Stratificational Approach to Language Description

Markéta Lopatková

Institute of Formal and Applied Linguistics, MFF UK

lopatkova@ufal.mff.cuni.cz

Stratificational Approach – Basic Principles

- every language comprises a restricted number of structural layers or strata,
- strata hierarchically related in such a way that
  - units or combinations of units on one stratum realize units or combinations of units of the next higher stratum
  - strata are linearly ordered

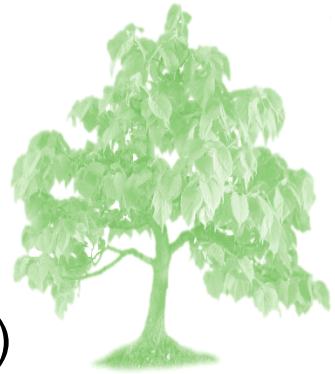
Stratificational Approach – Basic Principles

- every language comprises a restricted number of structural layers or strata,
- strata hierarchically related in such a way that
  - units or combinations of units on one stratum realize units or combinations of units of the next higher stratum
  - strata are linearly ordered
- the number of strata vary from (linguistic) theory to theory
  - semantics, constituted by …
    – sememic stratal system (semantics, deep structure)
  - grammar, constituted by
    – lexemic stratal system and
    – morphemic stratal system (surface structure)
  - phonology, constituted by
    – phonemic system

Stratificational Approach – Basic Principles

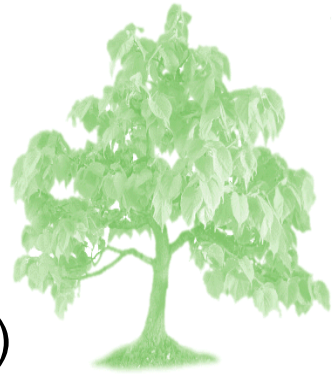
- every language comprises a restricted number of structural layers or strata,
- strata hierarchically related in such a way that
  - units or combinations of units on one stratum realize units or combinations of units of the next higher stratum
  - strata are linearly ordered
- the number of strata vary from (linguistic) theory to theory
  - semantics, constituted by …
    - sememic stratal system (deep structure)
  - grammar, constituted by
    - lexemic stratal system and
    - morphemic stratal system (surface structure)
  - phonology, constituted by
    - phonemic system
- grammar relates to semantics and phonology in a same way as the lexemic and the morphemic stratal systems within the grammar
- language as a network of relationships (rather than system of rules)

S. Lamb and Stratificational Approach



- Sydney M. Lamb … *Outline of Stratificational Grammar* (1966)
  - Berkeley, follower of glossematic school
  - four necessary levels of sentence analysis:
    - the sememic stratum … structure of clauses and sentences
    - the lexemic stratum … structure of phrases
    - the morphemic stratum … structure of word forms
    - the phonemic stratum … syllabe structure
  - each stratum has its elementary units
  - each stratum has its own combinatorial pattern
  - strata are hierarchically related
    - each "realized" by the elements in the level structurally beneath it
    - without making use of rules that convert one entity into another

