Typed Arithmetic Expressions with extensions

SYNTAX :

Syntax For **AND :**

AND t_1 t_2 t_1 and t_2 should be bool type or $t_1 \rightarrow t_1'$ and $t_2 \rightarrow t_2'$
(t_1' and t_2' must be bool type)

Syntax For **OR :**

OR t_1 t_2 t_1 and t_2 should be bool type or $t_1 \rightarrow t_1'$ and $t_2 \rightarrow t_2'$
(t_1' and t_2' must be bool type)

Syntax For **SWITCH :**

SWITCH t_1 CASE **0** : t_2 CASE **SUCC 0 :** t_3 where t_1 should be NAT type and t_2 ,t_3 can be R type(R : bool or NAT)

Typing Rules

AND

```
TmAnd(fi,t1,t2) ->
    if (=) (typeof t1) TyBool then
      if (=) (typeof t2) TyBool then TyBool
      else error fi "arms of And have different types"
```

OR

```
TmOr(fi,t1,t2) ->
    if (=) (typeof t1) TyBool then
      if (=) (typeof t2) TyBool then TyBool
      else error fi "arms of OR have different types"
```

SWITCH

```
TmSwitch(fi,t1,t2,t3) ->
    if (=) (typeof t1) TyNat then
      let tyT2 = typeof t2 in
      if (=) tyT2 (typeof t3) then tyT2
      else error fi "arms of conditional have different types"
    else error fi "guard of conditional not a nat type"
```

<u>Formal Operational Semantics</u> :

<u>AND :</u>

AND true t $\rightarrow$ t

AND false t $\rightarrow$ false

AND t true $\rightarrow$ t

AND t false $\rightarrow$ false

AND t_1 t_2 $\rightarrow$ need further evaluation

<u>OR :</u>

OR true t $\rightarrow$ true

OR false t $\rightarrow$ t

OR t_1 t_2 $\rightarrow$ need further evaluation

<u>SWITCH</u> :

SWITCH 0 CASE 0 : t_1 CASE SUCC 0 : t_2 $\rightarrow$ t_1

SWITCH SUCC 0 CASE 0 : t_1 CASE SUCC 0 : t_2 $\rightarrow$ t_2

Implementation:

We have updated/added in these files:

Core.ml : evaluation rules for SWITCH, AND and OR has been added.

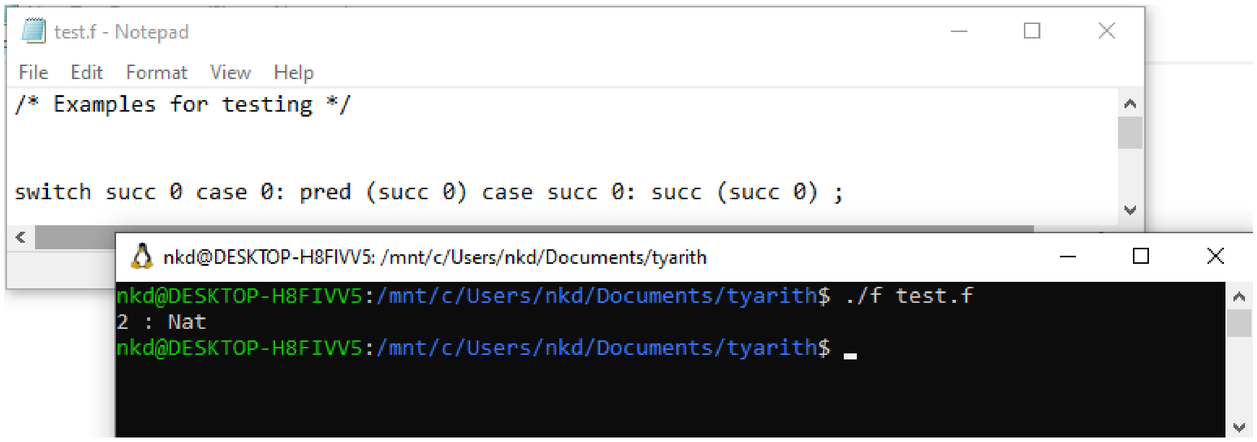
Syntax.ml, **Syntax.mli** : dataType, file information and printing code.

