In21-S4-CS3513 – Programming Languages

HomeWork 01

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Question 01

- Left recursion always produces a non-LL(1) grammar;

E -> E or T
-> E nor T
-> E xor T

- Common prefixes always produce a non-LL(1) grammar;

T -> F and T
-> F nand T
-> F

Therefore, the given grammar is non-LL(1)

Question 02

- Fixing Left Recursion

E -> TY	**{ not , (, i , true , false }**
Y -> or TY	**{ or }**
-> nor TY	**{ nor }**
-> xor TY	**{ xor }**
->	**{) }**

- Fixing Common Prefixes

T -> FX	**{ not , (, i , true , false }**
X -> and T	**{ and}**
-> nand T	**{ nand }**
->	**{ or , nor , xor ,) }**

- Modified Grammer

	First Set	Follow Set	Select Set
E -> TY	{ not , (, i , true , false }	{) }	**{ not , (, i , true , false }**
Y -> or TY	{ or , nor , xor }	{) }	**{ or }**
-> nor TY			**{ nor }**
-> xor TY			**{ xor }**
->			**{) }**
T -> FX	{ not , (, i , true , false }	{ or , nor , xor ,) }	**{ not , (, i , true , false }**
X -> and T	{and, nand, ε}	{ or , nor , xor ,) }	**{ and}**
-> nand T			**{ nand}**
->			**{ or , nor , xor ,) }**
F -> not F	{ not , (, i , true , false }	{ and, nand, or , nor , xor ,) }	**{ not }**
-> P			**{ (, i , true , false }**
P -> (E)	{ (, i , true , false }	{ and, nand, or , nor , xor ,) }	**{ (}**
-> i			**{ i }**
-> true			**{ true }**
-> false			**{ false }**

E -> TY **{ not , (, i , true , false }**
Y -> or TY **{ or }**
-> nor TY **{ nor }**
-> xor TY **{ xor }**
-> **{) }**
T -> FX **{ not , (, i , true , false }**
X -> and T **{ and}**
-> nand T **{ nand }**
-> **{ or , nor , xor ,) }**
F -> not F **{ not }**
-> P **{ (, i , true , false }**
P -> (E) **{ (}**
-> i **{ i }**
-> true **{ true }**
-> false **{ false }**

