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Parsing-Strategien

1. Agenda

- Drei Parsing-Strategien:
  - Shift-Reduce
  - Top-Down
  - Left-Corner
- Vergleich der Strategien

2. Shift-Reduce-Parsing

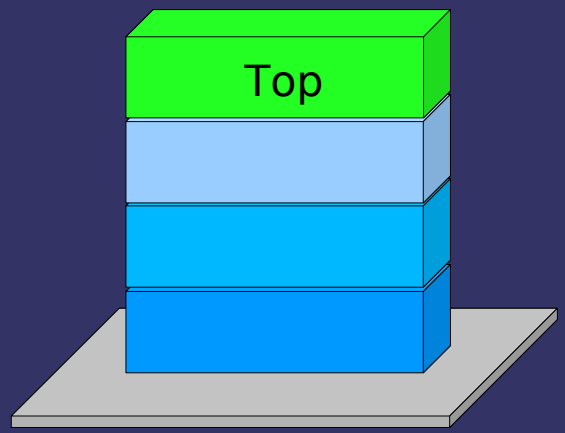
2.1 Grundidee

- Bottom-Up Verfahren

- vom Konkreten zum Abstrakten

2.1 Grundidee

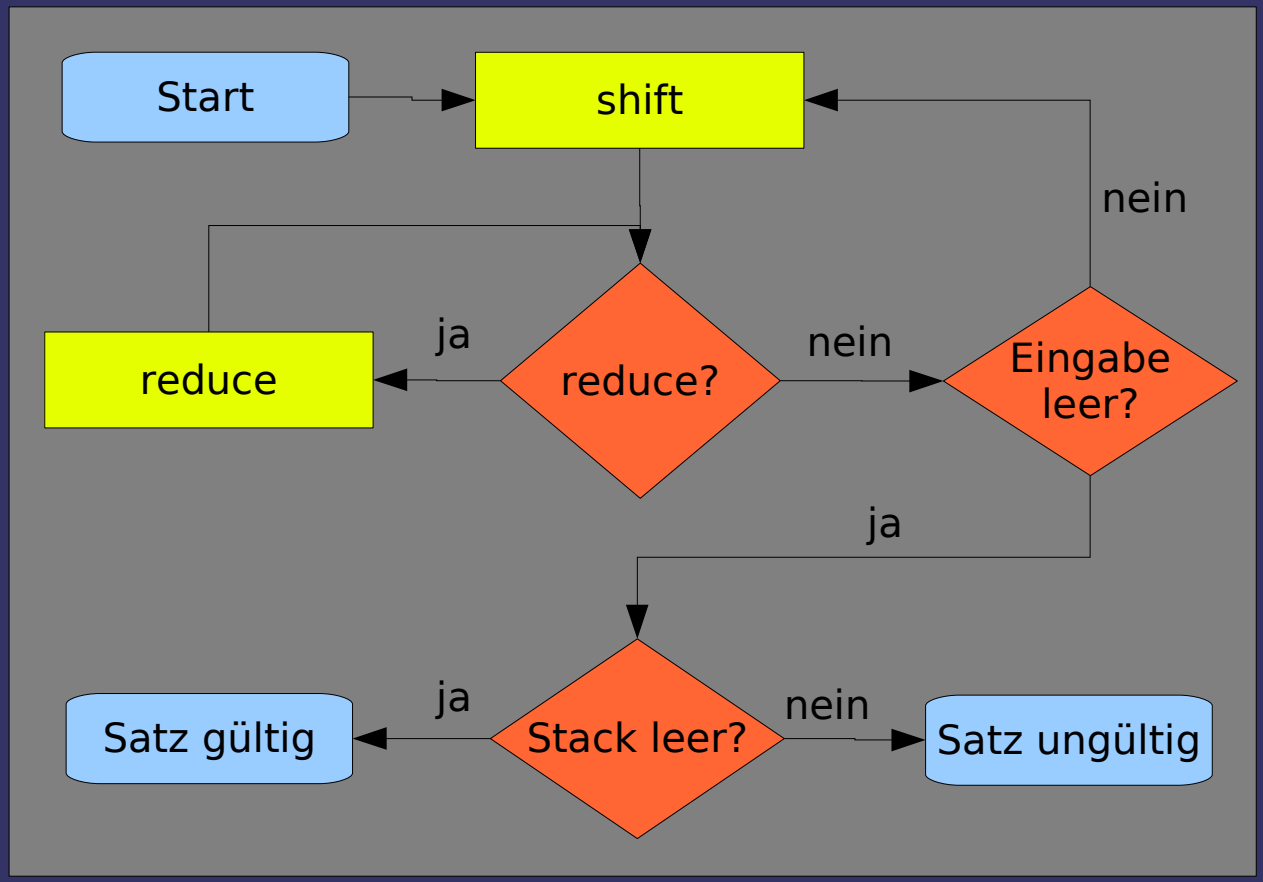
- Stack (Keller)
  - push
  - pop
  - LIFO



2.2 Operationen

- **Shift**: verschiebe Wort auf den Stack
- **Reduce**: Wende Regel von rechts nach links an

2.2 Operationen



2.3 Parsing

- Beispiel: 'He saw Mary with a telescope'

- Regelmenge

R={

S -> NP VP	PP -> P NP
PN -> Mary	NP -> PRO
P -> with	NP -> PN
PRO -> He	NP -> DET N
VP -> V NP PP	DET -> a
V -> saw	N -> telescope

}

2. Shift-Reduce

2.3 Parsing

Startzustand s_0:

Parse:

Stack:

Input: He saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Startzustand s_0:

Parse:

Stack:

Input: He saw Mary with a telescope

Aktion a_1 = shift(He)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_1:

Parse: He

Stack: He

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_1:

Parse: He

Stack: He

Input: saw Mary with a telescope

Aktion a_2 = reduce (PRO -> He)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_2:

PRO

Parse: He

Stack: PRO

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_2:

PRO

Parse: He

Stack: PRO

Input: saw Mary with a telescope

Aktion a_3 = reduce(NP -> PRO)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

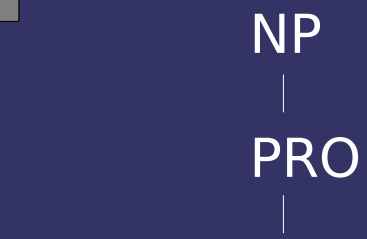
(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_3:



Parse: He

Stack: NP

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_3:

NP
|
PRO
|

Parse: He

Stack: NP

Input: saw Mary with a telescope

Aktion a_4 = shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_4:

Parse: He saw

Stack: NP saw

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_4:

NP
|
PRO
|

Parse: He saw

Stack: NP saw

Input: Mary with a telescope

Aktion a_5 = reduce(V -> saw)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_5:

Parse: He saw

Stack: NP V

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_5:

Parse: He saw

Stack: NP V

Input: Mary with a telescope

Aktion a_6 = shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_6:

Parse: He saw Mary

Stack: NP V Mary

Input: with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_6:

Parse: He saw Mary

Stack: NP V Mary

Input: with a telescope

Aktion a_7 = reduce(PN -> Mary)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_7:

Parse: He saw Mary

Stack: NP V PN

Input: with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_7:

Parse: He saw Mary

Stack: NP V PN

Input: with a telescope

Aktion a_8 = reduce(NP -> PN)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_8:

Parse: He saw Mary

Stack: NP V NP

Input: with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_8:

Parse: He saw Mary

Stack: NP V NP

Input: with a telescope

Aktion a_9 = shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_9:

Parse: He saw Mary with

Stack: NP V NP with

Input: a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_9:

Parse: He saw Mary with

Stack: NP V NP with

Input: a telescope

Aktion a_{10} = reduce(P -> with)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

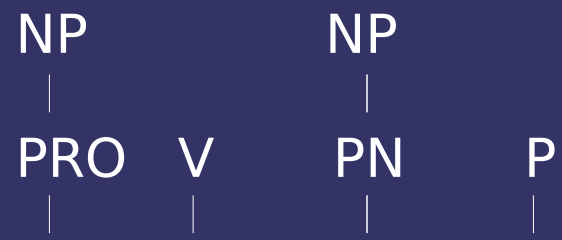
(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_{10}:



Parse: He saw Mary with

Stack: NP V NP P

Input: a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

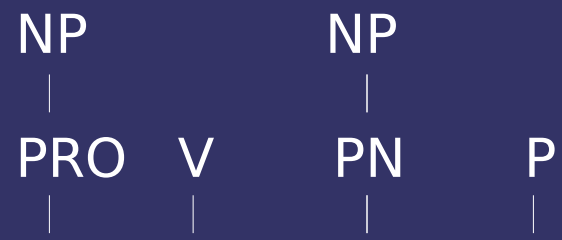
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{10}:



Parse: He saw Mary with

Stack: NP V NP P

Input: a telescope

Aktion a_{11} = shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

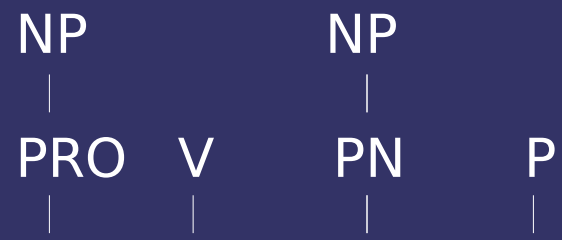
(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_{11}:



Parse: He saw Mary with a

Stack: NP V NP P a

Input: telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

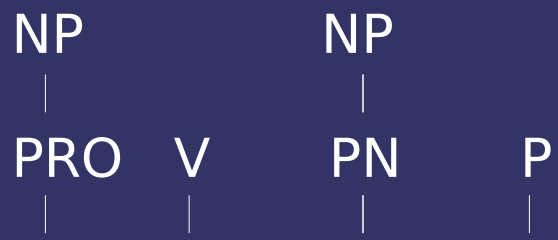
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{11}:



Parse: He saw Mary with a

Stack: NP V NP P a

Input: telescope

Aktion a_{12} = reduce(DET -> a)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

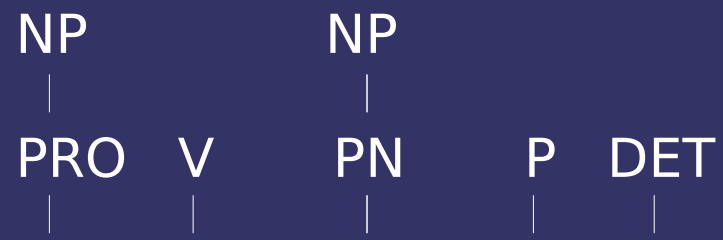
(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_{12}:



Parse: He saw Mary with a

Stack: NP V NP P DET

Input: telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

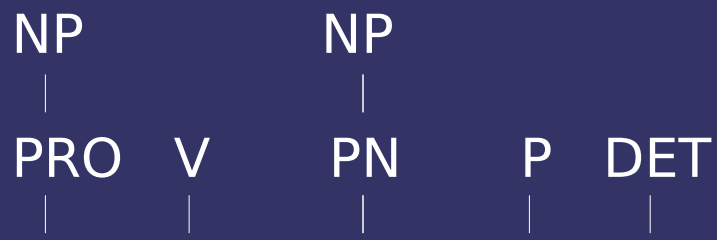
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{12}:



Parse: He saw Mary with a

Stack: NP V NP P DET

Input: telescope

Aktion a_{13} = shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

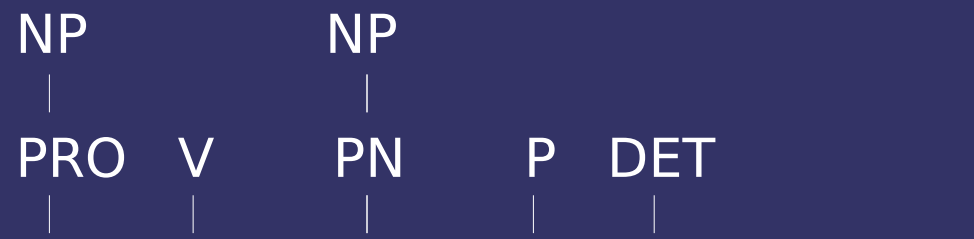
(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_{13}:



Parse: He saw Mary with a telescope

Stack: NP V NP P DET telescope

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

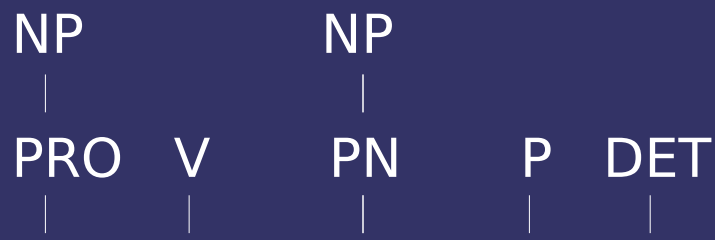
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{13}:



Parse: He saw Mary with a telescope

Stack: NP V NP P DET telescope

Input:

Aktion a_{14} = reduce(N -> telescope)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

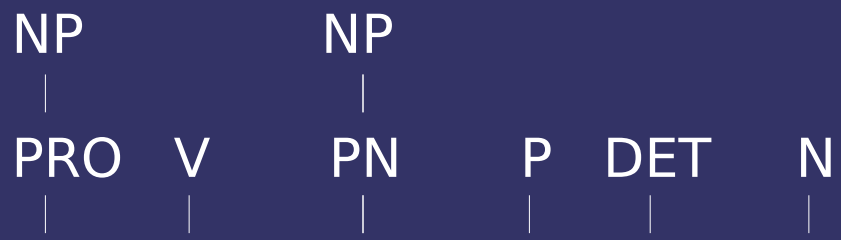
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{14}:



Parse: He saw Mary with a telescope

Stack: NP V NP P DET N

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

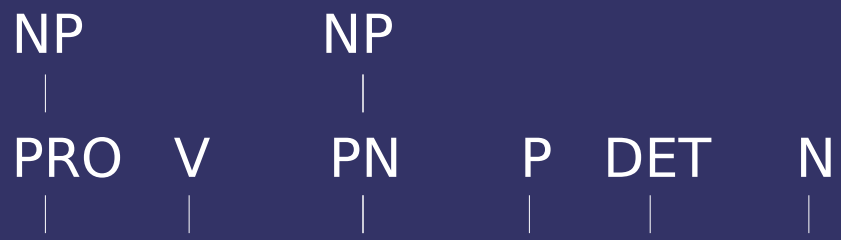
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{14}:



