple tags the contain this partial tag, and that they all map to the same UD POS. nom-prep is a function that determines if the word falls under the list of nominal adverbs, which are specified words that are tagged as nominals in CATiB and PATB, but behave like adverbs.

| CATiB POS | BW’ POS | UD POS |
|-----------|---------|--------|
| NOM       | *SUFF_DO| PRON   |
| NOM       | ABBREV  | NOUN   |
| NOM       | ADJ     | ADJ    |
| NOM       | ADJ_COMP| ADJ    |
| NOM       | ADV     | ADV    |
| NOM       | DEM_PRON| DET    |
| NOM       | DIALECT | X      |
| NOM       | FOREIGN | X      |
| NOM       | INTERJ  | INTJ   |
| NOM       | INTERROG_ADV | ADV |
| NOM       | INTERROG_PRON| PROPN |
| NOM       | LATIN   | X      |
| NOM       | NOUN    | ADV if nom-prep |
| NOM       | NOUN_NUM| NUM    |
| NOM       | NOUN_PROP| PROPN |
| NOM       | NOUN_QUANT| NUM |
| NOM       | POSS_PRON| PROPN |
| NOM       | PRON    | PRON   |
| NOM       | REL_ADV | ADV    |
| NOM       | REL_PRON| PRON   |
| NOM       | TYPE    | X      |
| PROP      | PROP    | PROPN  |
| PNX       | NUMERIC_COMMA| PUNCT |
| PNX       | PUNC    | PUNCT  |
| PRT       | CONJ    | CCONJ  |
| PRT       | CONNEC_PART| PART |
| PRT       | DET     | DET    |
| PRT       | FOCUS_PART| PART |
| PRT       | FUT_PART| AUX    |
| PRT       | INTERJ  | INTJ   |
| PRT       | INTERROG_PART| PART |
| PRT       | JUS_PART| PART   |
| PRT       | NEG_PART| PART   |
| PRT       | PART    | PART   |
| PRT       | PREP    | ADP    |
| PRT       | PSEUDO_VERB| CCONJ |
| PRT       | RC_PART | PART   |
| PRT       | RESTRIC_PART| PART |
| PRT       | SUB_CONJ| SCONJ  |
| PRT       | VERB_PART| AUX   |
| PRT       | VOC_PART| PART   |
| UNK       | DIALECT | X      |
| UNK       | LATIN   | X      |
| UNK       | TYPE    | X      |
| VERB      | !!      | VERB   |
| VERB-PASS | !!     | VERB   |

Table 3: Morphological features mapping from CATiB to NUDAR

| CATiB   | NUDAR   |
|---------|---------|
| NOM     | NOUN    |
| /chard0/char41/chard3/char40 | AmAm |
| 'front' | I |
| NOM     | NOUN_PROP| PROPN |
| /char10/char49/char1c/char0a/char4a/char2e/charcb/char40 | Albyt |
| 'the-house' | I |
| NOM     | ADVMOD  | ADV   |
| /chard0/char41/chard3/char40 | AmAm |
| 'front' | I |
| NOM     | NUMMOD  | NUM   |
| /char09/chare0/charf1/charaa/char4b/char2e/char50/char0d/char40 | Ârb |
| 'forty' | I |
| NOM     | NUM      | NUM   |
| /char41/char10/char4a/char1c/char0a/char4b/char2e | baytA |
| 'house' | I |
| NOM     | NUMMOD   | NUM   |
| /char09/chare0/charf1/charaa/char4b/char2e/char50/char0d/char40 | Ârb |
| 'forty' | I |
| NOM     | NUMMOD   | NUM   |
| /char41/char10/char4a/char1c/char0a/char4b/char2e/char09/chare0/charf1/charaa/char4b/char2e/char50/char0d/char40 | Ârba |
| 'forty houses' | I |

Figure 4: *Idafa* Construct: the object of a preposition-like nominal adverb

Figure 5: *Tamyiz* Construct: the numeral modifier of numbers between 11 and 99

The relations between numbers in compound number structures in CATiB are similar to the jective, and will always be headed by the word it modifies. *Number two* (*AvnAn*) can also be an adjective that attaches low to the word it modifies, or it can be part of the noun’s morphology.
relations between numbers and the nouns they modify. In this example, as shown in Figure 7, أربعون ألف Arbcwn ‘forty’ with the Tamyiz relation (TMZ) in CATiB. However, in NUDAR, the subtree would be headed by Alf, and Arbcwn would be attached to it with a compound relation.