Question 03

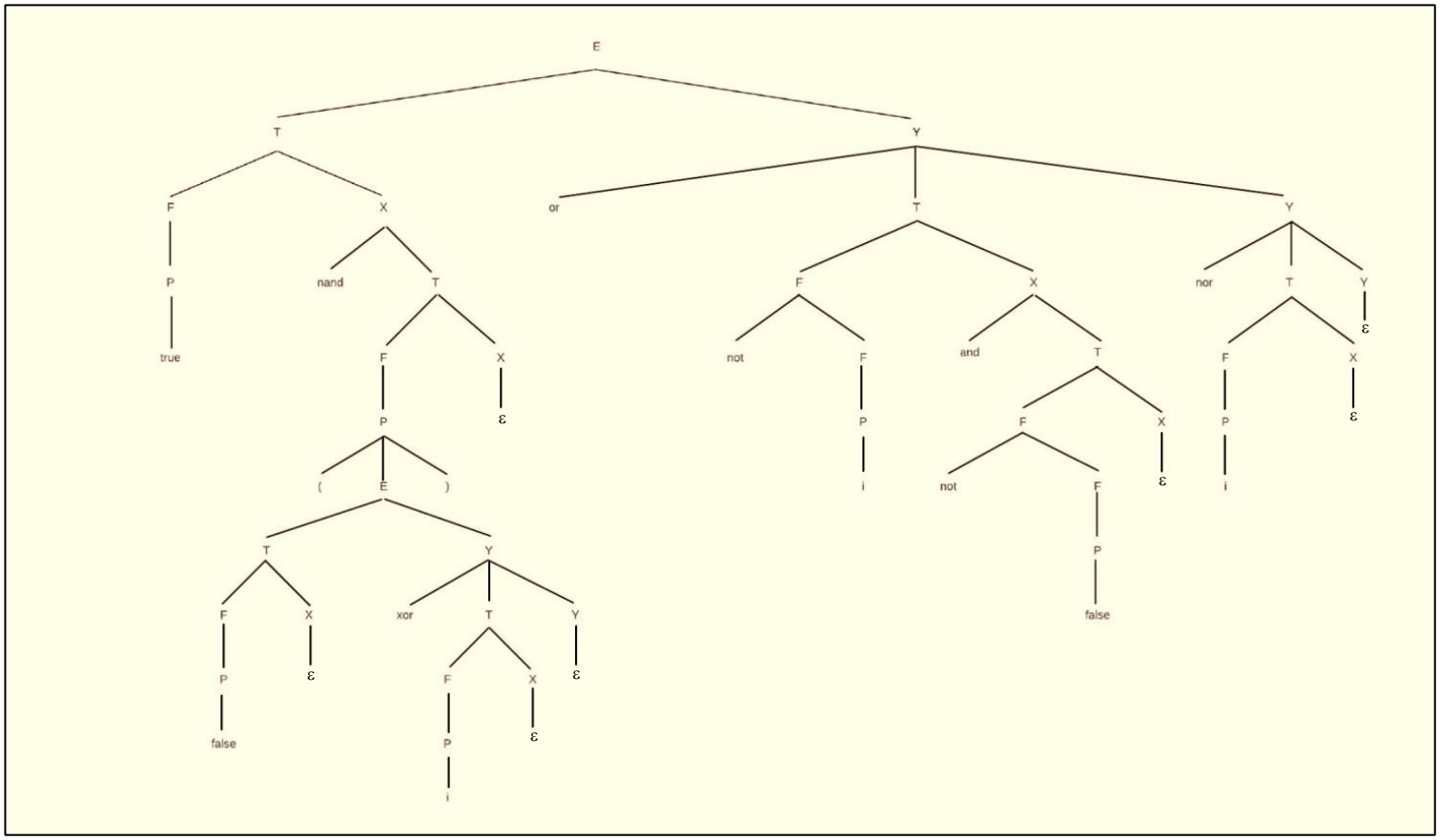
	or	nor	xor	and	nand	not	true	false	i	(	)
E						**E -> TY**	**E -> TY**	**E -> TY**	**E -> TY**	**E -> TY**	
Y	**Y -> or TY**	**Y -> nor TY**	**Y -> xor TY**								**Y ->**
T						**T -> FX**	**T -> FX**	**T -> FX**	**T -> FX**	**T -> FX**	
X	**X ->**	**X ->**	**X ->**	**X -> and T**	**X -> nand T**						**X ->**
F						**F -> not F**	**F -> P**	**F -> P**	**F -> P**	**F -> P**	
P							**P -> true**	**P -> false**	**P -> i**	**P -> (E)**	

Question 04

Stack	Input	Table Lookup
E	true nand (false xor i) or not i and not false nor i ⊥	**E -> TY**
TY	true nand (false xor i) or not i and not false nor i ⊥	**T -> FX**
FXY	true nand (false xor i) or not i and not false nor i ⊥	**F -> P**
PXY	true nand (false xor i) or not i and not false nor i ⊥	**P -> true**
true XY	true nand (false xor i) or not i and not false nor i ⊥	
XY	nand (false xor i) or not i and not false nor i ⊥	**X -> nand T**
Nand TY	nand (false xor i) or not i and not false nor i ⊥	
TY	(false xor i) or not i and not false nor i ⊥	**T -> FX**
FXY	(false xor i) or not i and not false nor i ⊥	**F -> P**
PXY	(false xor i) or not i and not false nor i ⊥	**P -> (E)**
(E) XY	(false xor i) or not i and not false nor i ⊥	
E) XY	false xor i) or not i and not false nor i ⊥	**E -> TY**
TY) XY	false xor i) or not i and not false nor i ⊥	**T -> FX**
FXY) XY	false xor i) or not i and not false nor i ⊥	**F -> P**
PXY) XY	false xor i) or not i and not false nor i ⊥	**P -> false**
false XY) XY	false xor i) or not i and not false nor i ⊥	
XY) XY	xor i) or not i and not false nor i ⊥	**X ->**
Y) XY	xor i) or not i and not false nor i ⊥	**Y -> xor TY**

