EECS 10: COMP METHODS IN ECE
Discussion 8

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Assignment Discussion

- Assignment 4
  - A menu-driven calculator for floating point numbers
  - Addition, Subtraction, Square root, …

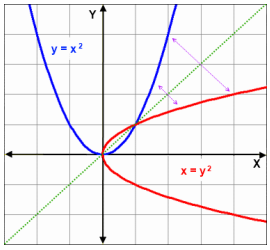
```
1. Add a floating point number to the current result;
2. Subtract a floating point number from the current result;
3. Multiply the current result by a floating point number;
4. Divide the current result by a floating point number;
5. Take the absolute value of the current result;
6. Get the approximate square root of the current result;
7. Get the sine of the current result;
8. Get the cosine of the current result;
9. Get the tangent of the current result;
10.Get the approximate Nth root of the current result;
11.Quit.
```

Today

Approximate Square Root

- Binary search for the square root of a floating point number.
  - Suppose `N` is a non-negative number, and `S` is its square root.

```
1. L = 0, R = max(1, N)
2. L*L <= N == S*S <= R*R
3. M = L + (R-L) / 2
4. if Abs(M*M - N) < 0.00001,
   return M
5. if M*M > N, R = M, goto 3
6. if M*M < N, L = M, goto 3
```



Approximate Square Root

- Example 1: `N = 9, S = 3`

```
1. L = 0, R = 9, M = 4.5, M*M > N
2. L = 0, R = 4.5, M = 2.25, M*M < N
3. L = 2.25, R = 4.5, M = 3.375, M*M > N
4. L = 2.25, R = 3.375, M = 2.8125, M*M < N
...
21. M = 3.000001
```

```
Iteration 1: the square root of 9.000000 is approximately 4.500000
Iteration 2: the square root of 9.000000 is approximately 2.250000
Iteration 3: the square root of 9.000000 is approximately 3.375000
Iteration 4: the square root of 9.000000 is approximately 2.812500
...
Iteration 21: the square root of 9.000000 is approximately 3.000001
```

Approximate Square Root

- Example 2: `N = 0.81, S = 0.9`

```
1. L = 0, R = 1, M = 0.5, M*M < N
2. L = 0.5, R = 1, M = 0.75, M*M < N
3. L = 0.75, R = 1, M = 0.875, M*M < N
4. L = 0.875, R = 1, M = 0.9375, M*M > N
...
17. M = 0.900002
```

```
Iteration 1: the square root of 0.810000 is approximately 0.500000
Iteration 2: the square root of 0.810000 is approximately 0.750000
Iteration 3: the square root of 0.810000 is approximately 0.875000
Iteration 4: the square root of 0.810000 is approximately 0.937500
...
Iteration 17: the square root of 0.810000 is approximately 0.900002
```

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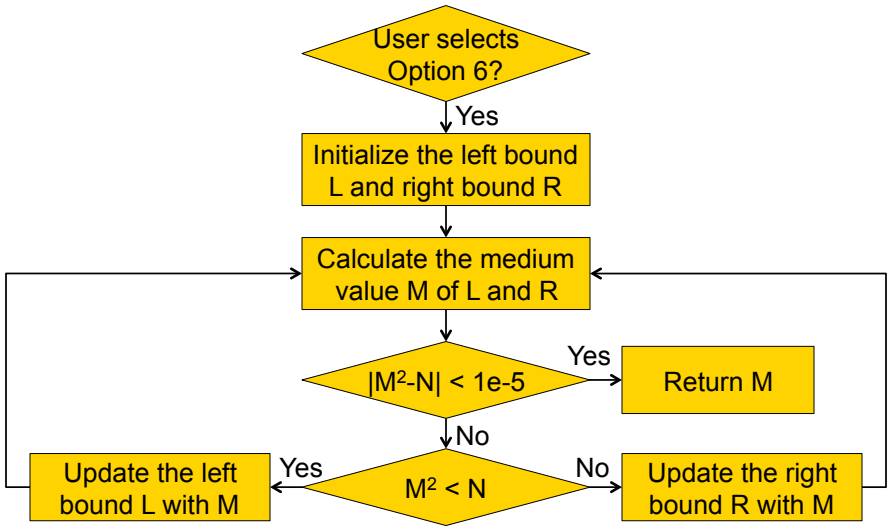
Control Flow



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Bonus: Approximate Nth Root

- Binary search for the Nth root of a floating point number
  - Suppose `N` is a non-negative number, and `S` is its Nth root.

```
1. L = 0, R = max(1, N)
2. L*L*…*L <= N == S*S*…*S <= R*R*…*R
3. M = L + (R-L) / 2
4. M*M*…*M ? N
```

- Prompt the user to enter an integer number

```
Please input the value of integer n(n>0):
```

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Sin, Cos and Tan

- Reuse the formula in Assignment 2 to calculate these values

$$\sin(x) = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n+1}}{(2n+1)!} = x - \frac{x^3}{6} + \frac{x^5}{120} - \frac{x^7}{5040} + \frac{x^9}{362880} + \ldots$$

$$\cos(x) = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{(2n)!} = 1 - \frac{x^2}{2} + \frac{x^4}{24} - \frac{x^6}{720} + \frac{x^8}{40320} + \ldots$$

$$\tan(x) = x + \frac{x^3}{3} + \frac{2}{15}x^5 + \frac{17}{315}x^7 + \frac{62}{2835}x^9 + \frac{1382}{155925}x^{11} + \frac{21844}{6081075}x^{13} + \ldots$$

- Still use `double` as the data type

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Program Requirements

- Define a separate function for each operation

```
double ApproximateRoot2(double op1);
double ApproximateSin(double op1);
double ApproximateCos(double op1);
double ApproximateTan(double op1);
double ApproximateRootN(double op1, unsigned
 int N);
```

- Do not use the C standard math library!
- Error handling
  - Print out an error message when the operand is invalid.
  - Prompt the user until a proper operand is entered.

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Assignment Discussion

- Error handling
  - "ERROR: Input out of the range!" for the tan function
  - "ERROR: Square root of a negative number!" for the square root function
  - "ERROR: Nth root of a negative number!" and "ERROR: Invalid integer N!" for the Nth root function

```
...
Please enter a selection: 10
----------------------------------------
Please input the value of integer n(n>0): 0
ERROR: Invalid integer N!
Please input the value of integer n(n>0):
```

- Verify your program with steps on Page 6
- Name your files as **calculator.c**, **calculator.txt** and **calculator.script**

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