Ontology-lexica with *lemon*

John P. McCrae and Sebastian Walter

Semantic Computing Group, Bielefeld University
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Problem

- Ontologies have become popular.
- Use several formalisms: RDFS, OWL, F-Logic, etc.
- Ontologies do not have much linguistic information.

- What is the plural? Easy for English, not for German

Ontologies

Take a word:

"edema"

And it means something, so we put it in an ontology and give it an identifier (URI):

`http://dbpedia.org/resource/Edema`

`http://de.dbpedia.org/resource/Odem`

In fact it (already) has lots of identifiers linked on the web

`mesh:D004487  icd10:R60.9 umls:C0013604`

Ontologies

- We can describe the entity with *axioms*
- Relationships to entities in other ontologies
- Use reasoning to infer equivalence
- All done with the "Web Ontology Language" (OWL)
- Published by W3C in 2002; version 2 in 2008

Ontology labels

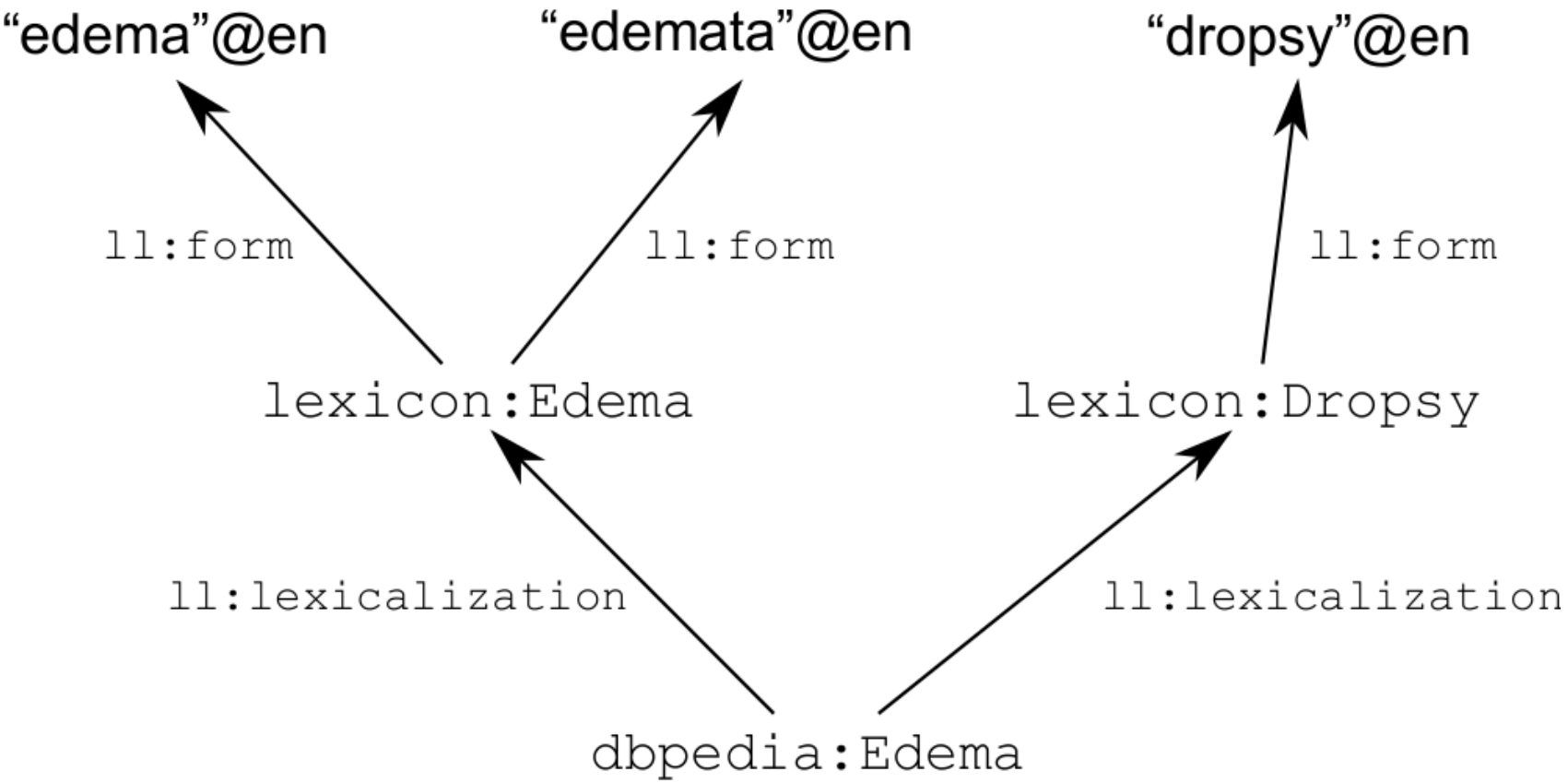
Concepts may be identified by many words

“edema” *“edemata”* *“dropsy”*

- These are all labels for the same ontology concept
- No differentiation
- Cannot say which are plural, which not

Inflection and Synonyms

We could introduce an element for each word:



