> **sml**

Standard ML of New Jersey v110.74 [built: Thu Aug 16 11:25:45 2012]

- **(\* Tutorial of basic ML types, values, and operators for COP 4020 \*)**

- **(\* ML comments go between parentheses and asterisks \*)**

- **5+5;**

val it = 10 : int

- **3-5; (\* notice negative in result is written with a tilde \*)**

val it = ~2 : int

- **#"m";**

val it = #"m" : char

- **"yo" ^ "yo";**

val it = "yoyo" : string

- **(\* plus and minus operators are only defined on ints and reals \*)**

- **"yo" + "yo";**

stdIn:6.6 Error: overloaded variable not defined at type

 symbol: +

 type: string

- **3 + 3.5; (\* both operands must be ints or both must be reals \*)**

stdIn:1.1-2.3 Error: operator and operand don't agree [literal]

 operator domain: int \* int

 operand: int \* real

 in expression:

 3 + 3.5

- **4.2 + ~1.0;**

val it = 3.2 : real

- **3 + #"A"; (\* these sorts of expressions work in C but not ML \*)**

stdIn:9.1-9.9 Error: operator and operand don't agree [literal]

 operator domain: int \* int

 operand: int \* char

 in expression:

 3 + #"A"

- **true andalso false;**

val it = false : bool

- **not(5=3); (\* notice equality test is only one equal sign \*)**

val it = true : bool

- **3>5 orelse 5<=3;**

val it = false : bool

- **3<>4; (\* inequality test \*)**

val it = true : bool

- **if 3=5 then false<>false else not true;**

val it = false : bool

- **(\* parentheses can be put around any expression \*)**

- **((if (3=(5)) then (false<>false) else (not true)));**

val it = false : bool

- **if 5 then 4 else 3; (\* "if" expression must have boolean type \*)**

stdIn:1.1-9.7 Error: test expression in if is not of type bool [literal]

 test expression: int

 in expression:

 if 5 then 4 else 3

- **(\* "then" and "else" expressions can have any type, \*)**

- **(\* but they must have the same type \*)**

- **if true then true else 4;**

stdIn:1.1-10.5 Error: types of if branches do not agree [literal]

 then branch: bool

 else branch: int

 in expression:

 if true then true else 4

- **(\* "if" expressions must have both "then" and "else" expressions \*)**

- **(\* there is no such thing as if-then expressions in ML \*)**

- **if true then 3;**

= **(\* SML/NJ responds with '=' because it expects more input \*)**

= **(\* this is a mistake, so kill this expression with ctrl-c \*)**

= **<ctrl-c>**

Interrupt

- **(\* we are now back, ready to input more expressions \*)**

- **(\* expressions can be nested \*)**

- **5 + (if true then 3 else 4);**

Question for class: How does SML/NJ respond at this point?

- **if (if 2=2 then 2=3 else 2=2) then (if 2=2 then 4 else 5)**

= **(\* SML/NJ responds with '=' because it expects more input\*)**

= **else (if 2=3 then 6 else 7);**

Question for class: How does SML/NJ respond at this point?

- **(\* quit with ctrl-d \*)**

- <**ctrl-d>**

>

> **sml**

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- **(\* Tutorial of top-level variables, tuples, and lists in ML \*)**

- **(\* Define *top-level variables* (i.e., global vars) with the "val" keyword \*)**

- **val v1 =** "**hi ";**

val v1 = "hi " : string

- **(\* Called "top-level" because not defined within another construct \*)**

- **(\* E.g., a var defined within a function is not a top-level var \*)**

- **val v2 =** **"there";**

val v2 = "there" : string

- **v1 ^ v2;**

val it = "hi there" : string

- **(\* Think of the following as creating a new variable called v1 \*)**

- **(\* Don’t think of the following as updating the value of the old v1\*)**

- **val v1 = 5;**

val v1 = 5 : int

- **(\* Technically, we have two variables called v1 defined now \*)**

- **(\* But the new definition overshadows the old one \*)**

- **v1 ^ v2;**

stdIn:5.1-5.8 Error: operator and operand don't agree [tycon mismatch]

 operator domain: string \* string

 operand: int \* string

 in expression:

 v1 ^ v2

- **(\* Forgetting the "val" keyword changes the expression’s meaning \*)**

- **v1 = 3;**

val it = false : bool

- **(\* A *tuple* is a comma-separated, finite sequence of expressions**

 **between parentheses (must have at least two expressions).**

 **The order of expressions within a tuple matters:**

 **(3,4) is different than (4,3).**

 **Expressions in a tuple can have different types:**

 **(3, 4.5, true) is a tuple of type int\*real\*bool \*)**

- **val t1 =** **(3, 4.5, true);**

val t1 = (3,4.5,true) : int \* real \* bool

- **(\* Can put general expressions in tuples and have nested tuples \*)**

- **val t2 = (if 2=2 then 3 else 4, (false, 5.6));**

val t2 = (3,(false,5.6)) : int \* (bool \* real)

- **(\* Access nth component of tuple t with: #n(t) \*)**

- **#3(t1);**

val it = true : bool

- **#1(#2(t2));**

val it = false : bool

- **(\* There are no tuples with zero components. \*)**

- **(\* However, () is a special value of type unit \*)**

- **();**

val it = () : unit

- **(\* Unit is an interesting type; only one value has type unit \*)**

- **(\* A *value* is anything that can be a final result of a program \*)**

- **if true then (if false then () else ()) else ();**

val it = () : unit

- **(\* Even the bool type is inhabited by two values, true and false \*)**

Question for class: How many values does type int have?

- **(\* A *list* is a comma-separated, finite sequence of expressions**

 **between brackets. Lists, unlike tuples, may have only 0 or 1 elements.**

 **The order of expressions within a list matters:**

 **[3,4] is different than [4,3].**

 **Unlike tuples, expressions in a list must have the same type:**

 **[3, 4, 5] is a list of type int list \*)**

- **val L = [3,4,5];**

val L = [3,4,5] : int list

- **val L2 = [3,4.5,true];**

stdIn:4.10-4.22 Error: operator and operand don't agree [tycon mismatch]

 operator domain: real \* real list

 operand: real \* bool list

 in expression:

 4.5 :: true :: nil

- **(\* list concatenation \*)**

- **val L = L @ [2];**

val L = [3,4,5,2] : int list

- **val L = [2] @ L;**

val L = [2,3,4,5,2] : int list

- **(\* prepending to a list with the *cons* operator \*)**

- **1 :: L;**

val it = [1,2,3,4,5,2] : int list

- **(\* Empty list can be written in two ways \*)**

- **(\* Empty list has type *‘a list*, meaning that ML knows it’s a list,**

=  **but it could be any type of list (e.g., int list or bool list) \*)**

- **[];**

val it = [] : 'a list

- **nil;**

val it = [] : 'a list

- **val L = 1::2::3::8::[];**

val L = [1,2,3,8] : int list

- **(\* First element in a list is the *head*; all others are the *tail* \*)**

- **hd(L);**

val it = 1 : int

- **tl(L);**

val it = [2,3,8] : int list

- **hd(nil);**

stdIn:13.1-13.8 Warning: type vars not generalized because of

 value restriction are instantiated to dummy types (X1,X2,...)

uncaught exception Empty

 raised at: smlnj/init/pervasive.sml:194.19-194.24

- **tl(nil);**

stdIn:1.1-2.2 Warning: type vars not generalized because of

 value restriction are instantiated to dummy types (X1,X2,...)

uncaught exception Empty

 raised at: smlnj/init/pervasive.sml:196.19-196.24