Computer Science 455: Compiler Design

Final Project

Fall 2018

Group Members:

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Method Used: Top-Down Parser

Languages Used: C++ & Python

Original Grammar

|  |  |  |
| --- | --- | --- |
| <prog> | → | **program** <id> ; **var** <dec-list> **begin** <stat-list> **end** |
| <id> | → | <letter> { <letter> | <digit> } |
| <dec-list> | → | <dec> : <type> |
| <dec> | → | <id> , <dec> | <id> |
| <type> | → | **integer** |
| <stat-list> | → | <stat> | <stat> <stat-list> |
| <stat> | → | <write> | <assign> |
| <write> | → | **show** ( <id> ) ; |
| <assign> | → | <id> = <expr> ; |
| <expr> | → | <expr> + <term> | <expr> - <term> | <term> |
| <term> | → | <term> \* <factor> | <term> / <factor> | <factor> |
| <factor> | → | <id> | <number> | ( <expr> ) |
| <number> | → | <sign> <digit> { <digit> } |
| <sign> | → | + | - | 𝜆 |
| <digit> | → | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| <letter> | → | a | b | c | d | e |

BNF Grammar

(those in **bold** are terminals)

|  |  |  |  |
| --- | --- | --- | --- |
| (1) | <prog> | → | **program** <id> <;> **var** <dec-list> **begin** <stat-list> **end** |
| (2) | <id> | → | <letter> <alphaNum> |
| (3) | <alphaNum> | → | <letter> <alphaNum> |
| (4) | <alphaNum> | → | <digit> <alphaNum> |
|  | <alphaNum> | → | **𝜆** |
| (5) | <dec-list> | → | <dec> : <type> <;> |
| (6) | <dec> | → | <id> <moreDec> |
| (7) | <moreDec> | → | <dec> |
|  | <moreDec> | → | **𝜆** |
| (8) | <type> | → | **integer** |
| (9) | <stat-list> | → | <stat> <moreStat> |
| (10) | <moreStat> | → | <stat-list> |
|  | <moreStat> | → | **𝜆** |
| (11) | <stat> | → | <write> |
| (12) | <stat> | → | <assign> |
| (13) | <write> | → | **show** <(> <id> <)> <;> |
| (14) | <assign> | → | <id> = <expr> <;> |
| (15) | <expr> | → | <term> <exprPrime> |
| (16) | <exprPrime> | → | **+** <term> <exprPrime> |
| (17) | <exprPrime> | → | **-** <term> <exprPrime> |
|  | <exprPrime> | → | **𝜆** |
| (18) | <term> | → | <factor> <termPrime> |
| (19) | <termPrime> | → | **\*** <factor> <termPrime> |
| (20) | <termPrime> | → | **/** <factor> <termPrime> |
|  | <termPrime> | → | **𝜆** |
| (21) | <factor> | → | <id> |
| (22) | <factor> | → | <number> |
| (23) | <factor> | → | <(> <expr> <)> |
| (24) | <number> | → | <digit> <moreDigits> |
| (25) | <number> | → | <sign> <digit> <moreDigits> |
| (26) | <moreDigits> | → | <digit> <moreDigits> |
|  | <moreDigits> | → | **𝜆** |
| (27) | <sign> | → | **+** |
| (28) | <sign> | → | **-** |
| (29) | <sign> | → | **𝜆** |
| (30) | <digit> | → | **0** |
| (31) | <digit> | → | **1** |
| (32) | <digit> | → | **2** |
| (33) | <digit> | → | **3** |
| (34) | <digit> | → | **4** |
| (35) | <digit> | → | **5** |
| (36) | <digit> | → | **6** |
| (37) | <digit> | → | **7** |
| (38) | <digit> | → | **8** |
| (39) | <digit> | → | **9** |
| (40) | <letter> | → | **a** |
| (41) | <letter> | → | **b** |
| (42) | <letter> | → | **c** |
| (43) | <letter> | → | **d** |
| (44) | <letter> | → | **e** |
| (45) | <;> | → | **;** |
| (46) | <(> | → | **(** |
| (47) | <)> | → | **)** |

