The Aims of Linguistic Theory

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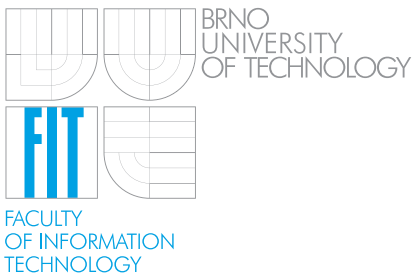

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Outline

- Natural Language Processing
- Structural Analysis
- Transformational Rules

- **Natural Language Processing**
- Structural Analysis
- Transformational Rules

Natural Language Processing

In contrast with programming language we have no

- *clear understanding* of expressions' structure,
- *explicit statement of the rules of syntax* – we have no direct access to them, they are concealed in our cognitive makeup

in natural languages.

Outline

- Introducing of some basic linguistic terminology.
- We show diagnostics and techniques used by linguists for the examiniation of the structure of natural language utterances.
- Some general goals of a theory of language.

Major Linguistic Goals

MAIN GOAL

- Generalizations about the STRUCTURE and MEANING of sentence.

These five perspectives contribute to this goal:

- Syntax – structure
- Semantics – meaning
- Pragmatics – meaning in spoken context
- Morphology – structure of the word
- Phonology – structure of sounds

- Others – structure of discourse, study of brain mechanisms

Syntax of the Sentence

Patterns

Certain structural regularities.

Example

1. *John left the party earlier.*
2. *The man with the coat left the party earlier.*
3. *Every guest left the party earlier.*
4. *He left the party earlier.*

Highlighted words in each sentence appear in the same structural context and all perform the same *grammatical function* – **subject**.

- Each highlighted word can be replaced by any of the others and it is still grammatically correct.
- This part is called DISTRIBUTINAL ANALYSIS.
- Important unit – *noun phrase*.

Examples: Distributional Analysis

Example

Prepositional Phrase

1. *The man with the coat walked in.*
2. *The book on the shelf is mine.*
3. *John put the book on the shelf.*

Example

Adjectival Phrase

1. *The young and happy couple just got married.*
2. *My children are young and happy.*

Example

Verb Phrase

1. *Bill ate the cake and Mary ate the pie.*
2. *Mary likes to go swimming and Bill does too.*
3. *John made Mary pack her bags.*

- Natural Language Processing
- **Structural Analysis**
- Transformational Rules

Structural Differencies

- Some structural differencies or similarities in sentences are not so obvious and they may be more elaborate.

Example

1. *I expected John to leave.*
2. *I persuaded John to leave.*

Considering two sentences above we know:

- There is a relation between *John* and *to leave*. (subject-predicate relation)
- *John* performs the role of the object in 2, but not in 1.
  - In 1, what is being expected is the entire proposition (John's leaving).

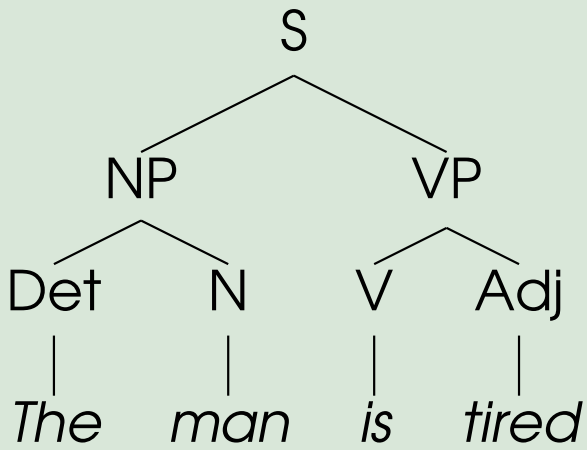
How do we do structural analysis?

- syntactic (also *diagnostic*) tests
- selectional properties of verbs:
  - in case of verb *persuade* the noun phrase must be animate (one can not persuade the book to do something)
- selectional restriction = dependency between verb and its object $\Rightarrow$ persuade *x* expect
- examining the meaning of sentences
- difference between object of the verb
  - *expect* – object is whole sentence
  - *persuade* – has two objects – noun phrase and embedded sentence

Tree Structures

- Tree structures are the key to the analysis of natural language syntax.

