Multilanguage Dynamic Wordnet: Timeflow Hydra

2025

Outline

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- Relational model of the language
- language concepts – synonymous sets
- 20 semantic and lexical binary relations
  - super-subordinate relation hyperonymy (AKA is-a)

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Wordnet for many languages

- English in Princeton
- $>$ 40 languages
- Developed or are still in development using the so called **synchronous model** - hyperonymy structure follows this of the Princeton WordNet
- ILI - Common identifier to align synsets (en - bg)

Problems:

- Developed by different teams using different software platforms, file formats, databases, etc.
- Stored and maintened separately
- The alignment (ILI manintanace) is made periodically usually for particular language pairs and particular version of these wordnet databases
- Collaborative Interlingual index (**CILI**) was developed to help reduce the sparse ILI mapping problem, but it did not succeed much

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Static model for wordnet

In a fixed moment of time:

- Family of synonymous sets (**synsets**)
- Semantic relations (hyperonymy, meronymy)
- Associated to them we have data like **POS**
- A word in a synset - **Literal** - $\langle synset, word/compound \rangle$
- Lexical relations
- Text data - **notes** - usage examples, synset or literal features like verb type, etc.

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Wordnet as a Kripke frame

3 types of objects - **Synset**, **Literal**, **Note**

We define special binary relations to encode the relationships between them.

- **Literal** relation connects a particular **literal** to its **parent synset**
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- **ILI** relates Synset in different languages representing the same notion.
- etc.

$\langle W, R \rangle$

W - Synset, Literal and Note objects

R - A set of binary relations

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Wordnet database management system

- First version - 2006
- Wordnet as a Kripke frame
- **Many** languages in a **single** database
- Second verion - Web SPA (Hydra for Web)
  Previous, still in production, system
  `http://dcl.bas.bg/bulnet` with **22** languages
- Searching with **Modal logic query language**

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Dynamic model for wordnet

A static wordnet database is an incomplete instantaneous description of the language. Over time, both the language and its wordnet representation change and evolve. If we take the snapshots of wordnet in the static model, we get a set of Kripke frames. Let's take the union of the resulting set of disjoint frames.

$$\{\langle W_t, R_t \rangle\}_{t \in T}$$

Dynamic wordnet model:

- Discrete time model
- **Only one** instance of object or relation can be changed in a single time moment
- For a moment we have an instance of the static model - with the most recent verion of the objects and relations (nearest previous version).
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Query language

The construction of wordnet and its editing opens questions about the evolution of the data and the structure over time. We would like to easily detect a problem, when it occured and who did it. We want it **without** reverting the data to previous state. We accomplish this and much more. We use model checking for searching.

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- **N** Individual constants (nominals) - in the system we use decimal numbers for them.
- **O** A set of constants for the features in the objects and their values. They use the schema $type('value')$. For instance pos('n') is such constant.
- A set of relation symbols (hypernym, literal)
- We have 4 types of temporal modifiers - for a fixed timestamp (real time moment), fixed operation moment (model time moment), relative future and relative past like this:
  - t1597379800000;
  - o1235;
  - f5;
  - p3;

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Formulae

- **AtomicFor** $\subseteq$ **For**.

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- q | r
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  `pos('n') & [hypernym]`$\perp$ `& lang('en')`
- Find the synsets that are exactly two levels below the top in the hyperonymy hierarchy:
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- Find inconsistency between Bulgarian and English:
  `<ili>(lang('en') & pos('n') & [hypernym][hypernym]`$\perp$ `&`
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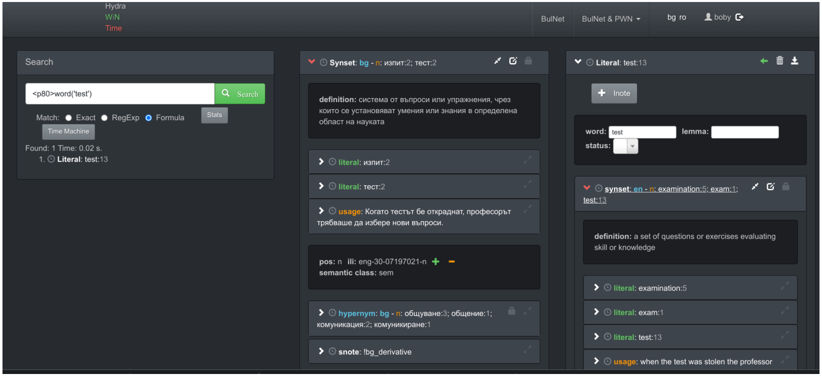

Search

<p80>word('test')

Search

Match: Exact RegExp [✓ Formula]

Stats

Time Machine

Found: 1 Time: 0.02 s.

1. **Literal**: test:13

Synset: bg - n: изпит:2; тест:2

definition: система от въпроси или упражнения, чрез които се установяват умения или знания в определена област на науката

literal: изпит:2

literal: тест:2

usage: Когато тестът бе откраднат, професорът трябваше да избере нови въпроси.

pos: n **ili:** eng-30-07197021-n

semantic class: sem

hypernym: bg - n: общуване:3; общение:1; комуникация:2; комуникиране:1

snote: !bg_derivative

Literal: test:13

Inote

word: test **lemma:**

status:

synset: en - n: examination:5; exam:1; test:13

definition: a set of questions or exercises evaluating skill or knowledge

literal: examination:5

literal: exam:1

literal: test:13

usage: when the test was stolen the professor

Figure: Hydra

Tracking and Real-time Updates

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  - Automatic history of all editing operations
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  - Next.js

Modernization

- Current implementation is outdated (KnockoutJS)
- Modernization plan: rewrite using AI
- Tech Stack:
  - React
  - Next.js

Deployment and Access

The **Time Flow Hydra** system is deployed and accessible:

`https://hydra.fmi.uni-sofia.bg/`

Conclusion and Future work

- Every touch is stored in the database
- Concurrent access
- Safely cleaning
- More modal operators like Since and Until (Sometime in the past, Sometime in the future)
- Separation
- GUI Assistant for linguists (Predefined queries)

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