

# 18 Feb 2025 - Language and Logic - Week 02

→ other categories can be derived from nouns and verbs.

may change  
in diff  
languages

using  
combinatorial  
behavior

→ more primary  
→ found in almost  
any language

Nouns : N

Verbs :  $\frac{(N \setminus S)}{N}$  or  $\frac{N \setminus S}{N}$

two participant

one participant

Determiners: N / N

Prepositions

Adjectives

Adverbs :  $X \mid X$   
           $\cong$   
          any one

Conjunctions :  $(X \mid X) \mid X$   
                  ↓  
                  combines objects  
                  of some category  
                  and returns in  
                  the same category

ran and fell down

→ Note on rewriting rules :

\* NP → det N  
      noun phrase   the   desk

\* VP → V NP  
      saw   the desk

\* PP → P

\* AP

} these are not categorial rules

Helpful in cancellations

\* Adv P → Adv

## Verbs in Composition

→ One participant verbs — intransitive  
sleep, dance

they sleep  
~~N~~      ~~N~~ / S  
S

→ Transitive verbs:

She saw the desk.  
N      (N/S)/N      N/N      N

first compose the  
object  
then verb,  
then subject.

# Adjectives in composition

→ Attributive adjective :



good   kid  
 head  
 noun

This	good	kid
N/N	N/ <del>N</del>	<del>N</del>
N/ <del>N</del>	<del>N</del>	
N	→	not a sentence

→ Predicative      acts like an intransitive verb

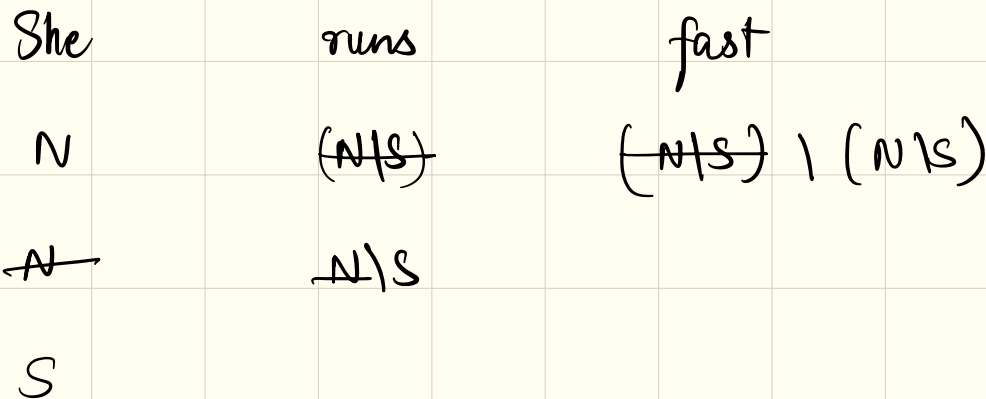
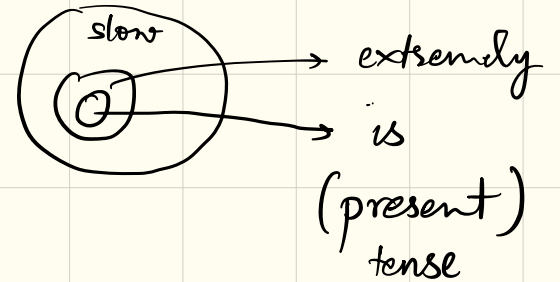
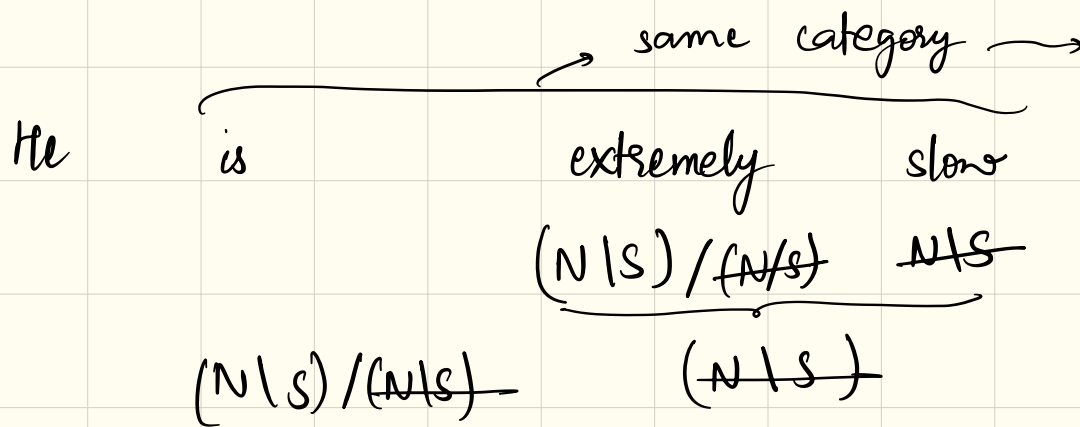
He	is	slow
N	(N/S)/( <del>N</del> S)	<del>N</del> S
<del>N</del>	<del>N</del> S	→ S