Parse: He saw Mary with a telescope

Stack: NP V NP P DET N

Input:

Aktion a_{15} = reduce(NP -> DET N)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

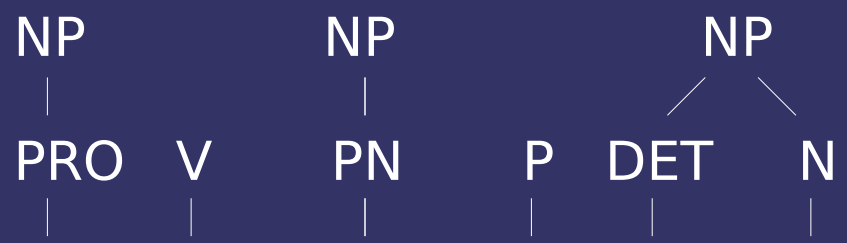
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{15}:



Parse: He saw Mary with a telescope

Stack: NP V NP P NP

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

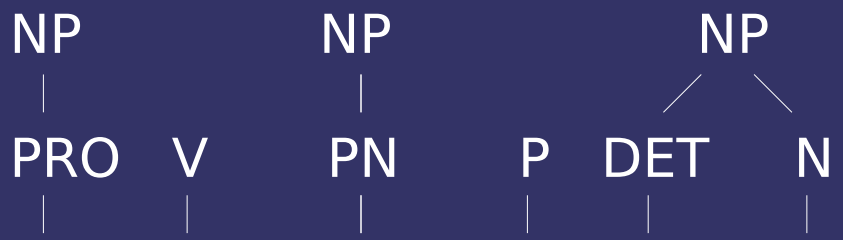
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{15}:



Parse: He saw Mary with a telescope

Stack: NP V NP P NP

Input:

Aktion a_{16} = reduce(PP -> P NP)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

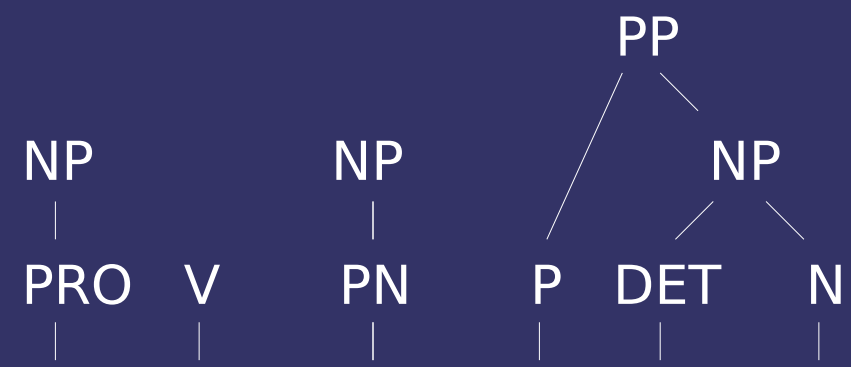
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{16}:



Parse: He saw Mary with a telescope

Stack: NP V NP PP

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

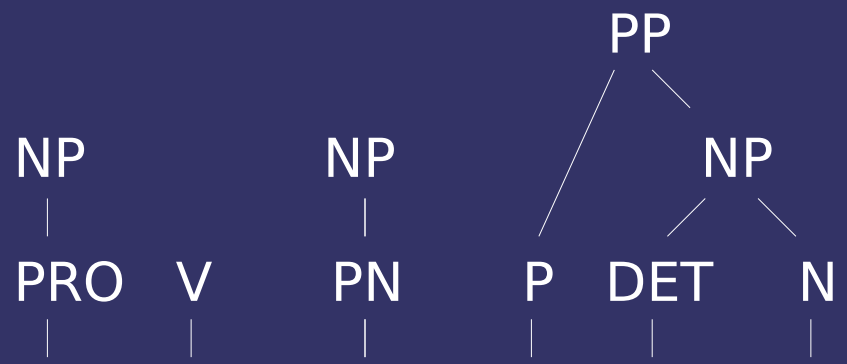
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{16}:



Parse: He saw Mary with a telescope

Stack: NP V NP PP

Input:

Aktion a_{17} = reduce(VP -> V NP PP)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

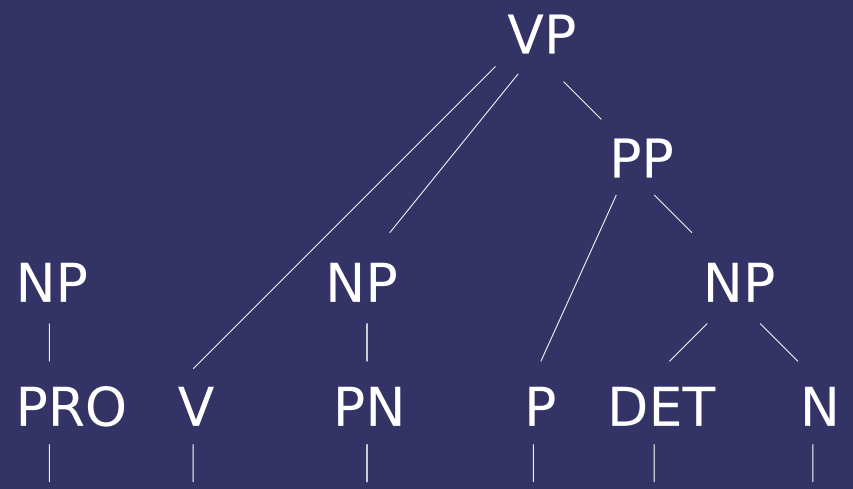
(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Zustand s_{17}:



Parse: He saw Mary with a telescope

Stack: NP VP

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

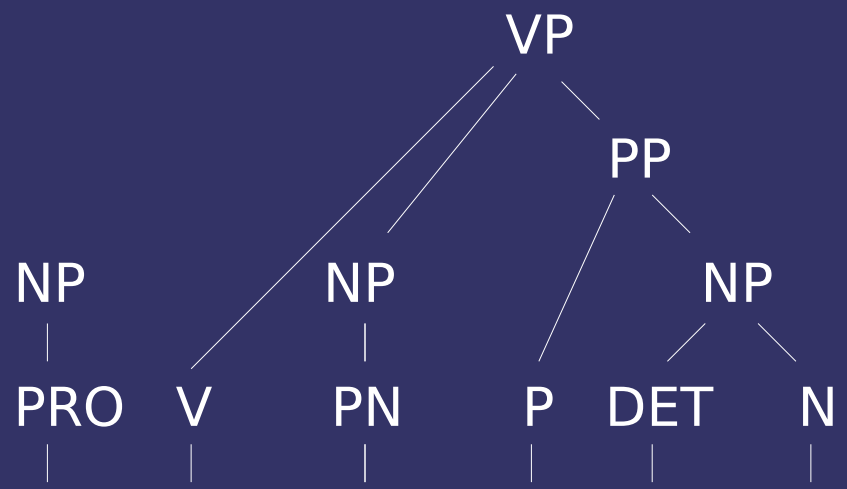
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{18}:



Parse: He saw Mary with a telescope

Stack: NP VP

Input:

Aktion a_{17} = reduce(S -> NP VP)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

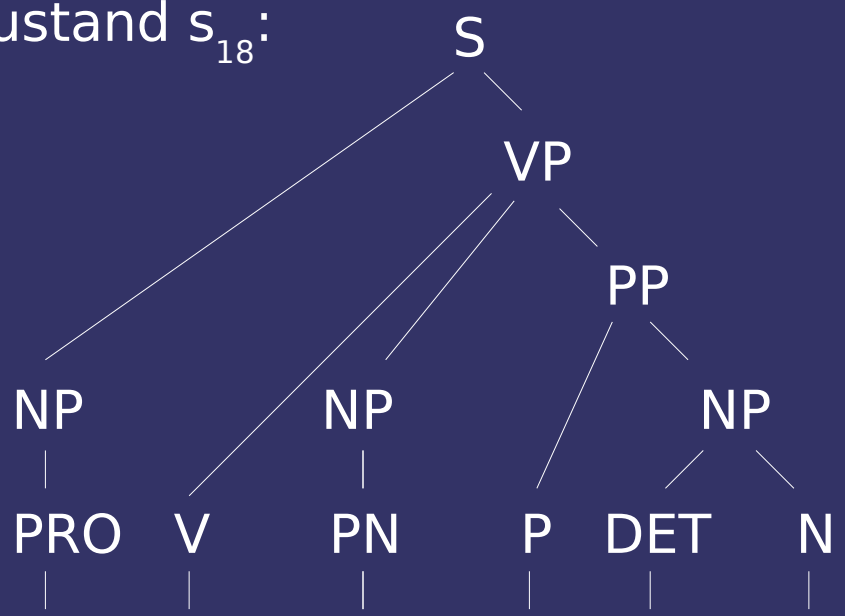
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{18}:



Parse: He saw Mary with a telescope

Stack: S

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

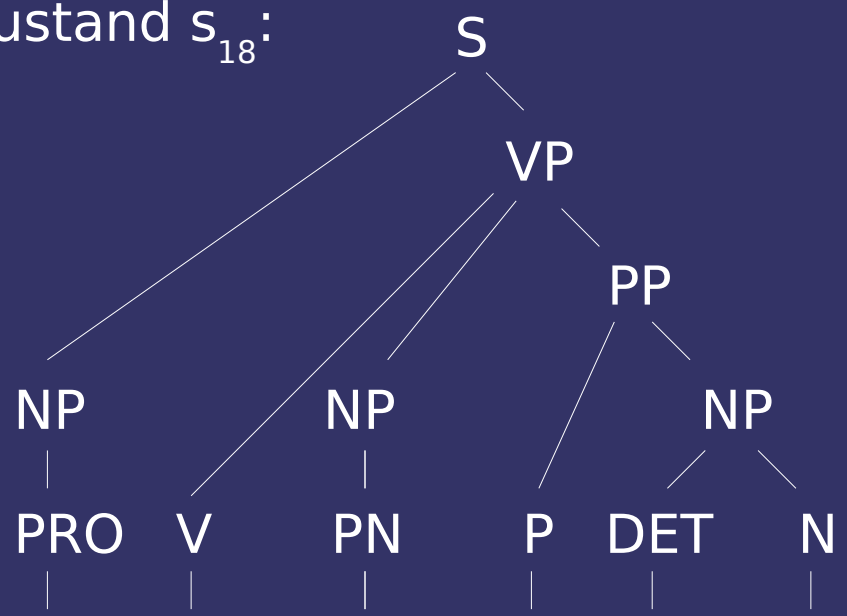
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{18}:



Parse: He saw Mary with a telescope

Stack: S

Input:

Parser terminiert, Startsymbol auf dem Stack, Eingabestring leer.

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

2. Shift-Reduce

2.3 Parsing

Backtracking:

Parse:

Stack:

Input: He saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) N -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(13) V -> saw

2. Shift-Reduce

2.3 Parsing

Backtracking:

Parse: He saw

Stack: NP saw

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) N -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(13) V -> saw

2. Shift-Reduce

2.3 Parsing

Backtracking:

Parse: He saw

Stack: NP N

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) N -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

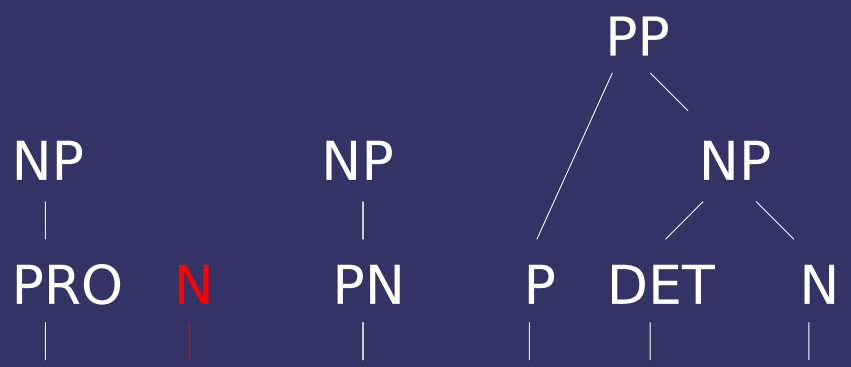
(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(13) V -> saw

Backtracking:



Parse: He saw Mary with a telescope

Stack: NP N NP PP

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) N -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

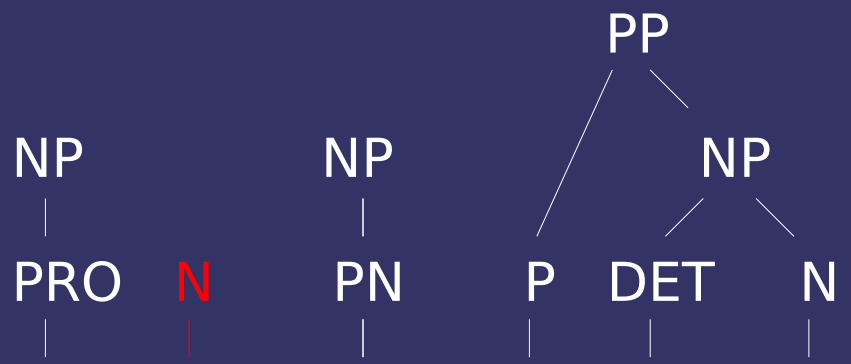
(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(13) V -> saw

Backtracking:



Parse: He saw Mary with a telescope

Stack: NP N NP PP

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) N -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(13) V -> saw

2. Shift-Reduce

2.3 Parsing

Backtracking:

Parse: He saw

Stack: NP saw

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) N -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(13) V -> saw

2. Shift-Reduce

2.3 Parsing

Backtracking:

Parse: He saw

Stack: NP V

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) N -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(13) V -> saw

2.4 Probleme

Zyklen: A -> B, B -> A, A -> a

2.4 Probleme

Tilgunsregeln der Form X -> ε

3. Top-Down Parsing

3.1 Die Grundidee

- Top-Down; von oben nach unten

- vom Abstrakten zum Konkreten

- Annahme, dass der Satz grammatisch ist

- Wir 'kennen' den Parsebaum, den wir erreichen wollen

3.2 Operationen

- Beschreibung
  - Input-Queue
  - Stack
  - Parse (Menge von Baumfragmenten)

3.2 Operationen

- PREDICT(list)
  - 'popt' den Stack
  - Generiert ein neues Item für jedes Element in der Liste
  - 'pusht' die Items in umgekehrter Reihenfolge auf den Stack
  - Macht jedes Item auf dem Stack zu einem Kind des gepopten Knoten

3.2 Operationen

- MATCH
  - Wird nur ausgeführt, wenn das oberste Element des Stacks ein **Terminal** ist
  - 'pop' auf den Stack
  - Ein Inputitem wird konsumiert
  - Das gepopte Item des Stacks wird im Baum durch das Inputitem ersetzt

3.3 Parsing

-Regelmenge

R={

S -> NP VP
PN -> Mary
P -> with
PRO -> He
VP -> V NP PP
V -> saw

PP -> P NP
NP -> PRO
NP -> PN
NP -> DET N
DET -> a
N -> telescope

}

'He saw Mary with a telescope'

3. Top-Down

3.3 Parsing

Startzustand:

Parse: S

Stack: S

Input: He saw Mary with a telescope

Aktion (1) = predict(NP, VP) (1)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

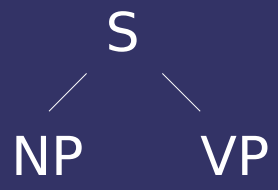
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

(1)



Parse:

Stack: NP VP

Input: He saw Mary with a telescope

Aktion (2) = predict(PRO) (2)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

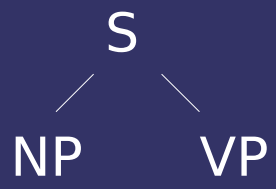
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Hier kommt Wahrscheinlichkeit ins Spiel...



