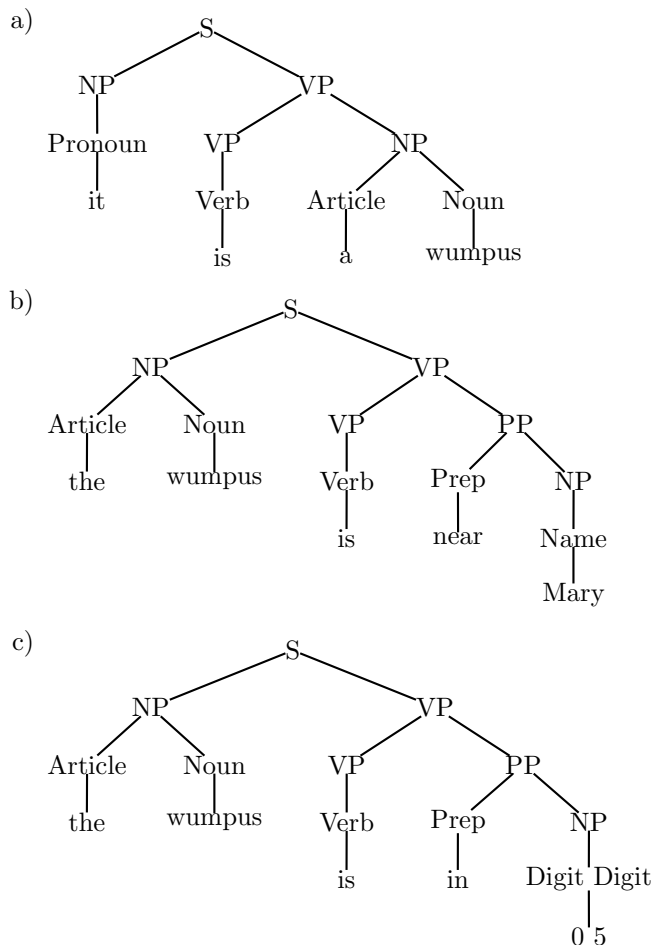


Solution for exercise 12.2

There have been two problems with this exercise:

- The rule “NP → Name” was missing in the grammar. Since this is needed for the second sentence, we assume it to be part of the grammar.
- “S conjunction S” cannot be transformed to “Digit or Digit”. We therefore assume the third sentence to read “the wumpus is in 0 5”.

Intuitive solutions:



Top-down algorithm:

a) [S :?]
 [S : [NP :?][VP :?]]
 [S : [NP : [Pronoun :?]][VP :?]]
 [S : [NP : [Pronoun : it]][VP :?]]
 [S : [NP : [Pronoun : it]][VP : [VP :?][NP :?]]]
 [S : [NP : [Pronoun : it]][VP : [VP : [Verb :?]][NP :?]]]
 [S : [NP : [Pronoun : it]][VP : [VP : [Verb : is]][NP :?]]]
 [S : [NP : [Pronoun : it]][VP : [VP : [Verb : is]][NP : [Article :?][Noun :?]]]]
 [S : [NP : [Pronoun : it]][VP : [VP : [Verb : is]][NP : [Article : a][Noun :?]]]]
 [S : [NP : [Pronoun : it]][VP : [VP : [Verb : is]][NP : [Article : a][Noun : wumpus]]]]

b) [S :?]
 [S : [NP :?][VP :?]]
 [S : [NP : [Article :?][Noun :?]][VP :?]]
 [S : [NP : [Article : The][Noun :?]][VP :?]]
 [S : [NP : [Article : The][Noun : wumpus]][VP :?]]
 [S : [NP : [Article : The][Noun : wumpus]][VP : [VP :?][PP :?]]]
 [S : [NP : [Article : The][Noun : wumpus]][VP : [VP : [Verb :?]][PP :?]]]
 [S : [NP : [Article : The][Noun : wumpus]][VP : [VP : [Verb : is]][PP :?]]]
 [S : [NP : [Article : The][Noun : wumpus]][VP : [VP : [Verb : is]][PP : [Prep :?][NP :?]]]
 [S : [NP : [Article : The][Noun : wumpus]][VP : [VP : [Verb : is]][PP : [Prep : near][NP :?]]]
 [S : [NP : [Article : The][Noun : wumpus]][VP : [VP : [Verb : is]][PP : [Prep : near][NP : [Name :?]]]]
 [S : [NP : [Article : The][Noun : wumpus]][VP : [VP : [Verb : is]][PP : [Prep : near][NP : [Name : Mary]]]]