is → does not contribute  
 any meaning  
 syntactical

# Adverbs in Composition

→ Adverbs modify both adjectives and verbs

→ subset → must have the same category



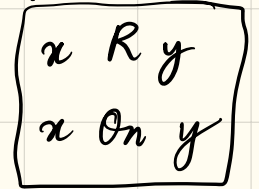
It is the adverb that cancels the category of verb

# Prepositions in Composition

① Prepositions applying to auxiliaries:

→ transitive verb-like  $\rightsquigarrow$  x is on y

cancellation is easier in Indian languages



The letter is on the desk

N/A A

(N/S)/A A

(N/S)/(A/S)

~~N/S~~

N/A A

~~A~~

N/S

~~A/S~~

# Prepositions applying to noun phrases

$\underbrace{N \ R \ N}_{N}$

the book

on

the desk

~~N/A~~ ~~A~~

$(N \setminus N) / A$  ~~A~~

~~N/A~~ ~~A~~

$N \setminus N$

~~A~~

$A \setminus N$

N

→ same relational structure

# Prepositions applying to verb phrases

dynamic      on      noun

(letter) comes into being (left) on (the desk)

Mimi

left      a      letter

prunes out other possibilities  
on      the desk

~~N/A~~

~~((N|S) \ (N|S)) / A~~

(N|S) \ (N|S) } prunes out verb phrase



## Prepositions applying to adverbs

→ prepositions can sometimes appear before adverbs (rare).

I shall do it

before long

current form

before it is too long

(shall do it)

replaces (before long)

→ alternative

(shall)

replaces (do it before long)

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What is type-raising?

→ some symbols / words / phrases may be complex in their functional nature that their category may not be clear.

→ procedure of composition may change

no standard way



S ↔ O

Subject may combine  
with verb

→ not arbitrary rules

→ Type-raising creates more complex functions

2 levels → 3 or 4 levels

→ Syntactic flexibility with non-standard composition.

# Non-standard composition

Joy likes, and I hate, democracy

$N \quad (N/S)N \quad ((N/S)(N/S))(N/S) \quad N \quad (N/S)/A \quad \cancel{N}$

---

$N \quad N/S$

???

object shared with 2 verbs

or iterative combination:  
Joy likes, she loves, and I hate, democracy

→ Requirements for 'like' → not fulfilled (democracy cancelled)  
arguments

combined

Joy likes, and I hate, democracy

N (N|S)/N (x|x)/x N (N|S)/N N

→ T

→ T

S(~~N|S~~) (~~N|S~~)|N (x|x)/x S(~~N|S~~) (~~N|S~~)|N N

\_\_\_\_\_

\_\_\_\_\_

↓

~~S|N~~ ((~~S|N~~)|(S/N))/(~~S|N~~) (~~S|N~~) N

S/N

~~N~~

S

Joy + likes } AND + democracy.  
I + hate }

\* Type-raising converts arguments into functions over functions-over-such-arguments.

