EECS 22: Advanced C Programming

Lecture 10

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Lecture 10: Overview

- Course Administration
  - Midterm course evaluation
- Midterm Course Review
  - Syntax and semantics of C programs
  - Types, expressions, statements, functions
  - Recursion, modules, Makefile, debugging
- Practice
  - Review Quiz
  - Programming Problem

Course Administration

- Midterm Course Evaluation
  - One week, starting this Sunday!
  - Sunday, Nov. 2, noon – Sunday, Nov. 9, noon
  - Online via EEE Evaluation application
- Feedback from students to instructors
  - Completely voluntary
  - Completely anonymous
  - Very valuable
    - Help to improve this class!
- Mandatory Final Course Evaluation
  - expected for week 10 (TBA)

Midterm Course Review

- L1: Introduction, course setup, Linux
- L2: Tokens, basic types, operators, formatted I/O
- L3: Control-flow statements, conditionals, loops
- L4: Arrays, accesses, pass by value/reference
- L5: Functions, call graph, trace, stack, recursion
- L6: Scope, variable lifetime, storage classes
- L7: Compiler components, translation units
- L8: Make, Makefile, rules, targets and dependencies
- L9: Assertions, debugging, GDB/DDD commands

Quiz: Question 21

- Which of the following variable declarations are valid in ANSI-C?
  (Check all that apply!)
  a) `double xyz;`
  b) `double x, y, z;`
  c) `double x = 1.0;`
  d) `double x = 1.1, y = 2.2, z = 3.3;`
  e) `double x,y,z = 1.0,2.0,3.0;`

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Quiz: Question 22

- Which of the following data types has the largest range of representable numbers?
  a) `char`
  b) `short int`
  c) `long long int`
  d) `unsigned int`
  e) `signed long int`

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Quiz: Question 23

- Which of the following data types can store the greatest value?
  a) `long int`
  b) `long long int`
  c) `unsigned long long int`
  d) `float`
  e) `double`

Quiz: Question 23

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  b) `long long int`
  c) `unsigned long long int`
  d) `float`
  e) `double`

Quiz: Question 24

- In the **gdb** debugger, what does **`next`** do?

a) It moves to the next argument of the function.
b) It calls the next function in the program.
c) It executes the next statement in the program.
d) It prints the value of the next variable.
e) It loads the next program into the debugger.

Quiz: Question 24

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Quiz: Question 25

- Assume that **x** is an integer in the range of 1 through 10 inclusively.
  Which of the following expressions can be used as a test for **x** being an even number?
  (Check all that apply!)

a) `x % 2 == 0`
b) `x / 2 > 1`
c) `x % 2 == 1`
d) `x / 2 * 2 == x`
e) `x==2 || x==4 || x==6 || x==8 || x==10`

Quiz: Question 25

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  (Check all that apply!)

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b) `x / 2 > 1`
c) `x % 2 == 1`
d) `x / 2 * 2 == x`
e) `x==2 || x==4 || x==6 || x==8 || x==10`

Quiz: Question 26

- Given the following function **grade**, what is the result of **grade(85)**?

a) **'A'**
b) **'B'**
c) **'C'**
d) **'D'**
e) **'F'**

```
char grade(int n)
{ char g = 'x';
  switch(n/10)
  { case 10:
    case  9: g = 'A';
    case  8: g = 'B';
    case  7: g = 'C';
    case  6: g = 'D';
    default: g = 'F';
   }
  return g;
}
```

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Quiz: Question 26

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   }
  return g;
}
```

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Quiz: Question 27

- What is the value of **x** after the following code fragment is executed?

```
int x = 0;
for(x = 1; x <= 10; x++)
   {  }
```

a) **0**
b) **1**
c) **9**
d) **10**
e) **11**

Quiz: Question 27

- What is the value of **x** after the following code fragment is executed?

