Enhanced Universal Dependencies: Enhancing Treebanks and Open Issues

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Based on collaborative work with Marie Candito, Filip Ginter, Bruno Guillaume, Jenna Kanerva, Paola Marongiu, Simonetta Montemagni, Guy Perrier, Nathan Schneider, Djamé Seddah, and Maria Simi
Properties of the basic syntactic representation:

- Spanning tree over the words of the sentence
- One-to-one mapping from words to nodes – no empty nodes
- Every word related to (at most) one other word
- Underspecified representation of predicate-argument structure
- Suitable for parsing but not for (all) downstream applications
Enhanced Dependencies

Properties of the enhanced syntactic representation:

- General graph structure – not a tree (and not spanning)
- Partial mapping from words to nodes – and vice versa
- Not a monotonic extension of basic dependencies
- Disambiguates aspects of predicate-argument structure
- Collapses paths into single arcs – for practical convenience
Enhancements in UD v2

1. Null nodes for elided predicates
2. Shared heads and dependents in coordination
3. Added subject relations in control and raising
4. Coreference in relative clause constructions
5. Augmented modifier relations
Ellipsis

Ellipsis in basic dependencies:

1. If the elided element has no overt dependents, we do nothing.

2. If the elided element has overt dependents, we promote one of these to take the role of the head.

3. If the elided element is a predicate and the promoted element a core argument or modifier, we use the orphan relation to attach other non-functional dependents to the promoted head.
Ellipsis

she bought two apples and he bought three apples.
Ellipsis
Ellipsis
Ellipsis

she bought two apples and he bought three apples

PRON VERB NUM NOUN CCONJ PRON VERB NUM NOUN

nsubj num obj cc nsubj num obj cc nsubj num

she bought two apples and he bought three apples

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PRON VERB NUM NOUN CCONJ PRON VERB NUM

nsubj num obj cc nsubj num obj cc orphan

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Ellipsis

Basic

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she bought two apples and he
```

```
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nsubj obj num cc orphan
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Enhanced

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she bought two apples and he
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PRON VERB NUM NOUN CCONJ PRON VERB NUM
```

```
nsubj obj num cc orphan
```

2
Ellipsis

**Basic**

```
  she  |  wanted  |  to  |  buy  |  two  |  apples  |  and  |  he  |  three  
  PRON |  VERB    |  PART|  VERB |  NUM   |  NOUN    |  CCONJ|  PRON|  NUM     
```

**Enhanced**