\* For given category  $N$ .

$N \rightarrow$  function over arguments that take  $N$  as argument

$$S / (N \setminus S)$$

$$f_1(N) = S$$

a function over  $f_2$

$$f_2(N \setminus S) = S$$

a function over  $N$

$$\left. \begin{array}{l} S / (N \setminus S) \\ S / (S \setminus S) \end{array} \right\} \rightarrow \text{not the correct type-raised category.}$$

Type-raising is order-preserving.

Joy	saw	Roy.
N	(N/S)/N	N
→ T		
S/(N/S)	<del>(N/S)/N</del>	N
S/N		<del>N</del>
S		

final argument within the  
embedded function must be  
same.

these days kids grump  
N/A ~~A~~ ~~A~~ N/S  
N ??? S

these days kids

$N \mid (N \mid N)$   
valid?

$N \mid (N \mid N)$

$N \mid (N \mid N)$  takes N as  
arg

$N \mid N$  takes N as  
arg

These days kids grump  
(N/N)

(N/N)/N N N N/S

(X) → does not take (N/N) as argument

(N/N)/~~N~~ ~~N~~ N

~~N/N~~

~~N~~

~~N~~

~~N/S~~

S



Solution:

These days

acts like  
an adverb,  
although it  
is a noun.

kids group

often, I play  
↓  
operates on whole  
sentence, returns a  
sentence

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→ Controversy around type-raising: still exists

— Mathematically sound but linguistically ~ eh

~ feels inadequate

Joy likes

S/(N+T) (N+T)/N

How come noun accepts verb to get S?

\* Non-standard type raising

Don't restrain yourself from mentioning this in exams

~ This is why different versions of categorial grammar exist (what version)

## Semantic Relation: Meaning

→ Inferential links between or among sentences.

→ operate on sentences / proposition (not word)

→ Inferential competence (??)

$$x \sqcup y = \{x : x \in v(x) \text{ or } y \in v(y)\}$$

## Entailment

entailed sentence  $\equiv$  a superset

X entails Y if and only if whenever X is true, Y is true as well.

X and  $\neg Y$  will be contradictory.

$$2 \times 2 = 4 \Rightarrow 2 + 2 = 4$$

→ Logical necessity

→ unidirectional

\* Rabbit is on the carpet  $\Rightarrow$   
Animal is on the carpet } superset

\* Today is Tuesday and it is hot  $\Rightarrow$   
Today is hot

\* Sonu went to Delhi by train  $\Rightarrow$   
Sonu went to Delhi.

## Two-way vs. one-way entailments

$\rightarrow$  verbs <sup>can</sup> encode entailment

++ | --

managed to | did not <sub>to</sub> managed to

bother to

remember to

negation  
+ - | - +

fail to

neglect to

forget to

- + | + - (?)

→ Not all verbs encode entailment.

He tried to write a book.

He planned to go for a trip.

} → Inbuilt uncertainty

## Implicature / Implication

X implies Y if and only if in some world where X is true,  
Y is true as well

→ Possibility, not guarantee.

} Human logic  
We tend to be  
sure even if it's  
not an entailment

→ If you finish your work, I won't give you a gift →  
If you don't finish your work, I won't give you a gift.

→ Defeasible

→ Implicatures can be cancelled

Human reasoning  
is very different  
from truth tables  
explored later

Implicature is not ambiguity

This is a bank → financial institution, river bank, database

This is a bank, but it is not a financial institution

→ When implicatures are cancelled, they are gone (??)

## Presupposition

→ combines the properties of both entailments and implicature.

$X$  presupposes iff  $X$  entails  $Y$  and  $\neg X$  entails  $Y$ .

### Example:

The king of France is / is not bald  $\Rightarrow$

There is a king of France.

## Presupposition Invariance

- Negation
- Modal
- Question
- Command
- Conditional

## Presuppositions can be cancelled (like implicatures)

- Negate the original sentence and the presupposition: refutations
- Presupposition negation: is-ness.



## Entailment vs. Presupposition

→ Next week, 1<sup>st</sup> test