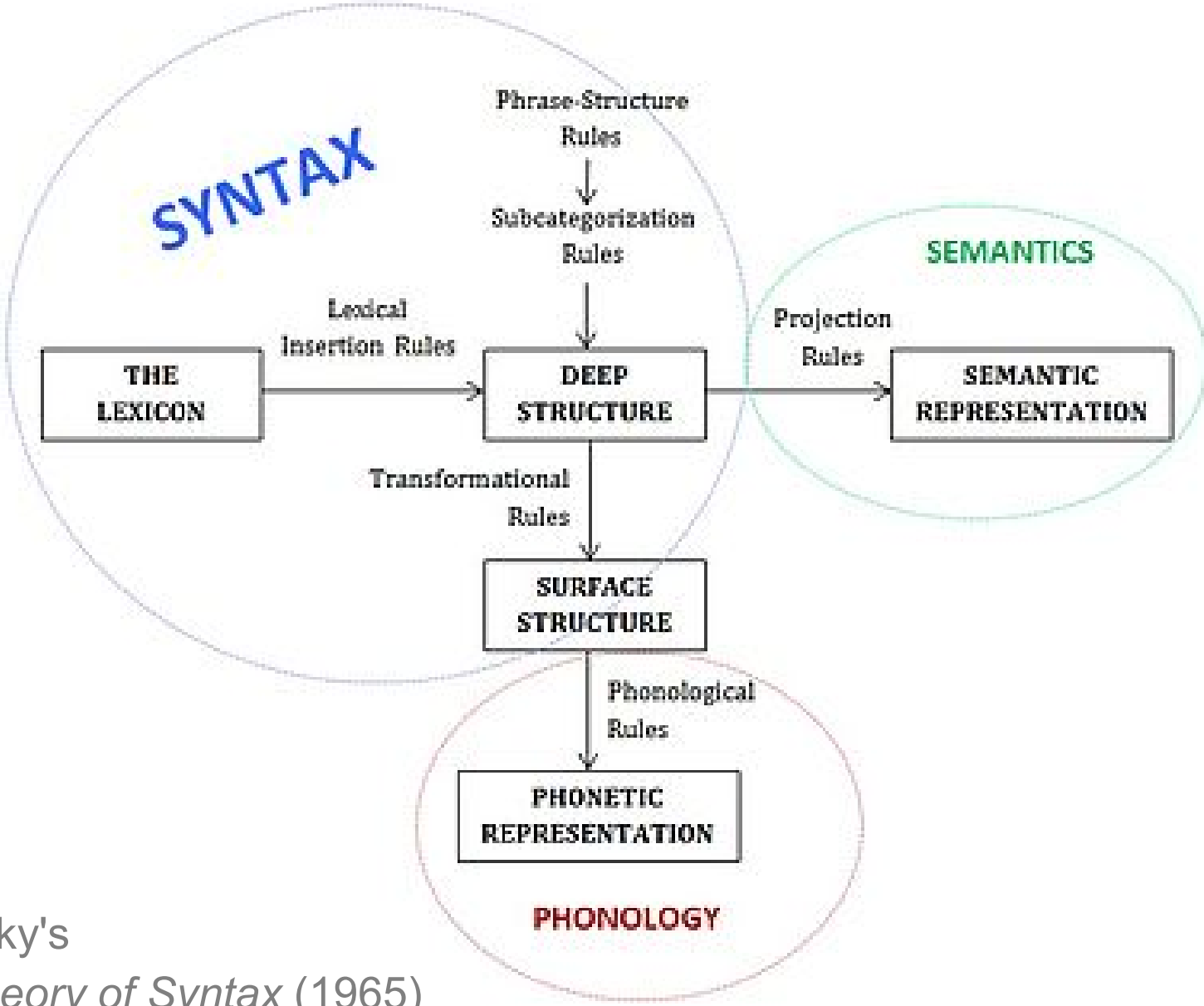
S. Lamb and Stratificational Approach



- Sydney M. Lamb … *Outline of Stratificational Grammar* (1966)
  - Berkeley, follower of glossematic school
  - four necessary levels of sentence analysis:
    - the sememic stratum … structure of clauses and sentences
    - the lexemic stratum … structure of phrases
    - the morphemic stratum … structure of word forms
    - the phonemic stratum … syllabe structure
  - each stratum has its elementary units
  - each stratum has its own combinatorial pattern
  - strata are hierarchically related
    - each "realized" by the elements in the level structurally beneath it
    - without making use of rules that convert one entity into another

⇨
- Functional Generative Description (FGD)
- Meaning ⇔ Text Theory (MTT)

Stratificational grammar as an alternative to *transformational grammar* (Chomsky)



vs. Noam Chomsky's

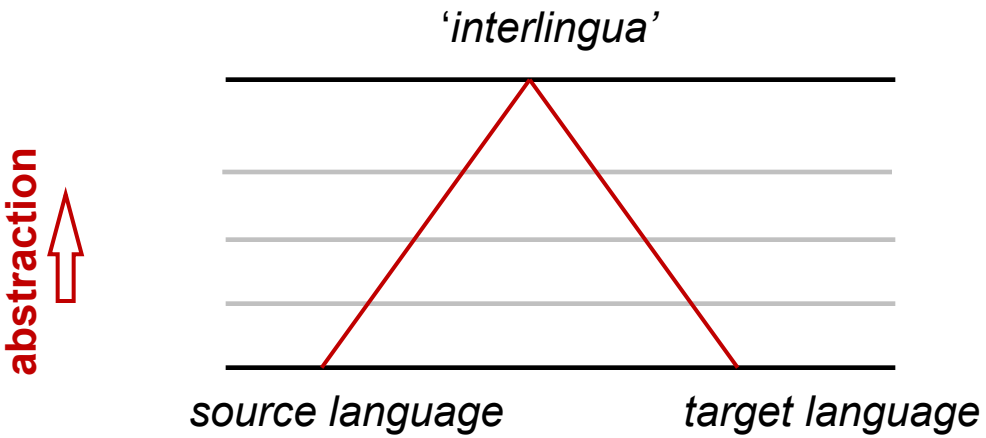
Aspects of the Theory of Syntax (1965)

- system of three components (syntax, semantics, phonology)
- three types of rules (phrase-structure, transformational, morphophonemic)

