

# Syntactic Structure

## Exercises

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### 1. Natural Language

Consider the following grammar:

S -> NP VP	N -> [boy]	prep -> [with]
NP -> Det N	N -> [man]	Adj -> [sweet]
NP -> NP PP	N -> [fork]	Adj -> [red]
NP -> Det Adj N	N -> [cake]	Det -> [the]
VP -> V NP	N -> [hat]	Det -> [a]
VP -> V NP PP	N -> [cherry]	V -> [gave]
PP -> P NP	N -> [spoon]	V -> [laughed]
	V -> [saw]	V -> [ate]
		V -> [wore]

a. Parse the following sentences:

The man wore a red hat.

The boy ate the sweet cake with a fork.

The man with the hat ate the sweet cake with a cherry with the spoon

b. Generate a new sentence using the grammar and provide its parse tree. Is it possible to generate any un-grammatical sentences?

c. Consider the following sentences:

The man slept

The man snored through the night.

The girl give the man the library book

Extend the grammar to deal with such examples (hint look at the way the verb operates)

d. Consider the following sentences

The man and the boy ate the cake.

The man gave the boy the hat and the cake.

The man laughed and gave the boy the cake

The man ate the cake and the boy wore the hat.

What simple additional rules could we add to deal with such examples?

## 2. Simple maths

As part of a calculator application, we'd like to check the syntactic validity of any mathematical expression and then use the resulting parse to extract the various parts of the expression for calculation.

S → Sum EQ Sum  
EQ → [=]  
Sum → [1][2]...[n]  
Sum → [X][Y][Z]  
Sum → Sum Op Sum  
Sum → LefthB Sum RighthB  
OP → [+][\*][/][-]  
LefthB → [(]  
RighthB → [)]

a. Show that the grammar accepts the following expressions:

$$(2 * X) + (Y + 3) = 2/3 + 4$$
$$((2 + X) - (2 - X)) = ((2 * Y) + (2 / Y))$$

b. One useful notation which is not allowed by the grammar is the following

$$2X + 3Y = 100$$

Alter the grammar to allow this notation.

## 3. A formal language

Consider the language

ABC  
ABABC  
ABABCAAC  
AABABCAAC

a. Verify that the following grammar covers this language:

S → X Y Z  
X → [A][AA][ACA]  
Y → [B][BAB][BAAB]  
Z → [C][CAC][CAAC]

b. Is this the only possible grammar to cover this language?

c. Produce three more sentences which this grammar produces.