```
  she  |  wanted  |  to  |  buy  |  two  |  apples  |  and  |  he  |  e_i  |  e_j  |  three  
  PRON |  VERB    |  PART|  VERB |  NUM   |  NOUN    |  CCONJ|  PRON|  VERB |  VERB |  NUM     
```
Coordination

Basic dependencies underspecify dependency relations into and out of coordinated phrases:

1. The shared head is attached only to the first conjunct (unambiguous).
2. Shared dependents are attached only to the first conjunct (ambiguous).
Coordination

Basic dependencies underspecify dependency relations into and out of coordinated phrases:

1. The shared head is attached only to the first conjunct (unambiguous).
2. Shared dependents are attached only to the first conjunct (ambiguous).
Coordination

Sue and Kim bought and sold stocks and bonds.

She likes alpine skiing and swimming.
Added Subjects

Enhanced dependencies add an explicit subject relation out of open clausal complements (\texttt{xcomp})

1. Subject relation to raised subject under raising verbs
2. Subject relation to controller under control verbs
3. Subject relation subject or object in nonverbal predication
Relative Clauses

Enhanced dependencies adds two relations:

1. Co-reference relation from antecedent to relative pronoun
2. Core argument relation from relative clause predicate to antecedent
Augmented Labels

Enhanced dependencies augments relation labels:

1. Adds case markers (adpositions) for \textit{obl} and \textit{nmod}
2. Adds markers (conjunctions) for \textit{advcl}
Augmented Labels

Enhanced dependencies augments relation labels:

1. Adds case markers (adpositions) for obl and nmod
2. Adds markers (conjunctions) for advcl
Enhanced UD Treebanks
Enhanced UD Treebanks

UD v2.2: 5 out of 102 treebanks

• English (EWT)
• Finnish (TDT, PUD)
• Latvian (LVTB)
• Russian (SynTagRus)
Enhanced UD Treebanks

UD v2.2: 5 out of 102 treebanks

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Case study on bootstrapping enhanced dependencies

- Joint work with Filip Ginter, Jenna Kanerva, Paola Marongiu, Simonetta Montemagni, Maria Simi
Case Study
Case Study

Two enhancers:
- Stanford – rule-based system developed for English
- Turku – data-driven system trained on Finnish
Case Study

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Two target languages:
- Swedish
- Italian
Case Study

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Two target languages:
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Three enhanced dependency types:
- Added subject relations in raising and control constructions
- Shared heads and dependents in coordination
- Null nodes for elided predicates
The Stanford System

• Based on English system by Schuster and Manning (2016)

• Pattern matching to detect structures to enhance

• Heuristics to predict enhanced dependencies

• Novel method for ellipsis by Schuster et al. (2018)
Stanford: Subjects

From any node attached as an \textit{xcomp} to a higher predicate, add an \textit{nsubj} dependency to:

1. The \textit{obj} of the predicate if such a dependent exists
2. The \textit{nsubj} of the predicate otherwise (raising, subject control)
Stanford: Coordination

Two types of added dependencies:

1. Shared heads for all coordinated elements

2. Shared dependents limited to core arguments of conjoined predicates:
   (i)obj, n/csubj, c/xcomp

3. Aims for high precision (rather than recall)
Stanford: Coordination

Two types of added dependencies:

1. Shared heads for all coordinated elements
2. Shared dependents limited to core arguments of conjoined predicates: (i) obj, n/csubj, c/xcomp
3. Aims for high precision (rather than recall)
Enhanced dependencies augments relation labels:

1. Align arguments and modifiers in the complete and gapped clause using similarity of word embeddings
2. Add null predicates corresponding to non-matched items and add dependencies based on matchings
Stanford: Ellipsis

Enhanced dependencies augments relation labels:

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Enhanced dependencies augments relation labels:

1. Align arguments and modifiers in the complete and gapped clause using similarity of word embeddings

2. Add null predicates corresponding to non-matched items and add dependencies based on matchings
The Turku System

- Based on Finnish system by Nyblom et al. (2016)
- Pattern matching to detect structures to enhance
- SVM classifier selects candidate dependencies
- Language-specific features omitted for generality
- Does not handle null nodes for elided predicates
From any **infinitive verb** attached as an **xcomp** to a higher predicate, consider adding an **nsubj** dependency to the **nsubj** of the predicate.

1. Binary SVM classifier decides if dependency is added or not
2. Object control is not considered at all
Turku: Subjects

From any *infinitive verb* attached as an *xcomp* to a higher predicate, consider adding an *nsubj* dependency to the *nsubj* of the predicate

1. Binary SVM classifier decides if dependency is added or not
2. Object control is not considered at all
The head and all dependents of the first conjunct are considered candidate head/dependents of all conjuncts

1. SVM classifier selects dependency label or null
2. Aims for high recall (rather than precision)
Turku: Coordination

The head and all dependents of the first conjunct are considered candidate head/dependents of all conjuncts

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Evaluation
Evaluation

Manual evaluation:

- 1000 sentences from the training set for subjects and coordination
- The entire training sets for ellipsis (rare)
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• 1000 sentences from the training set for subjects and coordination
• The entire training sets for ellipsis (rare)

Error classification:

• Basic errors – errors caused by incorrect basic dependencies
• Enhanced errors – errors in spite of correct basic dependencies
Evaluation

Manual evaluation:
  • 1000 sentences from the training set for subjects and coordination
  • The entire training sets for ellipsis (rare)

Error classification:
  • Basic errors – errors caused by incorrect basic dependencies