xor TY) XY	xor i) or not i and not false nor i ⊥	
TY) XY	i) or not i and not false nor i ⊥	**T -> FX**
FXY) XY	i) or not i and not false nor i ⊥	**F -> P**
PXY) XY	i) or not i and not false nor i ⊥	**P -> i**
i XY) XY	i) or not i and not false nor i ⊥	
XY) XY	) or not i and not false nor i ⊥	**X ->**
Y) XY	) or not i and not false nor i ⊥	**Y ->**
) XY	) or not i and not false nor i ⊥	
XY	or not i and not false nor i ⊥	**X ->**
Y	or not i and not false nor i ⊥	**Y -> or TY**
or TY	or not i and not false nor i ⊥	
TY	not i and not false nor i ⊥	**T -> FX**
FXY	not i and not false nor i ⊥	**F -> not F**
not FXY	not i and not false nor i ⊥	
FXY	i and not false nor i ⊥	**F -> P**
PXY	i and not false nor i ⊥	**P -> i**
i XY	i and not false nor i ⊥	
XY	and not false nor i ⊥	**X -> and T**
and TY	and not false nor i ⊥	
TY	not false nor i ⊥	**T -> FX**
FXY	not false nor i ⊥	**F -> not F**
not FXY	not false nor i ⊥	
FXY	false nor i ⊥	**F -> P**
PXY	false nor i ⊥	**P -> false**
false XY	false nor i ⊥	
XY	nor i ⊥	**X ->**
Y	nor i ⊥	**Y -> nor TY**
nor TY	nor i ⊥	
TY	i ⊥	**T -> FX**
FXY	i ⊥	**F -> P**
PXY	i ⊥	**P -> i**
i XY	i ⊥	
XY	⊥	**X ->**
Y	⊥	**Y ->**
-	⊥	

