Documenting Linguistic Dark Matter

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Ellipsis Constructions

- Omission of words in sentences that are usually obligatory in a given syntactic context
- Example: noun phrase (NP) or Forward Conjunct Reduction (FCR), as in example (1)

(1) a. My sister lives in Utrecht and ___ works in Amsterdam.
b. My sister lives in Utrecht and ***she***/***my sister*** works in Amsterdam.

- *gapping* in (2a) where the verb complex *is reading* is elided
- VP-ellipsis in (2b) where the entire predicate or Verb Phrase (VP) is elided

(2) a. Peter is reading a book and Mary ___ a newspaper.
b. She will hi-five Daniel, but I won't ___

- Context-dependent forms of ellipsis in responses to questions as in (3), the words *each candidate will talk* are elided:

(3) a. Will each candidate talk about taxes?
b. No, ___ about foreign policy.

- Lexical mismatches of elided word forms as in (4a)
- In highly inflecting languages like Hindi or Croatian (4b) elided words do not have to be homophonous

(4) a. John **reads** a book, but Paul and Mary (**read**) a newspaper.
b. Ivan **je čitao** knjigu a Marija i Petar (**su čitali**) novine. (Croatian)
I. be read book, but M. and P. be read newspaper

- Elided elements scattered over multiple positions in example (5) where the words *will*, *greet*, and *first* are elided

(5) Will Jimmy greet Jill first, or ___ Jill ___ Jimmy ___ ?

- ellipsis constructions are very common and often accompanied by specific semantic effects (Testa et al., 2023; Hardt, 2023)
  - various quantifier scope effects
  - semantic issues involve so-called *zeugma* (Sennet, 2016) as in example (6)

(6) a. John stole a book and Peter stole kisses from Mary.
b. John stole a book and Peter ___ kisses from Mary.

HELC Data

- HELC is constructed as a pair of sentences with optional context.
- The sentence pairs are separated by 4 dashes.
- The first line contains a sentence with ellipses.
- The second line contains the same sentence with the elided words spelled out.

Sample entry in the corpus:

```
Wird sie kommen oder ___ er gehen?
----
Wird sie kommen oder wird er gehen?
# TR eng: Will she come or will he go?
# added by: John Smith
# source: Wolfgang Klein (1981)
# Some Rules of Regular ...
```

- The canonical position of the elided word(s) is indicated by 3 underscores.
- Complex ellipsis constructions may have several elided positions.

Coverage

Languages: Arabic, Mandarin Chinese, Croatian, English, German, Gujarati, Hindi, Japanese, Kumaoni, Korean, Navajo, Norwegian, Polish, Russian, Spanish, Swedish, Telugu, Ukrainian

In preparation: Bengali, Bosnian, Bulgarian, Hebrew, Kanada, Serbian, Slovak, Slovenian, Tamil

Availability:

- Data website: `https://nlp-lab.org/ellipsis/`
- GitHub repositories: `https://github.com/dcavar/hoosierellipsiscorpus`

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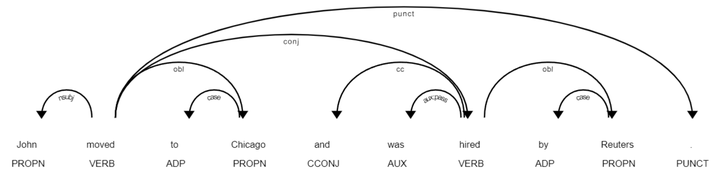
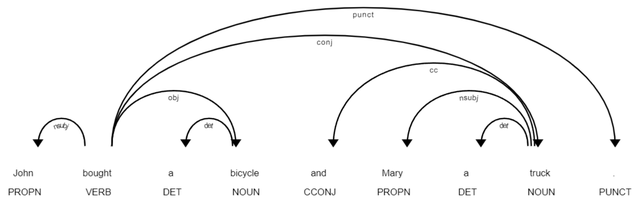
NLP Challenges

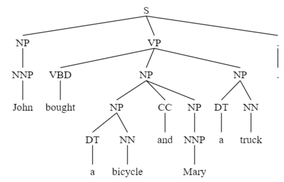
- Common State-of-the-Art NLP-pipelines fail, as in the following Stanza Dependency Trees: The syntactic subject in the second conjunct is not identified



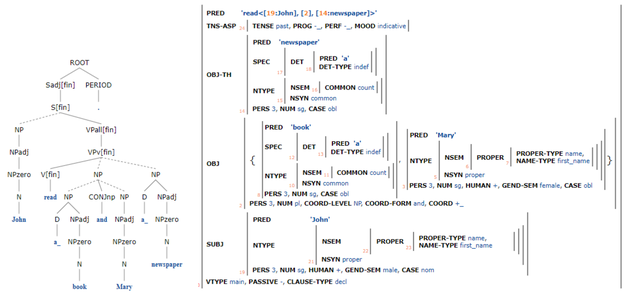
- Coordination and ellipsis with Stanza: Useless Dependency parse tree



- Constituent parsing with Stanza: no improvement – the common tendency is to analyze every coordination as local NP-coordination



- Lexical-functional Grammar using Xerox Linguistic Environment (XLE) and the English grammar:



- All NLP-pipelines fail with most constructions containing:
  - ellipsis
  - syntactic discontinuities
  - long-distance dependencies

  independent of underlying syntactic theory or ML model!

NLP Pipelines Tested

- Benepar Kitaev and Klein (2018); Kitaev et al. (2019)
- spaCy 3.x Honnibal and Johnson (2015)
- Stanford Stanza Qi et al. (2020)
- Stanford CoreNLP Manning et al. (2014)
- Xerox Linguistic Environment (XLE) Crouch et al. (2011)
- Quantum NLP pipelines, e.g., Lambeq Kartsaklis et al. (2021)
- LLMs: GPT-4

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Testing Ellipsis in Different Models

- Baseline: Logistic Regression
- Neural classifier using BERT
- SOTA LLMs: GPT-4, Claude 3, etc.
- LLMs tested using linguistic bias prompt and 0-shot or few-shot with 5 or more examples

Test 1: Binary Classification

- Does the sentence contain ellipses? Yes/No
- Test data: mix of distractor and target sentences (language dependent: e.g., English 575 target and 658 distractor sentences; Arabic 375 target and 500 distractor sentences)
- ten-fold randomized rotation for experiments

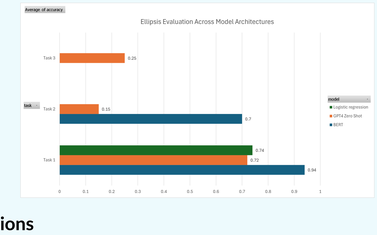
Test 2: Ellipsis Location

- Identify the location of the ellipses.
- Neural classifier using BERT
- SOTA LLMs: GPT-4, Claude 3, etc.

Test 3: Missing Words

- Identify the elided words.
- Only SOTA LLMs: GPT-4, Claude 3, etc.

Task 1:



model	accuracy
LR	0.74
BERT	**0.94**
GPT-4 zero-shot	0.72

Conclusions

- Logistic Regression outperforms GPT-4 zero-shot on Task 1
- BERT model outperforms GPT-4 zero-shot on Task 2
- GPT-4 on Task 3 only 25% accuracy with zero-shot

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The NLP-Lab (`https://nlp-lab.org/`)