Parse:

Stack: NP VP

Input: He saw Mary with a telescope

Ebenfalls Möglich: Aktion (2) = predict(Det N) (10)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

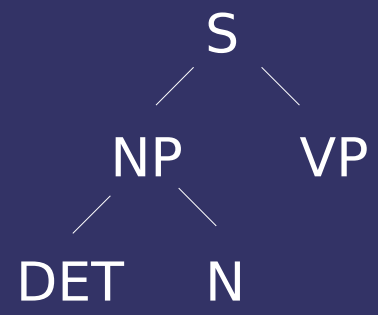
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

Hier kommt Wahrscheinlichkeit ins Spiel...



Parse:

Stack: DET N VP

Input: He saw Mary with a telescope

Aktion (3) = predict(a) (11)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

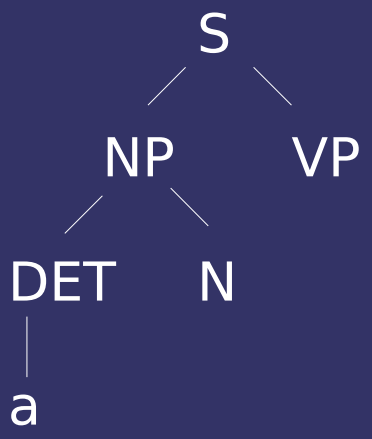
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

Hier kommt Wahrscheinlichkeit ins Spiel...



Parse:

Stack: a N VP

Input: He saw Mary with a telescope

Aktion (4) = match

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

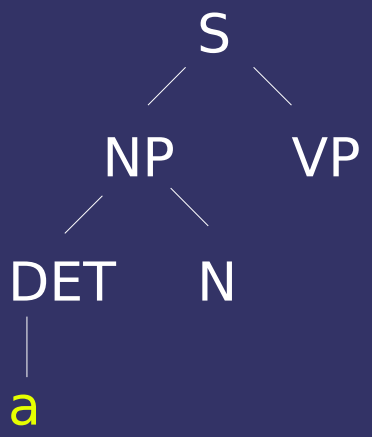
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

Hier kommt Wahrscheinlichkeit ins Spiel...



Parse:

Stack: a N VP

Input: He saw Mary with a telescope

Weiter im 'geplanten' Ablauf...

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

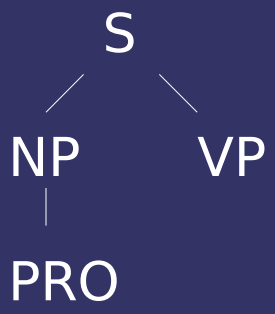
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

(2)



Parse:

Stack: PRO VP

Input: He saw Mary with a telescope

Aktion (3) = predict(He) (3)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

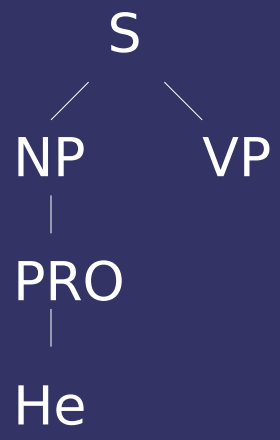
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

(3)



Parse:

Stack: He VP

Input: He saw Mary with a telescope

Aktion (4) = match

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

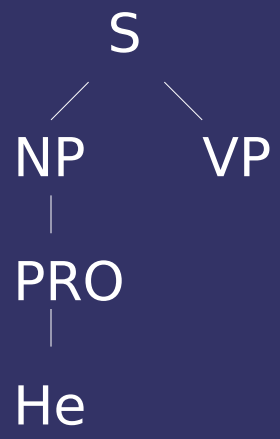
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(4)



Parse:

Stack: VP

Input: saw Mary with a telescope

Aktion (5) = predict(V NP PP) (4)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

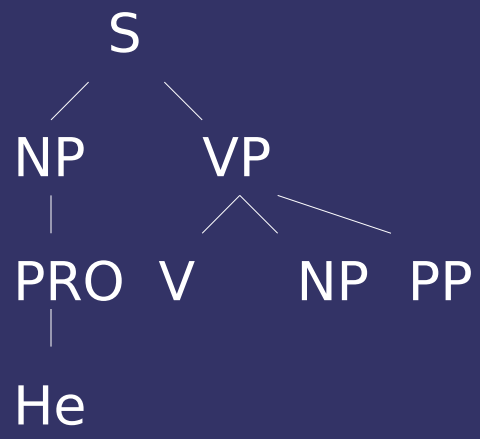
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(5)



Parse:

Stack: V NP PP

Input: saw Mary with a telescope

Aktion (6) = predict(saw) (5)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

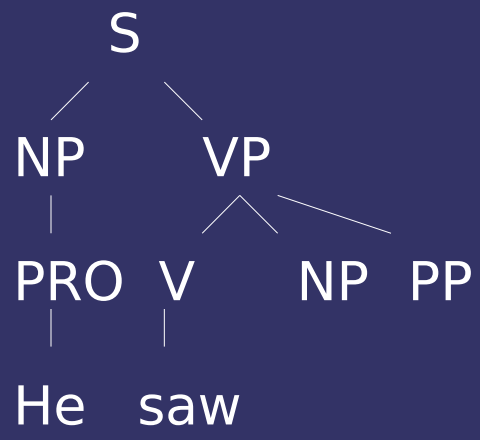
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(6)



Parse:

Stack: saw NP PP

Input: saw Mary with a telescope

Aktion (7) = match

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

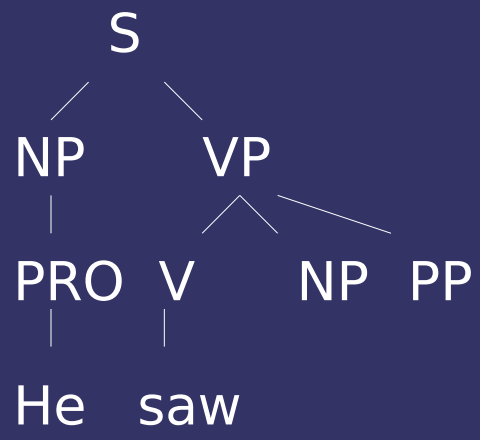
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(7)



Parse:

Stack: NP PP

Input: Mary with a telescope

Aktion (8) = predict(PN) (6)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

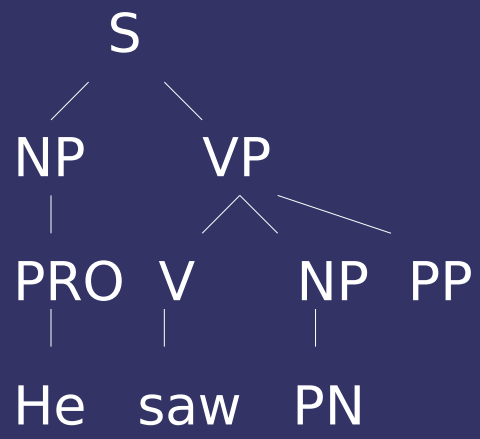
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(8)



Parse:

Stack: PN PP

Input: Mary with a telescope

Aktion (9) = predict(Mary) (7)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

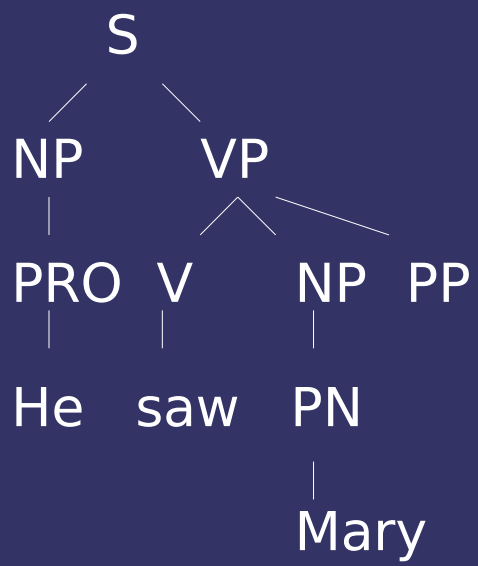
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(9)



Parse:

Stack: Mary PP

Input: Mary with a telescope

Aktion (10) = match

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

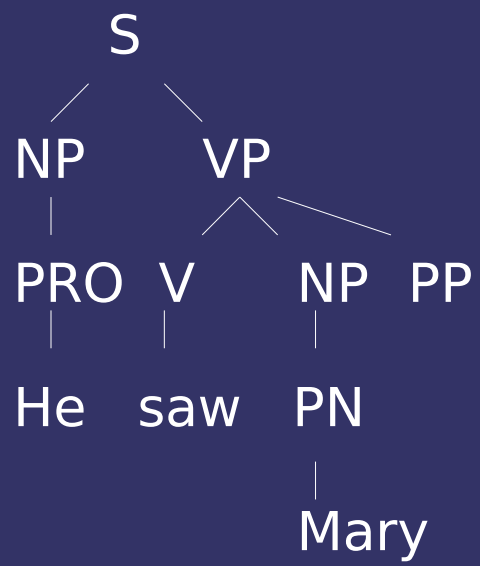
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(10)



Parse:

Stack: PP

Input: with a telescope

Aktion (11) = predict(P NP) (8)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

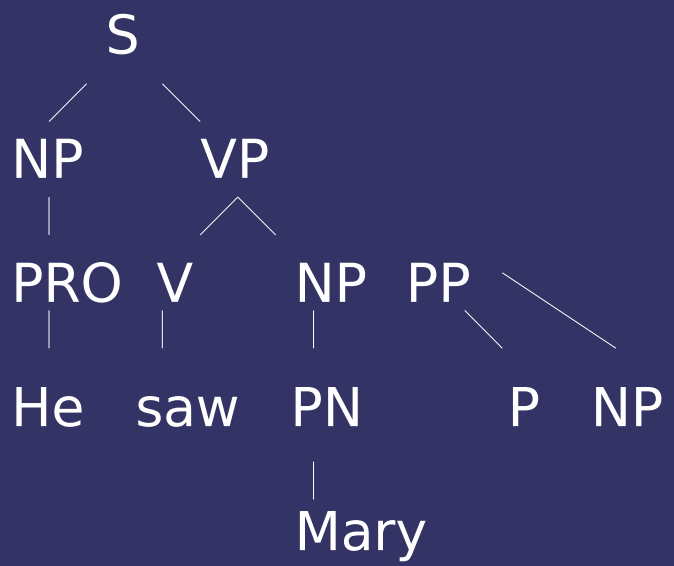
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(11)



Parse:

Stack: P NP

Input: with a telescope

Aktion (12) = predict(with) (9)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

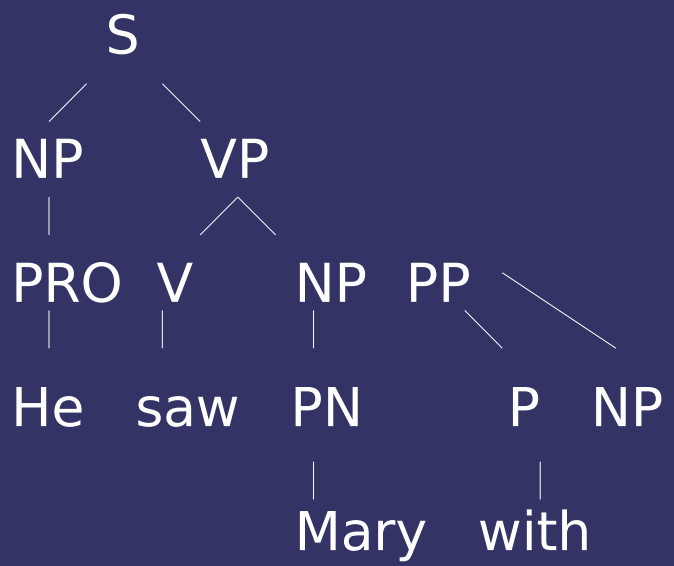
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

(12)



Parse:

Stack: with NP

Input: with a telescope

Aktion (13) = match

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

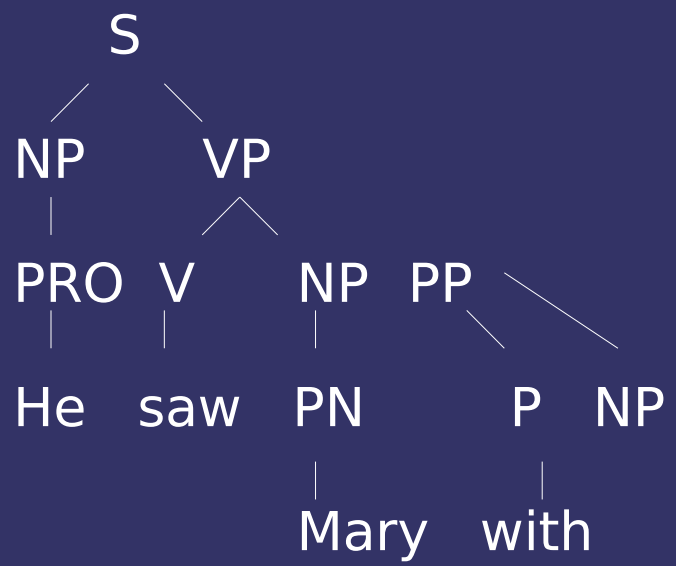
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