Question 05



Question 06

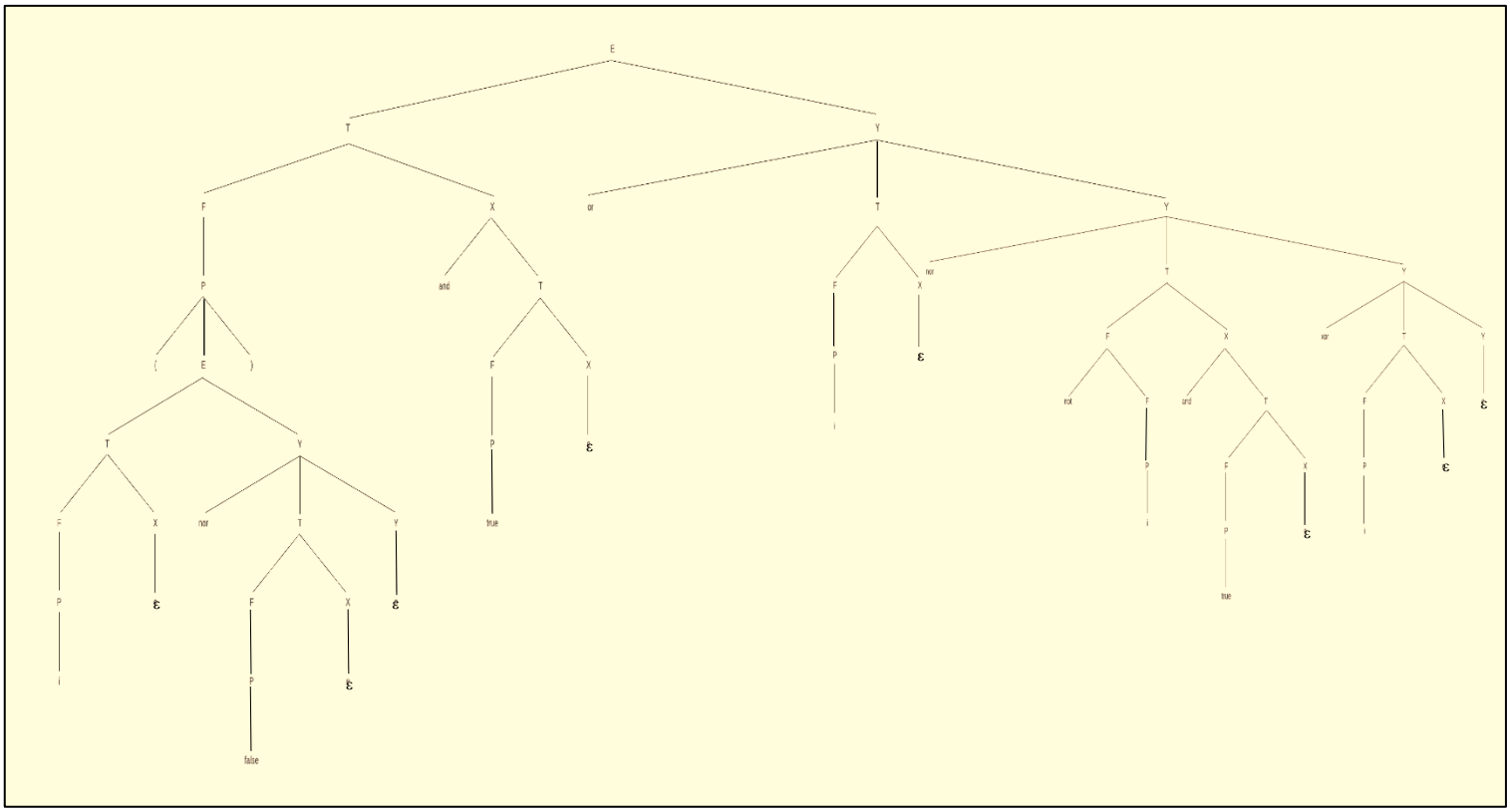
```
proc E;
        T(); Y();
        Write (E → TY);
end;

proc Y;
    case Next_Token of
        T_or : Read(T_or);
                T();
                Y();
                Write (Y -> or TY);
        T_nor : Read(T_nor);
                T();
                Y();
                Write (Y -> nor TY);
        T_xor : Read(T_xor);
                T();
                Y();
                Write (Y -> xor TY);

        T_) : Write (Y → );
        otherwise   Error;
    end;
end;
```

```
proc T;
        F(); X();
        Write (T → FX);
end;

proc X;
    if Next Token = T_and
    then
        Read(T_and);
        T();
        Write (X -> and T);
    else if Next Token = T_nand
    then
        Read(T_nand);
        T();
        Write (X -> nand T);
    else Write (X -> );
end;


proc F;
    case  Next Token of
        T_true, T_false, T_i, T_( : P();
                                    Write (F -> P);
        T_not: Read(T_not);
               F();
               Write (F -> not F);
        otherwise Error;
    end;
end;

proc P;
    case Next_Token of
        T_true : Read(T_true);
                 Write (P -> true);
        T_false : Read(T_false);
                  Write (P -> false);
        T_i : Read(T_i);
              Write (P -> i);
        T_( : Read(T_( );
              E();
              Read(T_) );
              Write (P -> (E));
        otherwise   Error;
    end;
end;
```