Functional Generative Description

Functional Generative Description

- motivation: machine translation



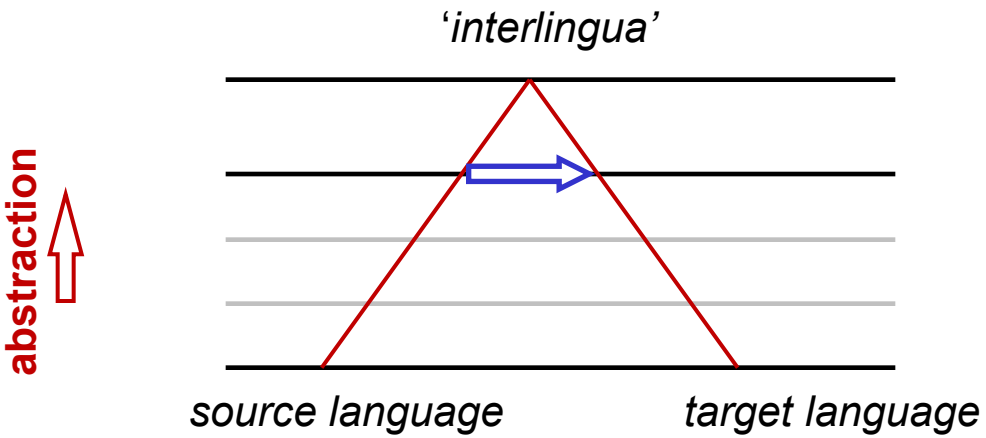
language independent representation

sentence ~ string of graphemes/phonemes

Sgall, P. (1967) *Generativní popis jazyka a česká deklinace.* Academia, Praha

Functional Generative Description

- motivation: machine translation



language independent representation

language meaning … transfer

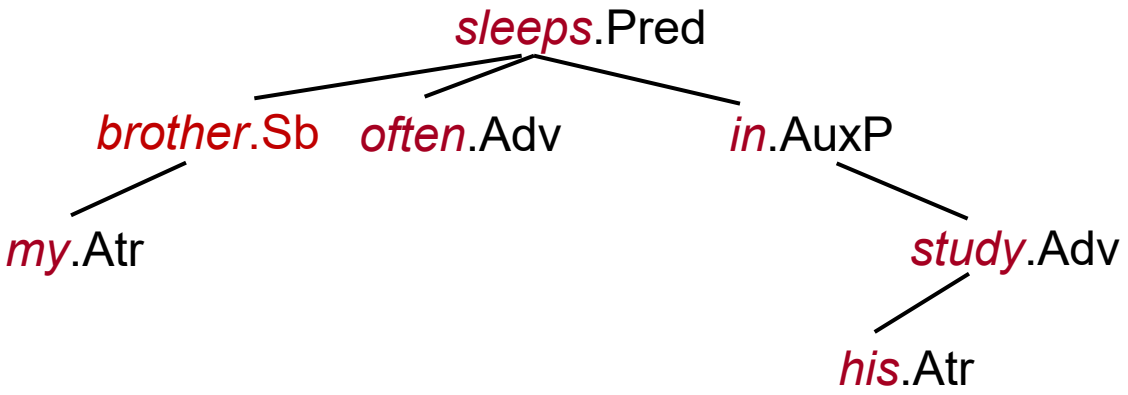
sentence ~ string of graphemes/phonemes

Sgall, P. (1967) *Generativní popis jazyka a česká deklinace.* Academia, Praha

Basic characteristics of FGD

'classical' version of FGD:

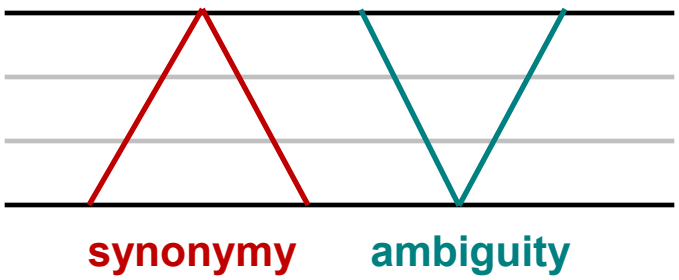
- dependency framework
  - formal description
  - suitable mathematical formalism



Basic characteristics of FGD

'classical' version of FGD:

- dependency framework
- stratificational approach



language meaning **~ function**

string of graphemes/phonemes **~ form**

Basic characteristics of FGD

'classical' version of FGD:

- dependency framework
- stratificational approach
- relation between a form and its function / a function and its form ⇨ *functional*

Basic characteristics of FGD

'classical' version of FGD:

- dependency framework
- stratificational approach
- relation between a form and its function
  / a function and its form

⇨ *functional*

structural linguistics:

- language meaning (not cognitive content)
- language as a system ~ langue
  vs. individual utterances ~ parol
- stress on testable criteria for distinguishing lang. phenomena

Two components of FGD

- generative component

  ~ to define all formally correct meaning representations
  (of possible sentences of a given language)

- formalism: 1) phrase rules, phrase structure trees + functors
  2) dependency trees

  ⇨ *generative*

- push-down automaton

Two components of FGD

- generative component

  ~ to define all formally correct meaning representations
  (of possible sentences of a given language)

- formalism: 1) phrase rules, phrase structure trees + functors
  2) dependency trees
- push-down automaton

⇨ *generative*

- translation component

  ~ translating meaning representations to lower layers

- sequence of push-down transducers plus finite-state automaton

System of layers in FGD

meaning

deep / underlying syntax
tectogrammar

surface syntax

morphematics

morphonology

expression

phonology/phonetics

System of layers in FGD (cont.)

sentence … full representation on each layer of description

each layer ~ set of descriptions for all possible sentences

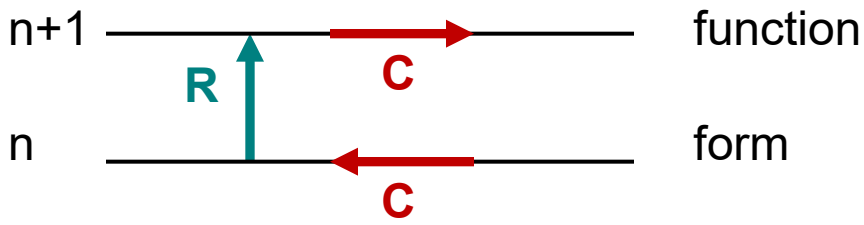
- finite set of elementary units
- finite set of operations and relations → set of complex units
- finite set of relations between sentence representations on a particular layer and its representations on adjacent layers

System of layers in FGD (cont.)

sentence … full representation on each layer of description

each layer ~ set of descriptions for all possible sentences

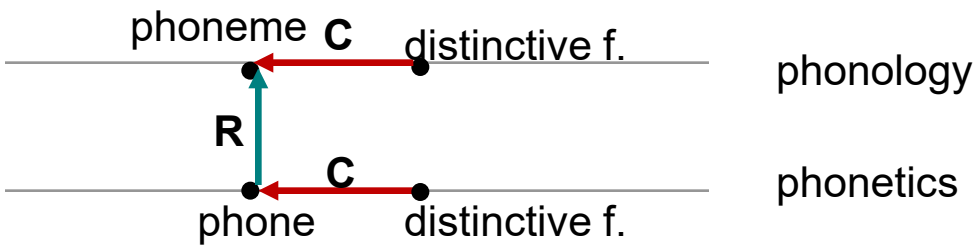
- finite set of elementary units
- finite set of operations and relations → set of complex units
- finite set of relations between sentence representations on a particular layer and its representations on adjacent layers



type C relations (composition): elementary units constitute complex units
i.e., relations between units of the same layer

type R relations (representation): form-function relation
i.e., relation between adjacent layers

System of layers in FGD (cont.)