(13)



Parse:

Stack: NP

Input: a telescope

Aktion (14) = predict(DET N) (10)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

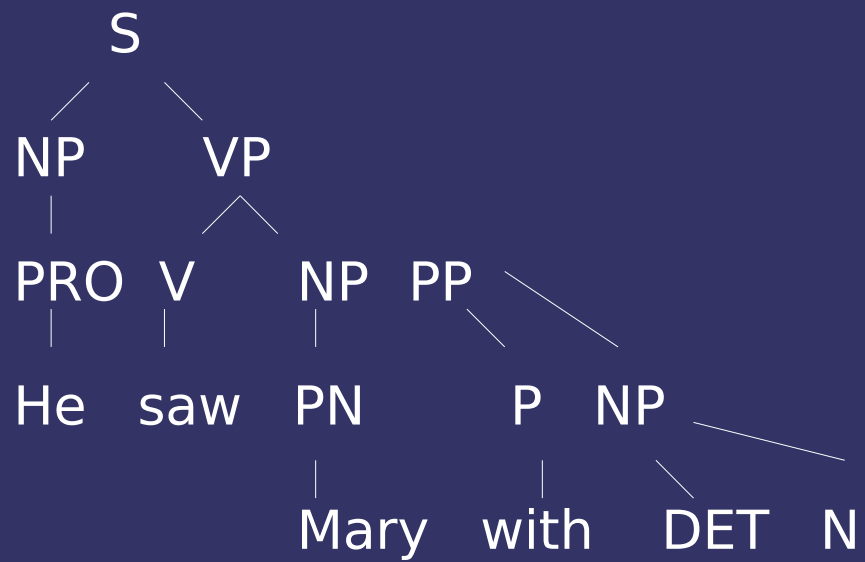
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

(14)



Parse:

Stack: DET N

Input: a telescope

Aktion (15) = predict(a) (11)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

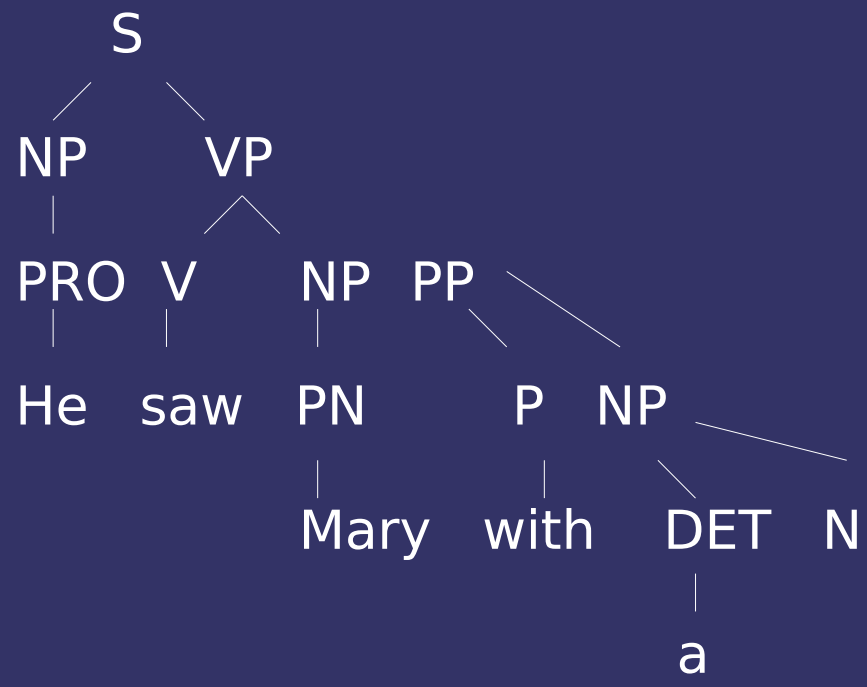
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

(15)



Parse:

Stack: a N

Input: a telescope

Aktion (16) = match

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

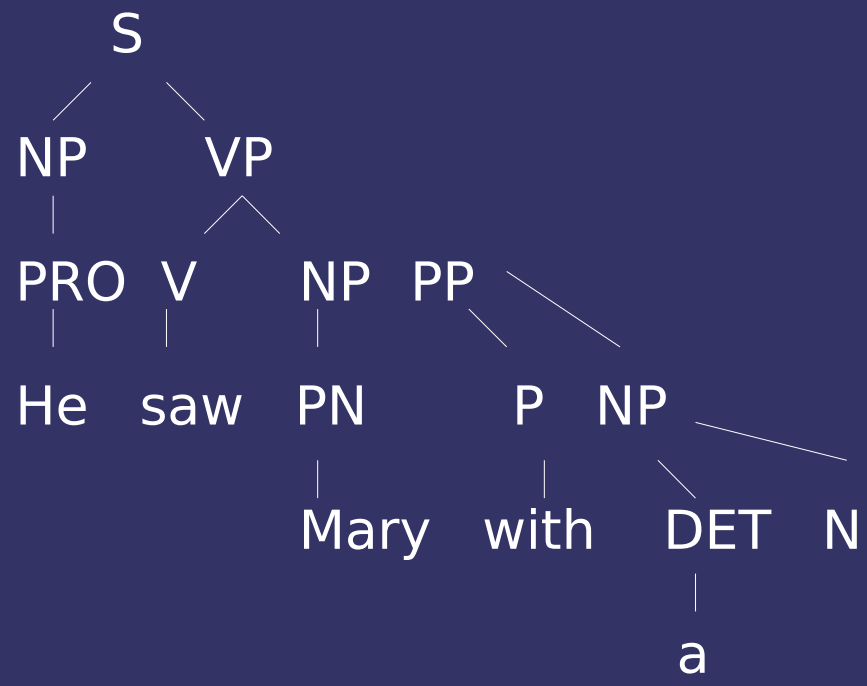
(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing

(16)



Parse:

Stack: N

Input: telescope

Aktion (17) = predict(telescope) (12)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

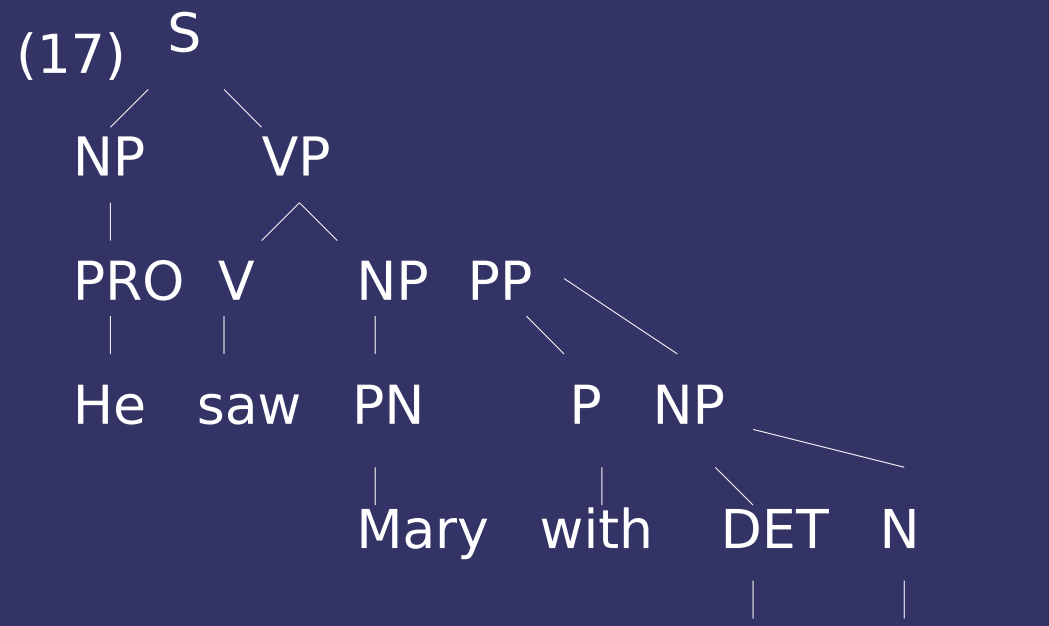
(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope



Parse: _____

Stack: telescope

Input: telescope

Aktion (18) = match

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

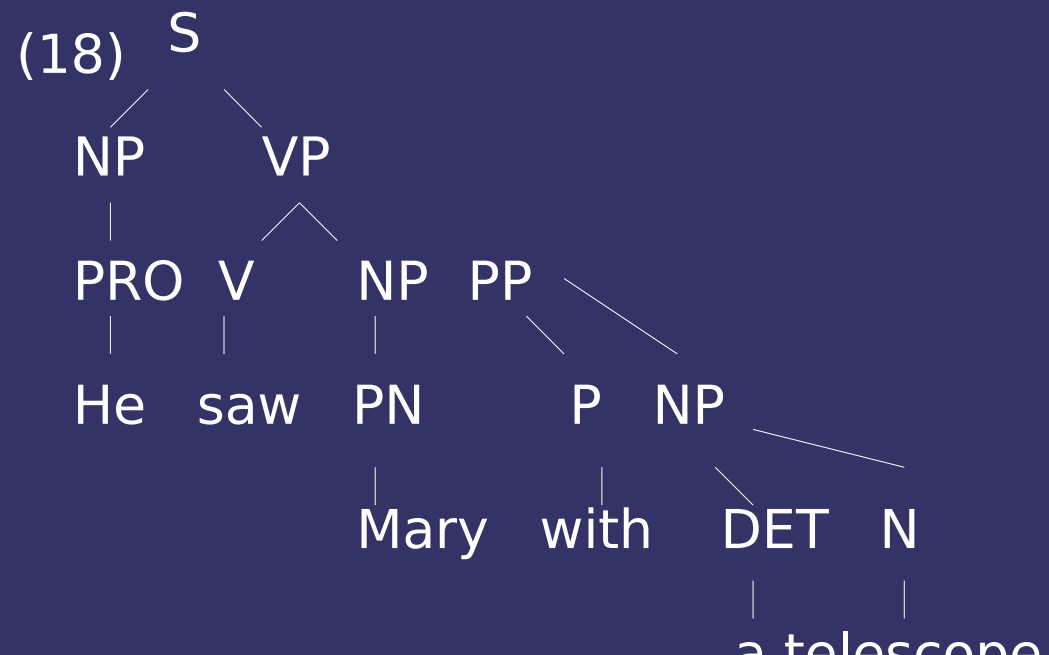
(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

3. Top-Down

3.3 Parsing



Parse:

Stack:

Input:

Der Parser terminiert, der Eingabestring ist leer!

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

3.4 Probleme

Ein großes Problem für Top-Down-Parser stellt Linksrekursion dar:

R={
NP -> NP conj NP
}

(1) NP -> NP conj NP
(2) NP conj NP -> NP conj NP conj NP
(3) NP conj NP conj NP -> NP conj NP conj NP conj NP
(4)...

Der TD-Parser wird nie Terminieren, da er zu keinem Zeitpunkt ein Terminal 'matchen' kann.

3.4 Probleme

Abhilfe zur Linksrekursion:

- Grammatik umwandlen, so dass sie nicht mehr linksrekursiv ist. (möglich)

- Aus linguistischer Sicht teilweise nicht erwünscht.

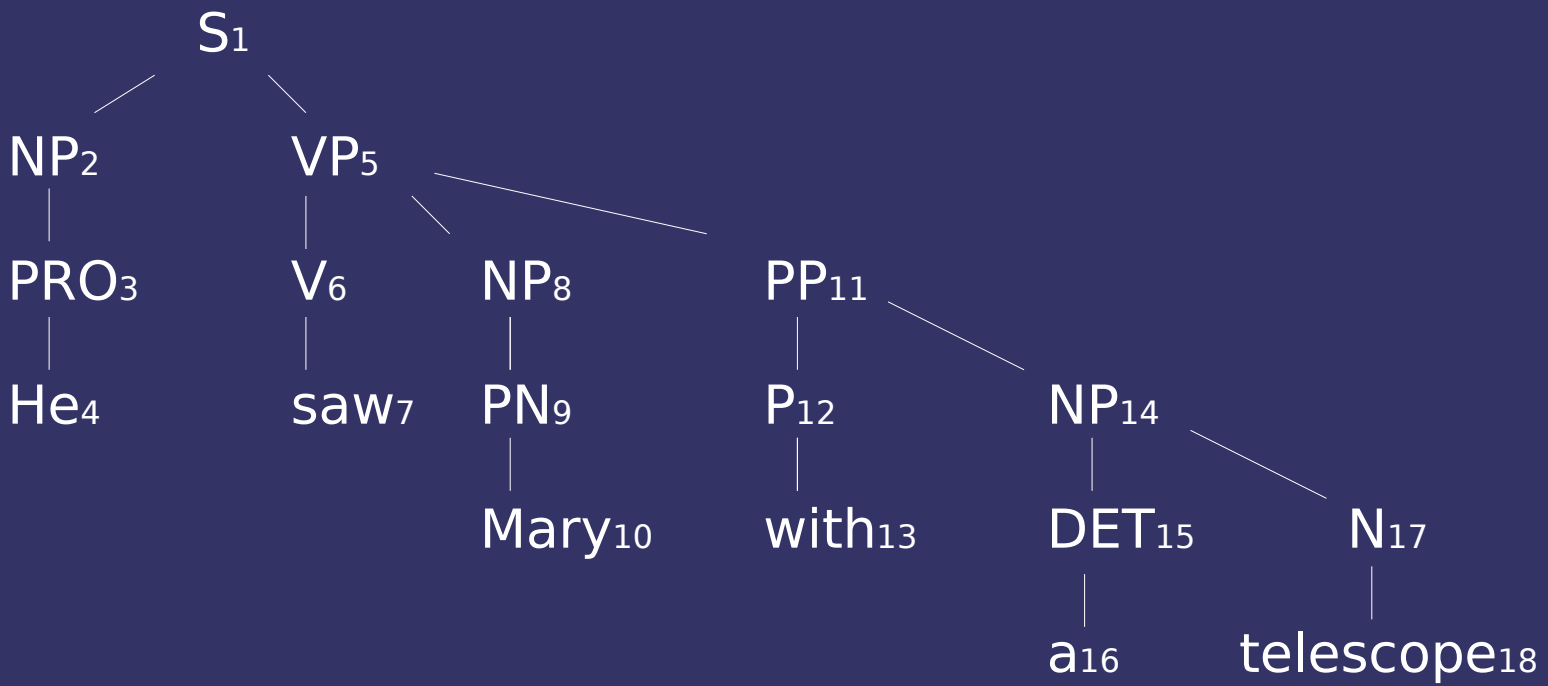
- Oder: Parsstrategie ändern

3.5 Unparsing

Auch der TD-Parser ist **reversibel**. Zu jeder predict-match Sequenz lässt sich ein eindeutiger Parsbaum erstellen.