```
int x = 0;
for(x = 1; x <= 10; x++)
   {  }
```

a) **0**
b) **1**
c) **9**
d) **10**
e) **11**

Quiz: Question 28

- Given the following program fragment, what is printed when it gets executed?

a) nothing
b) **0**
c) **10**
d) **20**
e) **30**

```
int i = 1;
int s = 0;
while (1)
  { i++;
    if (i >= 10)
       { break; }
    if (i % 2 == 1)
       { continue; }
    s += i;
   }
printf("%d", s);
```


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a) nothing
b) **0**
c) **10**
d) **20**
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  { i++;
    if (i >= 10)
       { break; }
    if (i % 2 == 1)
       { continue; }
    s += i;
   }
printf("%d", s);
```

Quiz: Question 29

- Given the following code fragment, which of the following statements are true? (Check all that apply!)

```
double f(int x);
void g(int x, int y)
{
  int z;

  z = f(x) + 2*y;
  return z;
}
```

a) Function **f** is declared.
b) Function **g** calls function **f**
c) Variable **z** is a local variable of function **g**
d) Function **g** is declared and defined.
e) **y** is a parameter of function **g**.

Quiz: Question 29

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b) Function **g** calls function **f**
c) Variable **z** is a local variable of function **g**
d) Function **g** is declared and defined.
e) **y** is a parameter of function **g**.

Quiz: Question 30

- Given the following program fragment, what is the value of **`g(2,f(3,4))`**?

a) **8**
b) **9**
c) **10**
d) **11**
e) **12**

```
int x = 7;

int f(int x, int y)
{
  return x + y;
}

int g(int x, int y)
{
  return f(y, x);
}
```


Quiz: Question 30

- Given the following program fragment, what is the value of **`g(2,f(3,4))`**?

a) **8**
b) **9**
c) **10**
d) **11**
e) **12**

```
int x = 7;

int f(int x, int y)
{
  return x + y;
}

int g(int x, int y)
{
  return f(y, x);
}
```

Programming Problem

- Task:
  - Write a program than calculates the square root of a positive number entered by the user
- Instructions:
  - Write a main module (file **`Main.c`**) that prompts the user for a value and prints the calculated square root
  - Write a square root module (files **`sqrt.c`** and **`sqrt.h`**) which implements a function with the signature **`double sqrt(double)`**
  - Write a corresponding **`Makefile`** to compile the program
- Algorithm:
  - Use a binary search algorithm to calculate the square root (see next page)

Binary Search Algorithm For Square Root

- Square Root Approximation Algorithm:
  - Input: positive real number N
  - Output: square root of N
  - Approximate the square root by use of a range $\{L, R\}$, where $L \le sqrt(N) \le R$
  - Start with the range $\{0, N\}$
  - Calculate the middle of the range $M = L + (R-L)/2$
  - If the square root of N lies in the lower half of the range, use $\{L, M\}$ as new range; otherwise use $\{M, R\}$
  - Repeat the bisection until the range is smaller than $1*10^{-5}$
  - Output M
- Hint:
  - $L \le sqrt(N) \le R \Leftrightarrow L*L \le N \le R*R$

Binary Search Algorithm For Square Root

- Example: **`Makefile`**

```
# Makefile:

SquareRoot: sqrt.o Main.o
        gcc sqrt.o Main.o -o SquareRoot

sqrt.o: sqrt.c sqrt.h
        gcc -c -Wall -ansi sqrt.c -o sqrt.o

Main.o: Main.c sqrt.h
        gcc -c -Wall -ansi Main.c -o Main.o

# EOF
```


Binary Search Algorithm For Square Root

- Example: **`Main.c`**

```
/* Main.c: main program file */

#include <stdio.h>
#include "sqrt.h"

int main(void)
{
    double x, s;

    do{ printf("Enter a positive value: ");
        scanf("%lf", &x);
      } while(x < 0.0);
    s = sqrt(x);

    printf("The square root of %g is %g.\n", x, s);
    return 0;
} /* end of main */

/* EOF Main.c */
```

Binary Search Algorithm For Square Root

- Example: **`sqrt.h`**

```
/* sqrt.h: header file for square root approximation */

#ifndef SQRT_H
#define SQRT_H

double sqrt(double n);

#endif /* SQRT_H */

/* EOF sqrt.h */
```


Binary Search Algorithm For Square Root

- Example: **`sqrt.c`**

```
/* sqrt.c: square root approximation */

#include <assert.h>
#include "sqrt.h"

double sqrt(double n)
{ double l, r, m;

  assert(n >= 0.0);
  l = 0;
  r = n;
  do { m = l + (r-l)/2;
       if (m*m < n)
       { r = m; }
       else
       { l = m; }
     } while(r-l < 1e-5);
  return m;
}
/* EOF sqrt.c */
```