SKOS-XL

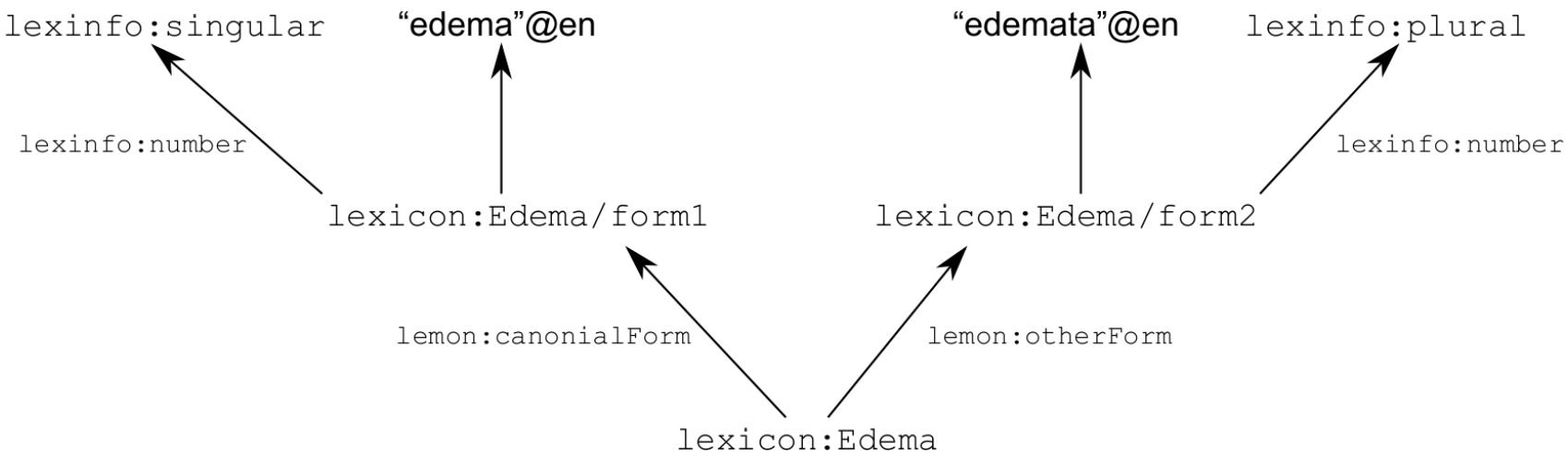
- Similar to SKOS-XL
  - eXtended Labels for the Simple Knowledge Organization System
  - W3C Recommendation since 2009
- SKOS-XL does not allow multiple forms of the same label
  - No grouping of “edema” and “edemata”
- “We [TopQuadrant] have yet to hear a use case that cannot be supported by SKOS alone” (Who need SKOS-XL? Maybe no-one. (Polikoff, 2013))

Forms

But such a distinction is only useful if we can say why:

"edema" (**singular**) *"edemata"* (**plural**)

Hence, forms are also nodes:

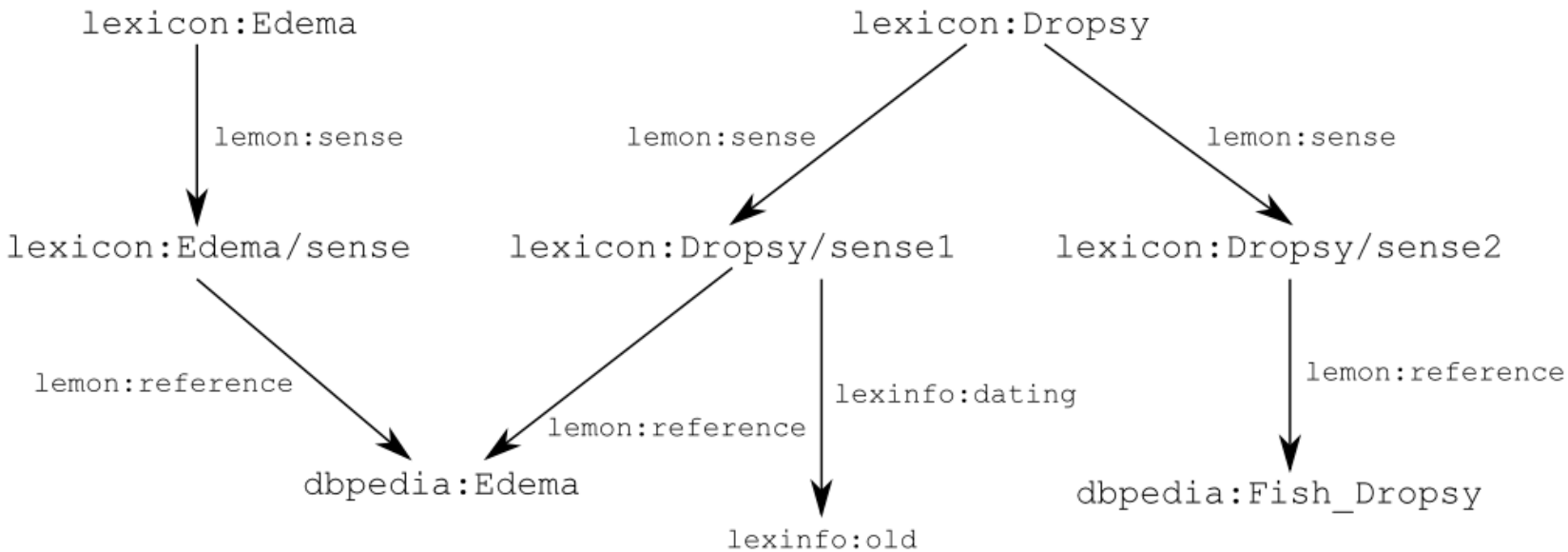


Senses

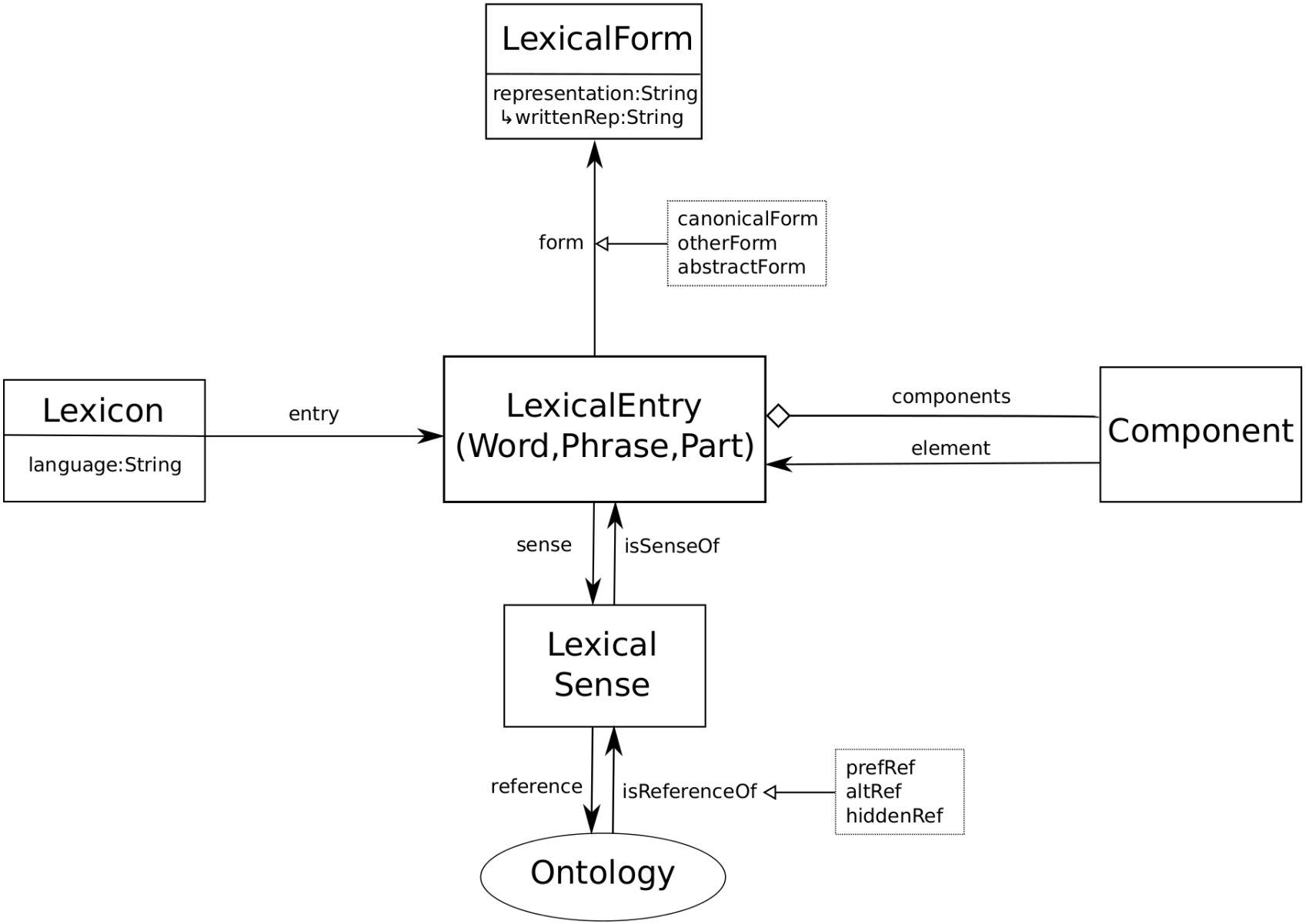
Sometimes we wish to say something about why a particular word is used

"edema" (**modern**) *"dropsy"* (**antiquated**)

Hence we introduce a sense to describe the usage of a word with a given meaning



The core of *lemon*



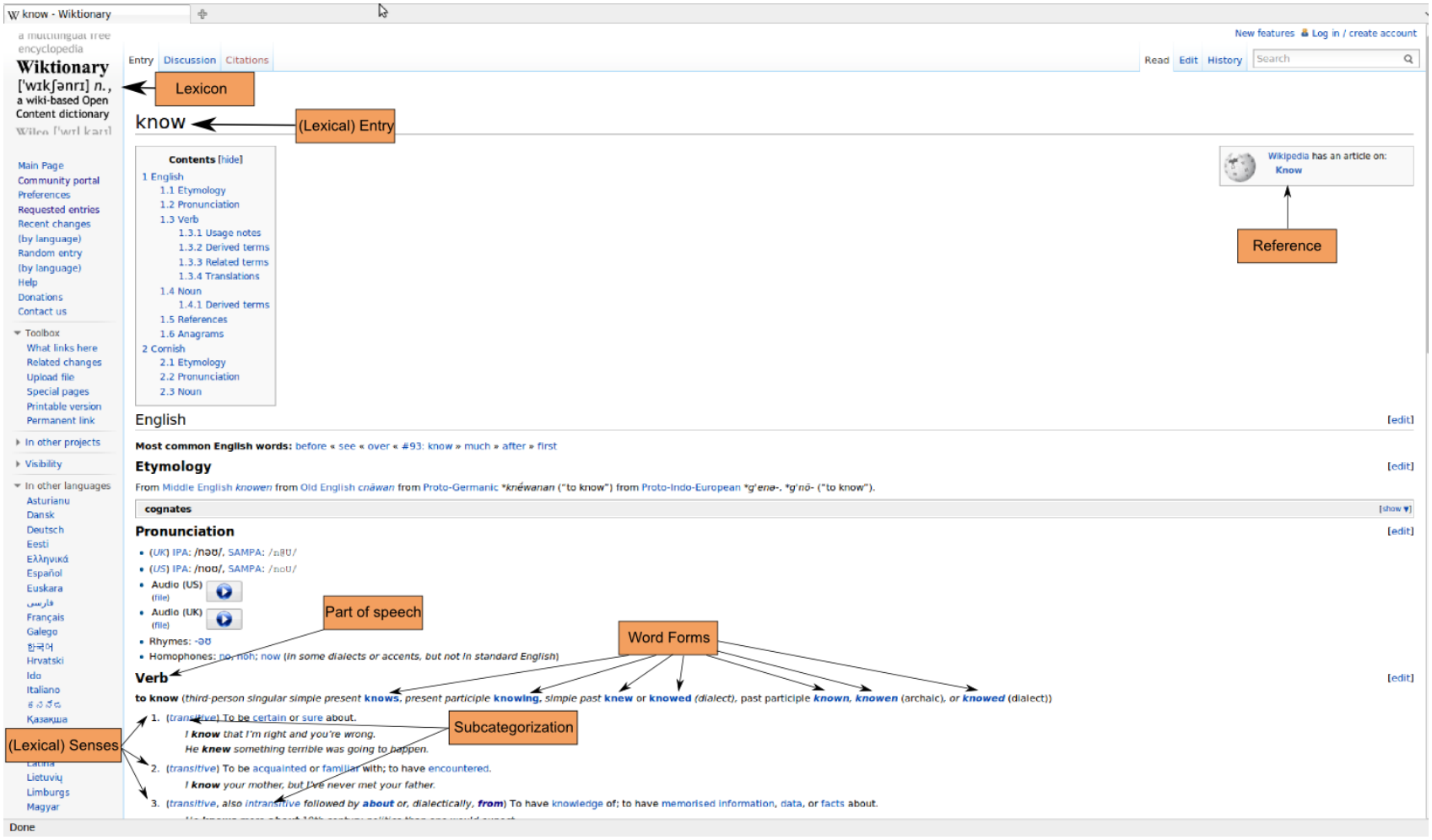
What is an (ontology-)lexicon?