Example



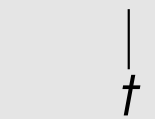
- S – sentence
- NP – noun phrase
- Det – determiner
- Adj – adjective
- N – noun
- VP – verb phrase

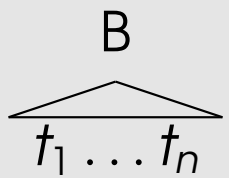
- Linguistic notation (phrase marker):

$$[_S[_{NP}[_{Det}\textit{the}][_N\textit{man}]][_{VP}[_V\textit{is}][_{Adj}\textit{tired}]]]$$

Phrase marker definition

If t is a tree and $\{t\}$ is the phrase marker for that tree, then:

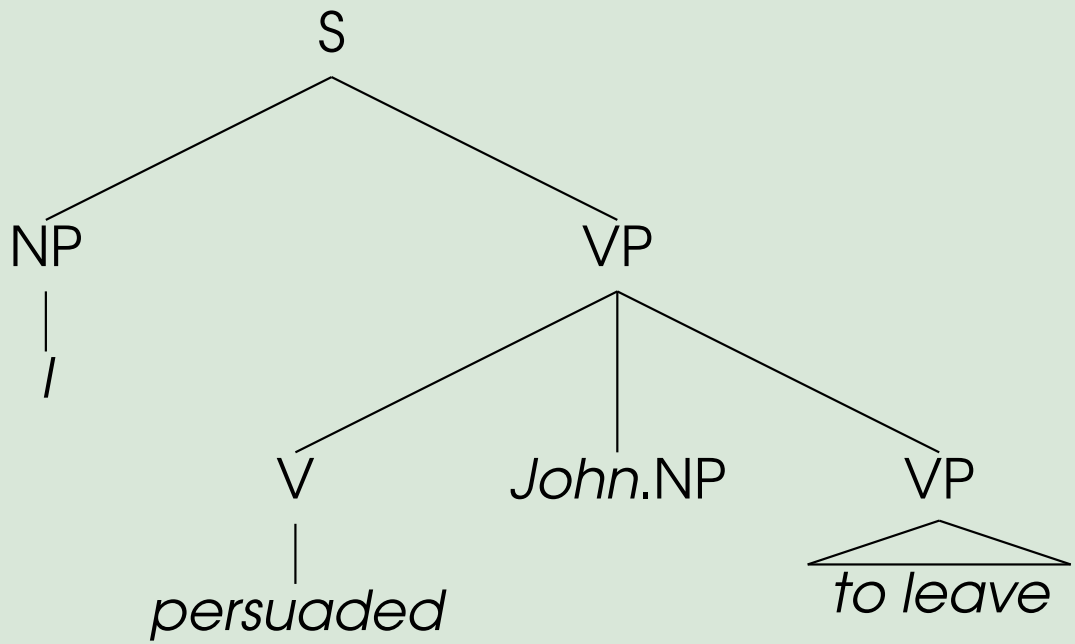
1. phrase marker for word is the word itself
2. the phrase marker for 

is $[_A\{t\}]$
3. the phrase marker for 

is $[_B\{t_1\} \ldots \{t_n\}]$

- *persuade*

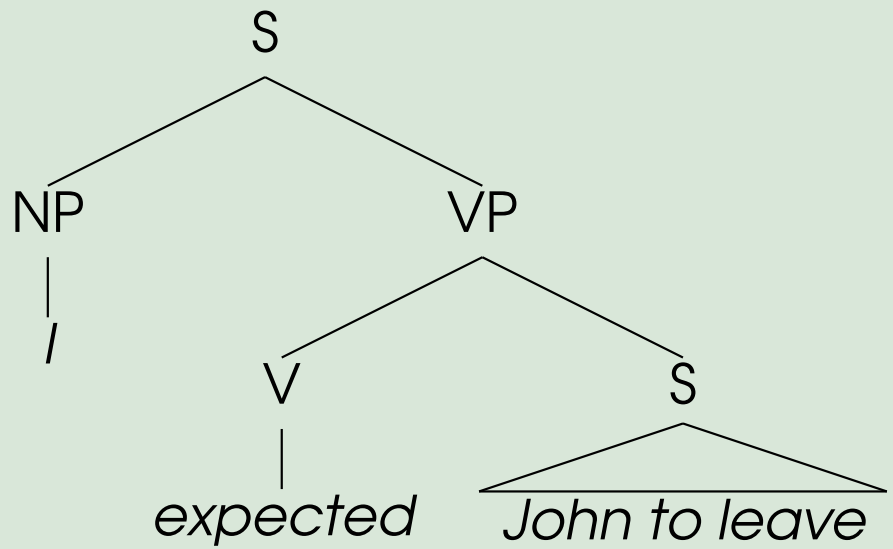
Example



[S[NP *I*][VP[V *persuaded*]][NP *John*[VP *to leave*]]

- *expect*

Example



[S[NP *I*[VP[V *expected*]]][S[NP *John*][VP *to leave*]]]]

- Note: As you can notice *John to leave* is marked as sentence S. (Further information can be found in literature.)

- Natural Language Processing
- Structural Analysis
- **Transformational Rules**

Transformational Rules

Q: How to relate two sentences with the same meaning but different structure?