First and Follow

|  |  |  |
| --- | --- | --- |
| **Non-terminals** | **FIRST** | **FOLLOW** |
| <prog> | program | $ |
| <id> | a…e | + - \* / = ) , : ; |
| <alphaNum> | a…e 0…9 𝜆 | + - \* / = ) , : ; |
| <dec-list> | a…e | begin |
| <dec> | a…e | : |
| <moreDec> | 𝜆 | : |
| <type> | Integer | ; |
| <stat-list> | show a…e | end |
| <stat> | show a…e | show end a…e |
| <moreStat> | show a…e 𝜆 | end |
| <write> | show | show end a…e |
| <assign> | a…e | show end a…e |
| <expr> | a…e 0…9 + - ( | ) ; |
| <exprPrime> | + - 𝜆 | ) ; |
| <term> | a…e + - ( 𝜆 | + - ) ; |
| <termPrime> | \* / 𝜆 | + - ) ; |
| <factor> | a…e + - ( 𝜆 | + - \* / ) ; |
| <number> | + - 𝜆 | + - \* / ) ; |
| <moreDigits> | 0…9 𝜆 | + - \* / ) ; |
| <sign> | + - 𝜆 | 0…9 |
| <digit> | 0…9 | 0…9 + - \* / ) ; |
| <letter> | a…e | a…e 0…9 |
| <;> | ; | begin var show end a…e |
| <(> | ( | a…e 0…9 + - ( |
| <)> | ) | + - \* / ) ; |

Parsing Table

(each number represents an equation from BNF Grammar)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | program | var | begin | end | : | , | integer | show | = | + | - | \* | / | 0 – 9 | a – e | ; | ( | ) |
| <prog> | (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <id> |  |  |  |  |  |  |  |  |  |  |  |  |  |  | (2) |  |  |  |
| <alphaNum> |  |  |  |  | 𝜆 | 𝜆 |  |  | 𝜆 | 𝜆 | 𝜆 | 𝜆 | 𝜆 | (4) | (3) | 𝜆 |  | 𝜆 |
| <dec-list> |  |  |  |  |  |  |  |  |  |  |  |  |  |  | (5) |  |  |  |
| <dec> |  |  |  |  |  |  |  |  |  |  |  |  |  |  | (6) |  |  |  |
| <moreDec> |  |  |  |  | 𝜆 | (7) |  |  |  |  |  |  |  |  |  |  |  |  |
| <type> |  |  |  |  |  |  | (8) |  |  |  |  |  |  |  |  |  |  |  |
| <stat-list> |  |  |  |  |  |  |  | (9) |  |  |  |  |  |  | (9) |  |  |  |
| <moreStat> |  |  |  | 𝜆 |  |  |  | (10) |  |  |  |  |  |  | (10) |  |  |  |
| <stat> |  |  |  |  |  |  |  | (11) |  |  |  |  |  |  | (12) |  |  |  |
| <write> |  |  |  |  |  |  |  | (13) |  |  |  |  |  |  |  |  |  |  |
| <assign> |  |  |  |  |  |  |  |  |  |  |  |  |  |  | (14) |  |  |  |
| <expr> |  |  |  |  |  |  |  |  |  | (15) | (15) |  |  | (15) | (15) |  | (15) |  |
| <exprPrime> |  |  |  |  |  |  |  |  |  | (16) | (17) |  |  |  |  | 𝜆 |  | 𝜆 |
| <term> |  |  |  |  |  |  |  |  |  | (18) | (18) |  |  | (18) | (18) |  | (18) |  |
| <termPrime> |  |  |  |  |  |  |  |  |  | 𝜆 | 𝜆 | (19) | (20) |  |  | 𝜆 |  | 𝜆 |
| <factor> |  |  |  |  |  |  |  |  |  | (22) | (22) |  |  | (22) | (21) |  | (23) |  |
| <number> |  |  |  |  |  |  |  |  |  | (25) | (25) |  |  |  |  |  |  |  |
| <moreDigits> |  |  |  |  |  |  |  |  |  | 𝜆 | 𝜆 | 𝜆 | 𝜆 |  |  | 𝜆 |  | 𝜆 |
| <sign> |  |  |  |  |  |  |  |  |  | (27) | (28) |  |  |  |  |  |  |  |
| <digit> |  |  |  |  |  |  |  |  |  |  |  |  |  | (30 – 39) |  |  |  |  |
| <letter> |  |  |  |  |  |  |  |  |  |  |  |  |  |  | (40 – 44) |  |  |  |
| <;> |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | (45) |  |  |
| <(> |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | (46) |  |
| <)> |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | (47) |