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Reasoning:
Ambiguities ~~and temporal interpretation~~

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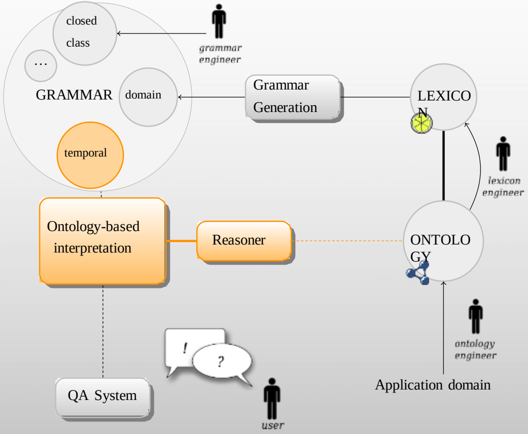
These slides are not the orginal ones produced by prof. Philipp Cimiano.

They have been edited by Manuel Fiorelli (fiorelli@info.uniroma2.it).

Today


closed
class
...
GRAMMAR
domain
temporal
grammar
engineer
Grammar
Generation
LEXICO
N
lexicon
engineer
Ontology-based
interpretation
Reasoner
ONTOLO
GY
ontology
engineer
!
?
QA System
user
Application domain

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Motivation

- Metonomy
  - The FIFA office called this morning.
  - Uruguay scored.
- Anaphora resolution
  - The monkey ate a banana. It was very hungry/tasty.
- Ambiguity
  - John deposited his money at the bank.
  - The police found a bomb in front of every building.

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Outline

Kinds of ambiguities

Representing and resolving ambiguities

Temporal interpretation

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Representing and resolving ambiguities

Temporal interpretation

Ambiguities

Ambiguities comprise all cases in which natural language expressions have more than one meaning. This can be due to:

- alternative lexical meanings
- structural properties (e.g. modifier/PP attachment sites)
- a combination of both
- scope ambiguities

Ambiguities

Ambiguities comprise all cases in which natural language expressions have more than one meaning. This can be due to:

- alternative lexical meanings
  - bank
  - New York
- structural properties (e.g. modifier/PP attachment sites)
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Ambiguities

Ambiguities comprise all cases in which natural language expressions have more than one meaning. This can be due to:

- alternative lexical meanings
- structural properties (e.g. modifier/PP attachment sites)
  - porcelain egg container
  - old elves and wizards
  - James Bond shot the man with the golden gun.
  - Put the box on the table by the window in the kitchen.
- a combination of both
- scope ambiguities

Ambiguities

Ambiguities comprise all cases in which natural language expressions have more than one meaning. This can be due to:

- alternative lexical meanings
- structural properties (e.g. modifier/PP attachment sites)
- a combination of both
  - He saw her duck.
- scope ambiguities

Ambiguities in ontology-based interpretation

Lexical ambiguities in the context of ontology-based interpretation comprise all cases in which a natural language expression does not correspond uniquely to one ontology concept.

- exclusive alternatives
- inclusive alternatives

Examples: Exclusive alternatives

- Give me all goals by de Jong.
  - soccer:NigeldeJong
  - soccer:LuukdeJong
- What is the biggest stadium?
  - soccer:capacity
  - soccer:dimensions

Examples: Inclusive alternatives

In some cases the ontology modelling is more fine-grained than the meaning of a natural language expression, i.e. an expression can correspond to several, overlapping ontology concepts that differ extensionally or intensionally.

- Give me all films starring Jeff Bridges.
  - only including leading roles
  - also including supporting roles
- Which stadiums have a capacity greater than 60 000?
  - soccer:totalCapacity
  - soccer:seatedCapacity

Examples: Vague expressions

Example: big refers to size, with respect to capacity or dimension

- The Metalist Stadium is big.

x
x = soccer:MetalistStadium soccer:capacity(x) > 40 000

Examples: Vague expressions

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x
x = soccer:MetalistStadium soccer:dimensions(x) > 16 500

Examples: Vague expressions

Example: big refers to size, with respect to capacity or dimension

- The Metalist Stadium is big.

x
x = soccer:MetalistStadium soccer:dimensions(x) > 16 500

Note: Both alternatives lead to a consistent interpretation.

Examples: Vague expressions

Example: with → soccer:team, soccer:match

- the team with the best players

  <PlayerRole> soccer:team <Team>

- the match with the most goals

  <Goal> soccer:match <Match>

Examples: Vague expressions

Example: with → soccer:team, soccer:match

- the team with the best players

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- the match with the most goals

  <Goal> soccer:match <Match>

Note: Due to sortal restrictions, only one of the alternatives is admissible.

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Quantities of ambiguities

Ambiguities are pervasive.