Lexer.mll : Keyword declaration.

```
 (* EVALUATION RULE  FOR SWITCH -------*)
 | TmSwitch(_,t1,t2,t3) when isValZero t1 ->
    t2
 | TmSwitch(_,t1,t2,t3) when isValSuccZero t1 ->
    t3
 | TmSwitch(fi,t1,t2,t3) ->
    let t1' = eval1 t1 in
    TmSwitch(fi,t1',t2,t3)
(* EVALUATION RULE FOR AND -------- *)
| TmAnd(fi,TmTrue(_),v2) when isValBool v2 ->
    v2
 | TmAnd(fi,TmFalse(_),v2) when isValBool v2 ->
    TmFalse(dummyinfo)
 | TmAnd(fi,v1,TmTrue(_)) when isValBool v1 ->
    v1
 | TmAnd(fi,v1,TmFalse(_)) when isValBool v1 ->
```

```
      TmFalse(dummyinfo)
  | TmAnd(fi,v1,t2) when isValBool v1 ->
      let t2' = eval1 t2 in
      TmAnd(fi,v1,t2')
  | TmAnd(fi,t1,t2) ->
      let t1' = eval1 t1 in
      TmAnd(fi,t1',t2)
 (* EVALUATION RULE FOR OR -------- *)
  | TmOr(fi,TmTrue(_),v2) when isValBool v2 ->
      TmTrue(dummyinfo)
  | TmOr(fi,TmFalse(_),v2) when isValBool v2 ->
      v2
  | TmOr(fi,v1,t2) when isValBool v1 ->
      let t2' = eval1 t2 in
      TmOr(fi,v1,t2')
  | TmOr(fi,t1,t2) ->
      let t1' = eval1 t1 in
      TmOr(fi,t1',t2)
(* BOOLEAN VALUE CHECK  -------- *)
let isValBool t = match t with
    TmTrue(_)              -> true
  | TmFalse(_)             -> true
  | _                      -> false
(* SUCC 0 VALUE CHECK  -------- *)
let isValSuccZero t = match t with
    TmSucc(_,t1) when isValZero t1 -> true
  | _
```

Output

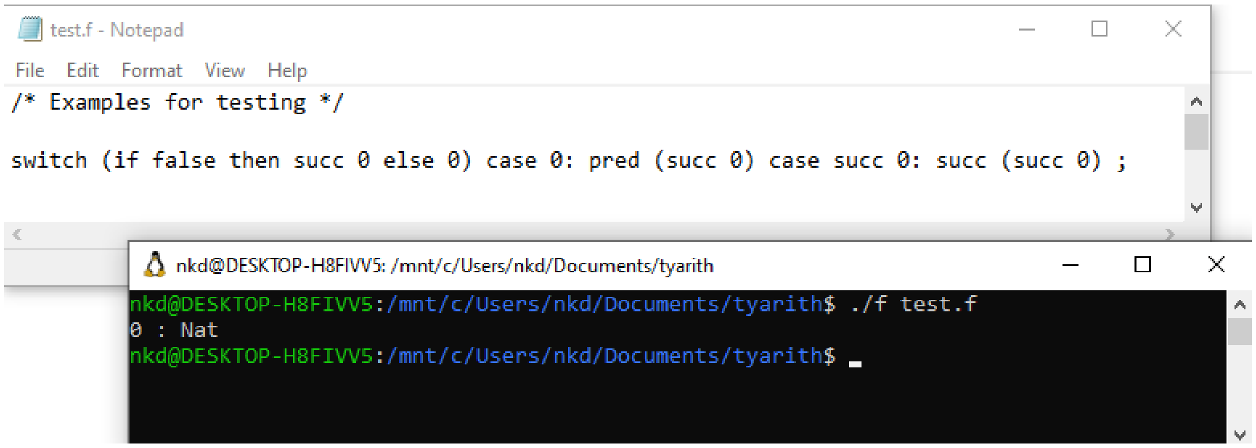

test.f - Notepad

```
/* Examples for testing */

switch succ 0 case 0: pred (succ 0) case succ 0: succ (succ 0) ;
```