- A lexicon is a collection of lexical information
- We do not need to define semantics within the lexicon
- "An ontology-based semantic lexicon would leave the semantics to the ontology, focusing instead on providing domain-specific terms and object descriptions in the ontology." (Buitelaar, 2010)

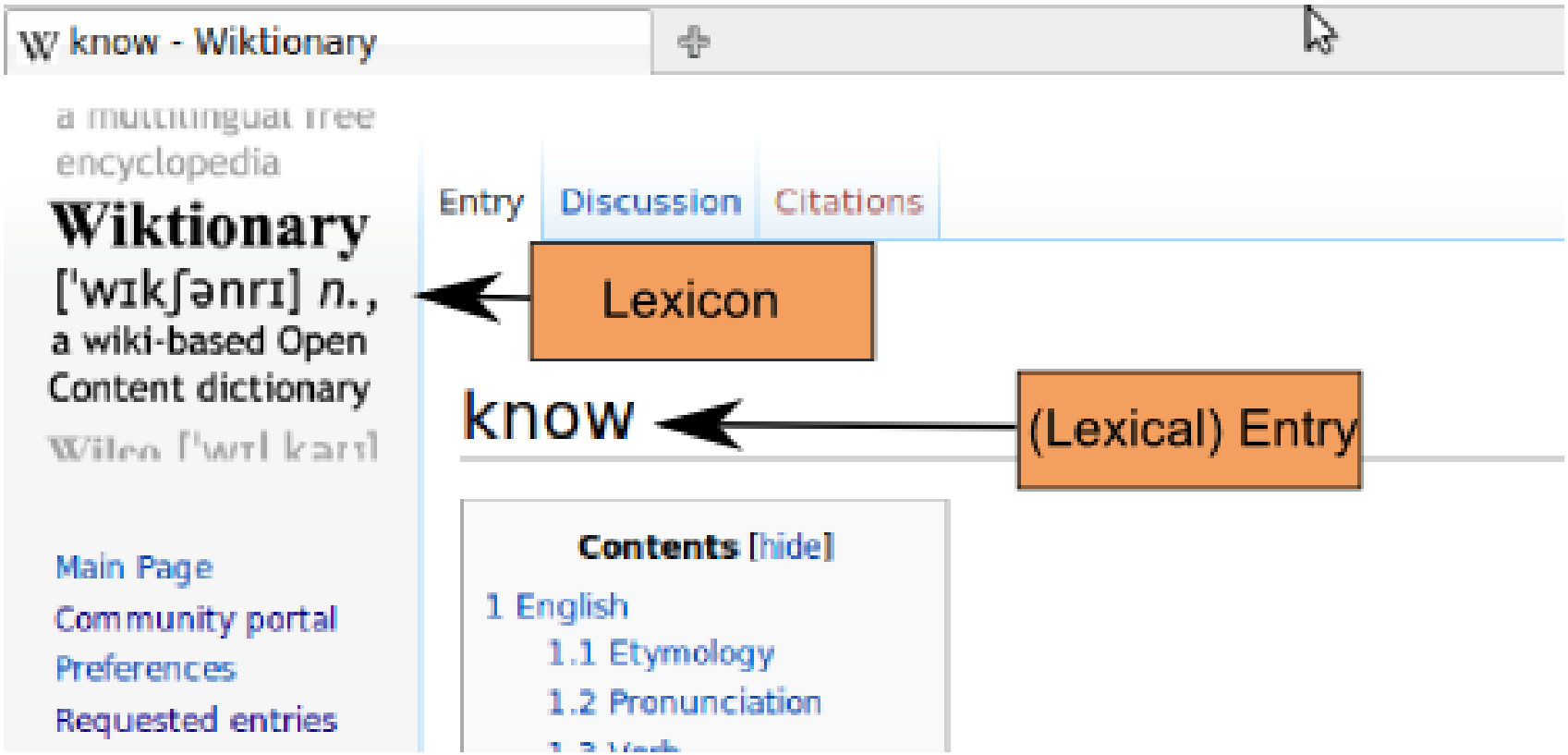
Dictionaries as lexica

- In fact, a lexicon represents much of the information already found in a dictionary
- That is words, their forms and their meaning
- Must be machine-readable
- Take Wiktionary as an example

