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Class Assignment
PCFG

Sentence : I saw a man with the telescope

Lexicons:

N → dog (0.3)	Det → the (0.4)	Adj → old (0.25)
N → man (0.4)	Det → a (0.6)	Adj → small (0.75)
N → cat (0.28)		
N → telescope (0.02)		

V → ate (0.4)	Pronoun → I (0.5)	Preposition → with (0.9)
V → cried (0.2)	Pronoun → he (0.5)	Preposition → under (0.1)
V → saw (0.4)		

Productions:

Production	Probability
S → VP NP	(0.4)
S → NP VP	(0.6)
VP → V	0.3
VP → V NP	0.3
VP → V PP	0.25
VP → V NP PP	0.15
NP → Pronoun	0.1
NP → Det Noun	0.3
NP → Det Adj Noun	0.2
NP → Noun	0.4
NP → NP PP	0.1
PP → Preposition NP	1

Bottom Up Parsing Table

State	Input	Action
$	I saw a man with a Telescope	shift
$i	saw a man with a telescope .	Reduce (Pr → i)
$ Pronoun	saw a man with the telescope $	Reduce (NP → Pr)
$NP	saw a man with the telescope $	shift
$NP saw	a man with the telescope . $	Reduce (V → saw)
$NP V	a man with the telescope $	shift
$NP V a	man with the telescope $	shift
$PP V Det	man with the telescope $	Shift
$NP V Det man	with the telescope $	Reduce (N → man)
$NP V Det N	with the telescope $	Reduce (NP → Det)
$NP V NP	with the telescope $	Shift
$ NP V NP with	with the telescope $	Reduce (Pr → with)
$NP V NP Prep	the telescope $	Shift
$ NP V NP Prep the	telescope $	Reduce (N → telescope)
$NP V NP Prep Det	telescope $	Shift
$ NP V NP Prep Det telescope	$	Reduce (N → telescope)
$NP V NP Prep Det N	$	Reduce (NP → Det N)
$NP V NP Prep NP	$	Reduce (PP → Prep · NP)
$ NP V NP PP	$	Reduce (NP → NP PP)
$ NP V NP	$	Reduce (VP → V NP)
$NP VP	$	Reduce (S → NP VP)
$ S	$	Accept

