BTB-WordNet: Status and Challenges

Petya Osenova

IICT-BAS and Sofia University “St. Kl. Ohridski”

Plan of the Talk

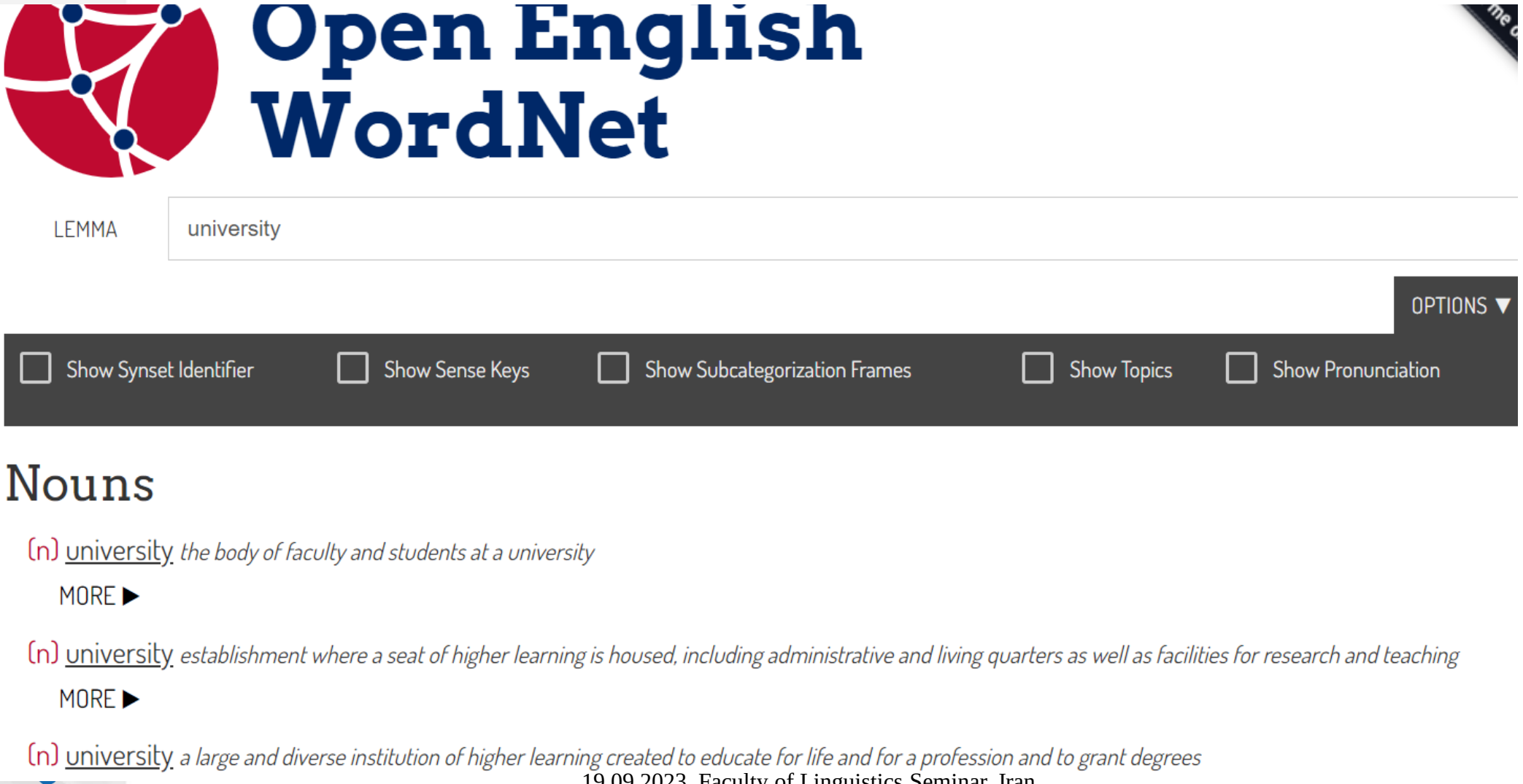
- Introduction
- Background of BTB-WordNet
- Challenges in mapping BTB-WordNet to the English wordnet
- Challenges in mapping BTB-WordNet to other resources
- Lessons Learnt

What a WordNet is?

- WordNet® is a large lexical database of English. Nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept. Synsets are interlinked by means of conceptual-semantic and lexical relations.
- WordNet resembles a thesaurus, in that it groups words together based on their meanings.

https://wordnet.princeton.edu/

Open English WordNet



Open English WordNet

(n) university *a large and diverse institution of higher learning created to educate for life and for a profession and to grant degrees*

Hypernyms (1)

(n) educational institution *an institution dedicated to education*

Hypernyms (1)

(n) institution, establishment *an organization founded and united for a specific purpose*

MORE ▶

Hyponyms (5)

(n) preschool *an educational institution for children too young for elementary school*

MORE ▶

(n) school *an educational institution "the school was founded in 1900"*

MORE ▶

(n) school *an educational institution's faculty and students "the school keeps parents informed" "the whole school turned out for the game"*

MORE ▶

Introduction

Bulgarian BulTreeBank WordNet (BTB-WN) is created in three different stages:

- Translation of English synsets from Core WordNet subset of Princeton WordNet into Bulgarian
- Identification of senses used in Bulgarian Treebank BulTreeBank
- Sense extension: a) detection of missing senses of processed lemmas and adding them to BTB-WN; b) extraction of information from the Bulgarian Wiktionary
- Result – 19200 synsets (2019)

Introduction (2)

Recent development of BTB-WN:

- Currently, there are around 35 000 synsets and 49313 lemmas
- Editing the BTB-WN with a special software (started in the CLaRK system which is an XML system for language resources development, and now moved to BTBDict one)
- Under constant manual check are: a) the definitions of the synsets; b) the synonyms of each synset; c) the mapping to the EWN; d) examples

Introduction (3)

Problems with the mapping between languages in general:

- WNs are not perfect: missing meanings, wrong classifications, etc.
- Languages differ in their linguistic properties
- WNs encode the cultural conceptualization reflected within the lexical bases of the languages

The Main Challenge

- The main challenge is the simultaneous creation of a data-driven WordNet for Bulgarian and a manually annotated treebank with semantic information
- It requires synchronization of the word senses in both - syntactic and lexical resources, without limiting the WordNet senses to the corpus or vice versa.

Parallel Semantic Enhancements

Semantic annotation of the treebank with Bulgarian resources

Extending the domain WordNets with general lexica

Our Approach Reflects the Creation Process

- *the expand method*: the translation of the synsets from the source into the target language
- *the merge method*: takes (also) into account the language specific resources

What combination of steps is the best? The one extreme, the other extreme, or some strategies in between?

Steps

- translation of English PWN into another language;
- data-driven approaches via identification of synsets within real texts;
- automatic extraction from existing lexical resources;
- various combinations of these.
- Also: automatic vs. manual work

Sum up

- There is no easy way to achieve typological consistency in building WordNets:
  - if the *expand* method is chosen, the language resource suffers from lack of nativeness of the hierarchy and relations;
  - if the *merge* method is followed, the language resource differs too much from other similar resources and it is time-consuming to map it back to them.

From the Corpora Perspective

- The usual way of annotating senses in treebanks is the following:
  - there is a WordNet for the language in question, and then the treebank is annotated with senses from it
  - HOWEVER, they bear also the restrictions that are presented in the so-called static lexical resources
  - Therefore: the sparseness of the sense coverage might be really problematic.

Our Strategy

- **In-language sense annotation**: We first annotated the treebank with senses from an explanatory dictionary of Bulgarian;
- **Synset compilation:** Only then we started the formation of synsets;
- **Mapping:** They were then mapped to the PWN while keeping track of the various sense discrepancies by different mappings.

Coverage Problems

- The extensions on the basis of:
  - text annotation
  - the existing lexicon
- Exhibit the sparseness problem:
  - not all synonyms appear in the annotated texts and the lexical entries.

For that reason, we performed checks on the completeness of the synsets with respect to the missing synonyms.

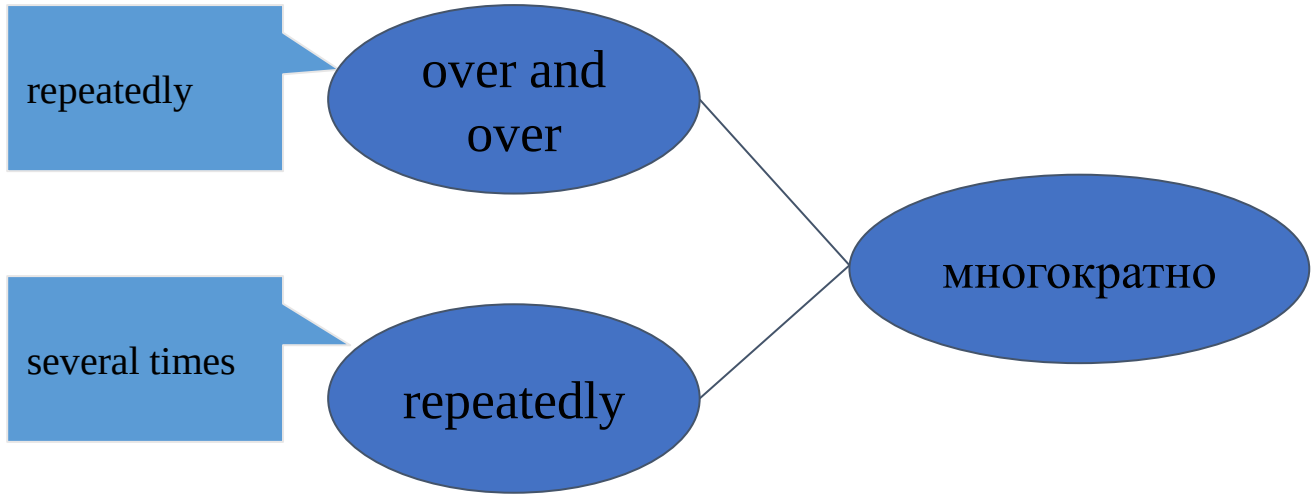
Mid-Observations

- We started from the domain semantic annotation.
- We were aware of the concept sparseness problem.
- We did not rely on pre-created WordNet, but rather on an explanatory dictionary of Bulgarian.
- Later mappings to PWN
- Early involvement in various NLP applications

