

ULB  
INFO-F403 - Introduction to language theory and  
compiling  
Introduction to language theory and compiling

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Academic year 2015-2016 - November 26, 2015

# Chapter 1

## Part 2 - Grammar

### 1.1 The modified grammar

This is our new modified grammar we ended up with :

```
[1] <Program>-> begin <Code> end
[2] <Code>-> Epsilon
[3] -> <InstList>
[4] <InstList>-> <Instruction> <NextInst>
[5] <NextInst>-> Epsilon
[6] -> ; <InstList>
[7] <Instruction>-> <Assign>
[8] -> <If>
[9] -> <While>
[10] -> <For>
[11] -> <Print>
[12] -> <Read>
[13] <Assign>-> [VarName] := <ExprArith>
[14] <ExprArith>-> <Term> <ExprArith2>
[15] <ExprArith2>-> <TermOp> <Term> <ExprArith2>
[16] -> Epsilon
[17] <Term>-> <Factor> <Term2>
[18] <Term2>-> <FactorOp> <Factor> <Term2>
[19] -> Epsilon
[20] <Factor>-> (<ExprArith>)
[21] -> - <ExprArith>
[22] -> [VarName]
[23] -> [Number]
[24] <TermOp>-> +
[25] -> -
[26] <FactorOp>-> *
[27] -> /
[28] <If>-> if <Cond> then <Code> <EndIf>
[29] <EndIf>-> fi
```

```

[30] -> else <Code> fi
[31] <Cond>-> <AndCond> <Cond2>
[32] <Cond2>-> or <AndCond> <Cond2>
[33] -> Epsilon
[34] <AndCond>-> <CondTerm> <AndCond2>
[35] <AndCond2>-> and <CondTerm> <AndCond2>
[36] -> Epsilon
[37] <CondTerm>-> <SimpleCond>
[38] -> not <SimpleCond>
[39] <SimpleCond>-> <ExprArith> <Comp> <ExprArith>
[40] <Comp>-> =
[41] -> >=
[42] -> >
[43] -> <=
[44] -> <
[45] -> /=
[46] <While>-> while <Cond> do <Code> od
[47] <For>-> for [VarName] from <ExprArith> by <ExprArith> to
<ExprArith> do <Code> od
[48] <Print>-> print([VarName])
[49] <Read>-> read([VarName])

```

Removing unreachable and/or unproductive variables wasn't much of an issue but only a bit of work. The real deal in this part was to handle the correct associativity while removing left-recursion. Keeping the order of priority was not a problem. The problem is that we lost the associativity to the left when we tried to remove left-recursions. We tried multiple solutions to keep left associativity while removing left-recursions but none worked. So from here, we only could satisfy one of those constraints. We choosed to remove left-recursion because otherwise the algorithm wouldn't work. This means that our compiler works but is kind of false because left associativity is not respected.

## 1.2 The action table

To build the action table, we first needed to calculate the first and follow sets. First(X) is made by taking the set of strings of terminals of maximum length which can start a string generated from X. Follow(X) is made by taking the set of strings of terminals of maximum length which can follow a string generated from X. This first and follow sets will help us to fill the action table.

```

FIRST :
-----
Program : {begin}
Code : {Epsilon, FIRST(InstList)}
InstList : {FIRST(Instruction)}
NextInst : {Epsilon,;}
Instruction : {FIRST(Assign, If, While, For, Print, Read)}
Assign : {VarName}
ExprArith : {FIRST(Term)}
ExprArith2 : {Epsilon, FIRST(TermOp)}

```

```

Term : {FIRST(Factor)}
Term2 : {Epsilon, FIRST(FactorOp)}
Factor : {(, -, VarName, Number}
TermOp : {+, -}
FactorOp : {*, /}
If : {if}
EndIf : {fi, else}
Cond : {FIRST(AndCond)}
Cond2 : {Epsilon, or}
AndCond : {FIRST(CondTerm)}
AndCond2 : {Epsilon, and}
CondTerm : {not, FIRST(SimpleCond)}
SimpleCond : {FIRST(ExprArith)}
Comp : {=, >=, >, <=, <, /=}
While : {while}
For : {for}
Print : {print}
Read : {read}

