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CS361

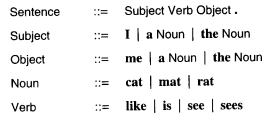
Programming Languages Principles and Implementation

Homework 4

## Grammars

**Exercise 1:**

We consider the BNF grammar below:



1. Show that **I like the cat.** is recognized by this BNF grammar using a rightmost derivation and, then, a parse tree.

Sentence 🡺 Sentence ::= Subject Verb Object **. 🡺** Sentence ::= Subject Verb ***the* Noun** **. 🡺** Sentence ::= Subject Verb ***the* cat** **. 🡺** Subject **like** ***the* cat** **. 🡺 I** **like** ***the* cat** **.**

Parse Tree:

Sen

.

Sub

Verb

Obj

Noun

the

like

I

cat

1. Provide an expression that is NOT recognized by the grammar.

**I love my cat**

**Exercise 2:**

We consider the following grammar:

EXPRESSION ::= NUMERAL | ( EXPRESSION OPERATOR EXPRESSION )

NUMERAL ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9

OPERATORS ::= + | -

Show that (4 - (3 + 2)) is a legal EXPRESSION using a leftmost derivation, and then, a parse tree.

EXPRESSION 🡺 EXPRESSION ::= NUMERAL | ( EXPRESSION OPERATOR EXPRESSION ) 🡺 EXPRESSION ::= ( NUMERAL OPERATOR EXPRESSION ) 🡺 EXPRESSION ::= ( 4 OPERATOR EXPRESSION ) 🡺 EXPRESSION ::= ( 4 - EXPRESSION ) 🡺 EXPRESSION ::= ( 4 – ( EXPRESSION OPERATOR EXPRESSION ) ) 🡺 EXPRESSION ::= ( 4 – ( 3 OPERATOR EXPRESSION ) ) 🡺 EXPRESSION ::= ( 4 – ( 3 + EXPRESSION ) ) 🡺 EXPRESSION ::= ( 4 – ( 3 + 2 ) )

Parse Tree:

)

+

(

O

-

O

(

E

)

E

E

N

E

E

4

N

N

2

3

**Exercise 3:**

Show that the following grammar is ambiguous:

X -> a | bX | bXcX

Where *a*, *b*, and *c* are terminals.

bXcX 🡺 bacba can be parsed into two different trees:

1.

X

X

X

b

c

b

X

a

a

2.

X

X

X

b

c

X

a

a

b

**Exercise 4:**

1. Design a BNF grammar that recognizes expressions of the form Ai where A is in {a, b, c} and i is a digit.

EXPRESSION ::= Ai

A ::== a | b | c

i ::== digit 🡺 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9

1. Design a BNF grammar that recognizes lists of the form A1, A2, A3, …, An. Use question a).

List :== {Adigit**,** }\*

A :== a | b | c

Digit :== 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9

**Exercise 5:**

1. Write a JAY program that computes the sum of the *n* first numbers with a loop.

**void main ( ) {**

**int num, sum;**

**num = 1;**

**sum = 1;**

**while ( num < n ) {**

**num + 1;**

**sum = sum + num;**

**} }**

1. Write a JAY program that assigns the minimum of two numbers in a variable called min.

**void main ( ) {**

**int n1, n2, min;**

**n1 = 4;**

**n2 = 7;**

**if ( n1 > n2 ){**

**min = n2; }**

**else {**

**min = n1; } }**

1. Provide 2 examples of lexical errors in JAY.

***Float c;***

***int [ ]a;***

***c = 4.4;***

***a = null;***

1. Provide 2 examples of JAY programs with 2 different syntax errors.

* ***void main ( ) {***

***if ( a < b ) {***

***a + 1;***

***}*** *//missing second curly-braces to close void main() {*

* ***void main ( ) {***

***if ( a == 1 & c < 5 ) { }*** *//only one (1) “&” inside the if() statement, instead of “&&”*

***}***

1. Provide 2 examples of JAY programs with errors that are neither detected during the lexical analysis nor during the syntactic analysis.

* ***void main ( ) {***

***int b;***

***b = 1;***

***b = b;***

***}***

* ***void main ( ) {***

***int a;***

***a = 0;***

***while ( 1 == 1 )***

***a + 1;***

***}***