Delving into the Mapping to Princeton and English Wordnet

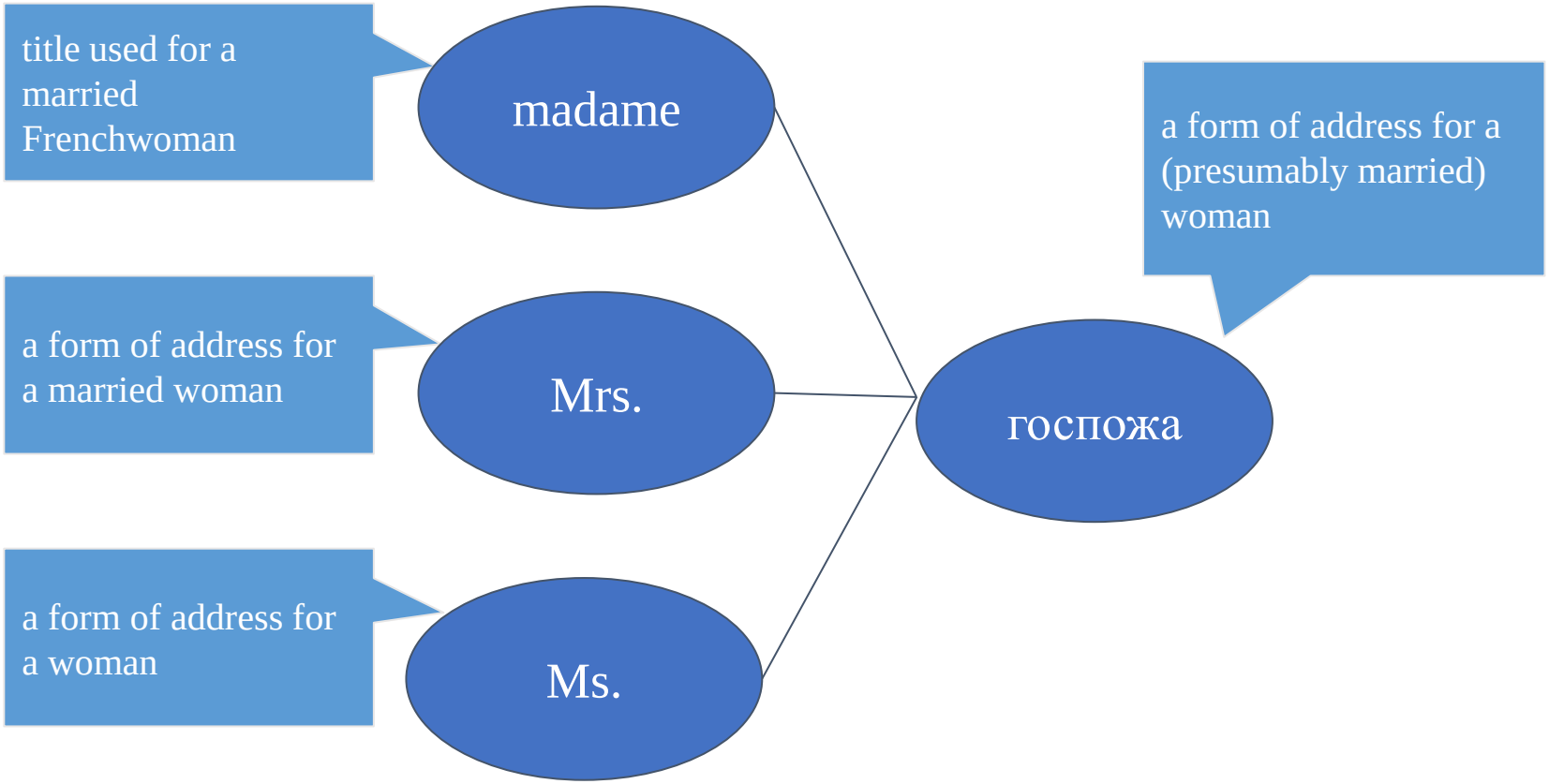
Problems of EWN Hierarchy

Differentiation with very subtle differences:



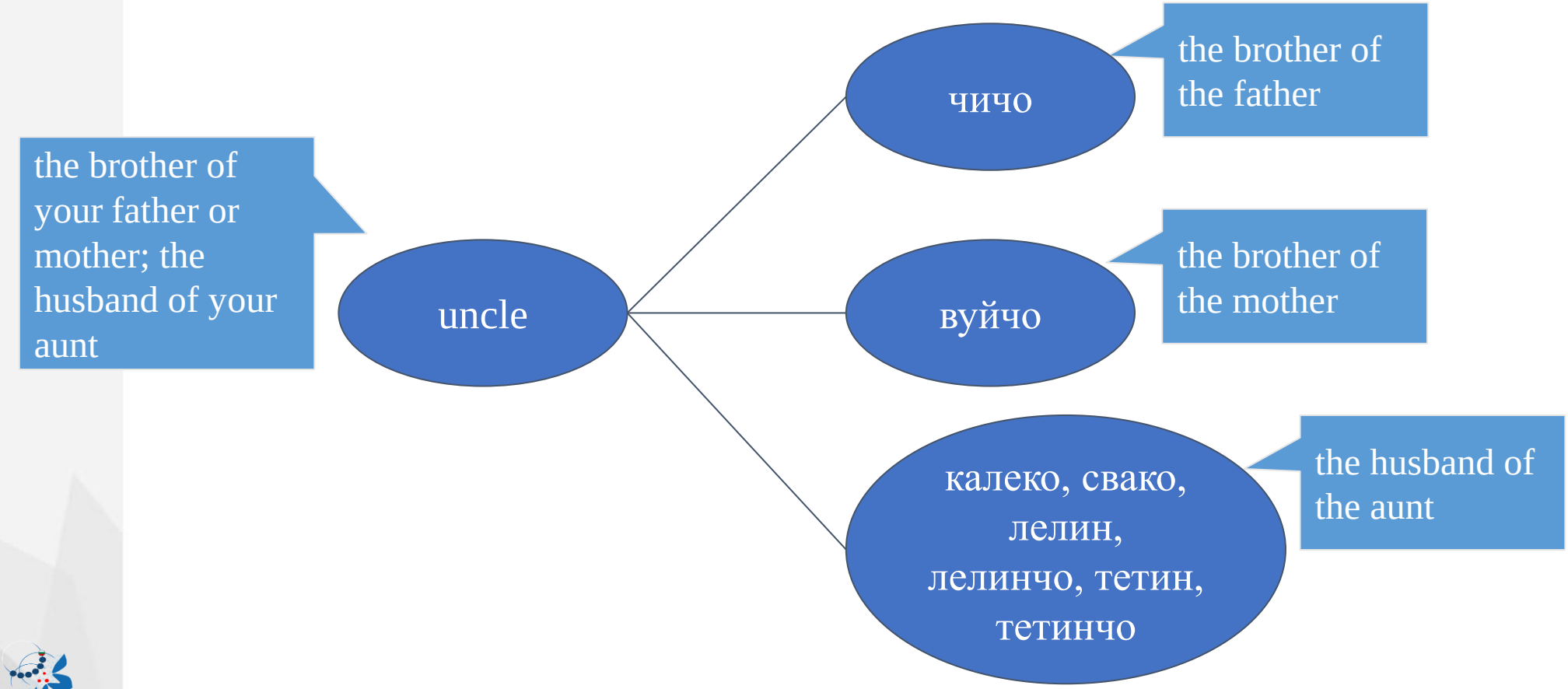
Problems of EWN Hierarchy

Differentiation with very subtle differences:



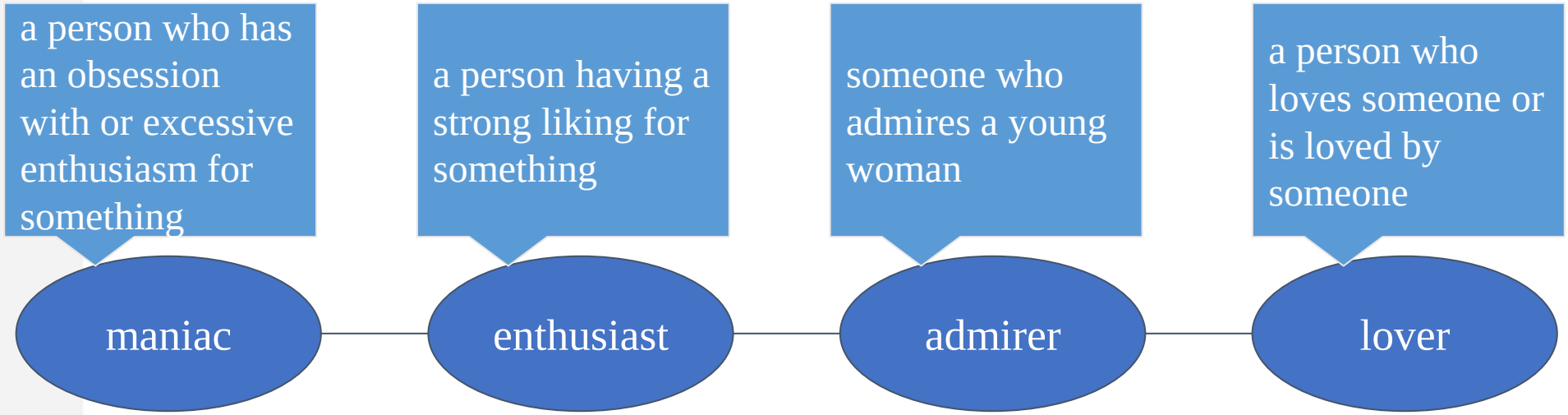
Problems of EWN Hierarchy

In some cases BTB-WN differentiates more concepts than EWN:



Problems of EWN Hierarchy

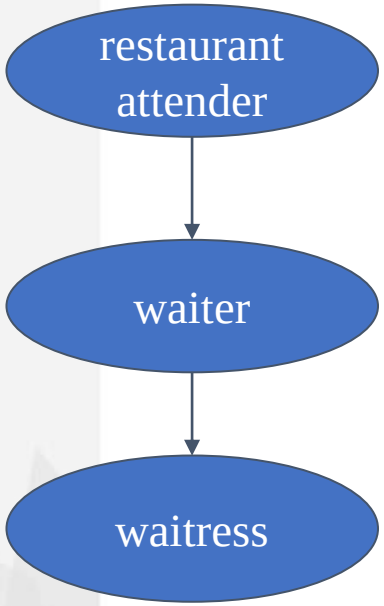
Changing the hierarchies as they are incorrect:



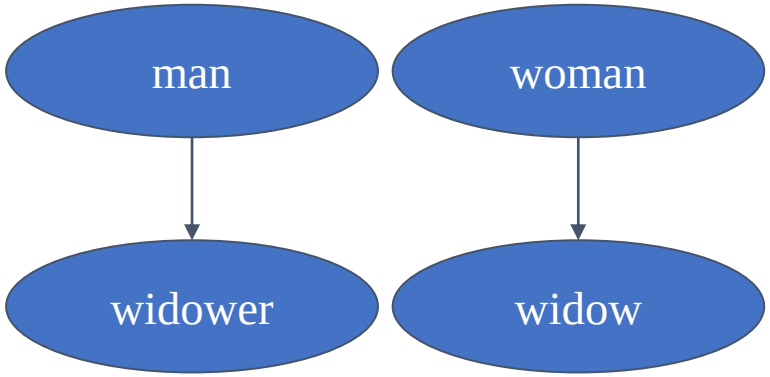
Problems of EWN Hierarchy

Male and female word forms:

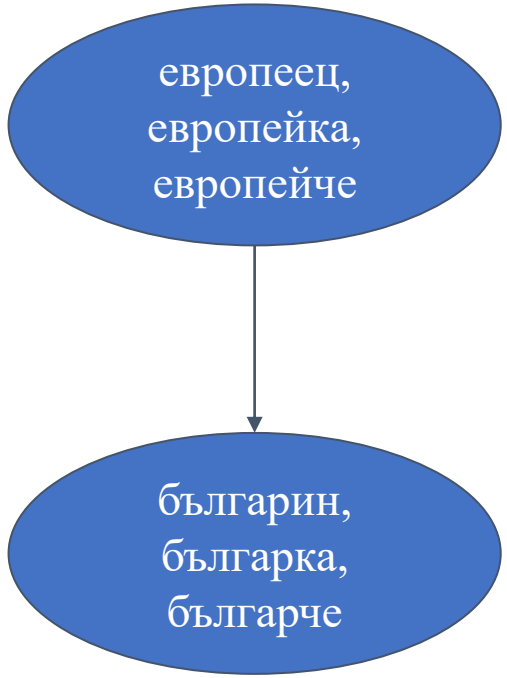
1. EWN



2. EWN



3. BTB-WN



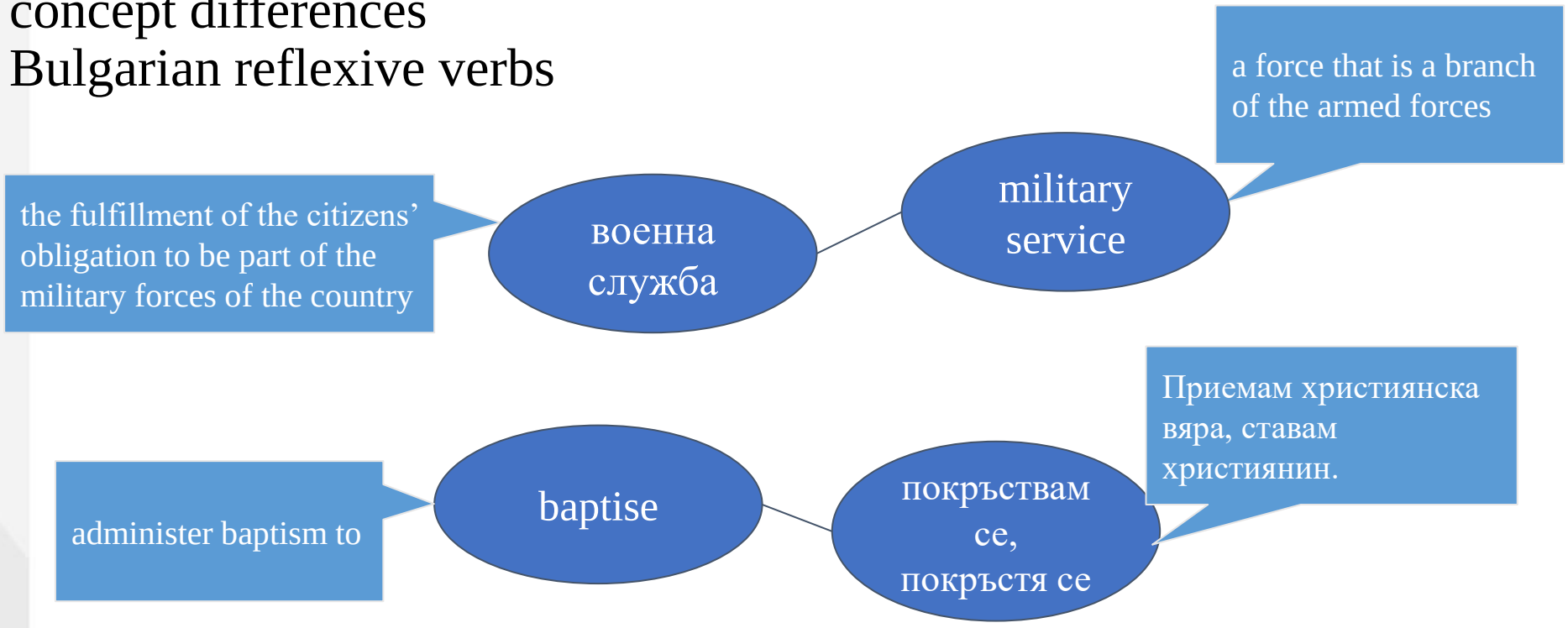
Missing Concepts in EWN

The gaps that we observe in EWN are of two main kinds:

- Language differences between English and Bulgarian
- Due to differing approaches

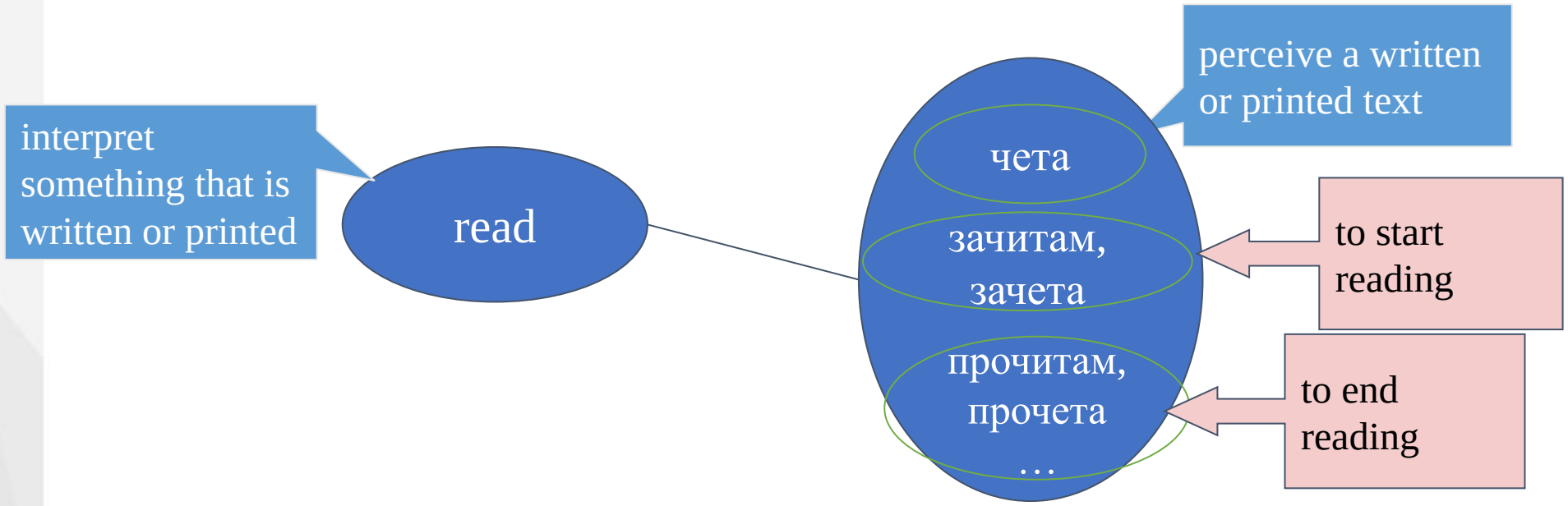
Missing Concepts in EWN

- Natural differences between English and Bulgarian:
  - concept differences
  - Bulgarian reflexive verbs



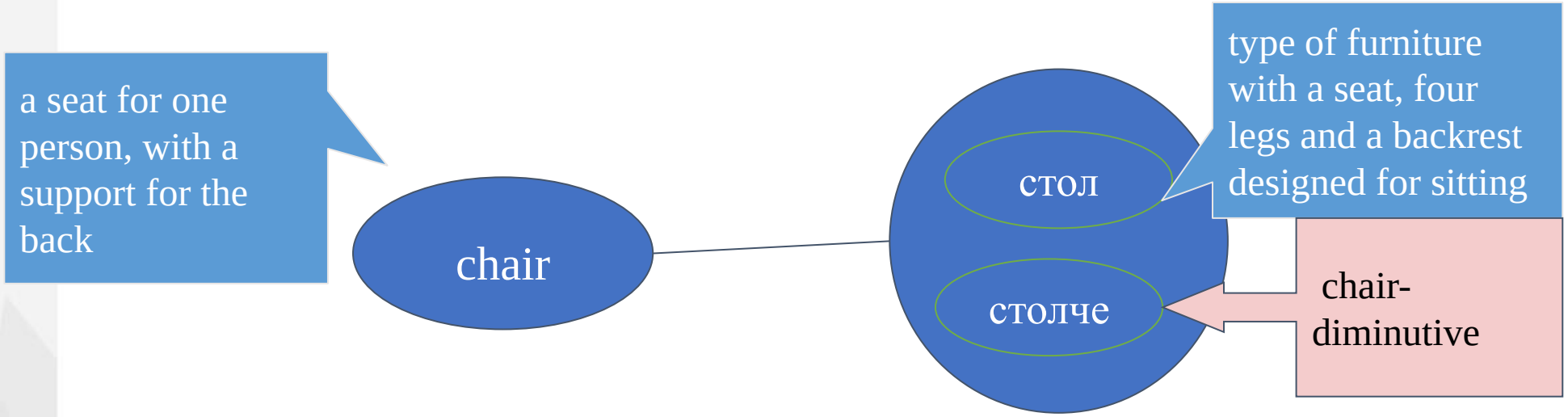
Additional Linguistic Information

Bulgarian verbs with prefixes that bear semantics of start, end, duration, repeatability, etc. of the action can not have an equal English synset so they will be mapped with the general meaning of the verb and labeled with their specific semantic features on the level of lemma