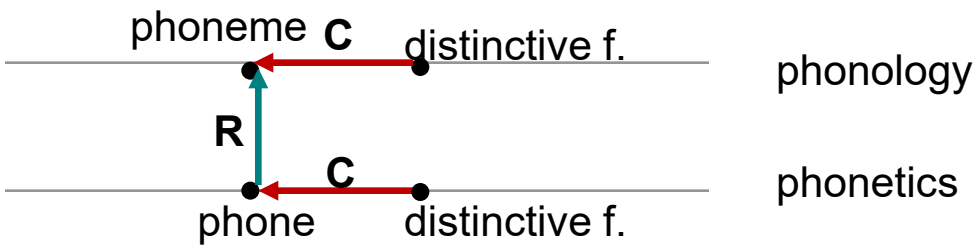


layer of phonetics

distinctive features … elementary units
phones (~ a speech sound) … complex units

suprasegmental units … prosody, intonation

System of layers in FGD (cont.)



layer of phonetics

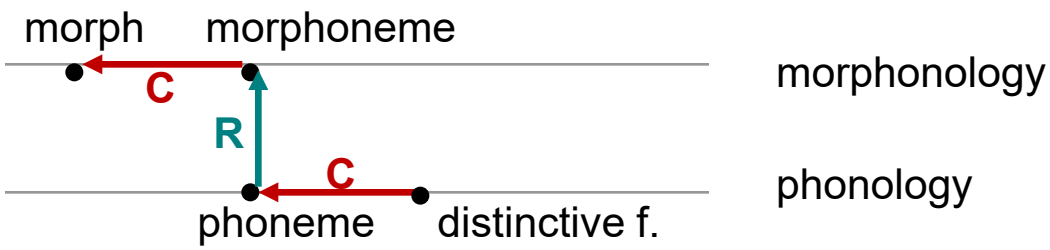
distinctive features … elementary units
phones (~ a speech sound) … complex units

suprasegmental units … prosody, intonation

layer of phonology

distinctive features … elementary units
phonemes (~ 'smallest' units that distinguish meaning) … complex units
asymmetry … allophones ~ variants of a single phoneme
language dependent (sing vs. sin)

System of layers in FGD (cont.)



layer of morphonology

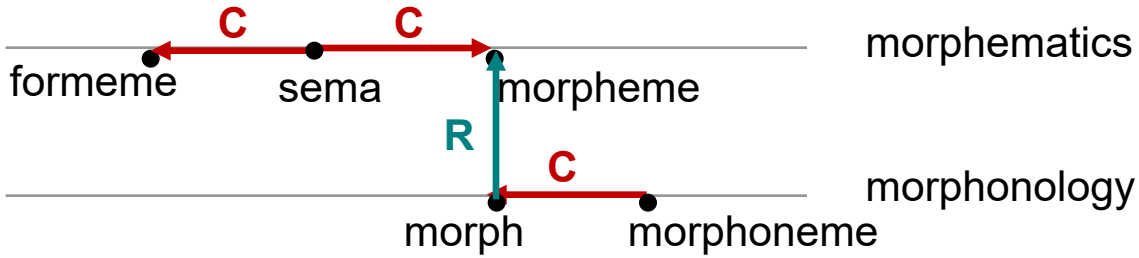
morphoneme ~ set of phoneme variants e.g. *k|c|č|.k* in *"matka"*

morph ~ string of morphonemes

lexical variants *(matk, matc, matč, mat.k)* ... 4 allomorphs
mat(k|c|č|.k) 1 morph

lexical variants *(foot, feet)* ... 2 allomorphs
f(oo|ee)t 1 morph

System of layers in FGD (cont.)



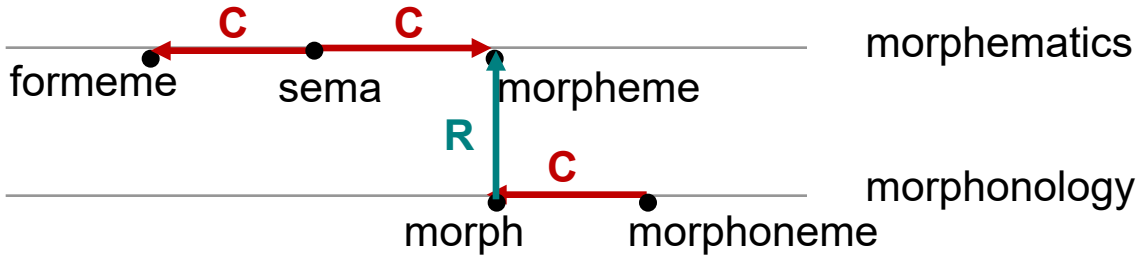
layer of morphematics

- morpheme ~ the smallest component that has semantic meaning
- lexical morpheme
  - roots

    e.g. lex. morpheme for *matka* consists of 4 allomorphs *(matk, matc, matč, mat.k)* ;
    for *to write (writ, wrot);* for *leaf (leaf, leav)*
  - derivational morphemes (affixes: prefixes, infixes, suffixes, …)

    il- (as in *illegal*), *non-* (as in *nonproblematic*)
    -ly (as in *legally*), *-ess* (as in *actress*)

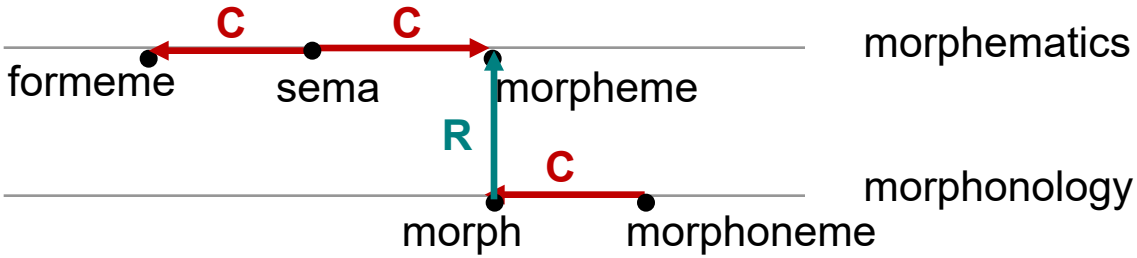
System of layers in FGD (cont.)



layer of morphematics

- morpheme ~ the smallest component that has semantic meaning
- lexical morpheme
- grammatical morpheme
  - inflectional affixes e.g. Cz: suffixes nouns: case, gender, number, …
    verbs: gender, number, tense, voice,
    Eng: suffixes nouns: plural *-s*
    verbs: past tense *-ed* , continuous *–ing*

System of layers in FGD (cont.)