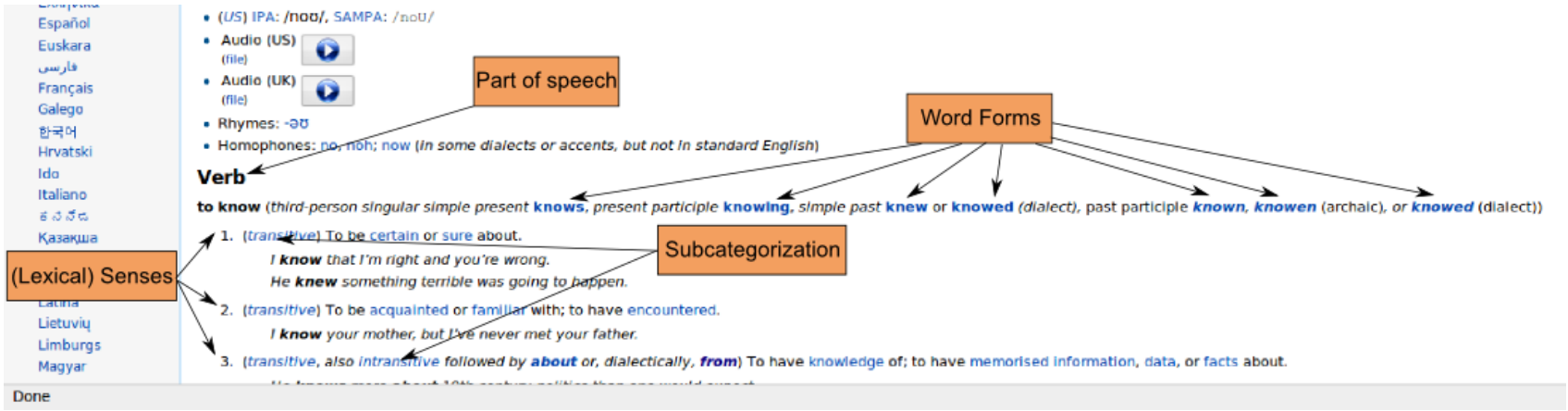
Wiktionary as a lexicon



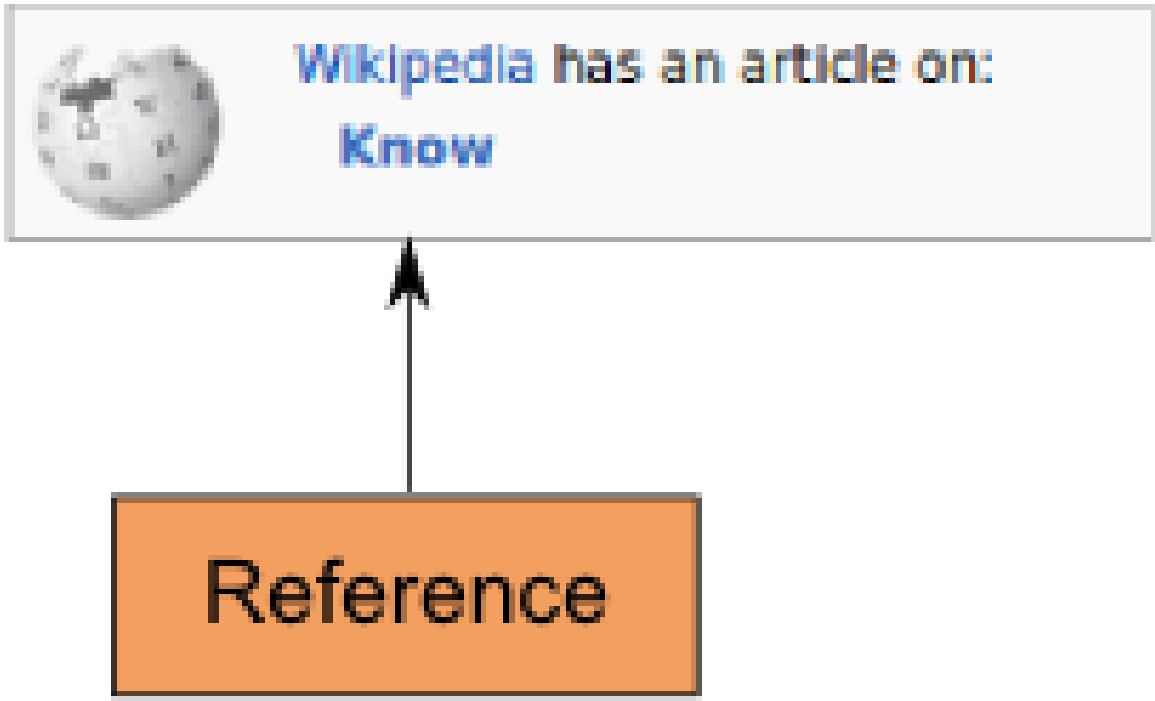
Wiktionary as a lexicon



Wiktionary as a lexicon



Wiktionary as a lexicon



lemon's origins

- Lexical Markup Framework (ISO 24613)
  - Standard for representing lexicons
  - XML
- LexInfo, LIR
  - Represent lexical information relative to an ontology
  - OWL
- SKOS (W3C Standard)
  - Designed for Taxonomy/Vocabulary representation
  - RDF

Design goals

- RDF(S)
- Conciseness
- Not prescriptive
  - i.e., uses data categories
- Semantics by reference
  - i.e., uses ontologies
- Extensible

Why *lemon*: RDF(S)

- RDF models are labelled directed graphs
  - Allows for smarter representation
- Each entry has a URI
  - Queriable on the web using standards
  - Clear responsibility for data
- Linking possible between different lexica
  - Reuse of lexicon data
- Some induction possible (subproperties, classes etc.)