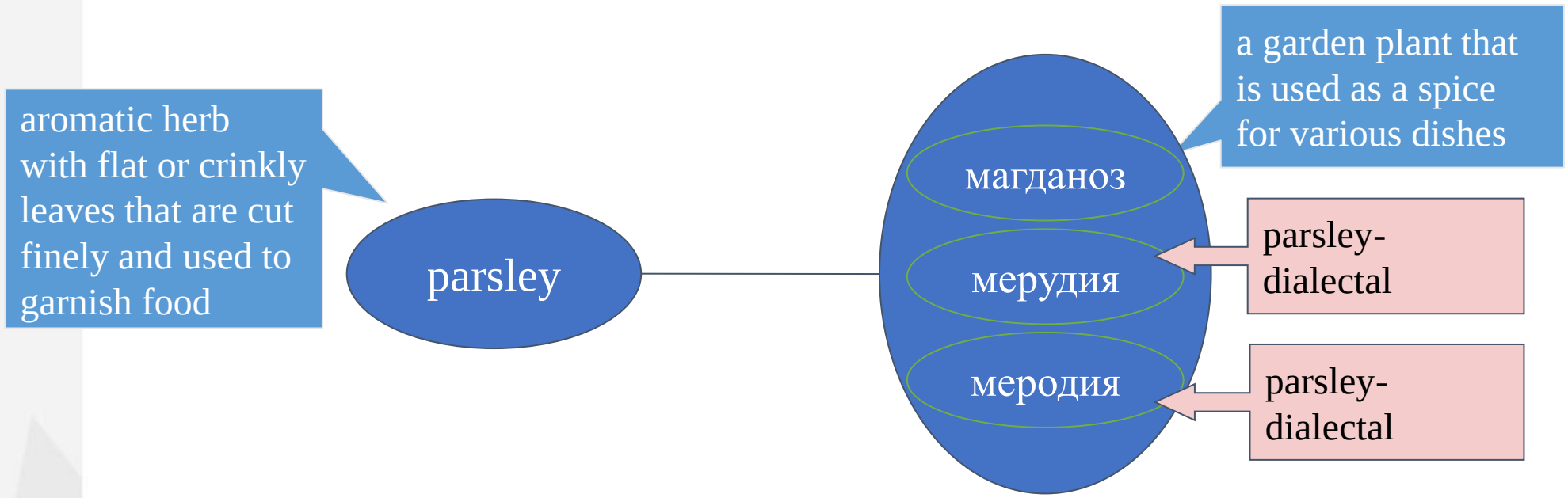
Additional Linguistic Information

The diminutive forms of the nouns will be in one synset with the general form. Bulgarian diminutives can have more than one meaning. The general one is that something is very small or very young, but they can also express gentle, diminishing or humiliating attitude.



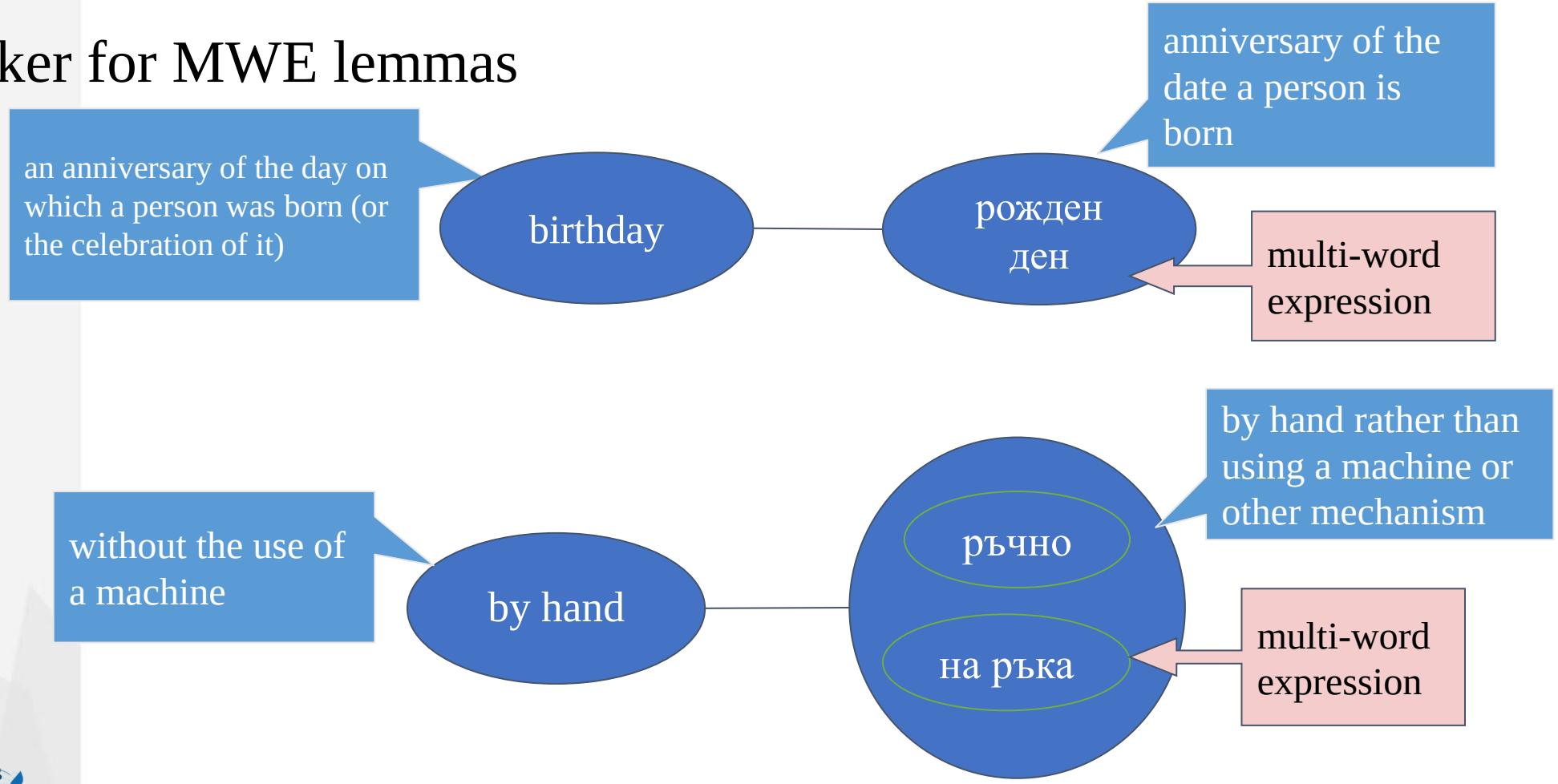
Additional Linguistic Information

Lemma markers for archaic, dialectal, slang, informal, vulgar, offensive, etc.



Additional Linguistic Information

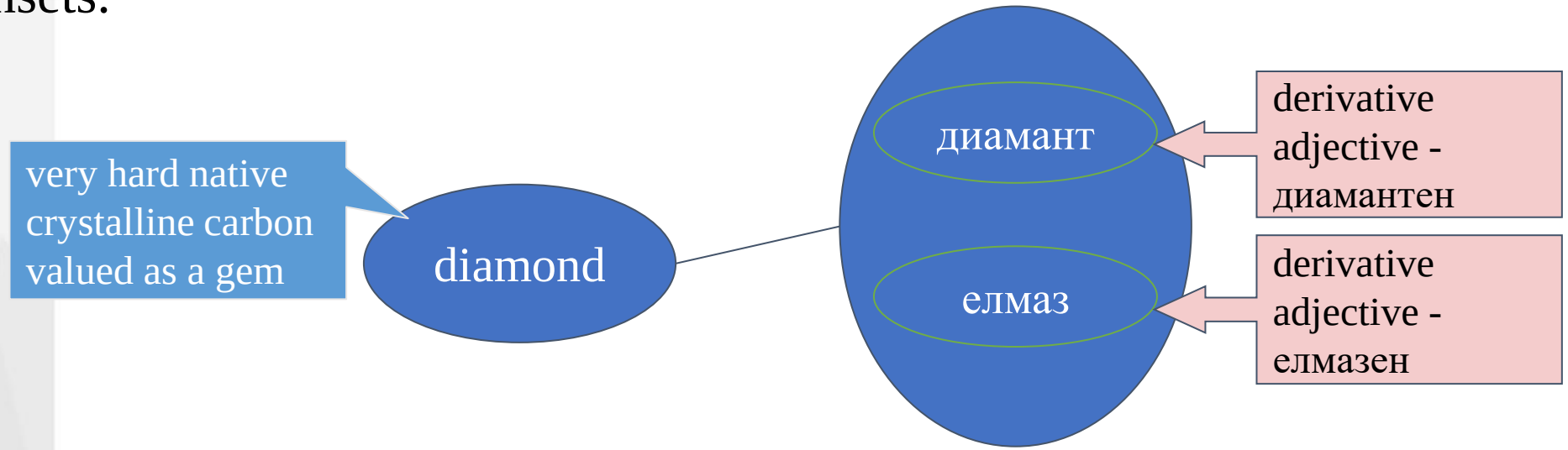
Marker for MWE lemmas



Additional Linguistic Information

Derivational relations between different parts of speech

These markers are again used for lemmas rather than synsets because if they are applied on synsets they would not be appropriate for members of one synset that are not derivationally related. A very common example is the conversion of English nouns to adjectives. Thus, for many noun synsets there are no adjective synsets.



Mid-Observations

- The challenges that are encountered in the mapping of two wordnets are related with the natural differences between the two languages but also depend on the way that the resource is built.
- The discrepancies are overpowered with interlingual relations and relations between lemmas and synsets in the BulTreeBank WordNet.