- 880 user questions for GeoBase
  - 1278 occurences of light expressions: is/are, has/have, with, in, of
  - 151 ocurrences of context-dependent expressions: big, small, major
- BBC articles about Euro 2012 matches
  - almost 10% of the words are vague expressions (with, of, for, possessives, etc.)
  - they occur in 60-80% of all sentences

Outline

Kinds of ambiguities

Representing and resolving ambiguities

Temporal interpretation

Representing ambiguities

When constructing a semantic representation, all possible meaning alternatives have to be considered.

Possible strategies:

- Enumeration: constructing a different semantic representation for every meaning alternative

Representing ambiguities

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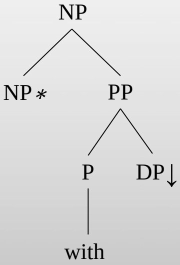
Possible strategies:

- Enumeration: constructing a different semantic representation for every meaning alternative
- Underspecification: constructing only one underspecified representation that subsumes all different interpretations (and resolve ambiguities as soon as possible)

Adding sortal restrictions

Example:

- match with the most goals
- striker with the most fouls

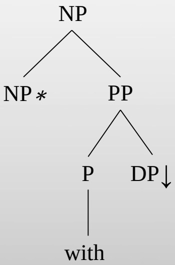


x
soccer:inMatch(y, x)
(y, DP)
x = Match, y = MatchEvent

x
soccer:agent(y, x)
(y, DP)
x = Person, y = Action

Adding metavariables

Semantic representations are enriched with metavariables and metavariable specifications that list all possible instantiations of a metavariable given certain sortal restrictions.



x
$P(y, x)$
(y, DP)
$P \mapsto$ inMatch(x = Match, y = MatchEvent) | agent (x = Person, y = Action)

Specifying meaning representations

The interpretation process now constructs one underspecified representation that still has to be specified.

Example: the match with the most goals

x, y
soccer:Match(x) soccer:Goal(y) P(y, x) max(y)
$P \mapsto$ inMatch(x = Match, y = MatchEvent) | agent (x = Person, y = Action)

Goal: Resolve metavariables to exactly those interpretations that are possible and consistent.

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Goal: Resolve metavariables to exactly those interpretations that are possible and consistent. ;ontological reasoning

Example

Example: the match with the most goals

x, y
soccer:Match(x) soccer:Goal(y) *P*(y, x) max(y)
P ↦ inMatch (x = Match, y = MatchEvent) | agent (x = Person, y = Action)

Check satisfiability of the intersection of x's type information with the sortal restrictions.

- soccer:Match ⊓ soccer:Match true
- soccer:Match ⊓ soccer:Person false

Example

Example: the match with the most goals

x, y

---

soccer:Match(x)
soccer:Goal(y)
P(y, x)
max(y)

P $\mapsto$ inMatch (x = Match, y = MatchEvent)
| agent (x = Person, y = Action)

Check satisfiability of the intersection of y's type information with the sortal restrictions:

- soccer:Goal $\sqcap$ soccer:MatchEvent   true
- soccer:Goal $\sqcap$ soccer:Action   false

Example

Example: the match with the most goals

x, y
soccer:Match(x) soccer:Goal(y) soccer:match(y, x) max(y)

Check satisfiability of the intersection of y's type information with the sortal restrictions:

- soccer:Goal $\sqcap$ soccer:MatchEvent true
- soccer:Goal $\sqcap$ soccer:Action false

Another example

- Franck Ribery scored a goal.
- Franck Ribery scored a penalty kick.

See p. 114 of the book

Semantically light expressions

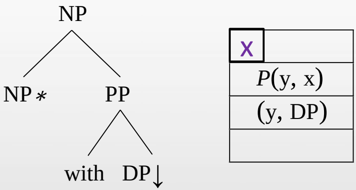
Caveat: Semantically light expressions (with, have,...) are not domain-dependent.

Semantically light expressions

Caveat: Semantically light expressions (with, have,…) are not domain-dependent.

In these cases, we can also assume the most underspecified representation: a metavariable without a metavariable specification.

Metavariables without specification



Strategy for resolving P(x, y):
Search the ontology for relations that admit the type of x (or a superclass) as domain and the type of y (or a superclass) as range.

Example

Example: the match with the most goals

x, y
soccer:Match(x) soccer:Goal(y) *P*(y, x)

Instantiating P: Find relations that admit soccer:Goal (or a superclass) as domain, soccer:Match (or a superclass) as range.

Example

Example: the match with the most goals

x, y
soccer:Match(x) soccer:Goal(y) soccer:match(y, x)

Instantiating *P*: Find relations that admit soccer:Goal (or a superclass) as domain, soccer:Match (or a superclass) as range.

- <Action> soccer:match <Match>

Quantitative results

Quantitative results on 624 Geobase user questions:

	Total # queries	Avg. # queries	Max. # queries
Enumeration	3180	5.1	96
Reasoning	2100	3.4 (-44%)	24 (-75%)