Unser Beispiel:

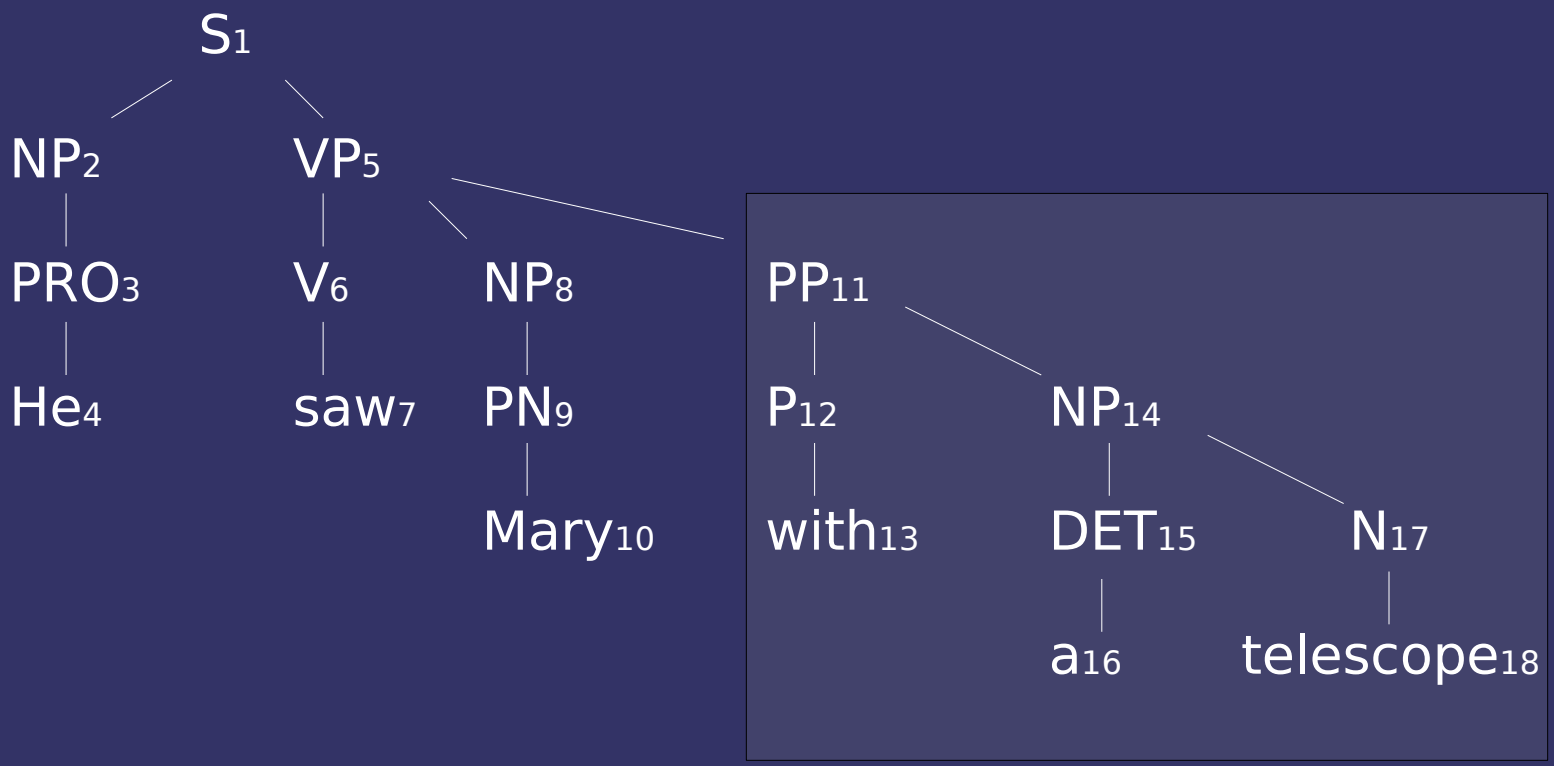
Es lässt sich eine Eindeutige Predict-Match Folge für jeden Parse des TD-Parsers finden, wenn man die Aktionen dann zuordnet, wenn der Parseknoten gerade oben auf dem Stack liegt:



3. Top-Down

3.5 Unparsing

Zu jedem Zeitpunkt i bilden die Aktionen $a_i \ldots a_{i+n}$ einen vollständigen Teilbaum mit Wurzel a_i. Im Bild gilt: $a_i = 11$



4. Left-Corner-Parsing

4.1 Grundidee

- kombiniert Top-Down und Bottom-Up

- Left-Corner: erstes Symbol auf der rechten Seite einer Regel

- Regeln werden anhand der Left Corner vorhergesagt

4.2 Operationen

- **Shift**: verschiebe Wort auf den Stack

- **Project**: wende Regel an, deren Left Corner mit dem obersten Stack-Element identisch ist, i.A. partielle Anw. der Regel

- **Attach**: wende Regel von rechts nach links an
(attach != reduce)

4. Left-Corner

4.3 Parsing

Zustand s_0:

Parse:

Stack:

Input: He saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

4. Left-Corner

4.3 Parsing

Zustand s_0:

Parse:

Stack:

Input: He saw Mary with a telescope

Aktion a_1 = shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

4. Left-Corner

4.3 Parsing

Zustand s_1:

Parse: He

Stack: He

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

4. Left-Corner

4.3 Parsing

Zustand s_1:

Parse: He

Stack: He

Input: saw Mary with a telescope

Aktion a_2 = Project(PRO -> He ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_2:

Parse: He

Stack: (PRO)

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_2:

PRO

/ \

??

Parse: He

Stack: (PRO)

Input: saw Mary with a telescope

Aktion a_3 = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_3:

PRO
|
Parse: He

Stack: PRO

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_3:

PRO

Parse: He

Stack: PRO

Input: saw Mary with a telescope

Aktion a_4 = Project(NP -> PRO ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

4. Left-Corner

4.3 Parsing

Zustand s_4:

Parse: He

Stack: (NP)

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_4:

Parse: He

Stack: (NP)

Input: saw Mary with a telescope

Aktion a_5 = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

4. Left-Corner

4.3 Parsing

Zustand s_5:

Parse: He

Stack: NP

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_5:

Parse: He

Stack: NP

Input: saw Mary with a telescope

Aktion a_6 = Project(S -> NP ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_6:

Parse: He

Stack: (S)

Input: saw Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_6:

Parse: He

Stack: (S)

Input: saw Mary with a telescope

Aktion a_7 = shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_7:

Parse: He saw

Stack: (S) saw

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_7:

Parse: He saw

Stack: (S) saw

Input: Mary with a telescope

Aktion a_8 = Project(V -> saw ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

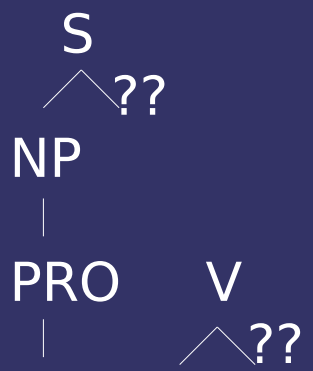
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_8:



Parse: He saw

Stack: (S) (V)

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

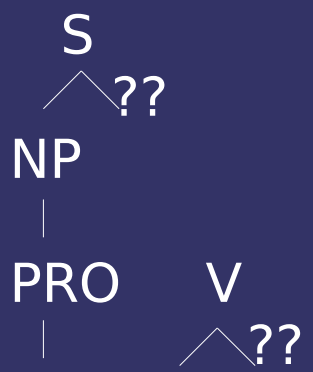
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_8:



Parse: He saw

Stack: (S) (V)

Input: Mary with a telescope

Aktion a_9 = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

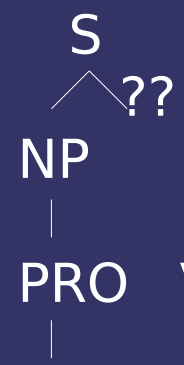
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_9:



Parse: He saw

Stack: (S) V

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

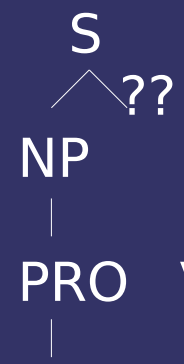
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_9:



Parse: He saw

Stack: (S) V

Input: Mary with a telescope

Aktion a_{10} = Project(VP -> V ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

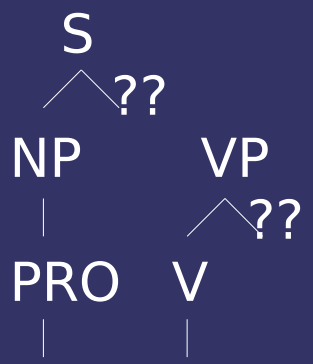
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{10}:



Parse: He saw

Stack: (S) (VP)

Input: Mary with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

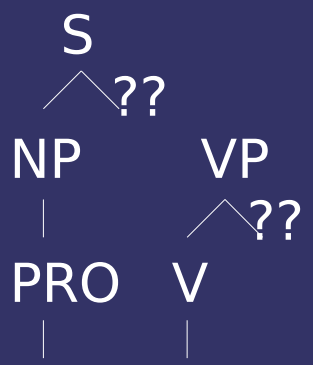
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{10}:



Parse: He saw

Stack: (S) (VP)

Input: Mary with a telescope

Aktion a_{11} = Shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

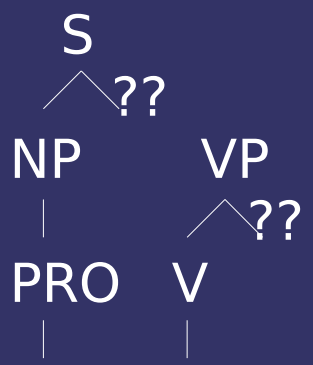
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{11}:



Parse: He saw Mary

Stack: (S) (VP) Mary

Input: with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

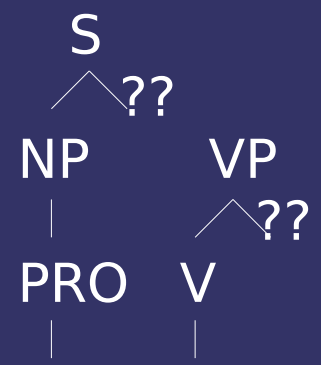
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{11}:



Parse: He saw Mary

Stack: (S) (VP) Mary

Input: with a telescope

Aktion a_{12} = Project(PN -> Mary ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

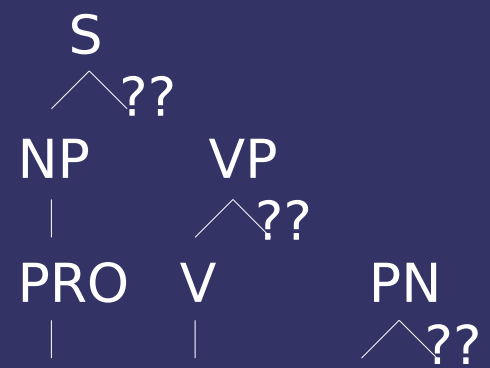
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{12}:



Parse: He saw Mary

Stack: (S) (VP) (PN)

Input: with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

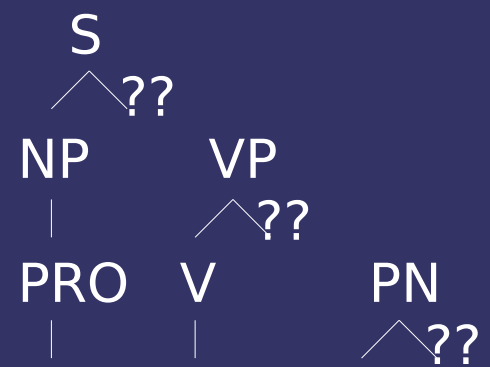
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{12}:



Parse: He saw Mary

Stack: (S) (VP) (PN)

Input: with a telescope

Aktion a_{13} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

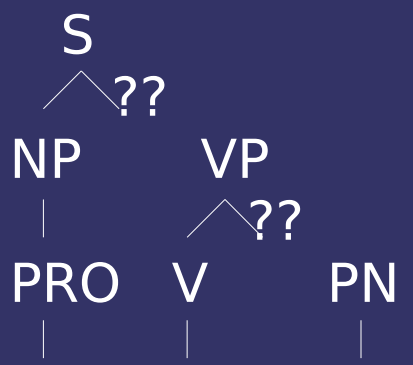
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{13}:



Parse: He saw Mary

Stack: (S) (VP) PN

Input: with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

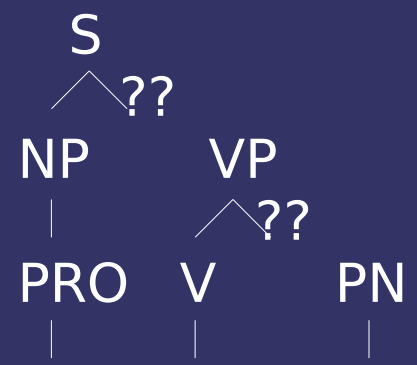
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{13}:



Parse: He saw Mary

Stack: (S) (VP) PN

Input: with a telescope

Aktion a_{14} = Project(NP -> PN ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