Why *lemon*: Conciseness

- Small models (i.e., fewer links, fewer kB)
- Easier to understand
- "Open-world": Not necessary to state all facts
  - Multiple points of view

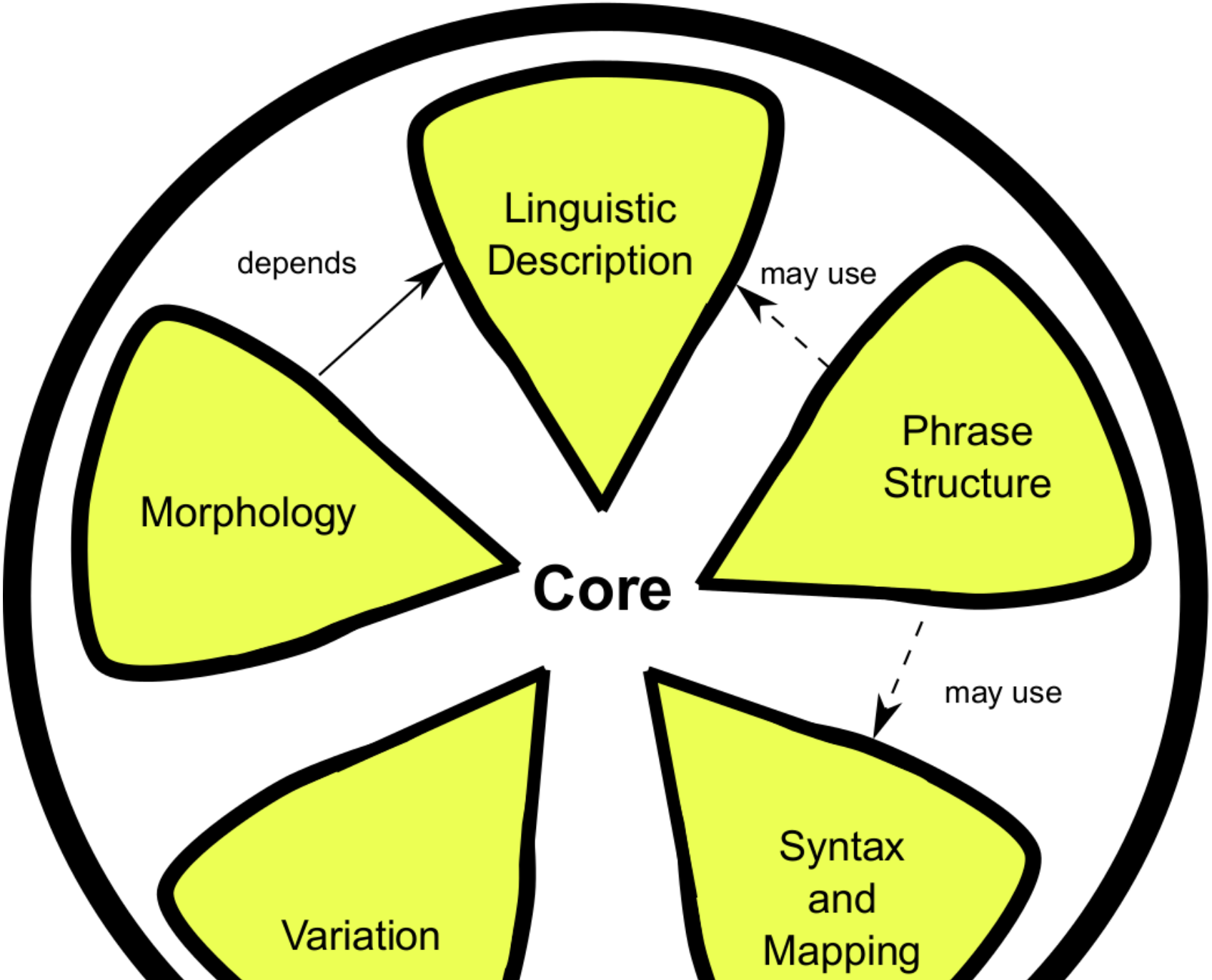
Why *lemon*: Semantics by Reference

- Meaning of a word given by reference
- Reference (generally an ontology) capable of representing more complex semantic information
- Disambiguation is performed relative to the ontology
- No (traditional) word senses
  - No clashing of word senses in cross-lingual mappings

Why *lemon*: Modular and extensible

- RDF(S) extensibility allows representation of
  - Subtle differences
  - Unexpected data categories
- Modularity
  - Different modules for different user requirements
  - New modules can be added later without affecting core

Modules


Linguistic Description
depends
may use
Morphology
Phrase Structure
Core
may use
Variation
Syntax and Mapping

Design Patterns

Why design patterns?

- Simplify usage of *lemon*
- Factorize common patterns
- Cover 95% of entries
- Expressable as simple language

Using the compiler

`http://services.lider-project.eu/lemonpatterns`

Documentation:
`https://github.com/jmccrae/lemon.patterns`

The Design Patterns Language

- Header consisting of prefix declarations
- Any number of lexicons
  - With a URI
  - And a language
- Any number of patterns