Figure 7: Compound Number Construct

3.4.5 Coordination Constructs

In CATiB, the coordinating conjunction heads the sub-tree of the following phrase in a cascading structure. In NUDAR, however, the construct is flat, with all the coordinating conjunctions and conjuncts being headed by the first conjunct of the coordination construct. The coordinating conjunctions take the relation cc, and the conjuncts take the relation conj. The difference between the two tree structures is illustrated in Figure 8.

It is also common for the coordinating conjunctions in Arabic to be sentence-initial discourse connectives (واو أو أبداعة أو استثنائية) (واو اعتراضية) (Habash et al., 2009). In these cases, the coordinating conjunctions are dependent on the root predicate of the sentence with the relation cc.

Figure 8: Coordination Construct

3.4.6 Proper Name Constructs

Proper nouns having two or more nominal elements have these elements linked using the language-specific relation flat:name in NUDAR. If a proper noun has more than two nominal elements, they all are headed by the first element of the proper name, unlike CATiB, where each element is headed by the one that precedes it, as seen in Figure 9.

Figure 9: Proper Name Construct

Apposition is marked by the relation appos in NUDAR, as in Figure 10, opposed to the MOD relation it takes in CATiB.
3.4.7 Preposition Constructs

Prepositions in NUDAR are case-marking elements that are dependent on the element they introduce. They attach low, unlike the CATiB structure. The label this relation takes is case, as can be seen in Figure 11.

3.4.8 Copular Constructs

The basic copular construct in Arabic does not include copular verbs. It has the same tree structure in both CATiB and NUDAR. The predicate heads the relation, and the subject attaches to it with the label *SBJ* in CATiB and *nsubj* in NUDAR, as seen in Figure 12.

Some so-called incomplete verbs in Arabic, such as *kAn* ‘to be’, and verb-like particles, such as *ân* ‘indeed/verily’ act like the copula verb *be* in English. Since copula verbs cannot be the heads of clauses, they attach to their predicates with the relation *cop*, like the example in Figure 13.

3.4.9 Subordinating Conjunction Constructs

Subordinating conjunctions introduce a finite clause that is subordinate to another clause. As with copula, they cannot head a clause. The subordinating clause’s predicate becomes the parent of the subordinating conjunction, as shown in Figure 14.

3.4.10 Clausal Complement Constructs

Clauses that are a core argument of a verb are attached to that verb with a *ccomp* or an *xcomp* relation. The *ccomp* relation is used for clauses that have their own subject, while *xcomp* refers to clauses with a subject that is the same as the
subject of the verb that heads them. An example of a clause attaching with a ccomp relation is in Figure 15.

3.5 Validation

During our conversion process, we selected a random subset of 17 sentences, containing 608 tokens, from the TRAIN set. We manually created a gold reference for this set, and we used it to fine tune our convertor. After we froze the conversion, we converted a randomly selected subset of 82 sentences, containing 2,685 tokens, from the TEST set, that we automatically converted into NUDAR, and manually checked and fixed to create a gold test set. This gold subset was used to test the performance of the final version of the convertor. The scores that we got in both subsets against the gold were very high. We show the Labeled and Unlabeled Attachment Scores (LAS and UAS respectively) and Label Accuracy Score (LAcc) in Table 4.

|     | LAS  | UAS  | LAcc |
|-----|------|------|------|
| Dev | 98.5%| 98.8%| 99.3%|
| Test| 98.0%| 99.1%| 98.3%|

Table 4: Conversion scores against manually created gold trees

An error analysis shows that the majority of the errors originated from the gold annotations of the PATB treebank. These errors are caused by either having the wrong dashtag, or attachment in the PATB trees (Habash et al., 2007a). A small number of errors were caused either by bugs in the conversion rules, or by missing rules.