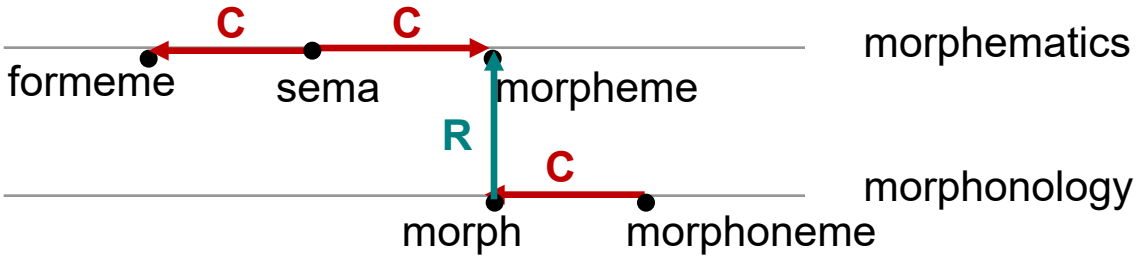
layer of morphematics

- morpheme ~ the smallest component that has semantic meaning
- lexical morpheme
- grammatical morpheme
  - inflectional affixes e.g. Cz: suffixes nouns: case, gender, number, …
    verbs: gender, number, tense, voice,
    Eng: suffixes nouns: plural *-s*
    verbs: past tense *-ed* , continuous *–ing*

e.g. *matk + a* *boy + s*
koup + il *play + ed*

- *sema* … a combination of grammatical morphemes that characterize a lexical morpheme (or strings of lexical morphemes)

System of layers in FGD (cont.)



layer of morphematics

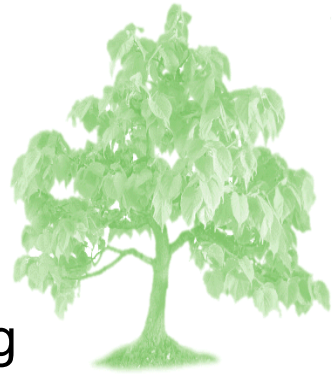
- morpheme ~ the smallest component that has semantic meaning
- lexical morpheme
- grammatical morpheme
- formeme:

  sequence of morphs realizing a single tagmeme / sentence member

  lexical f., case f. (i.e., prep+case), conjunction formemes (i.e., conj+verb mood)

Cz:	*vysok+á škol+a;*	*lamp+a;*	*na+lavic+i;*	*chod+í;*	*bud+e+chod+it*
Eng:	*white-collar;*	*lamp;*	*on+ table;*	*walk+s;*	*will+be+walk+ing*

System of layers in FGD (cont.)



morpheme ~ the smallest component that has semantic meaning

Czech … (inflection language):

nejneobhospodařovatelnější

nej-ne- ob-hospod-ař -ova-teln-ějš - í

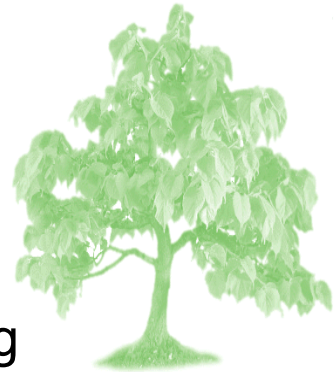
most-non- cultivate - [iter]- [adj] - [super]-[sg+nom+fem | sg+acc+neutr | … pl+voc+masc]

root

23 combinations ("meanings")

grammatical morphemes

System of layers in FGD (cont.)

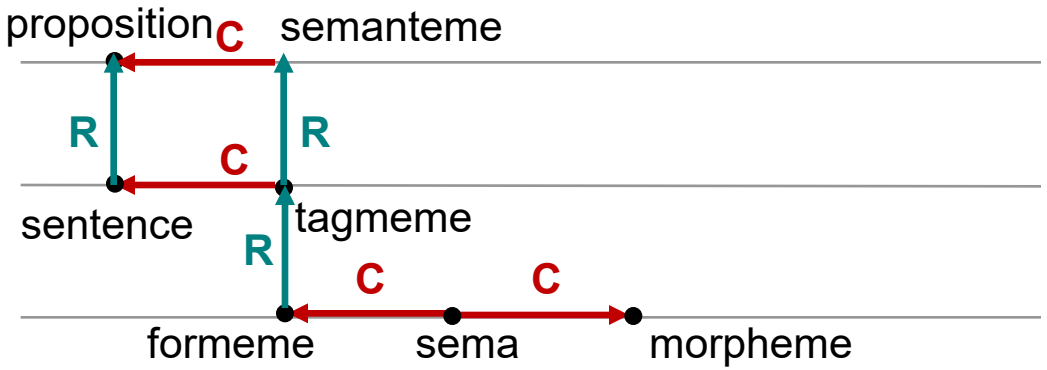


morpheme ~ the smallest component that has semantic meaning

Hungarian (agglutinative language):

fi-ú	boy		
fi-a	his/her son	fi-a-i	his/her sons
fi-á-é	his/her son's (singular object)	fi-a-i-é	his/her sons' (singular object)
fi-á-é-i	his/her son's (plural object)	fi-a-i-é-i	his/her sons' (plural object)