BTB-WordNet as a Hub for Resource Integration

Introduction

- The reported work here refers to the last three years (2020, 2021, 2022)
- It turned out that many NLP applications required **not only available resources but also appropriate integration among them**
- We started to view BTB-WN as a hub for linking grammar, other lexical data and world knowledge
- Our ultimate goal however would be that users could customize their own dictionaries, examples or other material through interlinked resources. In short: Maximum re-use of existing resources and contribution from different communities in building new ones!

Some History

- The development of BTB-WN goes back to the times when an *Ontology-based lexicon for Bulgarian* was initially constructed (**Simov and Osenova 2010**)
- Here we started with domain ontologies aligned to the upper ontology *DOLCE*, using *OntoWordNet* for introducing the middle level concepts
- The first version of BTB-WN was constructed by translation of Core WordNet and EuroWordNet Base concepts that were added to the Open Multilingual Wordnet (https://omwn.org/)

Some Broader Context

- The interface between lexical semantics and grammar, between lexicons and corpora has been extensively discussed from various points of view: linguistic, typological, formal, implementational, etc.
- We support the point of view in which the grammar is born in the lexicon, i.e. the *lexicalist-centric one*, without lowering the role of grammar at all. This is on a par with:
  - the linguistic theories that are constraint-based (such as **HPSG** and **LFG**) or are word-based (**dependency theories**)
  - the flagship project in **eLexicography - ELEXIS**

Rationale

- It is well-known that wordnets are thesauri. Despite providing the meanings of words grouped within synsets and relations among these synsets, they are still:
  - very static
  - self-contained and
  - often do not cover all parts of speech
- At the same time, they are good candidates for playing a central role – like a hub – for linking grammar, other lexical data and world knowledge

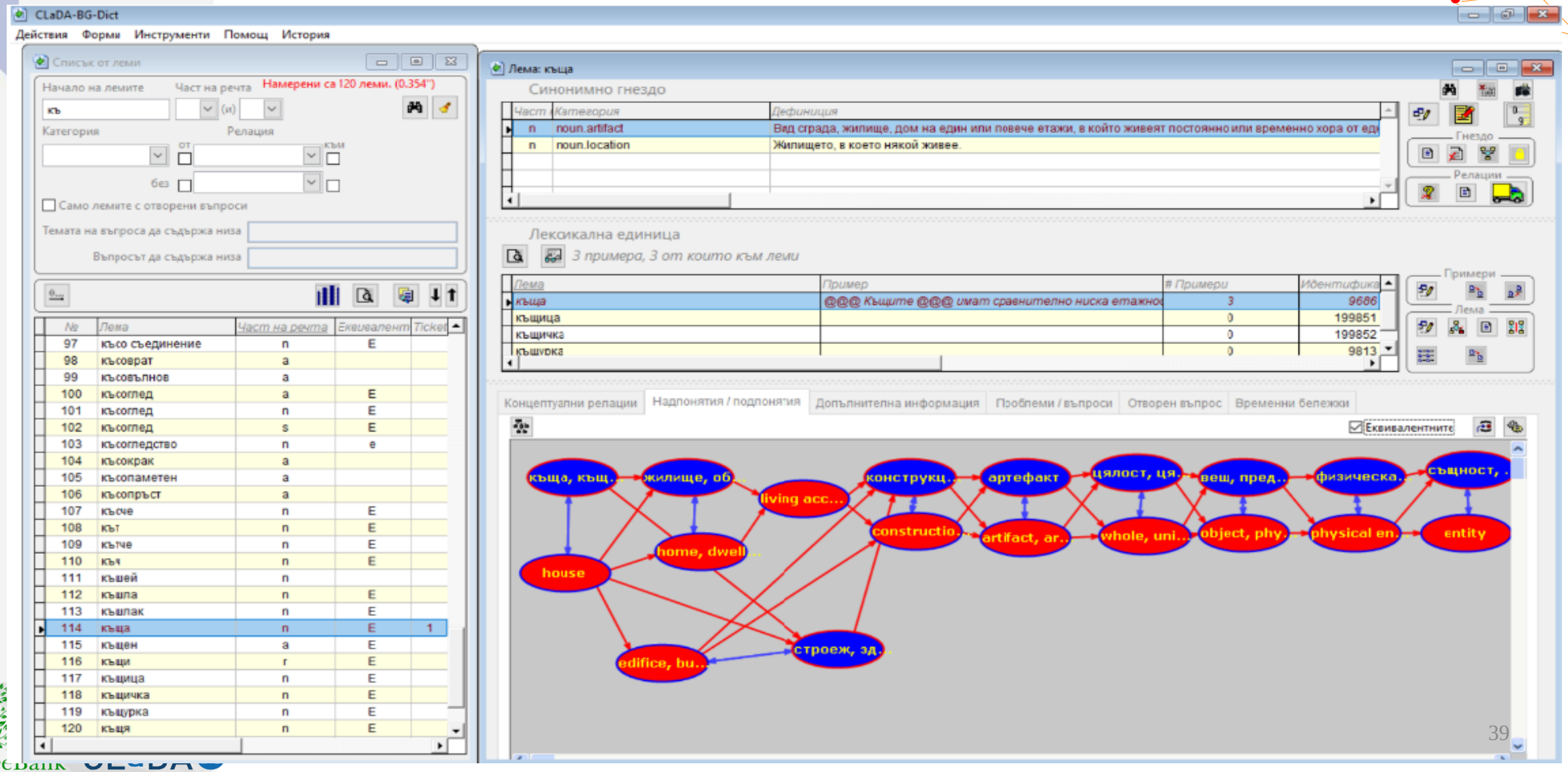
Linking of BTB-WN

- We switched from a tool that supported only local editing (where synsets were considered within a very limited context) (CLaRK system) to a tool that supports editing of the Wordnet data within a global context (CLaDA-BG-Dict)
- When a lemma is selected within BTB-WN, the following information can be accessed immediately:
  - the number of synsets related to it with the part-of-speech, as well as
  - the numbered meanings and links to the **Open English WordNet**
- The usage of almost each synonym within a synset is illustrated with examples
- Within the system the user could consult several other sources of information. The center of the system is BTB-WN

Linking of BTB-WN (2)

- The user could open as many editor forms as necessary in which to observe the synsets for different words
- The **Open English Wordnet** is available within the system
- The creation of a new Bulgarian synset could start from scratch entering all the information, including relations. But it is also possible to create such a synset with using an equivalent English synset
- In this way the relations of the English synsets are automatically transferred to BTB-WN

The Editor System CLaDA-BG-Dict



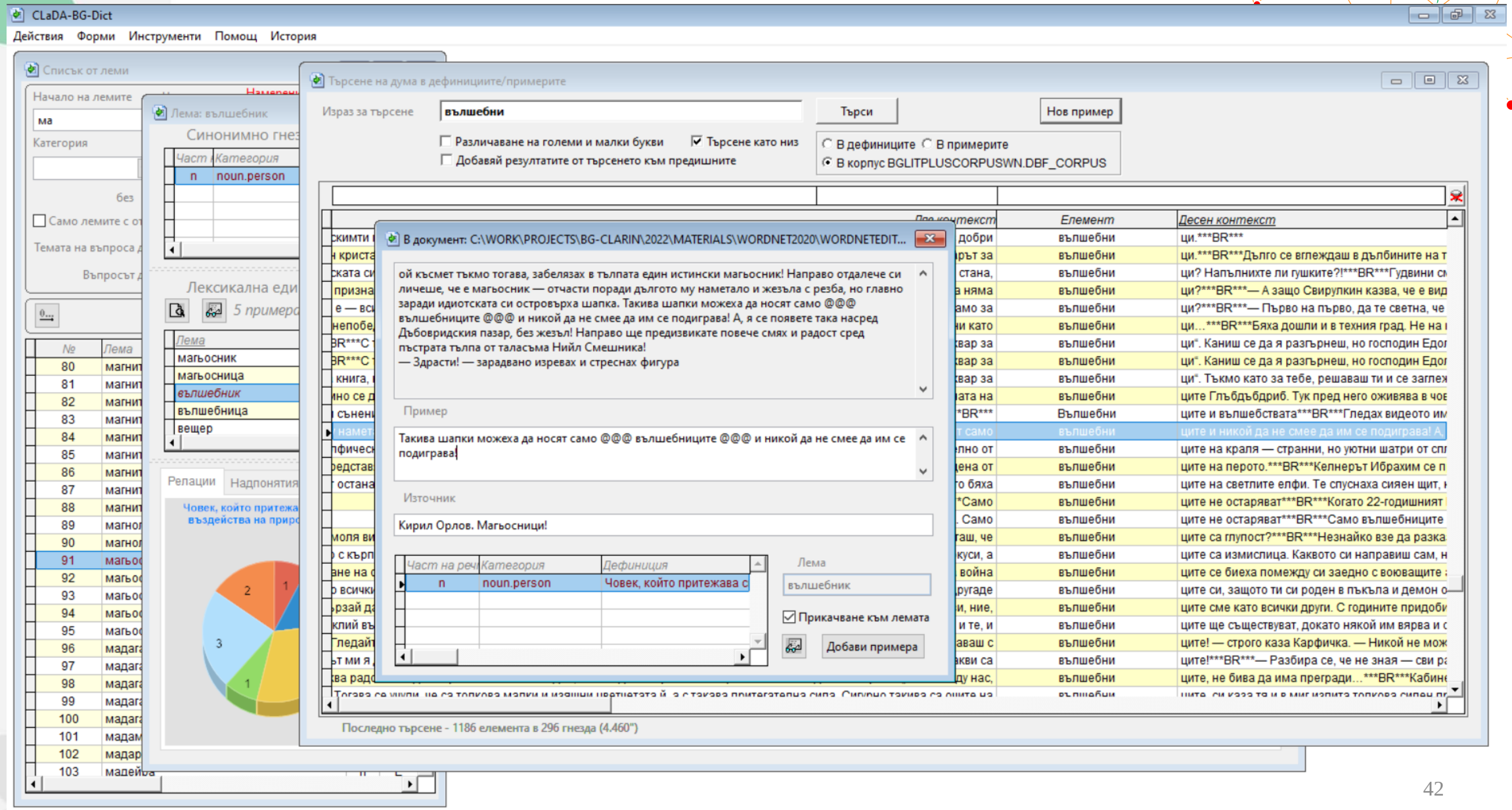
Linking of BTB-WN (3)