Question 07

```
P -> i
F -> P
X ->
T -> FX
P -> false
F -> P
X ->
T -> FX
Y ->
Y -> nor TY
E -> TY
P -> (E)
F -> P
P -> true
F -> P
X ->
T -> FX
X -> and T
T -> FX
P -> i
F -> P
X ->
T -> FX
P -> i
F -> P
F -> not F
P -> true
F -> P
X ->
T -> FX
X -> and T
T -> FX
P -> i
F -> P
X ->
T -> FX
Y ->
Y -> xor TY
Y -> nor TY
Y -> or TY
E -> TY
```

Question 08



Question 09

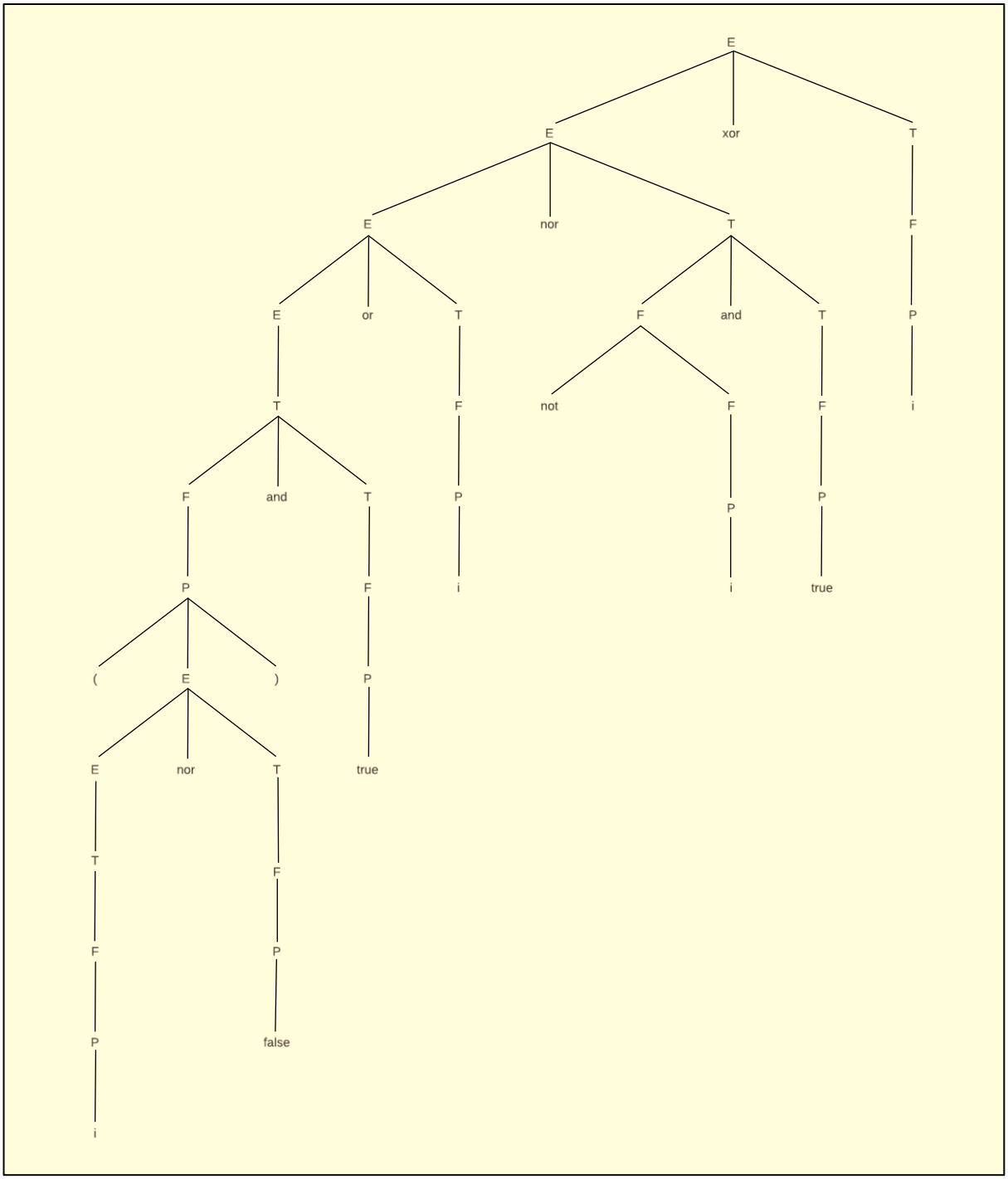
```
proc E;
        T();
        Write (E → T);
        while Next_Token ∈ {T_or,T_nor,T_xor} do
            if Next_Token = T_or
                then    Read (T_or); T();
                        Write (E → E or T);
            else if Next_Token = T_nor
                then    Read (T_nor); T();
                        Write (E → E nor T);
            else if Next_Token = T_xor
                then    Read (T_xor); T();
                        Write (E → E xor T);
end;

proc T;
        F();
        if Next_Token = T_and
            then    Read (T_and); T();
                    Write (T → F and T);
        else if Next_Token = T_nand
            then    Read (T_nand); T();
                    Write (T → F nand T);
        else    Write (T → F);
end;
```

```
proc F;
    case  Next Token of
        T_true, T_false, T_i, T_( : P();
                                    Write (F -> P);
        T_not: Read(T_not); F();
               Write (F -> not F);
        otherwise Error;
    end;
end;

proc P;
    case Next_Token of
        T_true : Read(T_true);
                 Write (P -> true);
        T_false : Read(T_false);
                  Write (P -> false);
        T_i : Read(T_i);
              Write (P -> i);
        T_( : Read(T_( ); E(); Read(T_) );
              Write (P -> (E));
        otherwise   Error;
    end;
end;
```