nkd@DESKTOP-H8FIVV5: /mnt/c/Users/nkd/Documents/tyarith

```
nkd@DESKTOP-H8FIVV5:/mnt/c/Users/nkd/Documents/tyarith$ ./f test.f
2 : Nat
nkd@DESKTOP-H8FIVV5:/mnt/c/Users/nkd/Documents/tyarith$
```

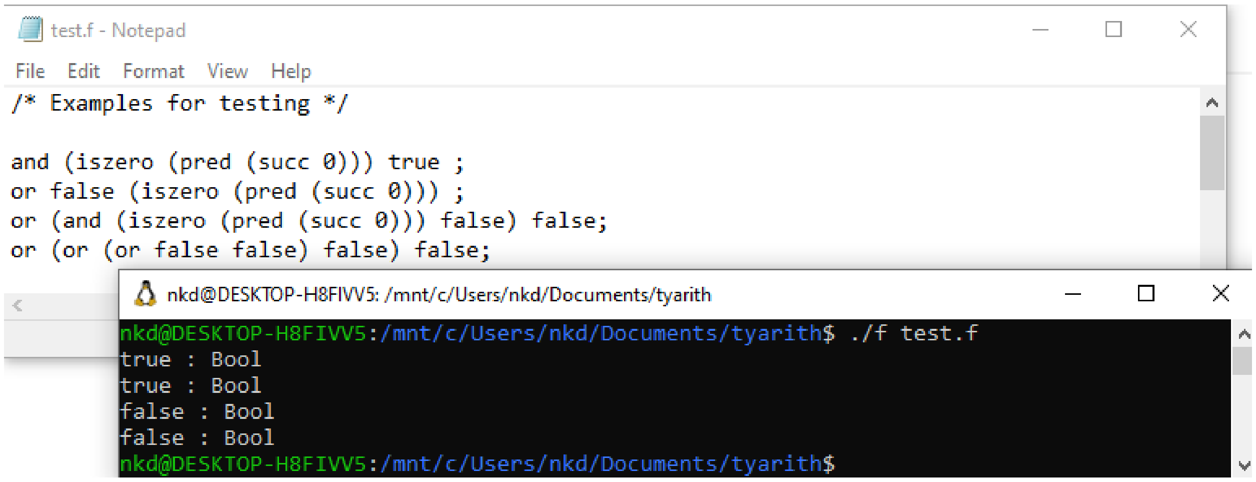

test.f - Notepad

```
/* Examples for testing */

switch (if false then succ 0 else 0) case 0: pred (succ 0) case succ 0: succ (succ 0) ;
```

nkd@DESKTOP-H8FIVV5: /mnt/c/Users/nkd/Documents/tyarith

```
nkd@DESKTOP-H8FIVV5:/mnt/c/Users/nkd/Documents/tyarith$ ./f test.f
0 : Nat
nkd@DESKTOP-H8FIVV5:/mnt/c/Users/nkd/Documents/tyarith$
```


test.f - Notepad

```
/* Examples for testing */

and (iszero (pred (succ 0))) true ;
or false (iszero (pred (succ 0))) ;
or (and (iszero (pred (succ 0))) false) false;
or (or (or false false) false) false;
```

nkd@DESKTOP-H8FIVV5: /mnt/c/Users/nkd/Documents/tyarith

```
nkd@DESKTOP-H8FIVV5:/mnt/c/Users/nkd/Documents/tyarith$ ./f test.f
true : Bool
true : Bool
false : Bool
false : Bool
nkd@DESKTOP-H8FIVV5:/mnt/c/Users/nkd/Documents/tyarith$
```