

Grammar 1

$$\begin{aligned} V &= \{S, NP, VP, PP, D, N, V\} \\ \Sigma &= \{the, a, some, cat, hat, mat, mice, in, on, near, sat, smiled, saw\} \end{aligned}$$

$$\begin{aligned} S &\rightarrow NP VP \\ S &\rightarrow S PP \\ NP &\rightarrow D N & D &\rightarrow the \mid a \mid some \\ NP &\rightarrow NP PP & N &\rightarrow cat \mid hat \mid mat \mid mice \\ PP &\rightarrow P NP & P &\rightarrow in \mid on \mid near \\ VP &\rightarrow V & V &\rightarrow sat \mid smiled \mid saw \\ VP &\rightarrow V NP \\ VP &\rightarrow V PP \\ VP &\rightarrow VP PP \end{aligned}$$

Example sentences:

The cat smiled

The cat sat on the mat

The cat saw some mice near the mat

The cat in the hat saw a hat on the mat near some mice

*The cat saw a mat a hat

*The cat in the hat some mice

*The cat saw mice

*The dog saw some mice

Grammar 2

$$\begin{aligned} V &= \{S\} \\ \Sigma &= \{a\} \end{aligned}$$

$$S \rightarrow S S \quad S \rightarrow a$$

Example sentences:

a

a a a a a

a a a a a a a a a a a a a

*a b a

Grammar 3

$V = \{S, NP, VP, Aux, Verb, Det, Nominal, Noun, PP, Prep\}$

$\Sigma = \{a, this, that, book, flight, meal, include, includes, from, to, on, Houston, Chicago, TWA, does\}$

$S \rightarrow NP VP$	$Det \rightarrow that this a$
$S \rightarrow Aux NP VP$	$Noun \rightarrow book flight meal$
$S \rightarrow VP$	$Verb \rightarrow book include includes$
$VP \rightarrow Verb$	$Prep \rightarrow from to on$
$VP \rightarrow Verb NP$	$Proper-Noun \rightarrow Houston Chicago TWA$
$NP \rightarrow Det Nominal$	$Aux \rightarrow does$
$NP \rightarrow Proper-Noun$	
$Nominal \rightarrow Noun$	
$Nominal \rightarrow Noun Nominal$	
$Nominal \rightarrow Nominal PP$	
$PP \rightarrow Prep NP$	

Example sentences:

book that flight

does this flight include a meal

this flight on TWA includes a meal

the flight from Chicago to Houston on TWA includes a meal

book a flight from Chicago to Houston on TWA