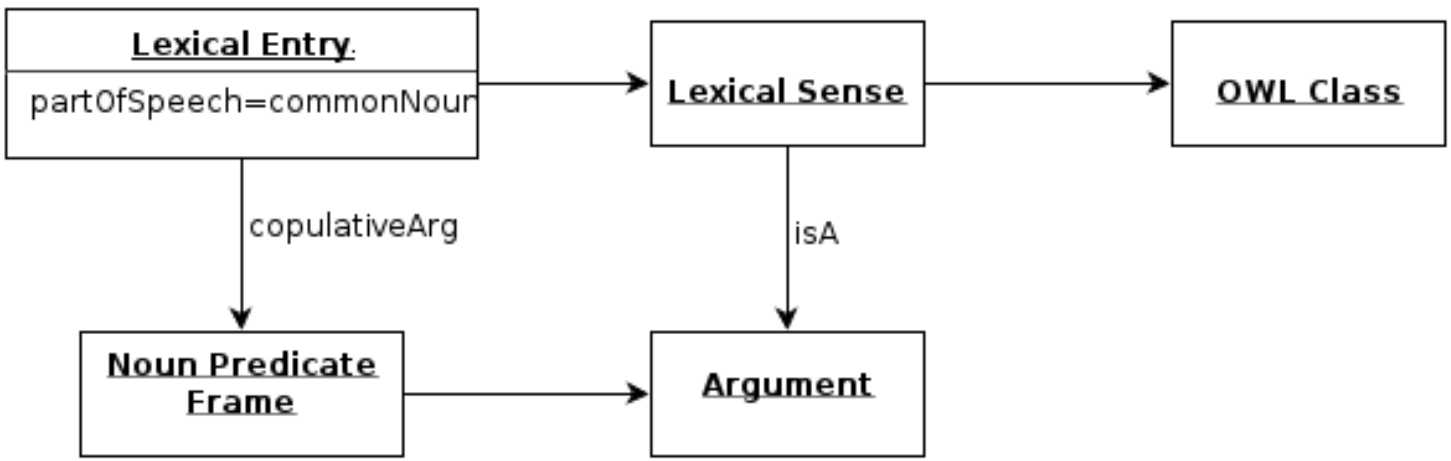
Example

```
@prefix example: <http://www.example.org/example#> .

Lexicon(<http://www.example.org/lexicon>, "en"
  ClassNoun("test", example:Test)
)
```

Noun Patterns

- Name, a proper noun referring to an individual
  - `Name("Microsoft", <http://www.microsoft.com/>)`
- Class Noun, a noun referring to a class in the ontology
  - `ClassNoun("test", dbpedia:Test)`



