ECE 270: Computer Methods in ECE

Assignment #2

Quadratic Equation Solver

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1 Statement of the Problem

We need to write a program in C language that is able to solve a quadratic equation of the form $ax^2 + bx + c = 0$. The program shouold be able to handle all 3 possible cases:distinct real roots, repeated real root, discrete complext roots. The result should be printed on the screen as well as into a file.

2 Description of Solution

The solution for a quadratic equation yeilds two roots entirely dependant on the value of the discriminant d.
The disriminant d can have three possible values each of which will give three possible solutions(combinations of roots) for the quadratic equation:

1. If $d > 0$ the quadratic equation has two unique real solutions(roots).
2. If $d = 0$ the quadratic equation has one real repeated solution(root).
3. If $d < 0$ the quadratic equation has two unique complex solutions(roots).

The numeric value for the discriminant d is calculated as such:

$$d = b^2 - 4ac \tag{1}$$

And then the roots of the quadratic equation can be found through the following formula:

$$x_{1,2} = \frac{-b \pm \sqrt{d}}{2a} \tag{2}$$

Note that in the case of $d < 0$ the negative underneate the square root is dealt with as the complex number i such that $i^2 = -1$.
Then the roots are best dealt with if they are split into a real part $= \frac{-b}{2a}$ and a complex part $= i\frac{\sqrt{|d|}}{2a}$ and equation **??** changes to:

$$x_{1,2} = \frac{-b \pm i\sqrt{|d|}}{2a} \tag{3}$$

3 Testing and Output

The proper testing of the program is done through changing the values $a, b, \& \ c$ to cover all three possible solutions of the quadratic equation.

I have set the program to loop according to user input enabiling several tests the output was displayed onto a screen and into a file.

The screen output is placed as a scrrenshot on the next page (page 4).

The file output is imported as a text on pages 4-5

```
This is a program to solve quadratic equations of the form ax^2 + bx + c .
Would you like to start the program?(Type y for yes or n for no):y
------------------------------------------------------------------------

Please enter the value of a:1

Please enter the value of b:-4

Please enter the value of c:4

The value of the discriminant is: 0.00

Therefore we have one real repeated root x1 = x2 = 2.00.
The factor is [ x - (2.00) ][ x - (2.00) ]

------------------------------------------------------------------------
Would you like to try again?(type y for yes or n for no):y
------------------------------------------------------------------------

Please enter the value of a:1

Please enter the value of b:0

Please enter the value of c:-4

The value of the discriminant is: 16.00

Therefore we have two real unique solutions which are x1= -2.00 and x2 = 2.00
The factors are [x - (-2.00)][x -(2.00)]

------------------------------------------------------------------------
Would you like to try again?(type y for yes or n for no):y
------------------------------------------------------------------------

Please enter the value of a:1

Please enter the value of b:-4

Please enter the value of c:5

The value of the discriminant is: -4.00

Therefore we have two unique complex solutions which are x1= 2.00 + 2.00i and x2 = 2.00 - 2.00i

The factors are [x - (2.00 + 2.00i)][x -  (2.00 - 2.00i)]

------------------------------------------------------------------------
Would you like to try again?(type y for yes or n for no):n
------------------------------------------------------------------------
                        ---OK have a nice day :)----
```

```
This is a program to solve quadratic equations of the form ax^2 + bx + c .
Would you like to start the program?(Type y for yes or n for no): y
------------------------------------------------------------------------


Please enter the value of a: 1.00
Please enter the value of b: -4.00
Please enter the value of c: 4.00
The value of the discriminant is: 0.00

Therefore we have one real repeated root x1 = x2 = 2.00 and our factor is x1 + -2.00

The factor is [ x - (2.00) ][ x - (2.00) ]

------------------------------------------------------------------------
Would you like to try again?(type y for yes or n for no): y

------------------------------------------------------------------------


Please enter the value of a: 1.00
Please enter the value of b: 0.00
Please enter the value of c: -4.00
The value of the discriminant is: 16.00

Therefore we have two real unique solutions which are x1= -2.00 and x2 = 2.00
The factors are [x - (-2.00)][x -(2.00)]

------------------------------------------------------------------------
Would you like to try again?(type y for yes or n for no): y

------------------------------------------------------------------------


Please enter the value of a: 1.00
Please enter the value of b: -4.00
Please enter the value of c: 5.00
The value of the discriminant is: -4.00

Therefore we have two unique complex solutions which are x1= 2.00 + 2.00i and x2 = 2.00 - 2.00i
```

```
The factors are [x - (2.00 + 2.00i)][x -  (2.00 - 2.00i)]


--------------------------------------------------------------------------

Would you like to try again?(type y for yes or n for no): n

--------------------------------------------------------------------------

---OK have a nice day :)----

--------------------------------------------------------------------------
```