The parse Tree is as follows :–
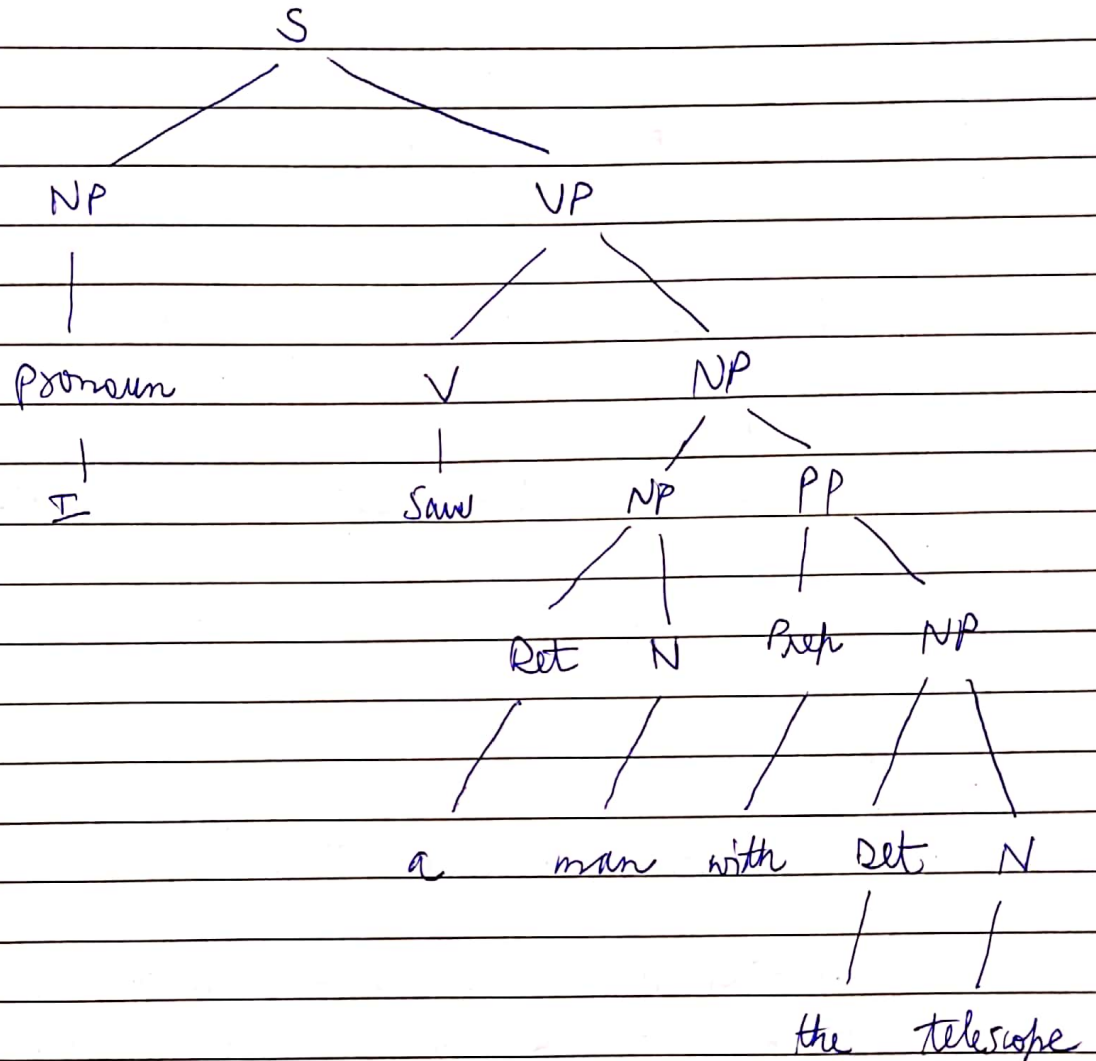
Derivation:

S => NP VP => Pronoun VP => I VP => I V NP
=> I saw NP PP => I saw Det NP PP => I saw a N PP
=> I saw a man PP => I saw a man Preposition NP
=> I saw a man with NP => I saw a man with
Det N => I saw a man with the the N => I
saw a man with the telescope