- In addition to granting access to OEW, the system provides access to dictionaries that are freely available to us, among which the **Bulgarian Explanatory Dictionary**, our **in-house Bulgarian Inflectional dictionary**, two **Bulgarian-English dictionaries**
- Each of these dictionaries could be consulted in isolation or simultaneously on the base of the alignments performed through lemmas
- The user could also define different lists of lemmas which to be mapped to the vocabulary of BTB-WN and to the vocabularies of the included dictionaries

Search in Corpora

- In addition to the data access options one can search with the selected lemma in *various text corpora*
- We consider the *definitions* and *examples* already included in BTB-WN as a corpus from which to select examples for other senses. In this case we could construct sense annotated corpora similar to *GlossCorpus*, *SemCor*
- The user could upload their own corpora when necessary

Search in Corpora

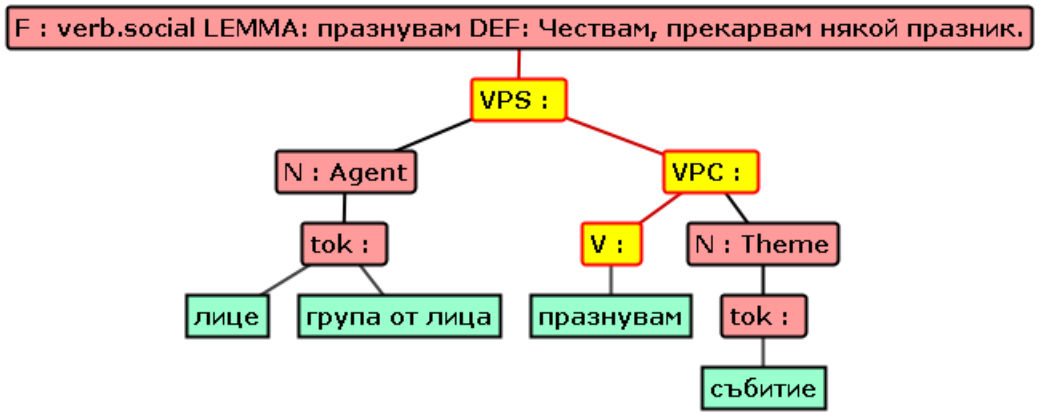


Link to Valency Dictionary

- The verb in a valency frame is connected to BTB-WN via a mapping to an appropriate synset from where access to the lexicographic class (such as *verb.social*, *verb.cognition*, etc.), the list of lemmas and the definition are available
- For example, if the *verb.emotion* worry is considered, the Bulgarian counterpart is displayed with a definition and a valency frame where the *Subject* has the role of *Experiencer* and the complement event that causes worrying has the role of *Stimulus*. The link to the **VerbNet frame** is also given

Example from the Valency Dictionary

- FramesDef: :лице група от лица празнувам събитие
  - FD: VerbNet:judgement-33
    - lemma: празнувам
    - def : Честват, прекарват някой празник.
    - F: verb.social LEMMA: празнувам DEF: Честват, прекарват някой празник.
      - VPS: :> лице група от лица празнувам събитие
        - N: Agent :> лице група от лица
        - VPC: :> празнувам събитие
          - V: :> празнувам
          - N: Theme :> събитие



From CLaRK to CLaDA-BG-Dict

When we switched from local processing in **CLaRK** system to the global processing in **CLaDA-BG-Dict** we had to perform examination of each synset in order to discover and repair every error that originated from the local processing. The synsets were checked with respect to the following criteria:

- Appropriateness of definitions
- Alignment to OEW
- Missing senses
- Wrong or missing relations
- Appropriateness of the examples

Appropriateness of Definitions

- We checked the definitions for the different kinds of word classes per synset
- This step was necessary, because we wanted to extend the definition to include more information than the definition within paper dictionaries
- This holds especially for adjectives. In the traditional dictionaries the adjective is usually defined as qualifying a noun. In our case we go further and develop the definition of the adjective also to the specific features of the qualified noun

Alignment to OEW

- In the previous versions having only a local view, we supported as many relations as possible between the Bulgarian and the English synsets some of which allowed in the noun and verb hierarchies to have disconnected elements
- With the switch to the global view it became much more convenient to verify these mappings and to re-consider some of them
- Now we focused on: *equivalent-to*, *hypernymy*, *homonymy* and *near-equivalent-to*

Missing Senses

- The construction of the early versions of BTB-WN were mainly driven by specific NLP tasks like Word Sense Disambiguation, Machine Translation, Mapping to Domain Ontologies
- In this applications we had to cover certain domains or type of texts. This resulted in representation of the senses of the different lemmas only partially
- Thus we decided to check the coverage of the resource with respect to the most common and well-established senses using the dictionaries available in the system (mainly)

Wrong or Missing Relations

- From the beginning we supported mapping to PWN (and now EOW). We are using this mapping to transfer automatically relations from English synsets to Bulgarian ones

- After the transfer the set of relations became eligible for modifications, if needed. This happens mainly when the mapping is not between equivalent synsets

Appropriateness of Examples

- The assigned examples were specially checked with respect to their appropriateness to the corresponding sense
- The most frequent error was when the example did not provide enough context for the meaning, and thus the corresponding word form might be interpreted ambiguously
- In such cases the example was extended or deleted
- Also we pay attention the examples to demonstrate as much as possible sense specific characteristics

Extensions

- Besides the examination of the existing synsets we extended BTB-WN with new synsets through the above mentioned vocabularies extracted from both types of sources - dictionaries and corpora
- Then the following information was added: derivational sets for these lemmas such as adjectives derived from nouns, aspectual variants of Bulgarian verbs that share a common basic sense, etc.
- In this way, more than **16 000 synsets** were added (in total **35 000**)
- At the moment we completed the coverage of the core vocabulary with about **6000** lemmas.

BTB-WordNet based applications

BTB-WN based Applications (not NLP)

- **The Bulgaria-centric knowledge graph**
  - BTB-WN has been further enriched with terms from various Social Sciences and Humanities domains such as history and ethnography. Here two challenges appeared. The first one is related to the introduction of terminological multiword expressions while the second one refers to the register of usage such as being archaic or dialectal, etc.
- **The bigger net of dictionaries and resources, called in our case *All about words***
  - The system includes a concordancer, a Wordnet viewer, a word form analyser, a viewer for the Bulgarian inflectional dictionary, viewers for other dictionaries.

Integrated View

Резултат от търсенето

lemma search

№	Лема	Част от речта
1	сметка	n

examples

Примери

Сметката ни в ресторанта излезе доста голяма.

Словоизменителен речник: сметка

Inflectional lexicon

сметк|а, ~ата, ~и, ~ите

Граматична информация

съществително нарицателно, женски род, единствено число, нечленувано

Значения в Мрежата от думи

BTB-WN definitions

Определяне на величина на нещо чрез редица математически действия.

Сума за заплащане срещу храната, напитките и обслужването в ресторант или друго подобно заведение.

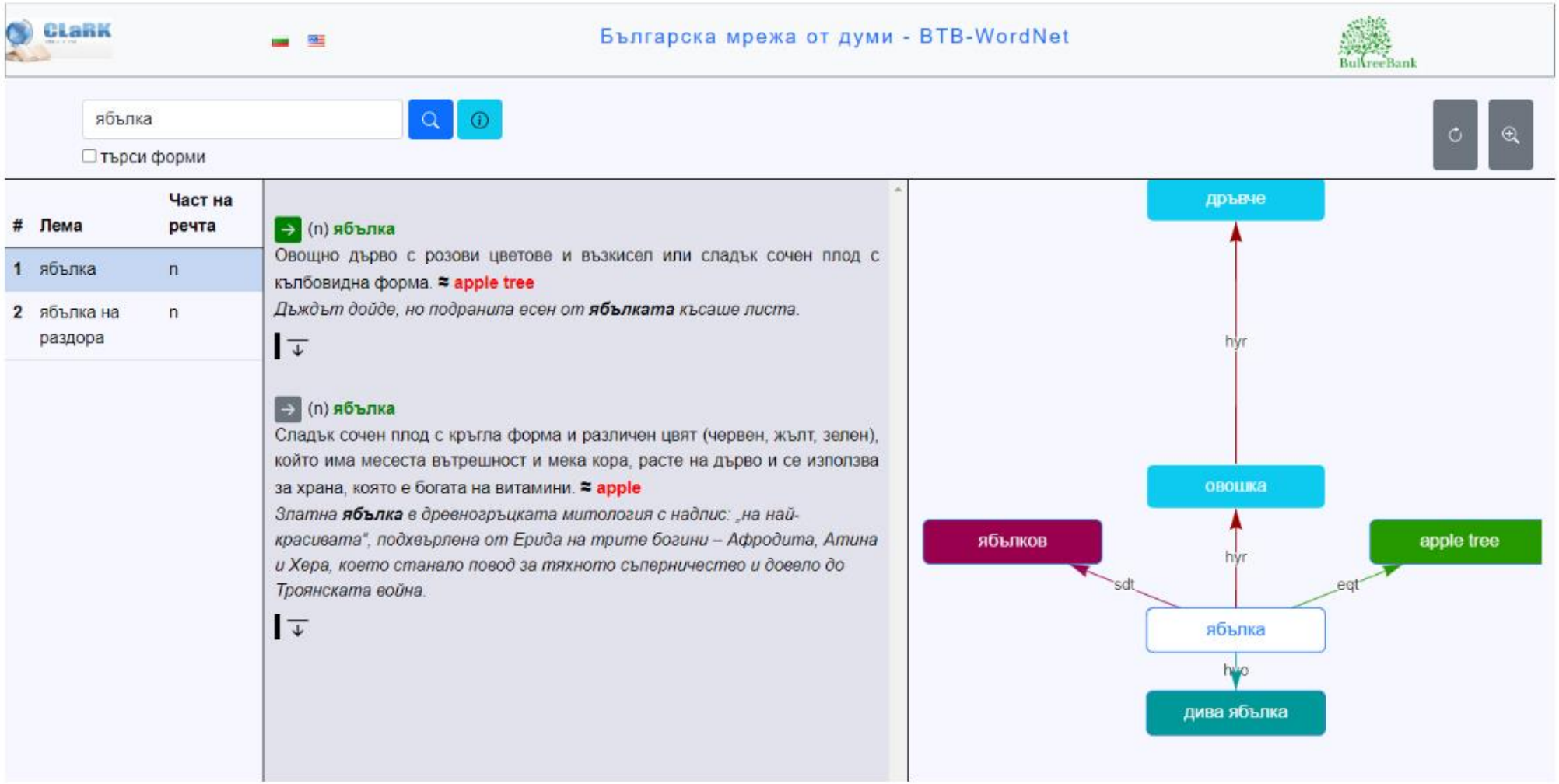
Документ за получени или изплатени суми (срещу продадена стока или извършена работа, услуга).Документ, сметка с подробно описание на продадена/купена стока.

