

11 Feb 2025 - Language and Logic - Week 01

Primary topics

① Natural language syntax and logical expressions } Categorical Grammar

→ Formal language theory → includes human language
Context-free grammar

② Relation between Meaning and logic

③ Logic and cognitive structures } supplementary remark



→ limitations in human reasoning

logic prunes out inessential stuff and focuses on essentials
← expressed beautifully in Math

Core questions

→ linguistic logic
vs.

classical logic

→ human logic →
peculiar,

Readings

No need ☺

listen

Evaluation

→ 2 tests (50% + 50%)

↓

5 MCQs + 5 analytic exercises

???

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Categorial grammar
↓
friday

→ Meanings, Grammar and Logic

① depends on syntax: arrangement matters,
arise from structure even before other factors
like context

② establish inferential links

not solely dependent on syntax/substrate
emerge
organization of symbols

③ Inferences in Human languages

"I did go to the market yesterday"

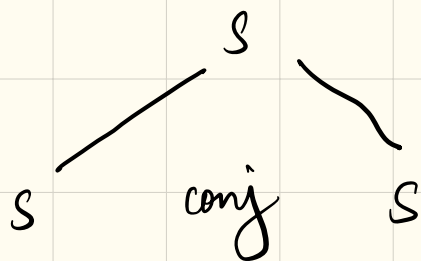
⇒ Will not go today
Infe

→ Building bigger structures

Subject & verbs
↑ each independ
ent
↓ diff possibility
??

Rani eats spaghetti and Rani exercises everyday

Meaning of a complex composition is determined
by structure + meaning of components



S → S conj S

→ S conj S conj S

→ S conj S conj S conj S

not possible
in a single sweep

→ language is combinatorial and compositional

Jonny left without filing the patent
⇒ Jonny didn't file the patent

} → there's no
NOT in
1st statement
→ without = negator

Meaning intuitions

* Ronny is a cricketer
is a sportsperson

} syntax
determines

own logic
property

sportsperson is a superset of cricketer

* It is sunny

It is warm

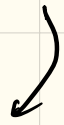
} does not automatically follow
→ possible

compositionality X

How are you able
to conclude? → by
the meanings
of words

meanings → organize/crystallize experience

She is a spinster
She is married



syntactically makes sense but
illegitimate conclusion
→ you may not know the
meaning

Probability vs. Fuzziness

→ continuum

* The patient should survive next week

Syntax
and
words
under

* The patient is young



compositionality x
word ?

Not all inferential links can be derived from syntax
→ partially from experience & exact word meanings

Syntax

Meaning of the word

Knowledge of the world

syntax

under determines

All men are human. No women are men

therefore, no women is human

Human language is complex \rightarrow determine if logically correct

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* Analogy from math

$x + y$, not $xy +$
 x/y but not y/x

part of
a system
known as

Categorial grammar

compositionality
can be formulated
based on some

\leftarrow logical principles

* similar in

CG

1935

1953

1958

formal
current form

\rightarrow

provides a natural way to account
correspondences

Categorial : category

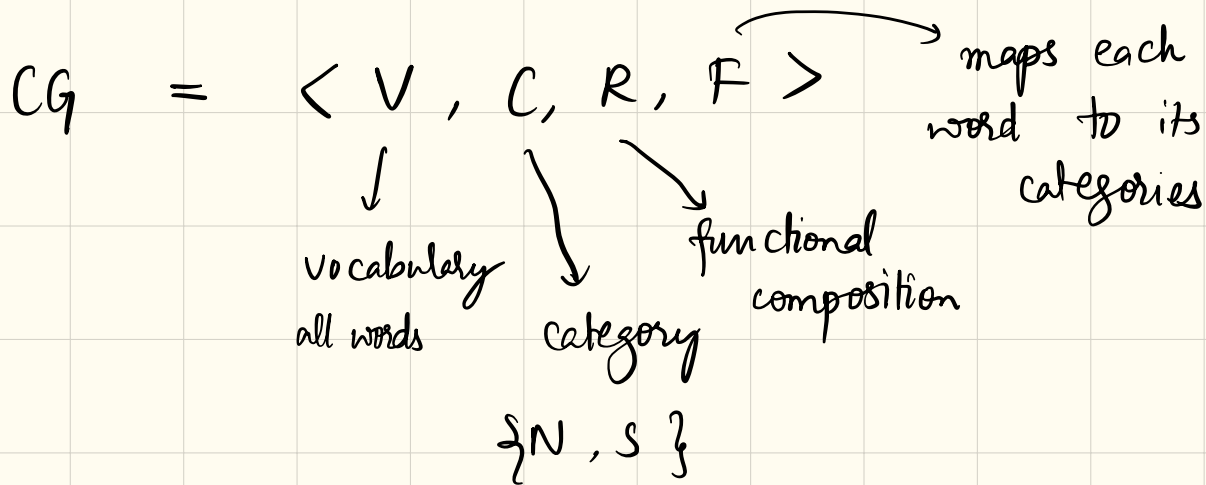
All categories are reduced to : nouns and sentences

→ brings elegance

→ how to describe propositions, etc? →

simplicity of

CG



R → defines
how words
can be
combined

R : set of functional composition rules

joy, chair, ... N
determiners ; a, an... N/N
function

$\frac{N}{N}$ original notation

$N \setminus N$ function

slash notation : '/' , '\'

→ indicates from which side the input is taken

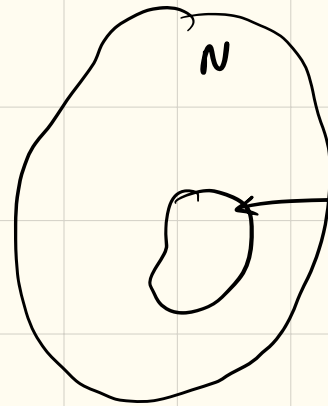
A car
/
~~N/N~~ → ~~N~~

Car A
~~N~~ ~~N/N~~
~~~~~  
other languages

# Illustration

what does cancellation  
mean?

|                 |                       |
|-----------------|-----------------------|
| <u>the</u>      | <u>book</u>           |
| <del>N/DT</del> | <del>DT</del>         |
| <hr/>           |                       |
| N               | } Noun-like<br>entity |



determiners  
pick up a subset

adjectives  $\rightsquigarrow$  like  
determiners

The way meanings combine is  
superimposed on how  
forms combine



I play.

$R \rightarrow$  combinatorial rule

$\hookrightarrow$  not many rules are required to get the complete language.

In many languages, subject is dropped, but subject and verb are not combined.

$(N \setminus S) / N$

$$\equiv \textcircled{1} f(N) = N/S$$

$$\textcircled{2} f(N) = S$$

CG  $\rightsquigarrow$  works for all languages

difficult for languages like Turkish, but possible  
words are glued together

F: the fn that maps words to its set of categories.

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|                |              |                     |                 |              |
|----------------|--------------|---------------------|-----------------|--------------|
| these          | <u>kids</u>  | <u>play</u>         | <u>a</u>        | <u>game</u>  |
| N/N            | N            | (N/S)/N             | <u>N/N</u>      | <del>N</del> |
| N/N            | N            | (N/S)/ <del>N</del> | <del>N</del>    |              |
| <del>N/N</del> | <del>N</del> |                     | N/S             |              |
| <del>N</del>   |              |                     | <del>N</del> /S |              |
| <hr/>          |              |                     |                 |              |
| S              |              |                     |                 |              |

✓