c) [S :?]
 [S : [NP :?][VP :?]]
 [S : [NP : [Article :?][Noun :?]][VP :?]]
 [S : [NP : [Article : the][Noun :?]][VP :?]]
 [S : [NP : [Article : the][Noun : wumpus]][VP :?]]
 [S : [NP : [Article : the][Noun : wumpus]][VP : [VP :?][PP :?]]]
 [S : [NP : [Article : the][Noun : wumpus]][VP : [VP : [Verb :?]][PP :?]]]
 [S : [NP : [Article : the][Noun : wumpus]][VP : [VP : [Verb : is]][PP :?]]]
 [S : [NP : [Article : the][Noun : wumpus]][VP : [VP : [Verb : is]][PP : [Prep :?][NP :?]]]
 [S : [NP : [Article : the][Noun : wumpus]][VP : [VP : [Verb : is]][PP : [Prep : in][NP :?]]]
 [S : [NP : [Article : the][Noun : wumpus]][VP : [VP : [Verb : is]][PP : [Prep : in][NP : [DigitDigit :?]]]]
 [S : [NP : [Article : the][Noun : wumpus]][VP : [VP : [Verb : is]][PP : [Prep : in][NP : [DigitDigit : 0 5]]]]

Bottom-up algorithm:

a) [it , is, a, wumpus]
 [[Pronoun:it] , is, a, wumpus]
 [[NP:Pronoun:it] , is, a, wumpus]
 [[NP:Pronoun:it] , [Verb:is], a, wumpus]
 [[NP:Pronoun:it] , [VP:[Verb:is]], a, wumpus]
 [[NP:Pronoun:it] , [VP:[Verb:is]], [Art:a], wumpus]
 [[NP:Pronoun:it] , [VP:[Verb:is]], [Art:a], [Noun:wumpus]]
 [[NP:Pronoun:it] , [VP:[Verb:is]], [NP:[Art:a], [Noun:wumpus]]]
 [[NP:Pronoun:it] , [VP:[VP:[Verb:is]], [NP:[Art:a], [Noun:wumpus]]]
 [S:[[NP:Pronoun:it] , [VP:[VP:[Verb:is]], [NP:[Art:a], [Noun:wumpus]]]]

b) [the, wumpus, is, near, Mary]
 [[Art:the], wumpus, is, near, Mary]
 [[Art:the], [Noun:wumpus], is, near, Mary]
 [[NP:[Art:the], [Noun:wumpus]], is, near, Mary]
 [[NP:[Art:the], [Noun:wumpus]], [Verb:is], near, Mary]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], near, Mary]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], [Prep:near], Mary]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], [Prep:near], [Name:Mary]]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], [Prep:near], [NP:[Name:Mary]]]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], [PP:[Prep:near], [NP:[Name:Mary]]]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[VP:[Verb:is]], [PP:[Prep:near], [NP:[Name:Mary]]]]
 [S:[[NP:[Art:the], [Noun:wumpus]], [VP:[VP:[Verb:is]], [PP:[Prep:near], [NP:[Name:Mary]]]]]

c) [the, wumpus, is, in, 0 5]
 [[Art:the], wumpus, is, in, 0 5]
 [[Art:the], [Noun:wumpus], is, in, 0 5]
 [[NP:[Art:the], [Noun:wumpus]], is, in, 0 5]
 [[NP:[Art:the], [Noun:wumpus]], [Verb:is], in, 0 5]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], in, 0 5]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], [Prep.:in], 0 5]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], [Prep.:in], [DigDig:0 5]]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], [Prep.:in], [NP:[DigDig:0 5]]]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[Verb:is]], [PP:[Prep.:in], [NP:[DigDig:0 5]]]]
 [[NP:[Art:the], [Noun:wumpus]], [VP:[VP:[Verb:is]], [PP:[Prep.:in], [NP:[DigDig:0 5]]]]]
 [S:[[NP:[Art:the], [Noun:wumpus]], [VP:[VP:[Verb:is]], [PP:[Prep.:in], [NP:[DigDig:0 5]]]]]]]

Problems: One big problem for top-down parsing is dealing with so-called **left-recursive rules**—that is, rules of the form $X \rightarrow X \dots$. With a depth-first search, such a rule would lead us to keep replacing X with $[X : X \dots]$ in an infinite loop. With a breadth-first search we would successfully find parses for valid sentences, but when given an invalid sentence, we would get stuck in an infinite search space.

In the wumpus grammar this problem occurs, e.g., with the rule $NP \rightarrow NP PP$.

For bottom-up parsing rules that have the empty word on the right side can be a problem, since this could lead to an infinite loop. Since we don't have such a rule, this shouldn't be a problem here.