  • Enhanced errors – errors in spite of correct basic dependencies

Evaluation metrics:
  • Precision – percentage of predicted dependencies that are valid
  • Recall – percentage of valid dependencies predicted (relative)
Results
## Results

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Note: The table shows the results for different error types and languages (Swe, Ita) across different categories (Subjects, Coordination, Ellipsis).
Error Analysis: Subjects
Error Analysis: Subjects

- Stanford has higher recall for both languages because it considers all \textit{xcomp} nodes (not just infinitives)

Il parco dei Virunga è diventato zona pericolosa ...

"The Virunga park has become a dangerous area ..."
Error Analysis: Subjects

• Stanford has higher recall for both languages because it considers all xcomp nodes (not just infinitives)

• Stanford has higher precision for Swedish because it handles object control

“If you ... let the money remain [in the account] until the end of 1971.”
Error Analysis: Subjects

• Stanford has higher recall for both languages because it considers all xcomp nodes (not just infinitives)

• Stanford has higher precision for Swedish because it handles object control

• Stanford has lower precision for Italian because it handles object control (sic)

E le autorità di Zagabria hanno proibito ai giornalisti di andare a Petrinja ...

“And the Zagreb authorities have forbidden journalists to go to Petrinja ...”
Error Analysis: Coordination
Error Analysis: Coordination

- Stanford has higher **precision** for both languages because it limits projected dependencies to core arguments
Error Analysis: Coordination

- Stanford has higher precision for both languages because it limits projected dependencies to core arguments.
- Turku has higher recall for both languages because it projects all kinds of dependents.
Error Analysis: Coordination

- Stanford has higher precision for both languages because it limits projected dependencies to core arguments.
- Turku has higher recall for both languages because it projects all kinds of dependents.
- Most common error type (especially for Turku): predicting shared left-dependents of the first conjunct.

Example: "For natural persons, estates and family foundations, the right to make deductions is canceled ..."
Error Analysis: Coordination

- Stanford has higher **precision** for both languages because it limits projected dependencies to core arguments.

- Turku has higher **recall** for both languages because it projects all kinds of dependents.

- Most common error type (especially for Turku): predicting shared left-dependents of the first conjunct.

---

Tutti ... conoscono la loro provenienza, ma nessuno ... fa nulla per prevenire il massacro ...

“Everyone .... knows where they come from, but nobody ... does anything to prevent the massacre.”
Error Analysis: Ellipsis
Error Analysis: Ellipsis

- The Stanford system developed for English works equally well (or better) for Swedish
Error Analysis: Ellipsis

• The Stanford system developed for English works equally well (or better) for Swedish

• The system has lower precision on Italian due (in part) to different word order constraints

"In the district of Berat 150 persons have been arrested, 70 others in the region of Valona ..."
Interim Conclusion

Encouraging results for bootstrapping UD treebanks

- High cross-lingual accuracy – even for unrelated languages
- A few language-specific adaptations may help a lot
- Swedish v2.2 will have enhanced dependencies! 😊🇸🇪

Future work

- Use enhancers to post-process basic dependencies output by parsers
(Some) Open Issues

- Vague guidelines for coordination
- Treatment of semantically void dependents
- Neutralization of syntactic alternations
Coordination
Coordination

• Current guidelines do not specify for which coordinate structures one should add dependencies
Coordination: Dependents

- Current guidelines do not specify for which coordinate structures one should add dependencies
- Case 1 — coordinated dependents: It seems reasonable to always add dependencies
Coordination: Dependents

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  • Exception: discourse, parataxis, list, conj, orphan
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Coordination: Dependents
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- This may lead to strange interpretations if one sees this process as a reverse conjunction reduction
Coordination: Dependents

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(1) the black and white movie
Coordination: Dependents

• This may lead to strange interpretations if one sees this process as a reverse conjunction reduction

(1) the black and white movie
(2) If you put your plate in the dishwasher and take the trash out, you can play outside
Coordination: Heads

• The basic representation does not indicate whether arguments and modifiers are shared across coordinated heads
Coordination: Heads

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Coordination: Heads

• The basic representation does not indicate whether arguments and modifiers are shared across coordinated heads

• Core arguments (n/csubj, (i)obj, xcomp, ccomp) can appear only once in almost all languages
  • This fact can be used for automatic addition of dependencies
Coordination: Heads

• Non-core arguments/modifiers are less straightforward:

(1) In the morning, we listened to a talk and we participated in a discussion.

(2) In the morning, we listened to a talk and an hour ago, we participated in a discussion.
Coordination: Heads

- Evaluation and annotation heuristic:

  Check whether it is syntactically possible to copy shared modifier and whether the semantics is (more or less) preserved.
Coordination: Heads

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- Should we actually try to neutralize some syntactic alternations (à la Candito et al. 2017)? Which ones?
Discussion Points

• How to improve the automatic generation of enhanced UD treebanks
• Treatment of coordination in enhanced UD
• Treatment of semantically void arguments in enhanced UD
• Treatment of syntactic alternations in enhanced UD