C SC 620
Advanced Topics in Natural Language Processing

Lecture 17

3/25

Reading List

- *Readings in Machine Translation*, Eds. Nirenburg, S. *et al*. MIT Press 2003.
- Reading list:
  - 12. Correlational Analysis and Mechanical Translation. Ceccato, S.
  - **13. Automatic Translation: Some Theoretical Aspects and the Design of a Translation System. Kulagina, O. and I. Mel'cuk**
  - 16. Automatic Translation and the Concept of Sublanguage. Lehrberger, J.
  - 17. The Proper Place of Men and Machines in Language Translation. Kay, M.

Paper 13. Automatic Translation. Kulagina, O. and I. Mel'cuk

- 1. The Place of Automatic Translation (AT) Among Problems of Wider Range
- Observation:
  - Too broad: quite naturally broken down into a number of simpler tasks which are to be solved autonomously (first)
  - Too narrow: quite naturally included into broader problems which dominate AT
- Presuppositions:
  - Knowledge of the language pairs
  - Understanding the context
  - Knowing how to accumulate translation experience to gradually raise the quality

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- 1.1 The Linguistic Problem
  - Knowledge of Language means ability to do
    - Analysis: T (text) -> M (meaning), and
    - Synthesis: M -> T
    - Notation for specifying meaning (*Semantic Language*)
      - Example (invariance of meaning under translation):
        - » We fulfilled your task easily
        - » What you had set us as a task was done by us with ease
        - » It was easy for us to fulfill your rask
        - » Fulfilling your task turned out to be easy for us

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- Broadness
  - The three AT tasks are also tasks of general linguistics, moreover cardinal problems of any serious theory of language
    - If linguistics had more or less complete solutions to offer here, only some minor (tech) problems would have to be solved to make practical AT possible (*Failure of linguistics*)
  - Also important for other applications of language information processing
    - e.g. information retrieval, automatic editing and abstracting (summarization), man-machine communication

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- Conclusion 1
  - Any serious progress in AT depends on progress in linguistics on the three tasks
  - Progress in linguistics possible only if linguistics is transformed on the basis of new approaches and conceptions, in close connection with mathematics

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- 1.2 The Gnostical Problem
  - Knowledge of language does not guarantee good translation. Knowledge of situational context also needed.
- A. Different Meanings Correspond to the Same Situation
  - The largest city of the USSR
  - The capital of the USSR

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- B. The Same Meaning Corresponds to Different Situations
  - To this purpose he used the book
  - To do this he made use of the book
  - Situations:
    - Read a book to get information or divert oneself
    - Put a book on a ream of sheets to prevent the wind from scattering them
    - Throw a book at a dog to drive the animal away

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- Knowledge of Situation needed
- (1) Multiple meanings, each of which refers to a certain situation, all of them different
  - Examples:
    - The box is in the pen (Bar-Hillel)
      - Pen: enclosure
      - Pen: writing instrument
    - Slow neutrons and protons (Bar-Hillel)
      - Wide and narrow scope for *slow*

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- Knowledge of Situation needed
- (1) Single meaning, unique situation (a knock at the door), language-particular
  - Example:
    - Come in! (Russian)
    - Forward! (Italian)

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- Conclusion 2
  - Progress in AT dependent on progress in the study of human thinking and cognition

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- 1.3 The Problem of Automating Researchers' Activity
- AT System:
  - Algorithms
    - T->M, M->T, M->S (situation), S->M
  - Data (for each language) - dynamic
    - Lexical
    - Syntactic
    - Stylistic
    - Distribution and functioning of all items in the whole range of possible contexts
    - Rules of correspondence between these items
    - Encyclopedia

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- Start with imperfect system
- Need to organize algorithms and data and have maintenance devices that accept man-made corrections and learn by itself
- Need systems to automatically collect and classify language data

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- Conclusion 3
  - Practical solution of AT depends on our ability to automate the scientific activities of humans

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- 2 Principal Components of an AT System
- 2.1 Analysis Algorithm
- 2.1.1 Lexico-morphological Analysis
  - "Morphs"
  - Word form -> Information (distribution and syntactic functions, semantic information)
- 2.1.2 Syntactic Analysis
  - Sentence -> syntactic tree(s)
  - Morphological ambiguities may be resolved here

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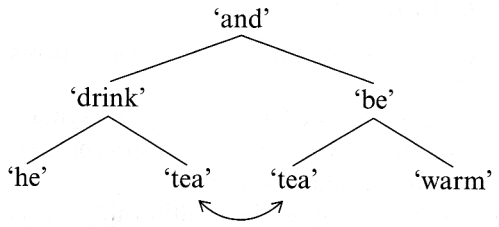
- 2.1.3 Semantic Analysis
  - Syntactic tree -> semantic structure (SEMS)
  - Possibly disambiguate syntactic trees here
  - Representation
    - Example: *He drinks warm tea*