3.6 Comparing PAUDT and NUDAR

A direct comparison between PAUDT and NUDAR proved hard to perform. Even though both treebanks follow the UD guidelines in general, there were many differences originating from the data sources, as well as from the interpretation of the guidelines. The data in PAUDT comes from portions of PATB parts 1 and 2, and from Arabic Gigaword. The data in the current NUDAR treebank comes from PATB parts 1, 2, and 3. In total, NUDAR contains 1,834 documents, and PAUDT contains 874 documents. The two treebanks overlap in 207 documents (based on document IDs). Within these shared documents, we find a number of differences such as PAUDT’s inclusion of article titles and full stop sentence segmentation, compared with missing article titles and occasional trees covering multiple sentences in NUDAR. Even among sentences that are similarly segmented, we find many tokenization differences: dates and times are tokenized differently (e.g., 11-5 vs 11 - 5), as well as specific Arabic words that are treated differently (e.g., في ما fima or في م fyma ‘in that’). Out of the shared 207 documents, only 335 sentences had the same tokenization, and these had additional differences in POS choice as well as tree structures and labels. We plan a more detailed comparison in the future to help consolidate the two treebanks.

4 Parsing Experiment

We conducted some experiments to benchmark the parsing scores in the NUDAR treebank. We also compare the result of parsing directly in NUDAR space to parsing in CATiB space then converting to NUDAR representation.

For our parsing experiments, we used the MaltParser (Nivre et al., 2006) to train an Arabic dependency parser in the space of both CATiB and NUDAR. We compared the output of the NUDAR parser, to the results of converting the output of the CATiB parser to NUDAR using the system described in Section 3.

For the CATiB parser, we used the optimized settings described by Shahrour et al. (2016), and were able to achieve comparable results. We used the gold CATiBex POS tags (Marton et al., 2013), and gold morphological features derived from gold BW tags, to train the parser on the TRAIN dataset of PATB parts 1, 2, and 3. We tested on the TEST dataset of the same treebank parts. The output of the parser was then converted to NUDAR representation.

For the NUDAR parser, we ran the MaltOptimizer (Ballesteros and Nivre, 2012) on the full TRAIN dataset of NUDAR. We used the optimized settings to train and run our parser.

The results of these experiments are shown in Table 5. The first row shows the result of training the MaltParser on the NUDAR training dataset with the optimized settings. The second row shows the results of training the MatlParser on the CATiB training dataset, with the optimized settings from Shahrou et al. (2016). Finally, the last row shows the results of converting the output of the CATiB parser to NUDAR representation.
Our results show that training a parser in NUDAR space produces better results than training a parser in CATiB space and converting the output to NUDAR representation. This can be attributed to the fact that the output of the CATiB parser does not produce the dashtags that are present in CATiB++, which help in the conversion process.

We also observe that the scores of the NUDAR parser are slightly lower than the scores of the CATiB parser. Although it is not possible to directly compare both parsers because of the different structures, we hypothesize that the larger label set in NUDAR (more than 40 labels compared to the eight labels of CATiB), and factors related to the structures, such as the longer distance between words and their parents in NUDAR (4.4 on average compared to 3.5 in CATiB) may be harder for a parser. We offer these insights as possible explanations, with the assumption that measuring and confirming these hypotheses need more research. It is also possible that further optimization will help increase the scores achieved by the NUDAR parser.

| System                        | REF          | LAS  | UAS  | LAcc |
|-------------------------------|--------------|------|------|------|
| NUDAR-Parser                  | NUDAR-GOLD   | 81.9%| 83.7%| 93.8%|
| CATiB-Parser                  | CATiB-Gold   | 83.1%| 85.0%| 94.3%|
| CATiB-Parser+converted        | NUDAR-GOLD   | 75.3%| 80.0%| 88.3%|

Table 5: Scores for the NUDAR and CATiB parsing and conversion experiments

5 Conclusion and Future Work

In this paper, we presented a fully automated converter from PATB to the UD syntactic representation. The conversion includes converting the POS tags and other morphological features, as well as the dependency relations and tree structures to UD, through a pipeline of conversion rules. The work was validated through a manually checked test set. We also present the results of an initial parsing experiment. This treebank will be made available as part of the UD v2.0 release as “UD Arabic-NYUAD”.

In the future, we plan to improve the conversion process, and to convert the remaining available PATB parts, in both MSA and dialectal Arabic into the UD syntactic representation. We also plan on converting other Arabic dependency treebanks, such as the CATiB treebank, and the Quranic treebank (Dukes and Habash, 2010) into UD. This will require enriching these treebanks with additional morphosyntactic features, as per the techniques described by Alkuhlani et al. (2013). More experiments on optimizing the parsing process are planned, to make use of the available features to improve the parsing results. Finally, we plan on exploiting the NUDAR treebanks and parsers for use in other areas of NLP such as machine translation.

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