Grammar 1

\[ V = \{S, NP, VP, PP, D, N, V\} \]
\[ \Sigma = \{the, a, some, cat, hat, mat, mice, in, on, near, sat, smiled, saw\} \]

\[ S \to NP \ VM \]
\[ S \to S PP \]
\[ NP \to D N \quad D \to the | a | some \]
\[ NP \to NP PP \quad N \to cat | hat | mat | mice \]
\[ PP \to P NP \quad P \to in | on | near \]
\[ VP \to V \quad V \to sat | smiled | saw \]
\[ VP \to V NP \]
\[ VP \to V PP \]
\[ VP \to VP PP \]

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

\[ V = \{S\} \]
\[ \Sigma = \{a\} \]

\[ S \to SS \quad S \to a \]

Example sentences:

a
a a a a a a
a a a a a a a a a a a a a a a
*a b a
Grammar 3

\[ V = \{S, NP, VP, Aux, Verb, Det, Nominal, Noun, PP, Prep\} \]
\[ \Sigma = \{a, this, that, book, flight, meal, include, includes, from, to, on, Houston, Chicago, TWA, does\} \]

\[
\begin{align*}
S & \rightarrow NP \ VP \\
S & \rightarrow Aux \ NP \ VP \\
S & \rightarrow VP \\
VP & \rightarrow Verb \\
NP & \rightarrow Det \ Nominal \\
NP & \rightarrow Proper-Noun \\
Nominal & \rightarrow Noun \\
Nominal & \rightarrow Noun \ Nominal \\
PP & \rightarrow Prep \ NP
\end{align*}
\]

Det \rightarrow that | this | a
Noun \rightarrow book | flight | meal
Verb \rightarrow book | include | includes
Prep \rightarrow from | to | on
Proper-Noun \rightarrow Houston | Chicago | TWA
Aux \rightarrow does

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