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- Synthesis
  - (Situation level excluded)
  - Replace semantic nodes
    - 1-to-1
    - Several nodes -> 1 node
    - 1 node -> several nodes
      - 'Rush along' -> very/great + fast + move
    - Syntactic node -> single/several semantic nodes
  - Semantic items to syntactic items
    - Success + great degree -> dramatic success
    - Staff -> staff [lab], personnel [hospital], crew [tank or ship], team [football], troupe [theater]

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- 2.2 Semantic Dictionary
- Text -> meaning: simplification
- Basic (English)
  - A few hundred items (plus technical items)
  - Other words must be expressible in Basic by means of non-ambiguous and readily understandable paraphrases
- Merge two Basics into one
  - Semantic Language, AT Interlingua
- Multiple stages: Russian of degree *N*

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- 2.3 Synthesis Algorithm
  - (Exclude Semantic Synthesis)
  - Syntactic Synthesis
    - By Primitive Word Groups (PWG)
      - Head and dependents
      - Verb, noun, adjective and adverb groups
    - Assemble PWGs into Definitive (Terminal) Word Groups (DWG)
      - Look at master and place PWG
      - Finite verb, subject, object, circumstantial complements, adverb and nominal/infinitive complement groups
    - Arrange DWGs to ensure acceptable word order
      - Preference rules at work

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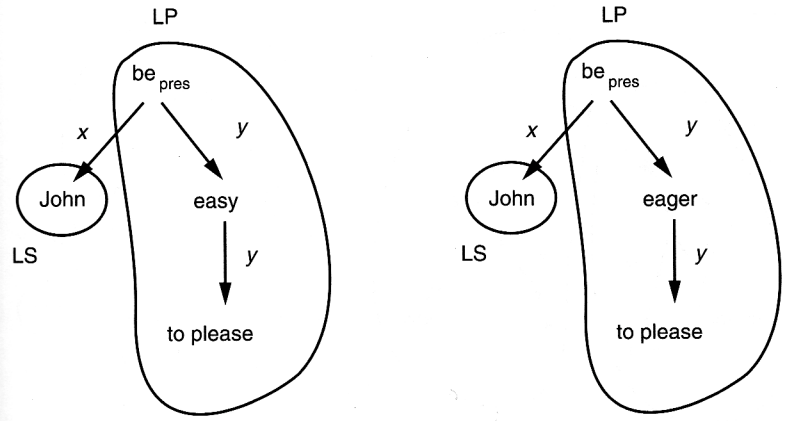

Figure 13.3
1_E) John is easy to please ⇒ (1_E)
2_E) John is eager to please ⇒ (2_E)

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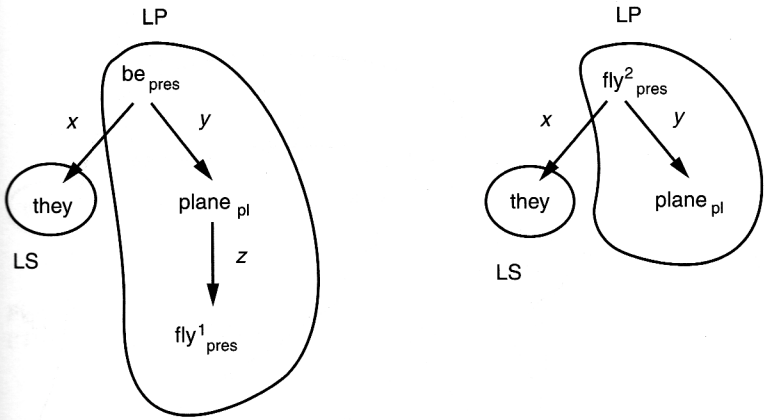

Figure 13.4
3_E) They are flying planes

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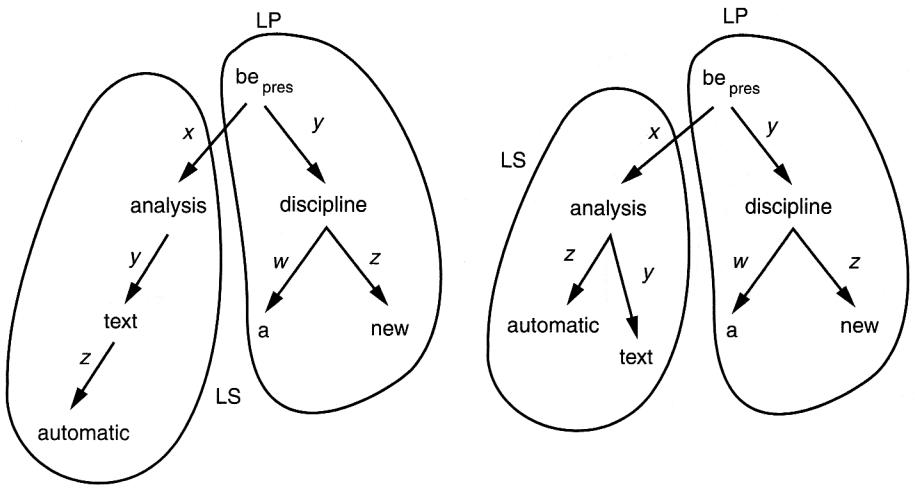