```

Follow:

```

-----
Program : {$}
Code : {end, FIRST(EndIf), fi, od}
InstList : {FOLLOW(Code)}
NextInst : {FOLLOW(InstList)}
Instruction : {FIRST(NextInst)}
Assign : {FOLLOW(Instruction)}
ExprArith : {(), by, to, do, FOLLOW(Assign,Factor, SimpleCond), FIRST(Comp)}
ExprArith2 : {FOLLOW(ExprArith)}
Term : {FIRST(ExprArith2)}
Term2 : {FOLLOW(Term)}
Factor : {FIRST(Term2)}
TermOp : {FIRST(Term)}
FactorOp : {FIRST(Factor)}
If : {FOLLOW(Instruction)}
EndIf : {FOLLOW(If)}
Cond : {then, do}
Cond2 : {FOLLOW(Cond)}
AndCond : {FIRST(Cond2)}
AndCond2 : {FOLLOW(AndCond)}
CondTerm : {FIRST(AndCond2)}
SimpleCond : {FOLLOW(CondTerm)}
Comp : {FIRST(ExprArith)}
While : {FOLLOW(Instruction)}
For : {FOLLOW(Instruction)}
Print : {FOLLOW(Instruction)}
Read : {FOLLOW(Instruction)}

```

Now that we have our first and follow sets, we can build our action table. This is how we fill the table :

For each token in  $\text{First}(X)$ , we add the corresponding rule to the corresponding cell in the table. If epsilon is in  $\text{First}(X)$ , for each token in  $\text{Follow}(X)$ , we add the corresponding rule to the corresponding cell in the table.

Our grammar is LL(1), this means that LL(1) parsing uses only one symbol of input to predict the next grammar rule that should be used. Therefore each cell of our action table contains at most one rule. This table will help us to decide which decision should be made if a given nonterminal  $N$  is at the top of the parsing stack, based on the current input symbol.

	VARNAM	NUMBER	BEG	END	;	ASSIGN	(	)	-	+	*	/	IF	THEN	FI	ELSE	NOT	AND	OR	=	>=	>	<=	<	/=	WHILE	DO	OD	FOR	FROM	BY	TO	PRINT	READ	\$
Program	-	-	1	-	-	-	-	-	-	+	*	/	-	-	-	-	-	-	AND	OR	=	>=	>	<=	<	/=	-	-	-	-	-	-	-	-	-
Code	3	-	2	-	-	-	-	-	-	-	-	-	3	-	2	2	-	-	-	-	-	-	-	-	-	3	-	2	3	-	-	-	3	3	-
InstList	4	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4	-	4	-	-	-	4	4	-	
NextInst	-	-	5	6	-	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	
Instruction	7	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	10	-	-	-	11	12	-
Assign	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ExprArith	14	14	-	-	-	1	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ExprArith2	16	16	-	16	1	-	1	16	15	15	16	16	-	-	16	16	16	16	16	16	16	16	16	16	16	-	16	16	-	-	-	16	16	-	-
Term	17	17	-	-	-	1	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Term2	-	-	-	19	1	-	-	19	19	19	18	18	-	-	19	19	19	-	19	19	19	19	19	19	19	-	19	19	-	-	-	19	19	-	-
Factor	22	23	-	-	-	2	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TermOp	-	-	-	-	-	-	-	25	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FactorOp	-	-	-	-	-	-	-	-	26	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
If	-	-	-	-	-	-	-	-	-	-	-	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EndIf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cond	31	31	-	-	-	3	-	31	-	-	-	-	-	-	-	-	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cond2	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-	-	32	-	-	-	-	-	-	-	-	33	-	-	-	-	-	-	-	-
AndCond	34	34	-	-	-	3	-	34	-	-	-	-	-	-	-	-	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AndCond2	-	-	-	-	-	-	-	-	-	-	-	-	-	36	-	-	-	35	36	-	-	-	-	-	-	-	36	-	-	-	-	-	-	-	-
CondTerm	37	37	-	-	-	3	-	37	-	-	-	-	-	-	-	-	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SimpleCond	39	39	-	-	-	3	-	39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Comp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	41	42	43	44	45	-	-	-	-	-	-	-	-	-	-	-
While	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46	-	-	-	-	-	-	-	-	-
For	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47	-	-	-	-	-	-
Print	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	-	-
Read	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49	-