Лична изгода, облага от нещо.

Мисъл за нещо, което човек възнамерява, смята да извърши.

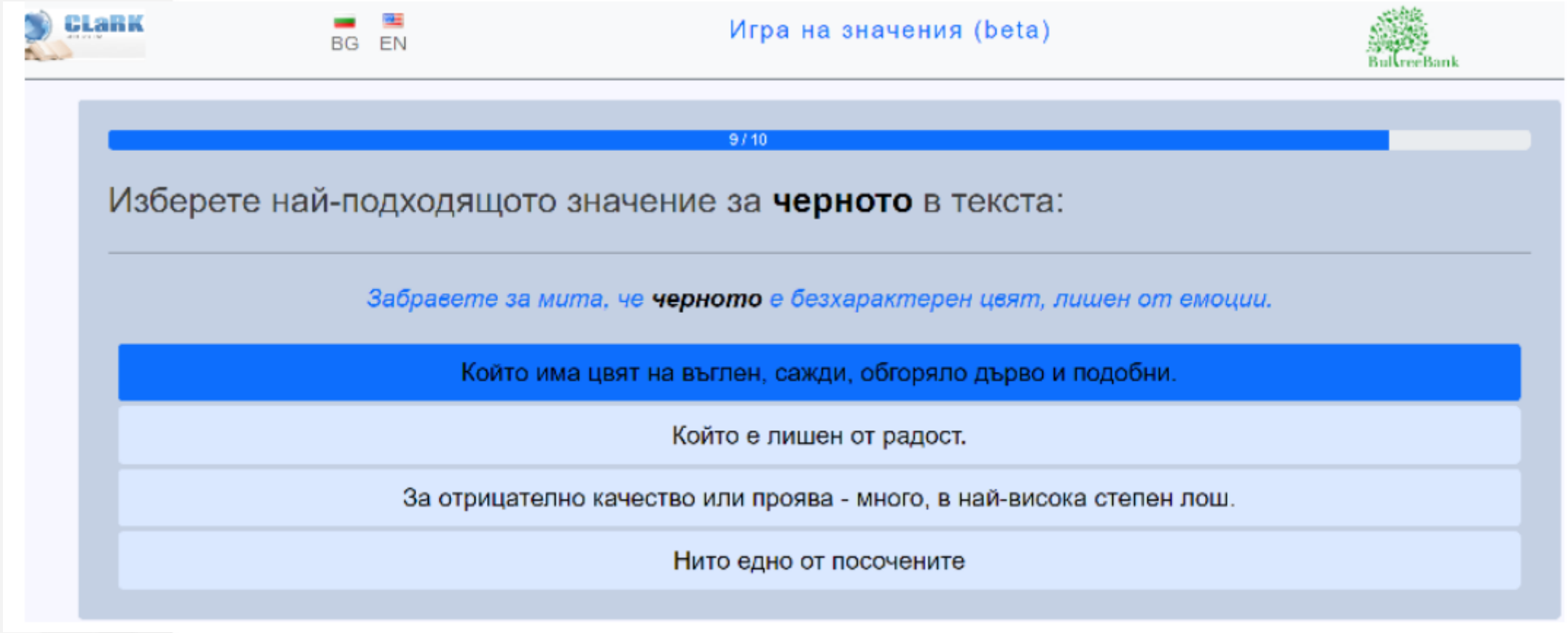
Missing part from the user interface: relations to other dictionaries

BTB-Wordnet Viewer

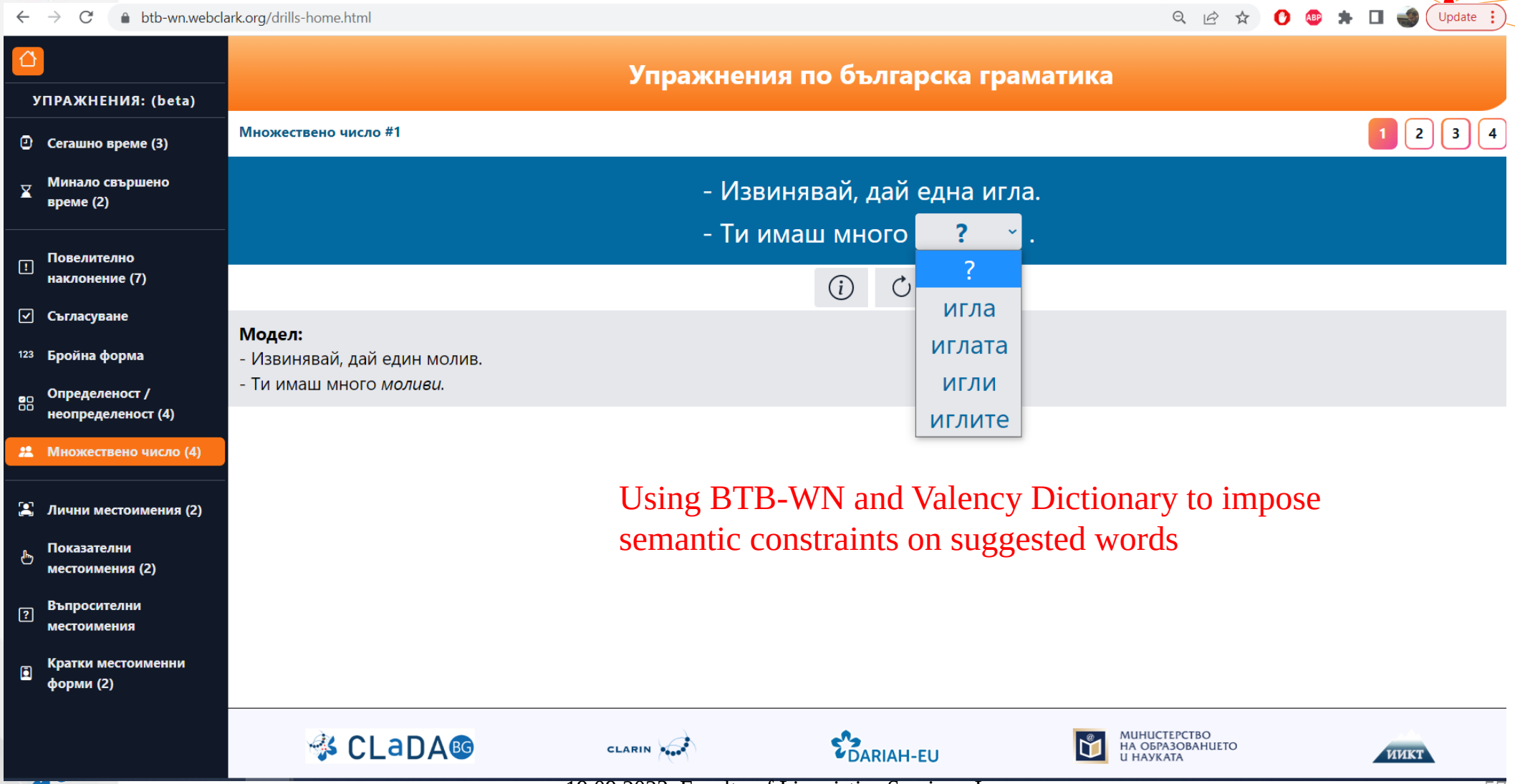


Game of Meanings

Select the correct definition for the highlighted word in the example!



Grammar Drills



Using BTB-WN and Valency Dictionary to impose semantic constraints on suggested words

Background: Motivation

- Lack of sufficient knowledge for solving many important NLP tasks, such as WSD, Relation Extraction, Entity Linking, Semantic Annotation, etc.
- Number of integrating efforts:
  - SemLink
  - PredicateMatrix
  - Uby
  - BabelNet

Background: Motivation

- Two facts are demonstrated:
  - A single knowledge resource is not sufficient for the most of the NLP tasks
  - The automatic integration of the various distinct resources is error prone

    (*This is especially true for low-resourced languages in semantics*.)

Background: Tasks

- Focus on the integration of BTB-WN and Wikipedia
  - (in general) Mapping of concepts in WordNet (synsets) to concepts and instances (named entities) in Wikipedia
  - The result is a new version of BTB-WN extended with:
    - New senses and new synonyms for the existing synsets
    - A controlled number of named entities that are specific to Bulgaria
    - Increasing the number of terminological concepts

Background: Tasks

- The work has been done manually, BUT with an automated preparatory phase
- The integrated resource combines general lexica with encyclopedic knowledge (terminology)
- The expected result would be twofold:
  - Mutual enrichment and improvement of both resources
  - An integrated resource that provides access to knowledge graphs (DBpedia, Wikidata – via Wikipedia URIs)

Related Work: BabelNet

- BabelNet - an automatically created very large, wide-coverage multilingual semantic network
  - Encodes knowledge as a labeled directed graph
  - Created by linking the largest multilingual Web encyclopedia – Wikipedia, to the most popular computational lexicon – WordNet

Related Work: BabelNet

- Relation to our work:
  - Adding more locally important content into the existing mappings
  - Enriching the resource that was constructed automatically with validated data
- The *Babelfy service* is very good at detecting concepts and names, but it still has problems with disambiguation among local (Bulgarian) people or places with the same name, or between a concept and a name

Related Work: BabelNet

- For example, the verb литва (*litva*, *start to fly*) is identified only as the country Литва (*Litva*, *Lithuania*) whose graphical form coincides with the verb
- Similar for the adjective русия (*rusiya*, *blond*) and the name of the country Русия (*Rusiya*, *Russia*)