Figure 13.5
Automatic text analysis is a new discipline ($4'_E$) or ($4''_E$)

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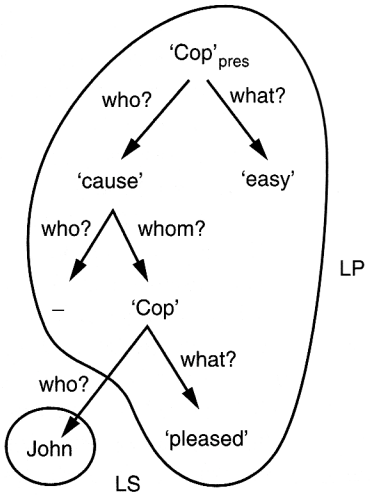

Figure 13.6
3. *Semantic analysis*

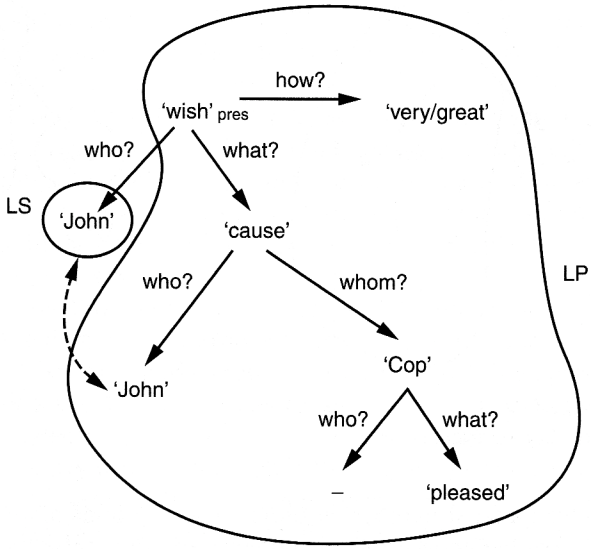

Figure 13.7
('To cause John be pleased is easy')

Figure 13.8
('John wishes very [much] that he (John) causes [someone] to be pleased')

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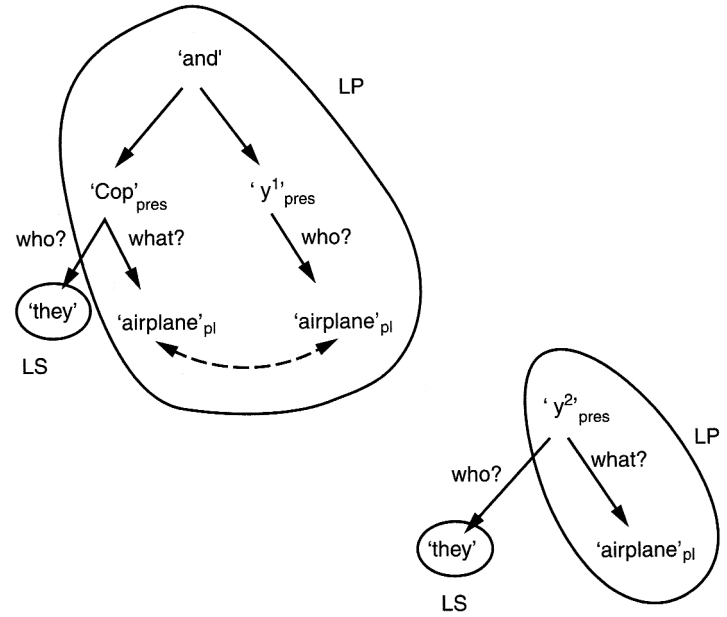

Figure 13.9
('They are airplanes, and [these] airplanes [are] flying')

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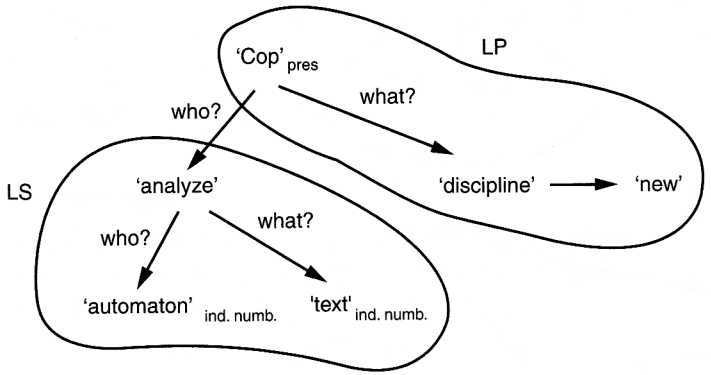

Figure 13.10
(4′): The syntactic tree is dropped by semantic analysis because of the semantic unacceptability of 'automatic text' (only devices, or actions and the like, can be 'automatic').

('Automaton[a] analyze[s] text[s]—is new discipline').