System of layers in FGD



deep / underlying syntax
tectogrammar

surface syntax

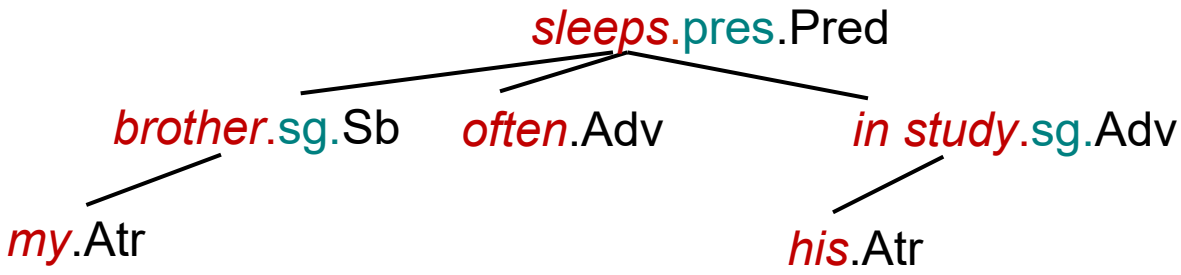
morphematics

two layers of syntax

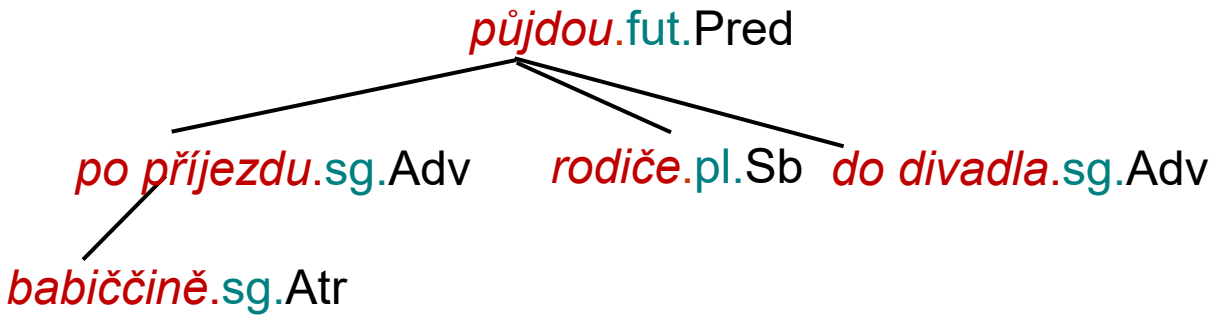
- tree-based dependency structure
  - nodes for tagmemes / sememes (complex symbols)
  - edges labeled with a type of a respective syntactic relation

The layer of surface syntax

My brother often sleeps in his study.



Po babiččině příjezdu půjdou rodiče do divadla.
[After grandma's arrival the parents will go to the theatre.]



The layer of surface syntax

surface syntactic tree

~ nodes for formemes → *tagmemes* / sentence members
(cz school syntax: větné členy)

~ edges for syntactic relations

+

surface word order … linear ordering of tree nodes

The layer of surface syntax

surface syntactic tree

~ nodes for formemes → *tagmemes* / sentence members
(cz school syntax: větné členy)

~ edges for syntactic relations

+

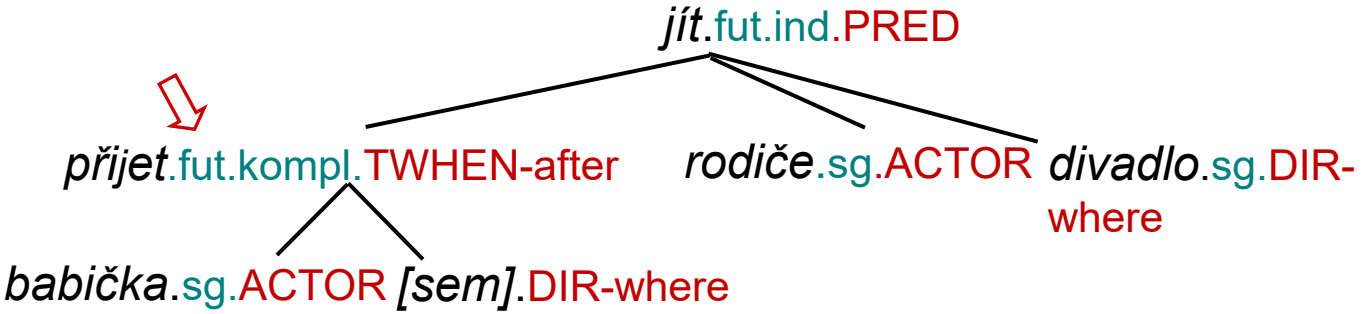
surface word order … linear ordering of tree nodes

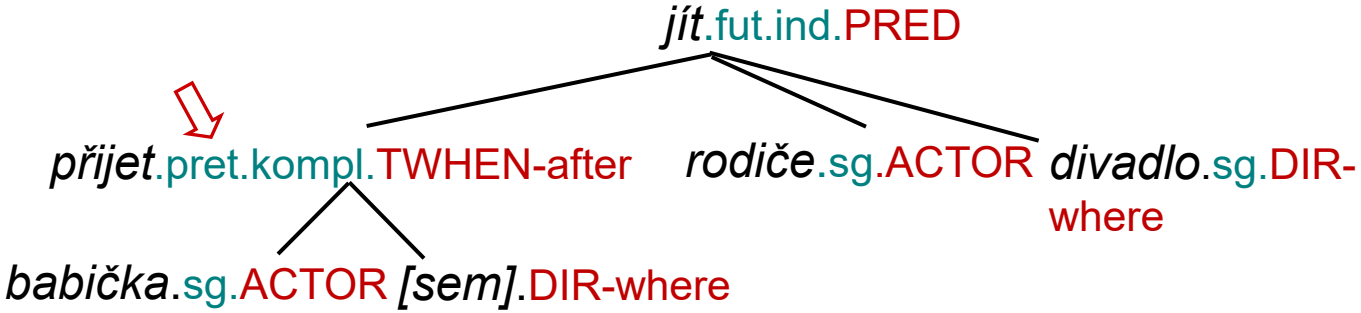
3 types of elementary units:

- lexical: units from a dictionary
- morphological: set of morphological features ~ *tags*
  (a pair of) trousers … sema - plural
- syntactic: subject, object, attribute, adverbial, complement,…

The layer of deep syntax

Po babiččině příjezdu půjdou rodiče do divadla.
[After grandma's arrival the parents will go to the theatre.]