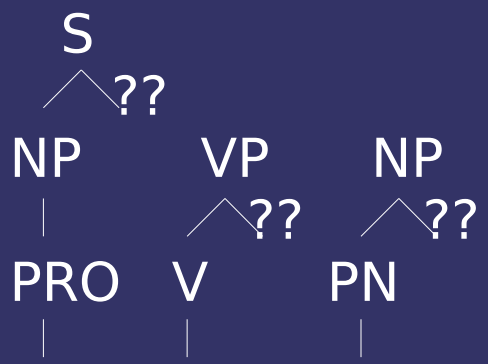
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{14}:



Parse: He saw Mary

Stack: (S) (VP) (NP)

Input: with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

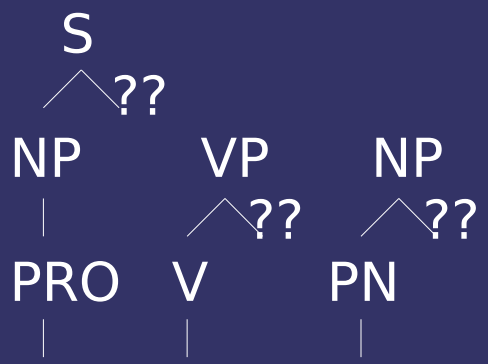
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{14}:



Parse: He saw Mary

Stack: (S) (VP) (NP)

Input: with a telescope

Aktion a_{15} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

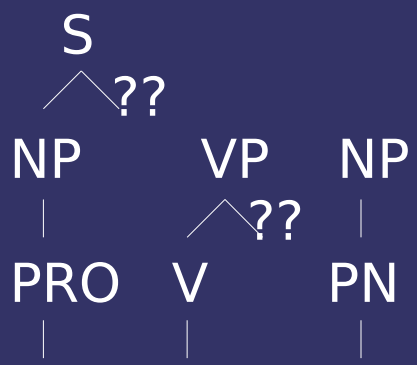
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{15}:



Parse: He saw Mary

Stack: (S) (VP) NP

Input: with a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

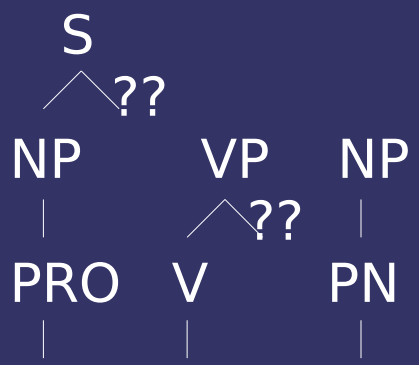
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{15}:



Parse: He saw Mary

Stack: (S) (VP) NP

Input: with a telescope

Aktion a_{16} = Shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

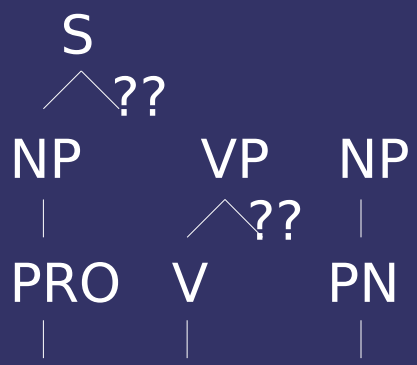
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{16}:



Parse:	He	saw	Mary	with
Stack:	(S)	(VP)	NP	with
Input:				a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

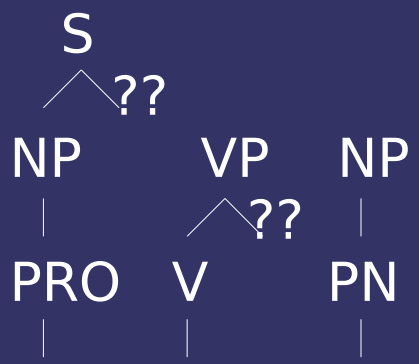
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{16}:



Parse: He saw Mary with

Stack: (S) (VP) NP with

Input: a telescope

Aktion a_{17} = Project(P -> with ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

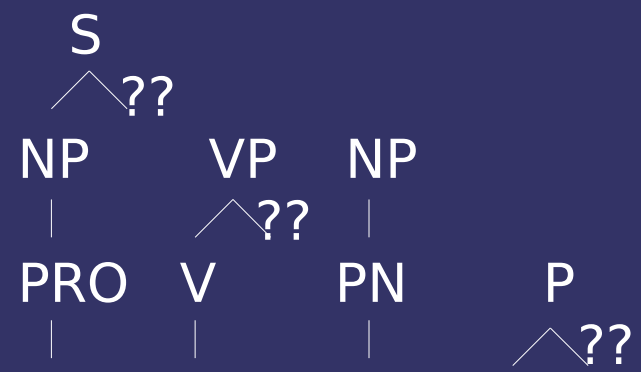
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{17}:



Parse: He saw Mary with

Stack: (S) (VP) NP (P)

Input: a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

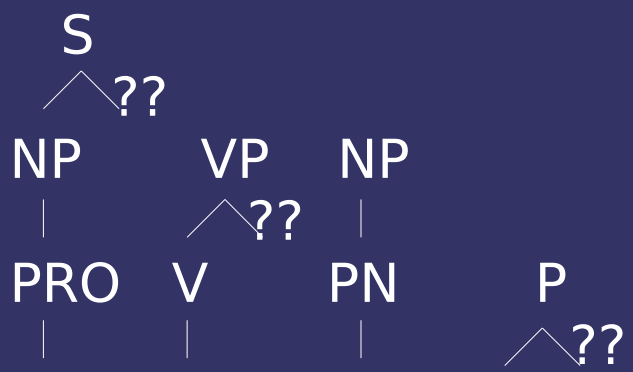
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{17}:



Parse: He saw Mary with

Stack: (S) (VP) NP (P)

Input: a telescope

Aktion a_{18} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

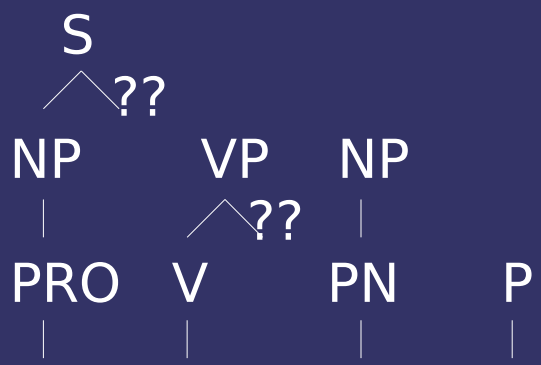
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{18}:



Parse:	He	saw	Mary	with
Stack:	(S)	(VP)	NP	P
Input:				a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

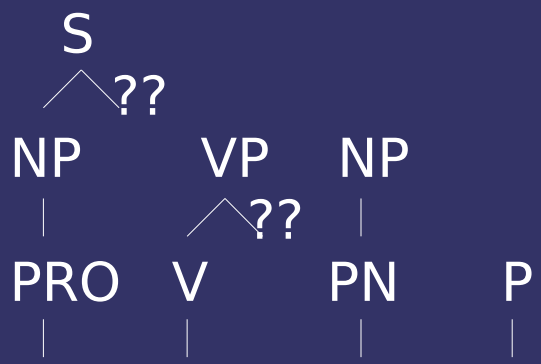
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{18}:



Parse: He saw Mary with

Stack: (S) (VP) NP P

Input: a telescope

Aktion a_{19} = Project(PP -> P ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

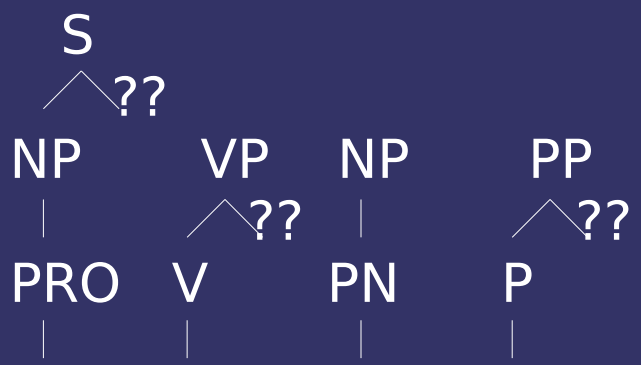
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{19}:



Parse: He saw Mary with

Stack: (S) (VP) NP (PP)

Input: a telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

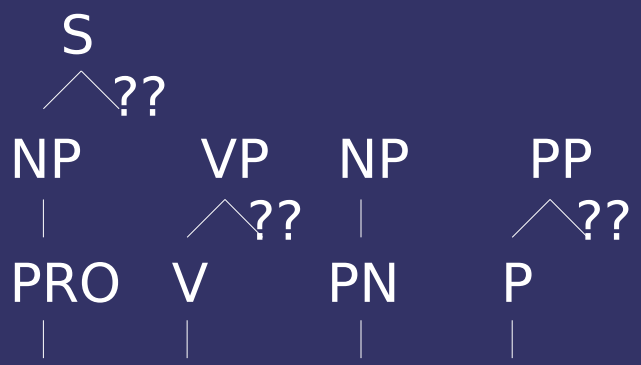
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{19}:



Parse: He saw Mary with

Stack: (S) (VP) NP (PP)

Input: a telescope

Aktion a_{20} = Shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

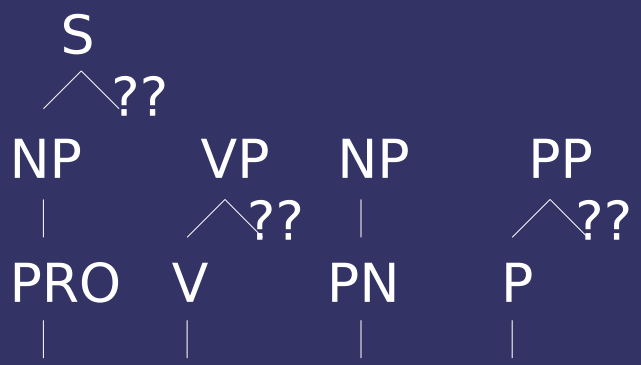
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{20}:



Parse:	He	saw	Mary	with		a
Stack:	(S)	(VP)		NP	(PP)	a
Input:					telescope	

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

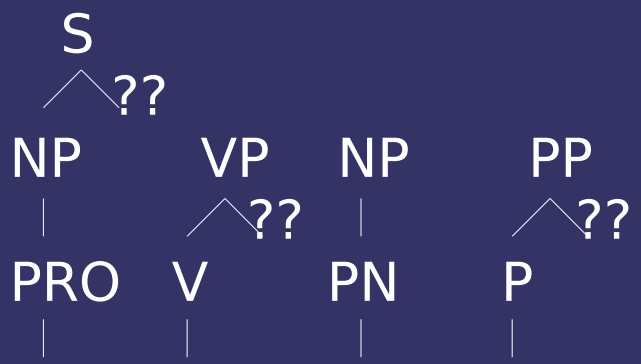
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{20}:



Parse: He saw Mary with a

Stack: (S) (VP) NP (PP) a

Input: telescope

Aktion a_{21} = Project(DET -> a ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

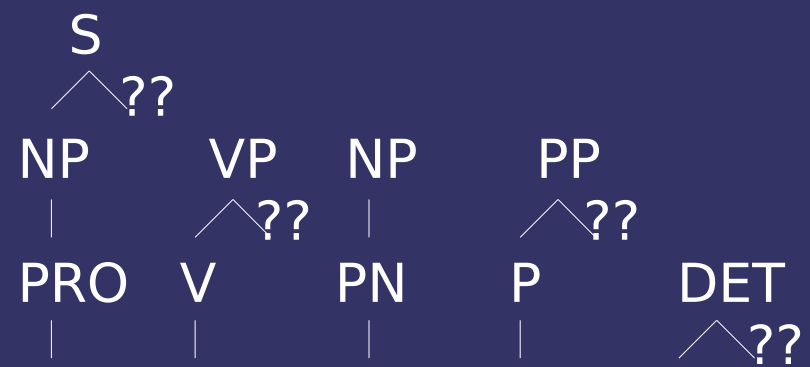
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{21}:



Parse: He saw Mary with a

Stack: (S) (VP) NP (PP) (DET)

Input: telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

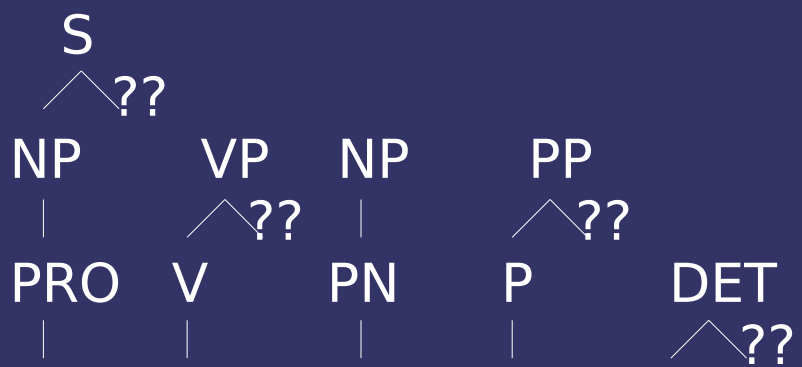
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{21}:



Parse: He saw Mary with a

Stack: (S) (VP) NP (PP) (DET)

Input: telescope

Aktion a_{22} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

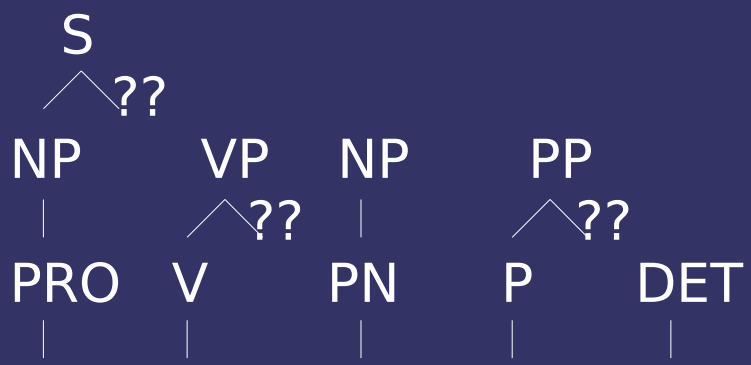
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{22}:



