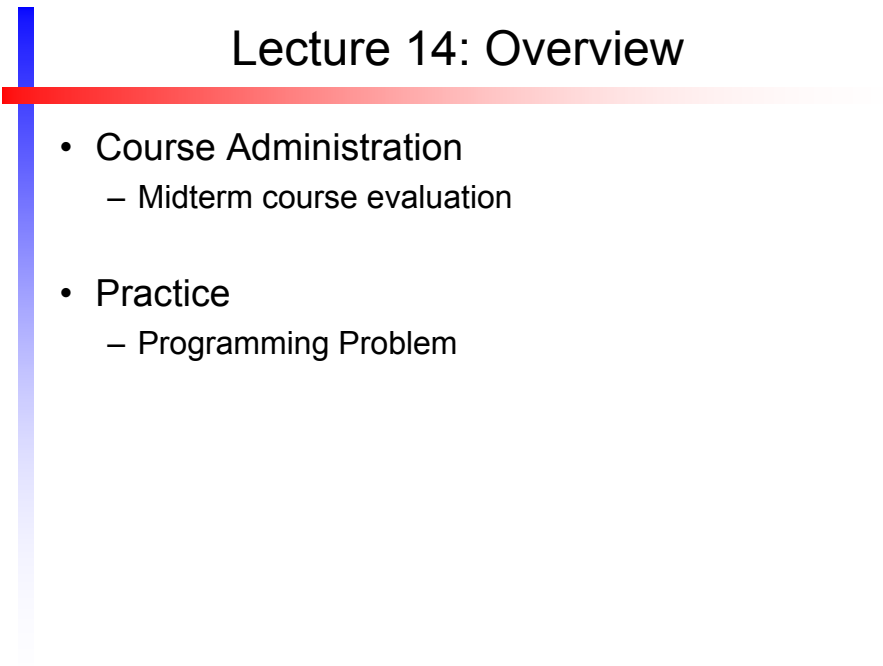# EECS 22: Advanced C Programming
Lecture 14

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Lecture 14: Overview

- **Course Administration**
  - Midterm course evaluation

- **Practice**
  - Programming Problem

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Course Administration

- Midterm Course Evaluation
  - This week!
  - Wednesday, Oct. 19, 8am – Oct. 26, 8am
  - 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)

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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)

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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:
  - $L \le sqrt(N) \le R \Leftrightarrow L*L \le N \le R*R$

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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
```

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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 */
```

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