The second parse tree will be :—

```
                        S
                   /         \
                 NP           VP
                 /          /  |   \
            Pronoun       V    NP    PP
                |         |    / \    /  \
                I        Saw  Det  N  Preposition   NP
                              |    |      |        /  \
                              a   man   with     Det   N
                                                  |    |
                                                 the  telescope
```
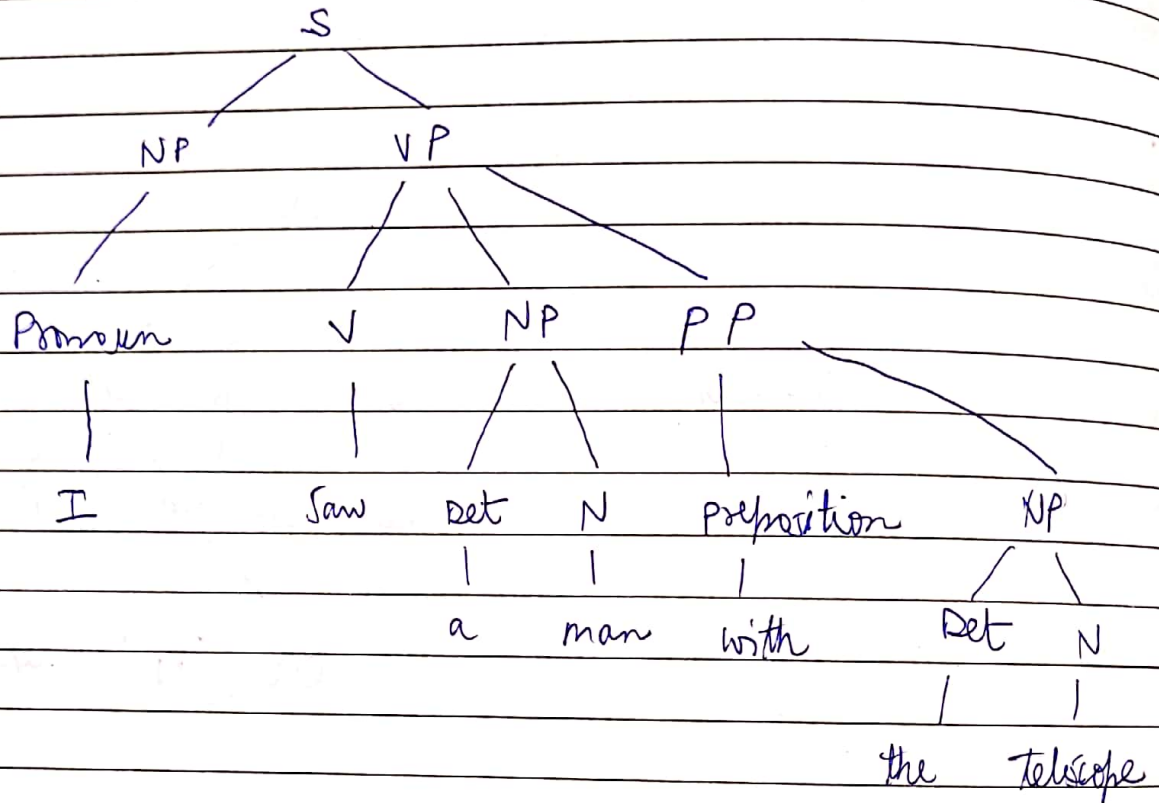
Derivation For Second Tree :—

S $\Rightarrow$ NP VP $\Rightarrow$ Pronoun VP $\Rightarrow$ i VP $\Rightarrow$ i V NP PP $\Rightarrow$ i Saw NP PP $\Rightarrow$ I saw Det N PP $\Rightarrow$ I Saw a N PP $\Rightarrow$ I Saw a man PP $\Rightarrow$ I saw a man preposition NP $\Rightarrow$ I saw a man with NP $\Rightarrow$ I saw a man with Det NP $\Rightarrow$ I saw a man the N $\Rightarrow$ I saw a man with the telescope.

Probability of First Tree

S $\Rightarrow$ NP VP   (0.6)
NP $\Rightarrow$ Pronoun   (0.1)
Pronoun $\Rightarrow$ I   (0.5)
VP $\Rightarrow$ V NP   (0.3)
V $\Rightarrow$ Saw   (0.4)

NP ⇒ NP PP   (0.1)

NP ⇒ Det N   (0.2)

Det ⇒ a   (0.6)

N ⇒ man   (0.4)

PP ⇒ Prep NP   (1)

Prep ⇒ with   (0.9)

NP ⇒ Det N   (0.2)

Det ⇒ the   (0.4)

N ⇒ Telescope   (0.02)

$$Probability = \Pi p_i = 2.488 \times 10^{-8}$$

Probability For Second Tree :-

S ⇒ NP VP   (0.6)

NP ⇒ Pronoun   (0.1)

Pronoun ⇒ I   (0.5)

VP ⇒ V NP PP   (0.15)

V ⇒ Saw   (0.4)

NP ⇒ Det N   (0.2)

PP ⇒ Proposition NP (1)

Det ⇒ a   (0.6)

N ⇒ man   (0.4)

Proposition ⇒ with (0.9)

NP ⇒ Det N   (0.2)

Det ⇒ the   (0.4)

N ⇒ Telescope   (0.02)

$$Probability \; P_2 = \Pi p_{i_2} = 1.244 \times 10^{-7}$$

As the second tree has a higher probability $P_2 > P_1$ the second derivation is much more likely to occur.