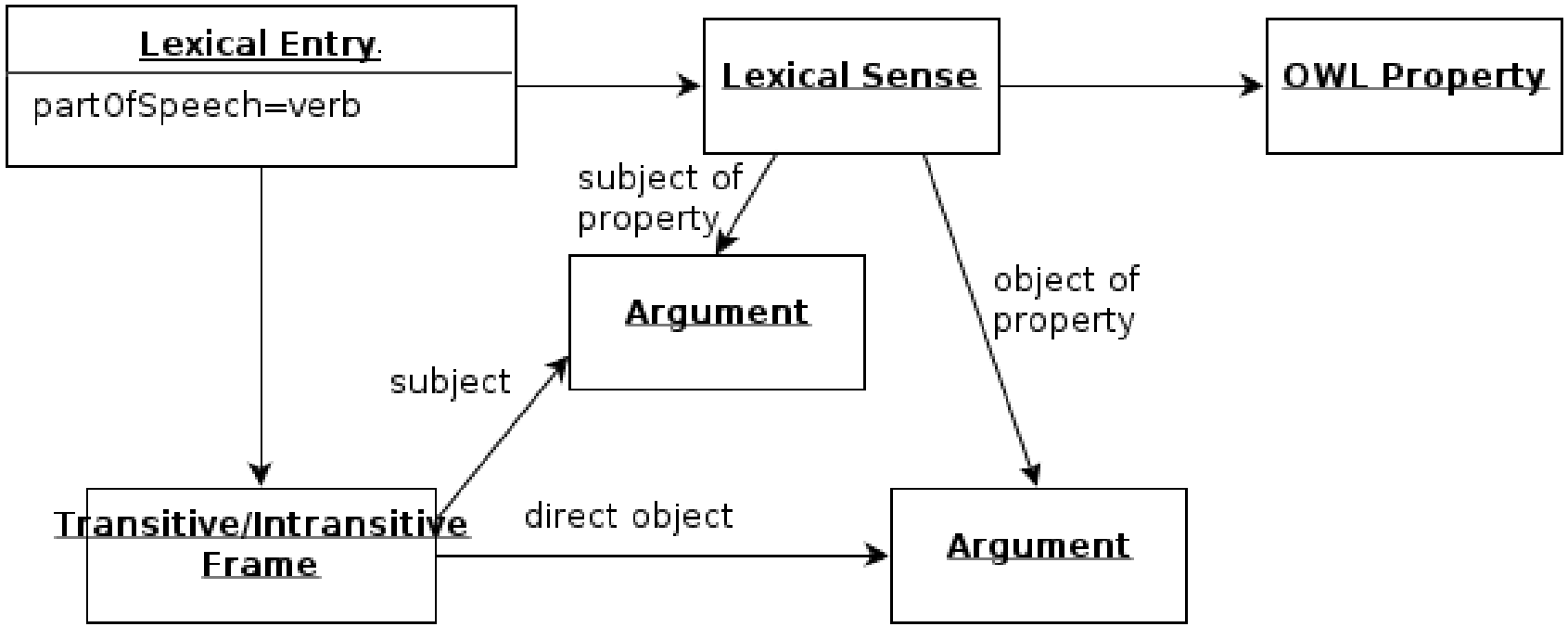
Noun Patterns

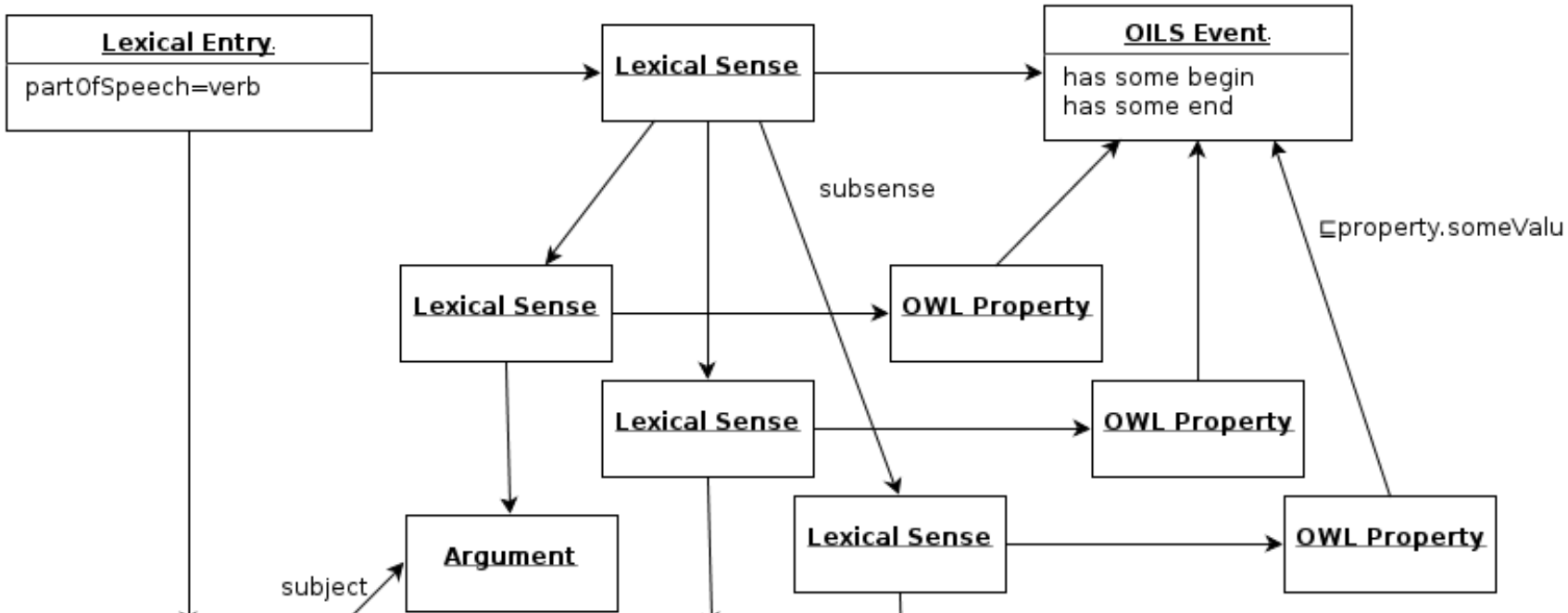
- If there is no class we may refer to a particular property value
  - `ObjectPropertyNoun("oenophile", ontology:loves, ontology:wine)`
- Relational Noun, a noun with a prepositional phrase referring to a property in the ontology
  - `RelationalNoun("father", dbpedia:father, propObj = PossessiveAdjunct)`
  - We use `PossessiveAdjunct` to allow "X is father of Y" and "X is Y's father"

Verb Patterns

- State Verb, a verb indicating a single property in the ontology
  - `StateVerb("know", foaf:knows)`
- Consequence Verb, a verb causing a property in the ontology
  - `ConsequenceVerb("die", dbpedia:deathDate, propObj = PrepositionalObject("on"))`
- Event Verb, a verb describing an event with multiple roles

Verb Pattern Example





Adjective Patterns

- Intersective Adjectives, an adjective referring to a class
  - `IntersectiveAdjective("Belgian", ontology:Belgian)`
  - `IntersectiveObjectPropertyAdjective( "Belgian", dbpedia-owl:nationality, dbpedia:Belgium)`
- Relational Adjective, like relational nouns
- Scalar Adjectives
  - `ScalarAdjective("big", [ontology:size > 5.0 for ontology:Building])`

Modifiers

- Inflectional form, e.g.,
  - `ClassNoun("Katze", onto:Cat) with plural "Katzen"`
- Gender (nouns-only)
  - `ClassNoun("Katze", onto:Cat) feminine` *(with . . .)*
- Register
  - `StateVerb("knows", foaf:knows) neutralRegister`

Arguments

- Indicated with `propSubj` and/or `propObj`
- `Subject` (subject of a verb only!)
- `CopulativeArg` (subject for nouns and adjectives!)
- `DirectObject`
- `IndirectObject`
- `PrepositionalObject("for")` (not normally used for “of”!)
- `PossessiveAdjunct`

Multiword Expressions

- Multiword terms can be specified using the following syntax
  - `ClassNoun(["blood"/noun "vessel"/noun], dbpedia:BloodVessel)`
- This gives a decomposition of a term

Task:

In your language model the following DBpedia properties:

- Person
- Surname
- GivenName
- profession = Historian
- Germany
- nationality = Germany
- stateOfOrigin
- relative
- predecessor
- spouse

Solution

```
@prefix dbo: <http://dbpedia.org/ontology/> .
@prefix dbr: <http://dbpedia.org/resource/> .
@prefix dbp: <http://dbpedia.org/property/> .

Lexicon(<>, "en",
  ClassNoun("person", dbo:Person),
  ClassNoun("surname", dbo:Surname),
  ClassNoun(["given"/noun "name"/noun], dbo:GivenName),
  ObjectPropertyNoun("historian", dbp:profession, dbr:Historian),
  Name("Germany", dbr:Germany),
  IntersectiveObjectPropertyAdjective("German", dbp:nationality, dbr:Germany),
  StateVerb("come", dbp:stateOfOrigin, propObj = PrepositionalObject("from"))
    with imperfect "came" with past participle "come",
  RelationalAdjective("related", dbp:relative, relationalArg = PrepositionalObject("to")),
  StateVerb("preceed",dbp:predecessor, propSubj = DirectObject, propObj = Subject),
  ConsequenceVerb("marry",dbp:spouse),
  RelationalNoun("husband",dbp:spouse,propObj = PossessiveAdjunct)
)
```