The layer of deep syntax

~ meaning of a sentence:

I. *semantemes*: only content (lexical) words as nodes,
their lexical and morphological features and mutual relations

terminology: deep / underlying / tectogrammatical representation (TR)

- modal verbs

  Peter wants to attend the concert. [to attend + volitive]

  Charles has to pass the exam. [to pass + debitive]

- nominalization

  After grandma's arrival … → [to arrive]

- active / passive verbs → [active form]

  Tato krásná kniha byla vydána nakladatelstvím Albatros.
  [This beautiful book was published by the Albatros publishing house.]

The layer of deep syntax

~ meaning of a sentence:

II. 3 basic types of elementary units:

- lexical: units from a (tectogrammatical) dictionary
- morphological: *grammatemes*

  meaning of individual morphological categories

  (a pair of) trousers … singular

  denominating (*pojmenovávací*)

  vs. co*rrelating* (*usouvztažňující*) categories
- syntactic: types of relation, *functors* and *subfunctors*

  Actor, Patient, Addressee, … local, temporal modifications …

The layer of deep syntax

~ meaning of a sentence:

III. *completeness of the representation*

- (surface) ellipses are restored
- omitted surface subject, object, comparison … valency

Czech: *Vidíš bratra? Vidím. Přichází.*
→ [Ty] vidíš bratra? [Já] vidím [ho]. [On] přichází [sem].
Russian: *Ты видел брата? Вижу [его]. Идёт.*
Spanish: *¿Ves este tronco?* [(Do) **you** see this log?]

The layer of deep syntax

~ meaning of a sentence:

IV. *deep word order*

- information structure / topic focus articulation
- increasing communicative dynamism:
  word order reflects "relative degree of importance in comparison with other expressions in the sentence […]"
- condition of *projectivity* !!!

The layers of surface vs. deep syntax

I. different sets of elementary units
   - 'morphological' lemma vs. tectogrammatical lemma
   - morphological categories vs. grammatemes
   - surface sentence members vs. functors

⇨ different sets of complex units
   - tagmeme vs. semanteme

The layers of surface vs. deep syntax

I. different sets of elementary units
- 'morphological' lemma vs. tectogrammatical lemma
- morphological categories vs. grammatemes
- surface sentence members vs. functors

⇨ different sets of complex units
- tagmeme vs. semanteme

II. elipses and completeness
- nodes represent formemes as appear in the surface sentence
  vs. *completeness of the representation* (valency)

The layers of surface vs. deep syntax

I. different sets of elementary units
- 'morphological' lemma vs. tectogrammatical lemma
- morphological categories vs. grammatemes
- surface sentence members vs. functors

⇨ different sets of complex units
- tagmeme vs. semanteme

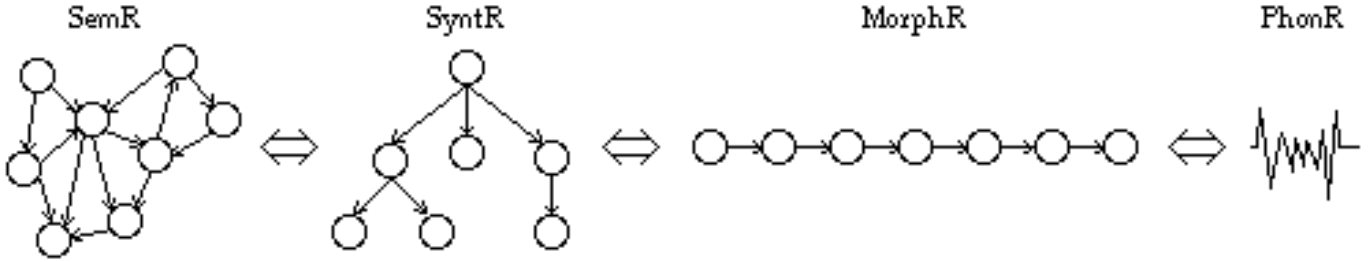
II. elipses and completeness
- nodes represent formemes as appear in the surface sentence
  vs. *completeness of the representation* (valency)

III. surface vs. deep word order
- order of words in a surface sentence
  vs. information structure
- nonprojective trees allowed
  vs. just projective trees

Meaning⇔Text Theory (MTT)

Meaning⇔Text Theory (MTT)

- Aleksandr Žolkovskij and Igor Mel'čuk, Moscow, 1965-…
  - formal representation of natural language (Russian)
  - aim: applications in NLP (machine translation, phraseology, lexicography)
- basic principle:
  - language consists in a mapping from the content or meaning (semantics) of an utterance to its form or text (phonetics)
  - sequence of mappings
    - the unordered network of the semantic representation (SemR)
    - dependency tree-structures of the syntactic representation (SyntR)
    - linearized chain of morphemes of the morphological representation (MorphR)
    - (the temporally-ordered string of phones of the phonetic representation, PhonR