Related Work

- (Osenova and Simov 2018) mention the initial attempt for annotating of named entities (NE) in BulTreeBank with URIs from DBpedia, to have access to instance information:
  - However: the BulTreeBank appeared to contain only a small number of named entities in Wikipedia
  - Thus the extension was insufficient and it required the use of the Wikipedia URIs and DBpedia classes for the missing NEs

Related Work

- (Rudnicka et al., 2017) present another attempt at linking two large lexico-semantic databases - Princeton WordNet and the plWordnet. The approach considers models and ideas originating from the bilingual lexicography and translation studies
- A recent and rather innovative example of the development of a FrameNet based on a corpus of written Dutch, and annotated with PropBank predicates and roles is the project of (Vossen et al., 2018)

Related Work

- (McCrae, 2018) reports on the mapping of the Princeton WordNet (PWN) instances to the English Wikipedia
- A subset of PWN instance concept synsets is automatically linked and manually evaluated on Wikipedia articles in order to *provide a gold standard for link discovery*

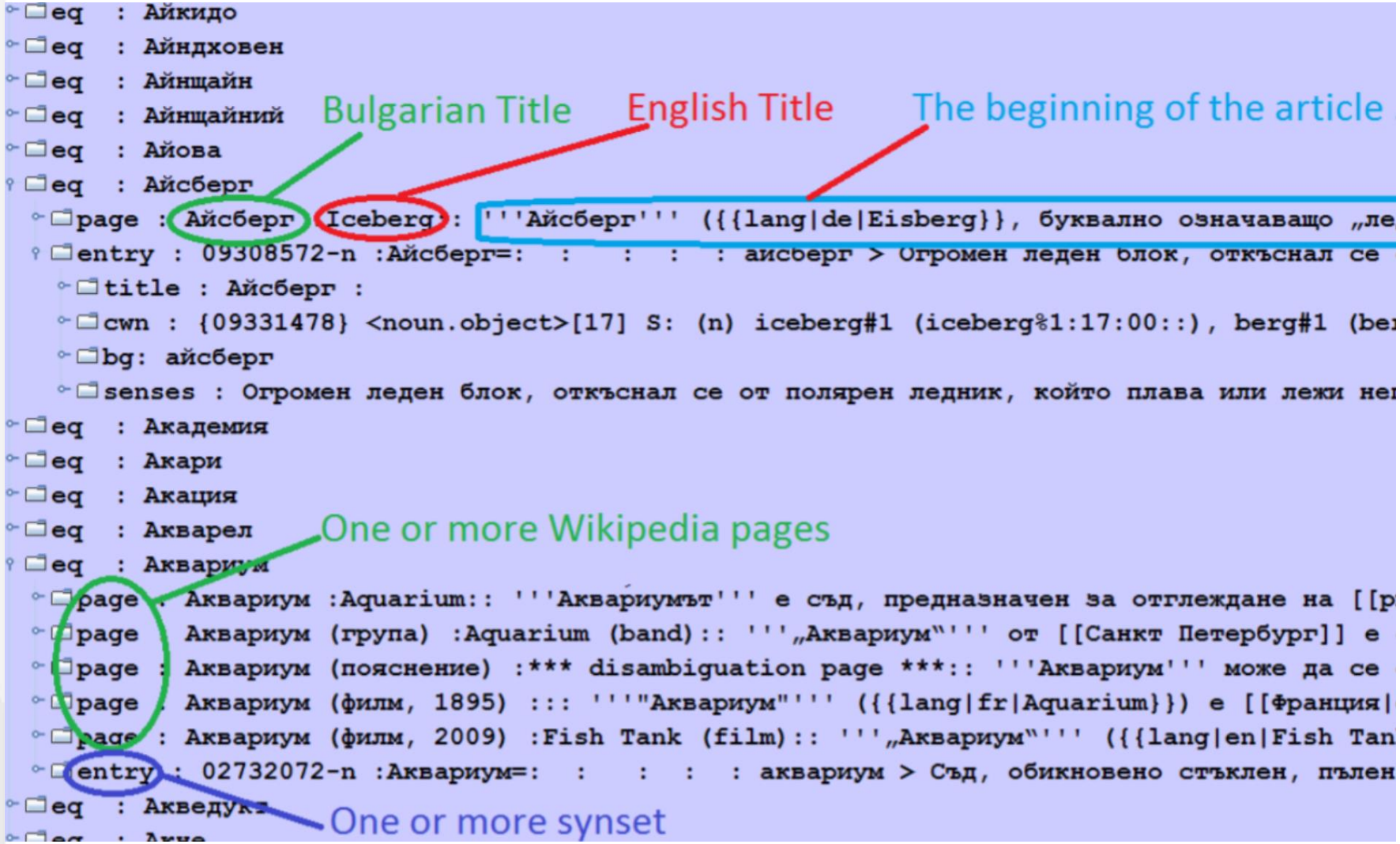
Typology of Mapping Links (McCrae, 2018)

- 5 types of links between PWN and Wikipedia:
  - Exact: one synset to one article
  - Broad: several synsets to one article
  - Narrow: one synset to several articles
  - Related: one-to-one relation, but not the same concept
  - Unmapped: not possible to map
- We adopt this typology but we aim to map concepts in addition to instances

Mapping BTB-WN to BG Wikipedia

- Preparatory automated work:
  - For each lemma within BTB-WN all matching articles in Wikipedia were automatically selected
  - The article titles were cleaned in advance from the modifiers given in brackets
    - The lemma маса as:
      - a) Маса_(мебел) masa (table, a piece of furniture),
      - b) Маса (величина) mass (a body of matter), and
      - c) Маса mob (a disorderly crowd of people)
    - Is mapped to Wikipedia articles with the appropriate titles

User Interface



Mapping

- For about 22 511 synsets in BTB-WN, 27 984 lemmas, 44 873 senses
- A little more than 13 000 Wikipedia articles have been extracted
- Apart from the mapping procedure, after consulting the individual senses in BTB-WN, the annotators checked whether new meanings had to be added to it
- The new meaning could be a sense for the common word or a named entity
- In both cases the annotator created a new synset entry in BTB-WN

Instance Mapping: Named Entities Processing

- Our approach:
  - Due to the high productivity in the case of named entities, many common words are presented as named entities in Wikipedia
  - We aim at Bulgaria-centered mappings
  - The annotator first filtered the candidates in order to introduce only the important names:
    - As a first step, only names of persons, organizations and locations are considered
    - For location names we select names of Bulgarian places or of well-known foreign places
    - For the rest of the names only well-known names are considered

Instance Mapping: Named Entities Processing

- Initially, a restriction to include larger cities in the world was introduced (larger than 100 000 citizens if they are not well-known)
  - Шенген (Schengen) is included in BTB-WN although it has less than 4000 citizens, but
  - Буден (Boden, a city in Sweden) is not included although its transliteration in Bulgarian coincides with an adjective (=awake)

Discussion

- It is evident that the above selection criteria are more or less arbitrary
- In our future work we need to make the definition more precise in order to cover all the names in Wikipedia, but
  - Without overloading the WordNet with the ambiguity coming from very rare named entities.
- At the moment we use a gazetteer as an initial filter

The Utility of the Gazetteer

- All the Wikipedia pages that correspond to the names in the gazetteer were extracted (10 899 pages). From them 1 515 already in BTB-WN
- The rest 9 384 pages were classified as:
  - Bulgarian locations
  - Other locations
  - People
  - Organizations and
  - Other
- They will be checked for inclusion in BTB-WN at a later stage
- In this way we selected also some important names that are not considered at the beginning of this work

Cases of Mapping

1. Exact mapping of senses represented in both resources
2. A concept represented in Wikipedia, but not in WordNet
3. A named entity in Wikipedia, missing in WordNet

In cases 2 and 3 annotators had to create a new synset and to establish a mapping

The annotation was performed by 5 people who considered nearly 1000 WordNet lemmas, automatically mapped to more than 13000 Wikipedia articles

Statistics over Current Mappings

Correspondence	Number Total: 1309	%
None	276	21.08
Equality	688	52.57
Many to One	128	09.78
New Concept	128	09.78
New Named Entity	68	05.19
New Synonyms	21	01.60

Examples: No mapping

- Стожер (stozher) in the Wikipedia is only a name of *a village* and *a newspaper*, while WordNet records only the concept стожер (stozher) as *pillar* (missing in Wikipedia)
- Thus, the WordNet entity cannot be mapped to Wikipedia. This case corresponds to McCrae's *Unmapped links*

Examples: Equality

- Столица (stolitsa, capital) is defined in the same way in both resources
- These cases are the majority of all mappings. It corresponds to McCrae's *Exact links*

Examples: Many-to-One

- Different parts of the same Wikipedia article are dedicated to different concepts
- Often this is the case for the disambiguation pages. Among the concepts, one usually corresponds to the mapped WordNet synset
- Corresponds to McCrae's *Broad links*

Examples: Many-to-One

- Стойка (Stoyka) has several representations as a given name or a surname
- But it also refers to the concepts of:
  - (body) posture and
  - stand
- BTB-WN contains only one concept - that of the posture
- Another problem in this case is that the two pages for these general concepts do not exist, but they are defined only in the disambiguation page. Thus, the annotator has to use a special relation to the disambiguation page

Mid-Observations

- In more than 78 % of the cases we establish a correspondence between BTB-WN and the Wikipedia
- Also we have added about 15 % new concepts and named entities
- The extension would enhance named entity linking, relation extraction and word sense disambiguation
- The main source of enriching BTB-WN appeared to be the NEs and the domain terms as well as MWEs

Limitations

- Wikipedia contains mainly nouns
- For the verbs, adjectives and adverbs other enriching sources should be considered
- Through the derivation relations in WordNet, however, we still could incorporate the presented in Wikipedia deverbal and adjectival nouns
- We envisage to map BTB-WN also to other semantic resources such as Wikidata

Lessons Learnt

- WordNets are not perfect resources since they reflect the grammar of a natural language, a certain conceptualization model of a society and complex lexicalized world knowledge.
- At the same time, WordNets are very necessary resources for a language since they show the hierarchy of interconnected lexical meanings, provide multilingual insights on our cognitive strategies of knowledge organization, and proved to be very useful in a number of NLP tasks.
- WordNets can be viewed as hubs for structuring grammar and semantic knowledge of a language.

Questions Any?