Understanding Natural Language with Functional Discourse Grammar

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Outline

The Project

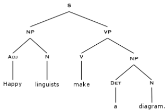
- I am writing my thesis at the Intelligent Systems group
- They are designing a companion robot for the kitchen domain

⟵ They're using Philips's iCat

- It has to understand language
- And I have to make the "understanding" part

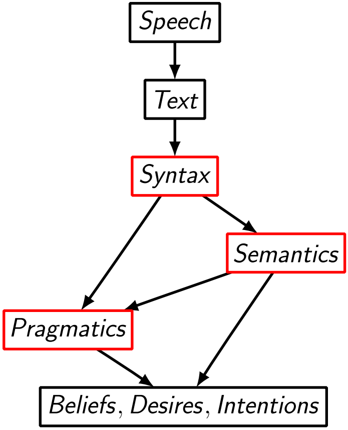
Converting Syntax to Semantics

- "Understanding" means here: "converting syntax to semantics".
- Syntax:



- Semantics: $\forall x \exists y (\ldots)$
- Why design it ourselves?

Relevance of Converting Syntax to Semantics



A Short History of Functional Discourse Grammar

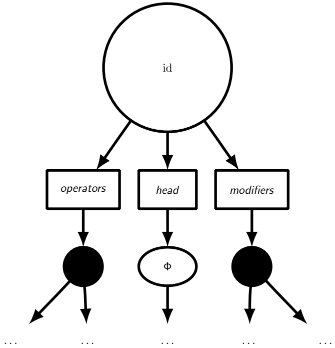
- Original *Functional Grammar* by Simon Dik (1940–1995)
- *Functional Discourse Grammar* introduced by Hengeveld & Mackenzie, 2008
- FDG principles:
  - No transformations or filters
  - Discourse Act as basic unit
  - Single theory of language
  - Maximal Depth
  - Not a Theory of Discourse

The Levels of FDG

- FDG analyzes utterances at four *Levels*
- That has to do with the Single Theory Principle
- The four levels are the Phonological, Morphosyntactic, Representational and Interpersonal Levels
- Syntax to Semantics $\sim$ Morphosyntactic Level to Representational Level

Tree Notation for FDG Levels

- Levels consists of layers may contain other layers: *Tree Structure*
- How I draw them as trees:



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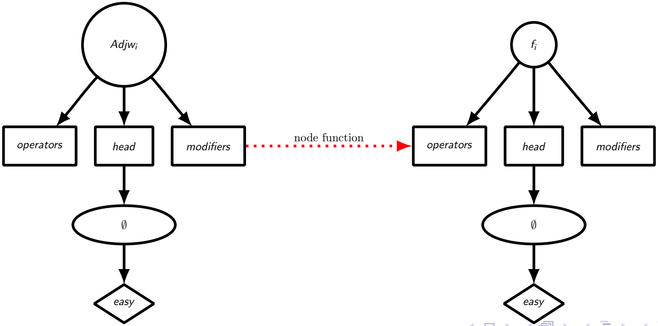
2. Try to glue the pieces together in a consistent way
3. Fill in some references to other parts of the tree
4. Add Prolog's backtracking to taste

Treewalk I

- Run through tree in depth-first order
- For every node (excluding list or restrictor nodes), apply *node function* to subtree rooted in it
- Node function returns list of *tree chunks* - pieces of the Representational Level
- Result of treewalk procedure: ordered list of chunks



Treewalk II

- Lexicon:
  - The node function often consults the *lexicon*
  - The lexicon contains only truly lexical items
  - It stores identifier, spelling, lexeme class, combination schemes and class-dependent properties
- Why such a complex treewalk procedure?
  - Not every utterance is as form-preserving as the previous example...
  - Some features depend on co-occurrence (count/mass)

Composition

- Those tree chunks are glued together during the *composition stage*
- Basic procedure:
  1. Start with an empty tree
  2. Add pieces to it as they fit, until there are no pieces any more
  3. Is the tree complete? If yes, solution. Else, backtrack.
- "Fitting" under point 2 above is defined by a mostly language-specific matching function. Universal bits for position, function, more?
- Matching function compares criteria stored on the chunks. So node function and matching function cooperate.

Coreference resolution

- For resolving anaphora and vaguely similar things: the *coreference resolution stage*
- Some nodes marked as dangling references by node function, resolved now
- Only used for implicit subjects in implementation

Demonstration

Conclusion

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- Using a three-step algorithm with backtracking, we can convert English syntax to semantics
- It works!

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- Using a three-step algorithm with backtracking, we can convert English syntax to semantics
- It works!
- For a small subset of English at least

Discussion

- Will it scale to any linguistic phenomenon?
- Isn't Functional Discourse Grammar too complex?
- How does this compare to the Categorial Grammar + Montague-like approach?
- Isn't there an easier way to convert one tree to the other?