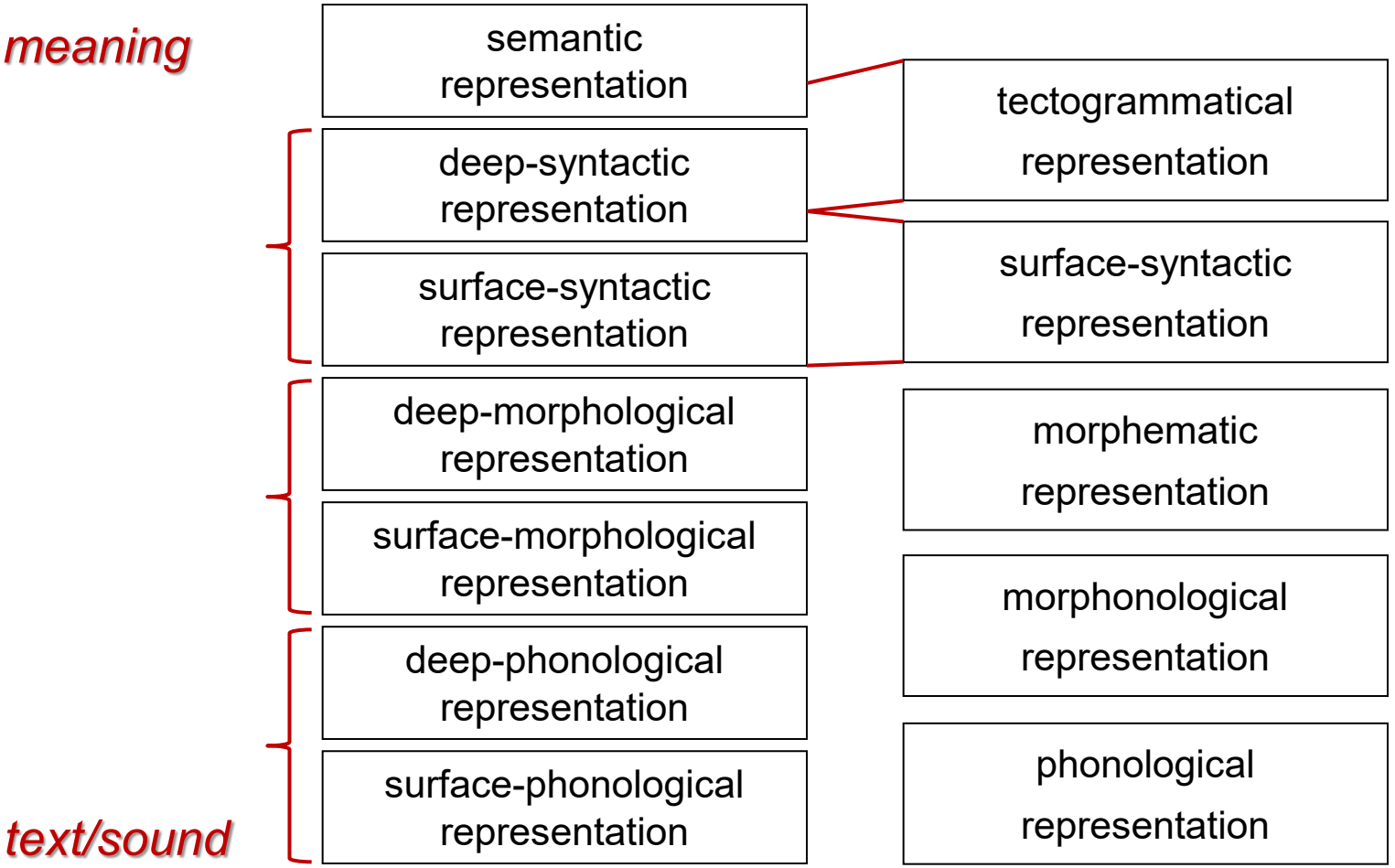


Meaning⇔Text Theory (MTT) and FGD

- both originated almost at the same time (Žolkovskij, Mel'čuk, 1965), (Sgall, 1967)
- the same roots in European structural linguistics
- both stratificational
- both dependency oriented (syntax)
- distinguishing deep and surface syntactic representations
- independence between the dependency structure and word order in a sentence.
- orientation to languages typologically different than English
- both proved to be useful and successful in large-scale implementations
    - machine translation system ETAP for MTT (Apresian et al., 2003);
    - Prague Dependency Treebank (PDT) for FGD, (Hajič et al., 2001), machine translation systems, esp. CZ-Eng pair

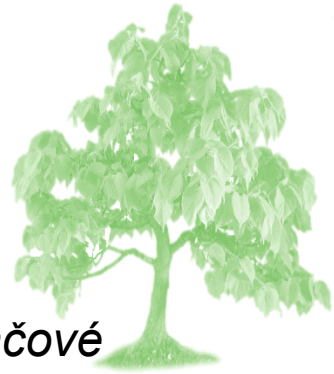
based on (Žabokrtský, 2006)

Meaning⇔Text Theory (MTT) vs. FGD



based on (Žabokrtský, 2006)

References



- Hajičová, E., Panevová, J., Sgall, P. (2002) *Úvod do teoretické a počítačové lingvistiky*, sv. I. Karolinum, Praha.
- Štekauer, P., ed. (2000) *Rudiments of English Linguistics*.Slovacontact, Prešov.
- Sgall, P. (1967) *Generativní popis jazyka a česká deklinace.* Academia, Praha
- Žabokrtský, Z. (2006) Resemblances between Meaning ⇔ Text Theory and Functional Generative Description. *In Proceedings of the 2nd International Conference of Meaning-Text Theory*, Slavic Culture Languages Publishers House, Moskva, pp. 549-557.
- https://www.britannica.com/science/linguistics/Stratificational-grammar

- Sgall, P., Hajičová, E., Panevová, J. (1986) *The Meaning of the Sentence in Its Semantic and Pragmatic Aspects.* Reidel, Dordrecht.
- Petkevič, V. (1995) A New Formal Specification of Underlying Structure. *Theoretical Linguistics* Vol.21, No.1.