Question 10

```
P -> i
F -> P
T -> F
E -> T
P -> false
F -> P
T -> F
E -> E nor T
P -> (E)
F -> P
P -> true
F -> P
T -> F
T -> F and T
E -> T
P -> i
F -> P
T -> F
E -> E or T
```

```
P -> i
F -> P
F -> not F
P -> true
F -> P
T -> F
T -> F and T
E -> E nor T
P -> i
F -> P
T -> F
E -> E xor T
```



Question 11

```
proc E;
        T();
        while Next_Token ∈ {T_or,T_nor,T_xor} do
            if Next_Token = T_or
                then    Read (T_or); T();
                        Build_tree('or', 2);
            else if Next_Token = T_nor
                then    Read (T_nor); T();
                        Build_tree('nor', 2);
            else if Next_Token = T_xor
                then    Read (T_xor); T();
                        Build_tree('xor', 2);
end;

proc T;
        F();
        if Next_Token = T_and
            then    Read (T_and); T();
                    Build_tree('and', 2);
        else if Next_Token = T_nand
            then    Read (T_nand); T();
                    Build_tree('nand', 2);
end;

proc F;
    case  Next Token of
        T_true, T_false, T_i, T_( : P();

        T_not: Read(T_not); F();
               Build_tree('not', 1);
        otherwise Error;
    end;
end;

proc P;
    case Next_Token of
        T_true : Read(T_true);
                 Build_tree('true', 0);
        T_false : Read(T_false);
                  Build_tree('false', 0);
        T_i : Read(T_i);
              Build_tree('i', 0);
        T_( : Read(T_( ); E(); Read(T_) );

        otherwise   Error;
    end;
end;
```

Question 12

```
Build_tree('i', 0);
Build_tree('false', 0);
Build_tree('nor', 2);
Build_tree('true', 0);
Build_tree('and', 2);
Build_tree('i', 0);
Build_tree('or', 2);
Build_tree('i', 0);
Build_tree('not', 1);
Build_tree('true', 0);
Build_tree('and', 2);
Build_tree('nor', 2);
Build_tree('i', 0);
Build_tree('xor', 2);
```