

Announcements

- Exam #1
 - re-grade requests due by 1:45 on Thursday
- Program #1b
 - will return hand-grading portion today
 - re-grade requests due by 1:45 one week from today
- Program #2
 - Due March 15th at 8:00 pm
- Reading
 - Chapter 14 (Today)
 - Chapter 12, 10.2 (Thursday)

Steps in compiling a program

- Converting .c to .o files
 - Pre-processor
 - Compiler (or Translator)
 - Scanner/Parser
 - Type Checker
 - Optimizer
 - Code Generator
 - Assembler
 - Converts assembly code to machine code
- Converting .o's to an executable
 - Linker
 - resolves symbols
 - function use and definitions
 - global variable declarations and use

Pre-processor

- Makes a pass over the program before the compiler
- Handles
 - #include statements
 - Symbolic constants
 - Macros
 - Pre-processor Symbols
 - and other pre-processor directives
 - thgings that start w/ #

Pre-defined Symbols

- `__FILE__`
 - the name of the source file being compiled
- `__LINE__`
 - line number of the current line in the file
- `__DATE__`
 - Date the file was compiled
- `__TIME__`
 - Time the file was compiled
- `__STDC__`
 - 1 if the compiler conforms to ANSI C
- Note: these start with two underscores and end with two underscores

#define

- #define name stuff
- Symbolic constants
 - Primary Use
 - #define MAX_SIZE_TABLE 1024
- Macros
 - #define name(parameter-list) stuff
 - Example:
 - #define SUM(a,b) a + b
- Note: all caps is a convention
 - not required by the preprocessor
 - makes it easier for us
- Macros are a single line
 - Can define a "continuation" by ending line with \
 - #define macro1 a very long macro \
 - that runs onto another line

Common Macros

- Square:

- `#define SQUARE(x) ((x) * (x))`
- `foo = SQUARE(a + 1)`
- This is replaced to:
 - `foo = ((a + 1) * (a + 1))`

- Double:

- `#define DOUBLE(x) ((x) + (x))`
- `foo = 10 * DOUBLE(3)`
- This is replaced to:
 - `foo = 10 * ((3) + (3))`

- Maximum:

- `#define MAX(a, b) ((a) > (b) ? (a) : (b))`
- `printf("%d is the max", MAX(5,6));`
- This replaces to:
 - `printf("%d is the max", ((5)>(6)?(5):(6)));`

Macro Substitution

- Items are textually replaced so you must be careful!!
- Consider:
 - `#define SQUARE(x)        x * x`
 - `foo = SQUARE(a + 1)`
 - This is replaced to:
 - `foo = a + 1 * a + 1`
 - `#define DOUBLE(x)        x + x`
 - `foo = 10 * DOUBLE(3)`
 - This is replaced to:
 - `foo = 10 * 3 + 3`

#define substitution

1. Check macro invocation arguments for macros
 - If present, replace with macro values
2. Replace macros invocations by defined macro
3. Scan for any defined macros used in program
 - If found, repeat steps 1 & 2

String literals are not scanned for macro replacement

Macros vs. Functions

- They look similar, but macros
 - are textually replaced into program
 - can be faster than subroutines for short things
 - macros can not be recursive
 - do not check types of parameters
 - replaced code is type checked during compile
- Example: macro being passed a type as a param

```
#define MALLOC(n, type) \  
((type *) malloc( (n) * sizeof( type )))
```

Other Issues with Macros

- Side Effects of Macro Parameters
 - Replace each use of parameter
 - Consider:
 - `#define DOUBLE(x) ((x) + (x))`
 - `y = DOUBLE(++j);`
 - `y = ((++j) + (++j))`
- Can be hard to tell macros from functions
 - Solution, use all upper case for macro names
- `#undef name`
 - un-define the macro named “name”
- Compiler Command Line Definition
 - `gcc -DFOO=3`
 - defines FOO just as though `#define FOO 3` appeared in program

Conditional Compilation

- `#if const-ex1`
 - statements done iff “const-ex1” is true
 - `#elif const-ex2`
 - statements done iff “const-ex1” is false and “const-ex2” is true
 - `#else`
 - statements done iff “const-ex1” is false and “const-ex2” is false
 - `#endif`
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- `defined(macro-name)`
 - one example of a constant expression
 - 1 if macro-name is defined, 0 if not
- `#error`
 - stops the compilation at this point
- Useful if code must be different on different systems
- Tends to make code hard to read

File Inclusion

- `#include "foo.h"`
 - Works as we have seen earlier
- What if `foo.h` includes another file
 - Pre-processor can handle this
- What if `"foo.h"` and `"bar.h"` each `#include stuff.h`
 - This is fine, until one program includes both `foo.h` and `bar.h`
- Solution (inside `stuff.h`):

```
#ifndef STUFF_H
#define STUFF_H

....

#endif
```