Parse:	He	saw	Mary	with	a	
Stack:	(S)	(VP)	NP	(PP)	DET	
Input:						telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

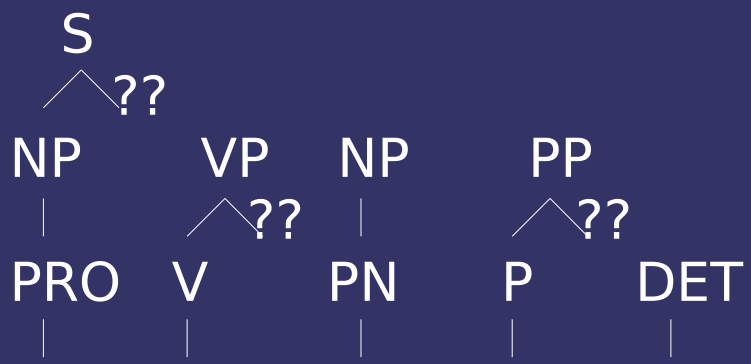
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{22}:



Parse: He saw Mary with a

Stack: (S) (VP) NP (PP) DET

Input: telescope

Aktion a_{23} = Project(NP -> Det ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

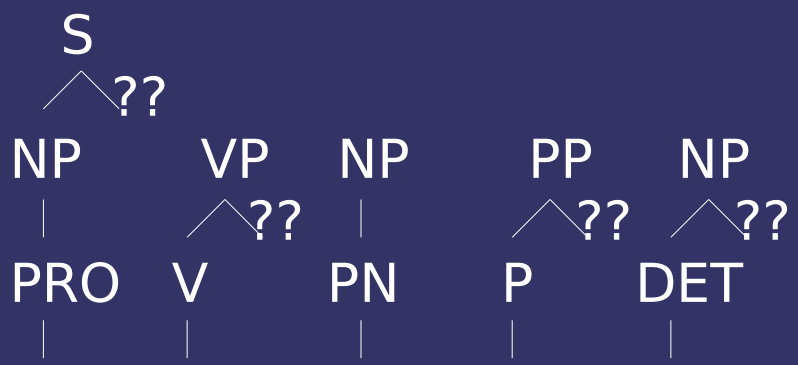
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{23}:



Parse: He saw Mary with a

Stack: (S) (VP) NP (PP) (NP)

Input: telescope

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

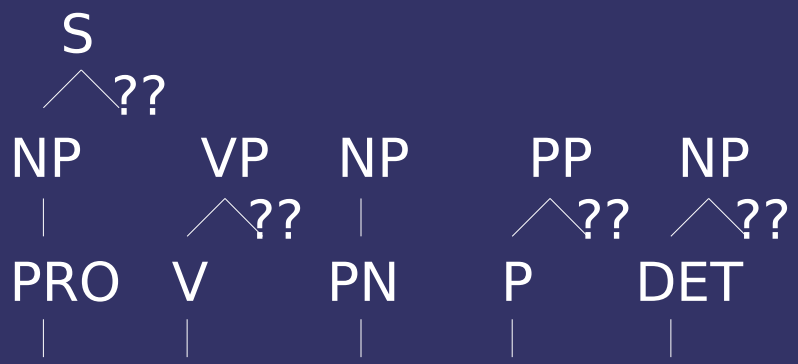
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{23}:



Parse: He saw Mary with a

Stack: (S) (VP) NP (PP) (NP)

Input: telescope

Aktion a_{24} = Shift

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

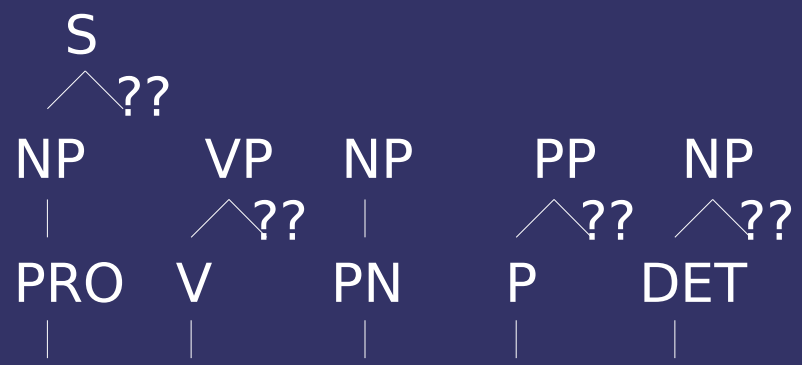
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{24}:



Parse:	He	saw	Mary	with	a	telescope
Stack:	(S)	(VP)	NP	(PP)	(NP)	telescope
Input:						

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

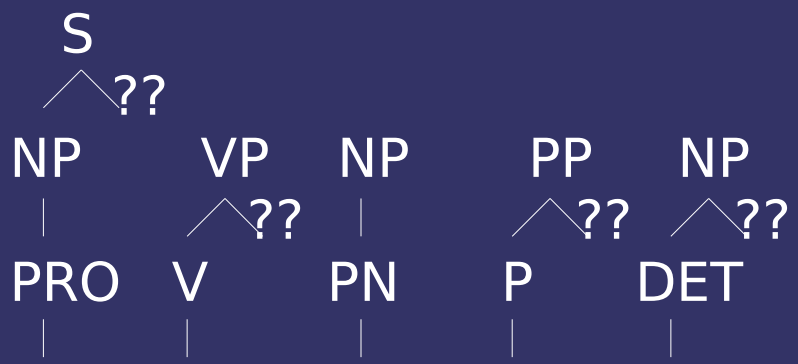
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{24}:



Parse: He saw Mary with a telescope

Stack: (S) (VP) NP (PP) (NP) telescope

Input:

Aktion a_{25} = Project(N -> telescope ??)

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

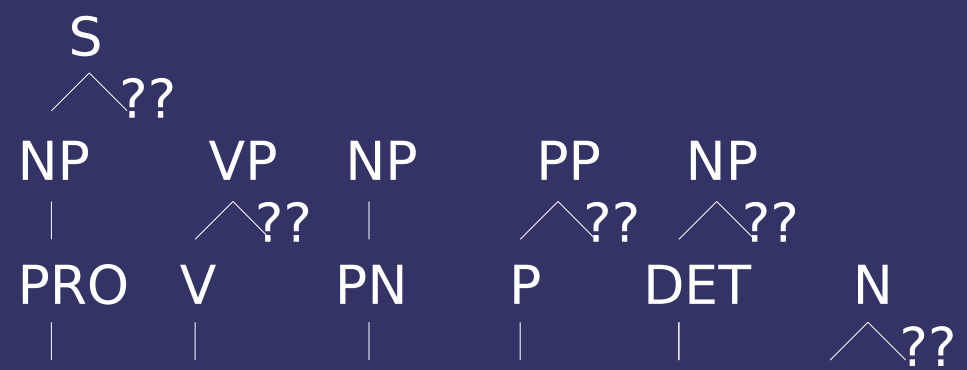
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{25}:



Parse: He saw Mary with a telescope

Stack: (S) (VP) NP (PP) (NP) (N)

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

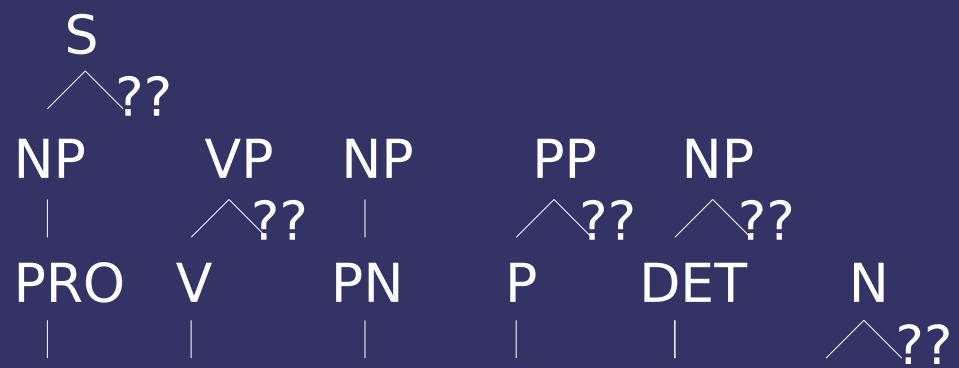
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{25}:



Parse: He saw Mary with a telescope

Stack: (S) (VP) NP (PP) (NP) (N)

Input:

Aktion a_{26} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

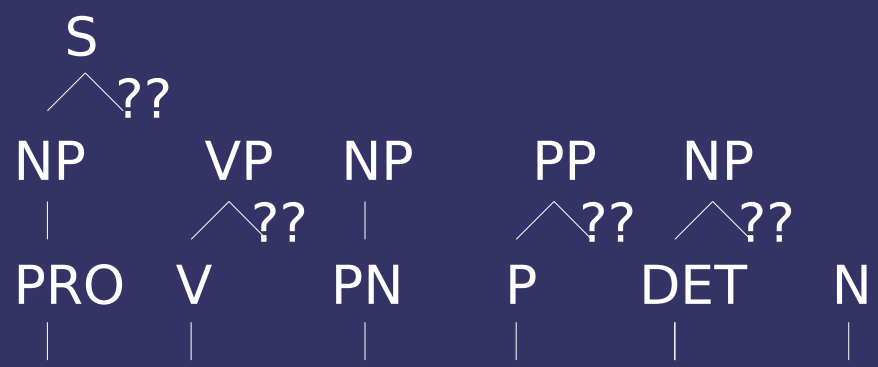
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{26}:



Parse: He saw Mary with a telescope

Stack: (S) (VP) NP (PP) (NP) N

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

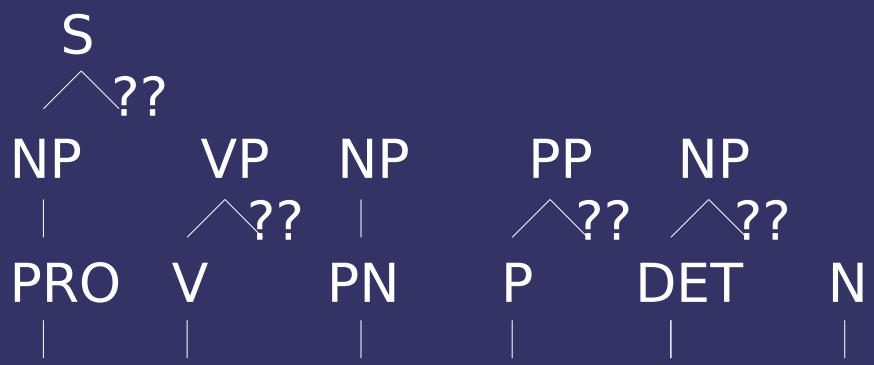
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{26}:



Parse:	He	saw	Mary	with		a	telescope
Stack:	(S)	(VP)		NP	(PP)	(NP)	N
Input:							

Aktion a_{27} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

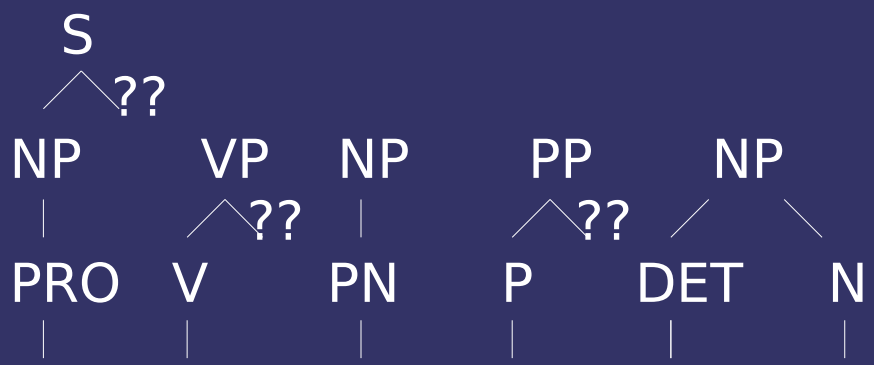
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{27}:



Parse: He saw Mary with a telescope

Stack: (S) (VP) NP (PP) NP

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

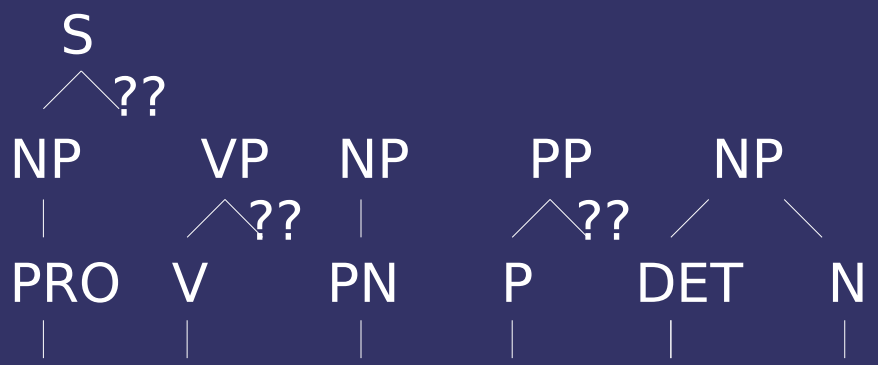
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{27}:



Parse: He saw Mary with a telescope

Stack: (S) (VP) NP (PP) NP

Input:

Aktion a_{28} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

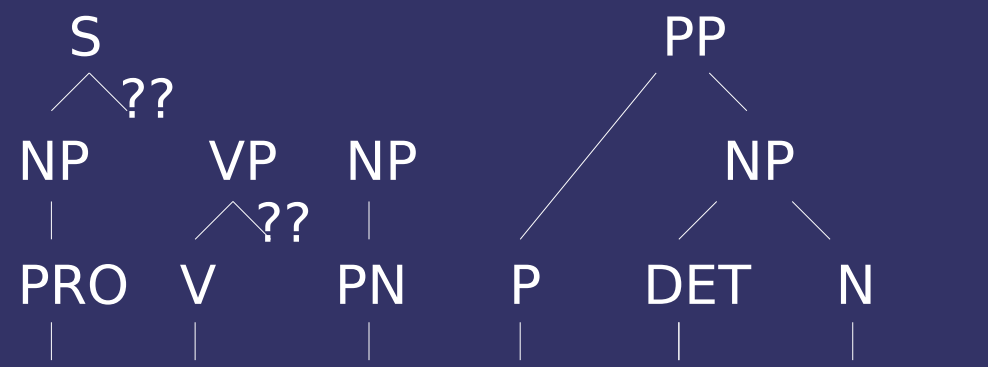
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{28}:



Parse: He saw Mary with a telescope

Stack: (S) (VP) NP PP

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

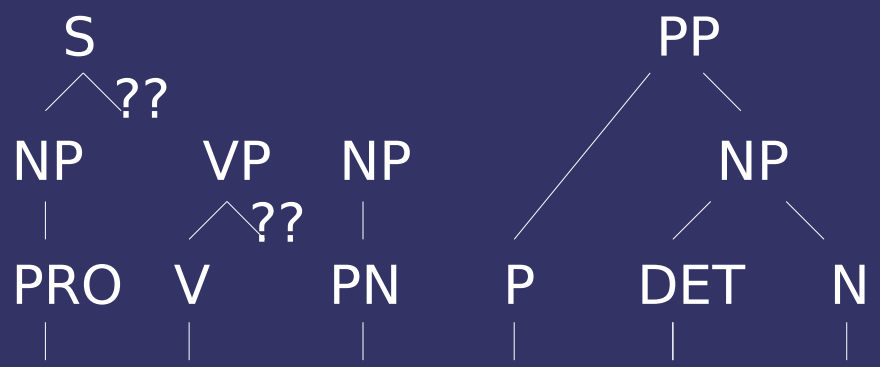
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{28}:



Parse: He saw Mary with a telescope

Stack: (S) (VP) NP PP

Input:

Aktion a_{29} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

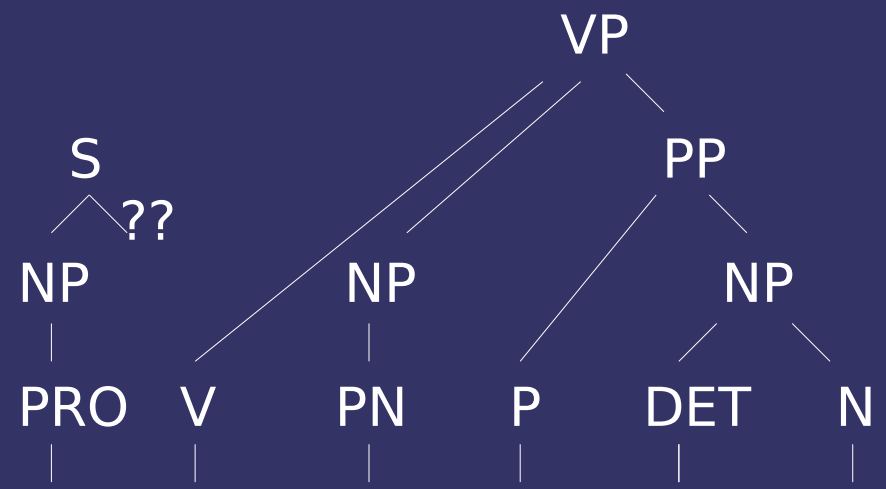
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{29}:



Parse: He saw Mary with a telescope

Stack: (S) VP

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

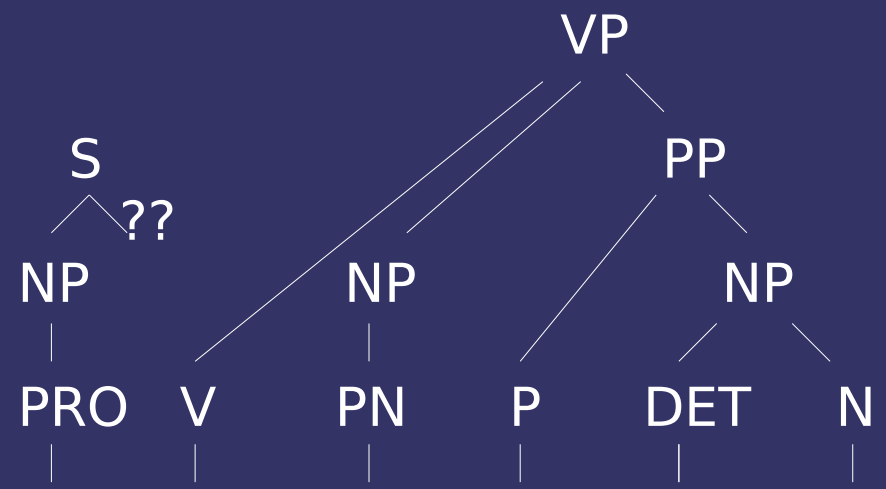
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{29}:



Parse: He saw Mary with a telescope

Stack: (S) VP

Input:

Aktion a_{30} = Attach

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

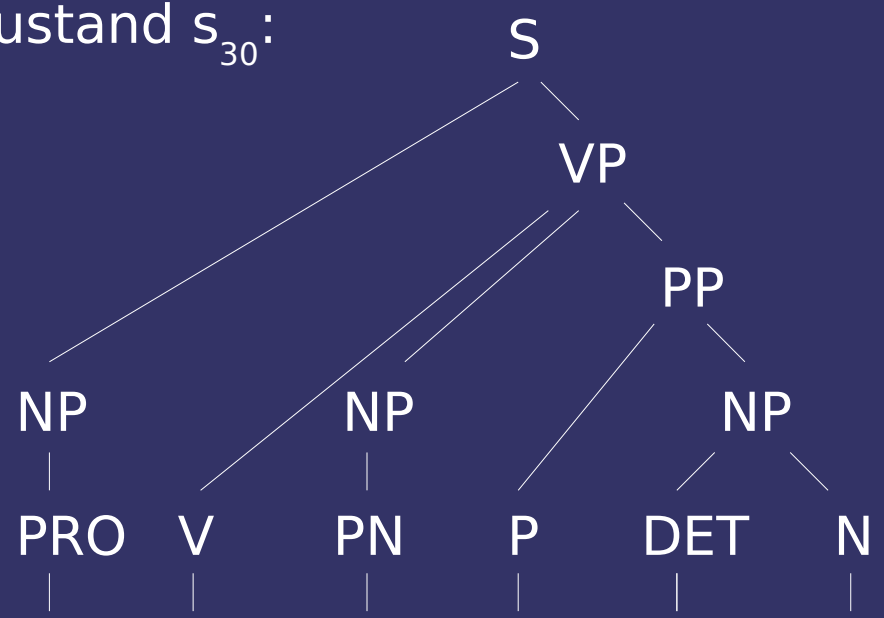
(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

Zustand s_{30}:



Parse: He saw Mary with a telescope

Stack: S

Input:

Grammatik:

(1) S -> NP VP

(2) NP -> PRO

(3) PRO -> He

(4) VP -> V NP PP

(5) V -> saw

(6) NP -> PN

(7) PN -> Mary

(8) PP -> P NP

(9) P -> with

(10) NP -> DET N

(11) DET -> a

(12) N -> telescope

4.4 Probleme

wie beim SR-Parser:

- Zyklen

- ε-Regeln

5. Ausblick

5.1 Binarization

- Erstellung von Binärbäumen

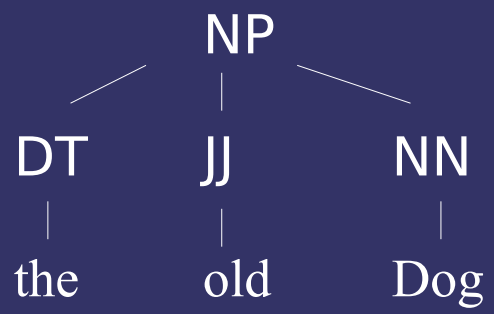
- Verschiedene Möglichkeiten der B.

- Kalt benutzt 4 Arten von B.
  - left binarization
  - right binarization to binary
  - right binarization to unary
  - right binarization to nullary

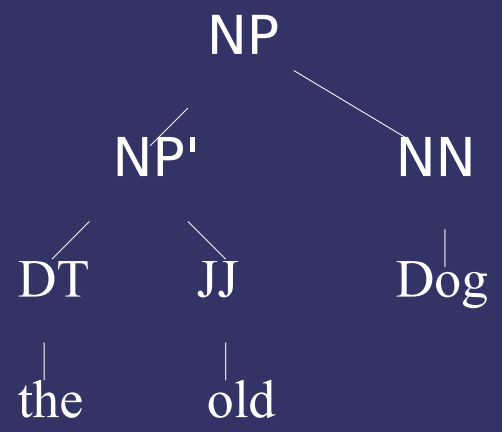
- $G_{b1} <> G_{b2}$

Ursprüngliche Grammatik

G = <Φ, Σ, R, NP>
Φ = {NP, DT, JJ, NN}
Σ = {the, old, dog}
R = {NP->DT JJ NN, DT->the, JJ->old, NN->dog}

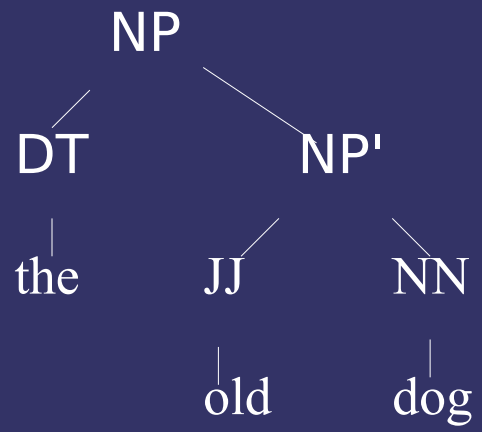


left binarized(L)



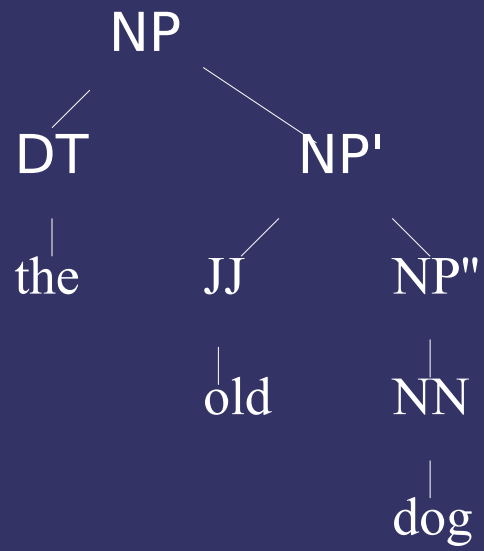
G = <Φ, Σ, R, NP>
Φ = {NP, DT, JJ, NN, NP'}
Σ = {the, old, dog}
R = {NP->NP' NN, NP'->DT JJ, DT->the, JJ->old,
NN->dog}

right binarized to binary(R2)



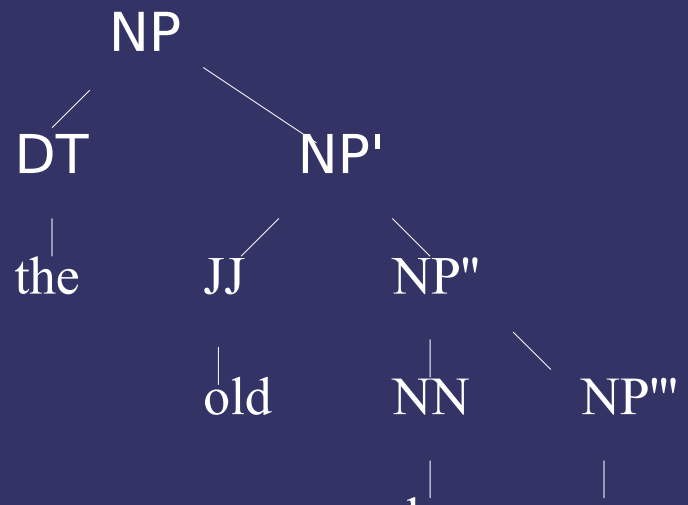
G = <Φ, Σ, R, NP>
Φ = {NP, DT, JJ, NN, NP'}
Σ = {the, old, dog}
R = {NP->DT NP', NP'->JJ NN, DT->the, JJ->old,
NN->dog}

right binarized to unary(R1)



G = <Φ, Σ, R, NP>
Φ = {NP, DT, JJ, NN, NP'}
Σ = {the, old, dog}
R = {NP->DT NP', NP'->JJ NP'', NP''->NN,
DT->the, JJ->old, NN->dog}

right binarized to nullary(R0)



G = <Φ, Σ, R, NP>
Φ = {NP, DT, JJ, NN, NP'}
Σ = {the, old, dog}
R = {NP->DT NP', NP'->JJ NP'', NP''->NN NP''',
DT->the, JJ->old, NN->dog, NP'''->ε}

5.2 Markov Parsing Models (MPM)

- Wahrscheinlichkeitsmodell
- In jedem Zustand s_i wählt der Parser eine Aktion a_i, die für den gegebenen Zustand s_i die höchste Wahrscheinlichkeit aufweist.

- formal: $P(t|\sigma) = \prod_{i=1}^{n} P(a_i|s_i)$

σ = input string
t = parse,

5.3 Ergebnisse (Kalt)

Parser	Transformation	Coverage	Length <= 100 Precision	Length <= 40 Precision	Words per second
SR	L	99.8	75.8	77.0	33,74
SR	R2	94.9	77.2	78.2	33,56
SR	R1	90.8	77.3	78.3	28,4
LC	L	95.6	71.9	72.8	25,81
LC	R2	99.9	74.0	75.0	24,95
LC	R1	96.2	74.3	75.4	21,61
TD	L	31.0	57.1	58.3	41,74
TD	R2	42.3	61.6	62.6	45,27
TD	R1	72.0	66.8	68.2	30,73
TD	R0	98.4	72.1	73.2	21,3

5.4 Folgerung

- Die erreichten Werte entsprechen ca. den Werten des Statistischen Parsings vor 10 Jahren (Charniak '96)

- Allerdings ist es mit der Methode Kalts möglich, in linearer Zeit zu parsen (kein backtracking!)

- Geschwindigkeiten nahe PoS-Taggern

- SotA des statistischen Parsings

Quellen:

Kalt,Tom: Induction of greedy controllers for deterministic treebank parsers, DCS Massachusetts

Prescher, Detlef: Unparsing, University of Amsterdam

(Linksrekursion)
http://www.brawer.ch/prolog/DCGs.pdf