- active and passive forms in English

A: Relatedness between sentences can be captured by deriving the two phrase markers (Chomsky):

- S-structures (surface structure)
- D-structures (deep structure)

Transformational Rules

According the Chomsky transformational theory, grammar for natural language has the following components:

1. Set of phrase structure rules (all of them in form of context-free rules)
2. A lexicon (dictionary for the language)
3. The transformational rules
4. Rules of phonology

Lexicon contains this type of information:

1. Categorization
2. Subcategorization
3. Selectional Restriction
4. Argument structure
5. Lexical semantics
6. Phonetic representation

Example

Lexical entry for word *hit*
hit: V, <NP>, (AGENT, THEME, INSTR)

- (1) represents grammatical type,
- (2) *hit* is a transitive verb, taking an NP object,
- (4) argument structure is a list of thematic roles

Transformational Rules

- Transformational rules establish generalization in language.

Passive Transformation

- One rule captures the relatedness between the **active** and **passive** forms of sentence.
- Definition: In a context, NP V NP X:
  - transpose two NP,
  - add the relevant form of the verb *be*,
  - change the verb to its past participle.

Passive Transformation					
SD:	NP	V	NP	X	
	1	2	3	4	$\Rightarrow$
SC:	3	*be*+2(pp)	4	*by* + 1	

- SD - structural description
- SC - structural change

Example

$$[_S[_{NP}\textit{this man}[_{AUX}][_{VP}[_V\textit{love}][_{NP}\textit{Mary}]]]$$

SD:	*this man*	*love*	*Mary*	X	
	1	2	3	4	$\Rightarrow$
SC:	3	*be*+2(pp)	4	*by* + 1	
	Mary	*is loved*	ε	*by this man*	

The **result** of the passive transformation is **the sentence in passive form with the same meaning as the sentence in active form**.

Passive Transformation

Example

Some problems could be in sentences containing idioms. For example:

1. *John took advantage of the situation.*
2. *Advantage was taken of the situation by John.*
3. *The situation was taken advantage of by John.*

Contraction in English

Eg. using verb *want* in everyday speech:

- *I wanna buy the beer for the party.*
- ***want*** and ***to*** become one word phonetically
- (also others – *going to* $\rightarrow$ *gonna*, *used to* $\rightarrow$ *useta*)

But there is no possibility to contract *want* and *to* in this case:

- *I want Bill to buy a beer for the party.*

$\Rightarrow$ *Q*: Can we contract *want* and *to* if they are contiguous?

Answer: **No.**

Example

- *Who do you **want to** buy the beer for the party?*
  we can not contract to
- ☹*Who do you **wanna** buy the beer for the party?*

$\rightarrow$ Why we can not do this? It is explained by deep study of the sentence structure.

wh-questions

- One type of generalization that can be captured by transformations involves questions.
- Questions involving who and what are called wh-questions.

Example

TYPE I

1a *John drove his car.*

2a *John thinks Mary drove his car.*

3a *John thinks Mary wants Bill to drive his car.*

TYPE II

1b *What did John drive?*

1c *Who drove his car?*

2b *Who does John think drove his car?*

2c *What does John think Mary drove?*

3b *Who does John think Mary wants to drive his car?*

3c *What does John think Mary wants Bill to drive?*

wh-movement

- Q: How could we generate sentences in these two classes? (TYPE I. and TYPE II. in previous example)
- A: Transformational rule **wh-movement**. This transformation takes the phrase structure with wh-word and moves that word to a designated spot in the sentence.

wh-movement

SD:	X	wh	Y		
	1	2	3		$\Rightarrow$
SC:	2	*do*+1	e	3	

- e - empty category (trace) marking an interesting concept

Example

Applying this rule to sentence 1b:

SD:	*John drive*	*what*	ε		
	1	2	3		$\Rightarrow$
SC:	2	*does*+1	e	3	

Result: What$_i$ does John drive e_i?

- Index *i* means that wh-word and trace refer to the same thing.

By comparing two sentences 1a and 1b we get following semantic representation:

1. DRIVE(John, John's car)
2. ?(For which x) DRIVE (John, x)

Example

- wh-questions explain previous example with contraction of *want* and *to*.
- In fact, *want* and *to* are not contiguous, because there is a **NP-trace** between them.
  - *You want who to buy the beer for the party?*

    and after applying the wh-movement we get:

  - *Who$_i$ do you want e_i to buy the beer for the party?*

Cycling Nature of Transformational Rules

Example

- *John is believed to be wanted by police, by everyone in this room.*

→ Apply reverse passive transformation to get the sentence in active form:

- *Everyone in this room believes John to be wanted by police.*

→ The sentence still contains a passive form → apply passive transformation:

- *Everyone in this room believes the police to want John.*

- Original deep structure:
  - $[_S[_{NP}$ *everyone* . . . $][_{VP}$ *believe* $[_S[_{NP}$ *the police*$]$ *want John*$]]]$

In the original sentence were two passives. How do we know where to apply the rule first?

Cycling Nature of Transformational Rules

How do we know where to apply the rule first?

1. Apply the rule to the lowest (most deeply embedded) sentence.
2. Work our way up to the top cycle.

- wh-movement also applies cyclically.

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