

Milestone 1A - Group 06

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1 Transform the μ -Opal EBNF Grammar to an equivalent BNF grammar

EBNF Grammar

$\langle Prog \rangle ::= \langle Def \rangle + \#$
 $\langle Def \rangle ::= \underline{DEF} \langle Lhs \rangle \equiv \langle Expr \rangle$
 $\langle Lhs \rangle ::= \underline{MAIN} \vdash \langle Type \rangle$
 $\quad | \quad \underline{id} \left[\left(\underline{id} \vdash \langle Type \rangle \left(\vdash \underline{id} \vdash \langle Type \rangle \right)^* \right) \right] \vdash \langle Type \rangle$
 $\langle Type \rangle ::= \underline{nat} \mid \underline{bool}$
 $\langle Expr \rangle ::= \underline{number} \mid \underline{true} \mid \underline{false}$
 $\quad | \quad \underline{id} \left[\left(\langle Expr \rangle \left(\vdash \langle Expr \rangle \right)^* \right) \right]$
 $\quad | \quad \underline{IF} \langle Expr \rangle \underline{THEN} \langle Expr \rangle \left[\underline{ELSE} \langle Expr \rangle \right] \underline{FI}$

Equivalent BNF Grammar with semantic actions

$\langle Prog \rangle ::= \langle Defs \rangle \# \textcircled{1}$
 $\langle Defs \rangle ::= \langle Def \rangle \textcircled{2} \mid \langle Def \rangle \langle Defs \rangle \textcircled{3}$
 $\langle Def \rangle ::= \underline{DEF} \langle Lhs \rangle \equiv \langle Expr \rangle \textcircled{4}$
 $\langle Lhs \rangle ::= \underline{MAIN} \vdash \langle Type \rangle \textcircled{5}$
 $\quad | \quad \underline{id} \left(\vdash \langle Type \rangle \right) \textcircled{6}$
 $\quad | \quad \underline{id} \left(\langle Params \rangle \right) \vdash \langle Type \rangle \textcircled{7}$
 $\langle Params \rangle ::= \langle Param \rangle \textcircled{8} \mid \langle Param \rangle \vdash \langle Params \rangle \textcircled{9}$
 $\langle Param \rangle ::= \underline{id} \vdash \langle Type \rangle \textcircled{10}$
 $\langle Type \rangle ::= \underline{nat} \textcircled{11} \mid \underline{bool} \textcircled{12}$
 $\langle Expr \rangle ::= \underline{number} \textcircled{13} \mid \underline{true} \textcircled{14} \mid \underline{false} \textcircled{15} \mid \underline{id} \textcircled{16}$
 $\quad | \quad \underline{id} \left(\langle Args \rangle \right) \textcircled{17}$
 $\quad | \quad \underline{IF} \langle Expr \rangle \underline{THEN} \langle Expr \rangle \underline{FI} \textcircled{18}$
 $\quad | \quad \underline{IF} \langle Expr \rangle \underline{THEN} \langle Expr \rangle \underline{ELSE} \langle Expr \rangle \underline{FI} \textcircled{19}$
 $\langle Args \rangle ::= \langle Expr \rangle \textcircled{20} \mid \langle Expr \rangle \vdash \langle Args \rangle \textcircled{21}$

1	Prog	::=	Defs # (1)		
2	Defs	::=	Def Def1		
3	Def1	::=	(2)		
4			Defs (3)		
5	Def	::=	<u>DEF</u> Lhs == Expr (4)		
6	Lhs	::=	<u>MAIN</u> ; Type (5)		
7			<u>id</u> (Lhs1		
8	Lhs1	::=) ; Type (6)		
9			Params) ; Type (7)		
10	Params	::=	Param Params1		
11	Params1	::=	(8)		
12			, Params (9)		
13	Param	::=	<u>id</u> ; Type (10)		
14	Type	::=	<u>nat</u> (11) <u>bool</u> (12)		
15	Expr	::=	<u>number</u> (13) <u>true</u> (14) <u>false</u> (15)		
16			<u>id</u> Expr1		
17			<u>IF</u> Expr <u>THEN</u> Expr Expr2		
18	Expr1	::=	(16)		
19			(Args) (17)		
20	Expr2	::=	<u>FI</u> (18)		
21			<u>ELSE</u> Expr <u>FI</u> (19)		
22	Args	::=	Expr Args1		
23	Args1	::=	(20)		
24			Expr, Args (21)		

Nullable: NO: Prog, Defs, Def, Lhs, Lhs1, Params, Param, Type, Expr, Expr2, Args
 YES: Def1, Params1, Expr1, Args1

Dir(2) = Fst (Def Def1) = Fst (Def) = {DEF}

Dir(3) = Flw(Def1) = Flw(Defs) = {#}

Dir(4) = Fst(Defs) = Fst(Def) = {DEF}

Dir(5) = {DEF}

Dir(6) = {MAIN}

Dir(7) = {id}

Dir(8) = {}}

Dir(9) = Fst(Params) = Fst (Param) = {id}

Dir(10) = Fst(Param) = {id}

Dir(11) = Flw(Params1) = {,}

Dir(12) = {,}

Dir(13) = {id}

Dir(14) = {nat; bool}

Dir(15) = {number; true; false}

Dir(16) = {id}

Dir(17) = {IF}

Dir(18) = Flw(Expr1) = Flw(Expr) = {THEN; FI; ELSE; number; true; false; id; IF; ,}

Dir(19) = {{}

Dir(20) = {FI}

Dir(21) = {ELSE}

Dir(22) = {number; true; false; id; IF}

Dir(23) = Flw(Args1) = Flw(Args) = {}} \cup Flw(Args1) = {}}

Dir(24) = {number; true; false; id; IF}

Flw(Defs) = {#} \cup Flw(Def1) = {#} \cup Flw(Defs) = {#}

Flw(Params1) = Flw(Params) = {}} \cup Flw(Params1) = {}}

Flw(Expr) = {THEN} \cup Fst(Expr2) \cup {FI} \cup Fst(Arg1) \cup {,} = {THEN; FI; ELSE; number; true; false; id; IF; ,}