

# Homework # 2

## due Tuesday, February 8, 3:30 PM

### 1 Ambiguous Grammars

Some programming languages have “if” expressions:

```
<expr> ::= <expr> + <expr> | <expr> = <expr> | <expr> * <expr>
        | if <expr> then <expr> else <expr>
        | <INTEGER> | <ID> | ( <expr> )
```

Thus one can write:

```
(if x = 0 then 1 else 10 * x ) + y
```

However the grammar above is ambiguous.

- Show three parse trees for the string “if 1 = 2 then 3 else 4 \* 5 + 6”
- Rewrite the grammar to be unambiguous, where: if has lowest precedence, then =, then + and then \*, with highest precedence. Both + and \* should have left associativity, and = should be non-associative (x = y = z should be a syntax error).

### 2 First Experience with ML

I assume you have a computer you can install software on. Install SML on your own computer. Start up a session and evaluate the following two expressions:

```
Time.now();
if 1 = 2 then 3 else 4 * 5 + 6;
```

Print out the window with the contents of this session. Indicate which of the three parse trees SML/NJ chose for the second expression.

### 3 Standard compilation sequence

Write a file `square.cc`:

```
#include <iostream>
using namespace std;

int main()
{
    int i;
    cin >> i;
    cout << i*i;
    exit(0);
}
```

On miller or weise, compile this program to assembly (`g++ -S square.cc`) and to object file (`g++ -c square.cc`) and to an executable (`g++ square.cc`). Answer the following questions:

1. Look in the assembly file (`square.s`) and find out in the function `main` how it refers to `cin`. Show that here.
2. Use the program `c++filt` to convert that “mangled” name into a readable name. What is the full name of `cin` ? Why does C++ mangle the name?
3. What other functions exist in the assembly file? Give their unmangled names.
4. Use `/usr/ccs/bin/elfdump` to examine the object file, `square.o`. How does the file refer to `exit` ?
5. Look at the relocation table for the text segment: `.rel.text`. What does `_ZNSolsEi` refer to? Why is it there? Why is there *no* entry for `int i` ?
6. Use the command `ldd` on the executable `a.out`. This indicates what shared libraries are used by the executable and where they (currently) can be found. List each and investigate what each does; report why each is being used.

## 4 Submitting Your Work

If you do not have your own computer, see me, and I will give you you an alternate assignment.

Turn in your answers on paper.