4 Code

```c
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int main(void)
{
    //we want to create a quadratic equation solver

    float a, b, c, d,x1,x2,real,imaginary;
    char answer; //A character to introduce more user interaction through a yes/no answer
    FILE *fo;

    fo=fopen("data.txt","w");
    printf("This is a program to solve quadratic equations of the form ax^2 + bx + c .\n");
    fprintf(fo,"This is a program to solve quadratic equations of the form ax^2 + bx + c .\n");
    //----Introduction----//

    printf("Would you like to start the program?(Type y for yes or n for no):");
    scanf("%c",&answer);
    fprintf(fo,"Would you like to start the program?(Type y for yes or n for no): %c",answer);
    //---User input and interaction----//

    while(answer == 'y') //a loop to keep program running as long as user wishes//
    {
        printf("--------------------------------------------------------------------------\n");
        printf("\nPlease enter the value of a:");
        scanf("%f",&a);
        fprintf(fo,"\n--------------------------------------------------------------------------\n");
        fprintf(fo,"\nPlease enter the value of a: %.2f",a);
        //----     ----//

        printf("\nPlease enter the value of b:");
        scanf("%f",&b);
        fprintf(fo,"\nPlease enter the value of b: %.2f",b);
        //----     ----//
        printf("\nPlease enter the value of c:");
        scanf("%f",&c);
        fprintf(fo,"\nPlease enter the value of c: %.2f",c);
        //----     -----/
        d= pow(b,2) - 4*a*c; //calculating the discriminant d//
        x1= (-b-sqrt(d))/(2*a);//calculating first root//
        x2= (-b+sqrt(d))/(2*a);//calculating second root//

        //----For complex roots we have to split real part from complex part----//
```

```
        real= -b/(2*a);//calculating real part//
        imaginary= sqrt(fabs(d));//calculating imaginary part//
        printf("\nThe value of the discriminant is: %.2f\n",d);
        fprintf(fo,"\nThe value of the discriminant is: %.2f\n",d);
        if(d==0)
        {
            printf("\nTherefore we have one real repeated root x1 = x2 = %.2f." ,x1);
            printf("\nThe factor is [ x - (%.2f) ][ x - (%.2f) ]\n",x1,x2);
            printf("\n--------------------------------------------------------------------------------");
            fprintf(fo,"\nTherefore we have one real repeated root x1 = x2 = %.2f and our factor is x1 + %.2f \n"
                 ,x1,-1*x1);
            fprintf(fo,"\nThe factor is [ x - (%.2f) ][ x - (%.2f) ]\n",x1,x2);
            fprintf(fo,"\n--------------------------------------------------------------------------------");
        }

        else if (d>0)
            {
                printf("\nTherefore we have two real unique solutions which are x1= %.2f and x2 = %.2f" ,x1 ,x2);
                printf("\nThe factors are [x - (%.2f)][x -(%.2f)]\n",x1 ,x2);
                printf("\n--------------------------------------------------------------------------------");
                fprintf(fo,"\nTherefore we have two real unique solutions which are x1= %.2f and x2 = %.2f" ,x1
                     ,x2);
                fprintf(fo,"\nThe factors are [x - (%.2f)][x -(%.2f)]\n",x1 ,x2);
                fprintf(fo,"\n--------------------------------------------------------------------------------");
            }
            else
            {
                printf("\nTherefore we have two unique complex solutions which are x1= %.2f + %.2fi and x2 = %.2f -
                    %.2fi\n",real ,imaginary ,real, imaginary);
                printf("\nThe factors are [x - (%.2f + %.2fi)][x - (%.2f - %.2fi)]\n",real ,imaginary ,real,
                    imaginary);
                printf("\n--------------------------------------------------------------------------------");
                fprintf(fo,"\nTherefore we have two unique complex solutions which are x1= %.2f + %.2fi and x2 =
                    %.2f - %.2fi\n",real ,imaginary ,real, imaginary);
                fprintf(fo,"\nThe factors are [x - (%.2f + %.2fi)][x - (%.2f - %.2fi)]\n",real ,imaginary ,real,
                    imaginary);
                fprintf(fo,"\n--------------------------------------------------------------------------------");
            }
            printf("\nWould you like to try again?(type y for yes or n for no):");
            scanf(" %c", &answer);
            fprintf(fo,"\nWould you like to try again?(type y for yes or n for no): %c\n",answer);
        }
    printf("--------------------------------------------------------------------------");
    printf("\n\t\t\t---OK have a nice day :)----");
    printf("\n--------------------------------------------------------------------------");
    fprintf(fo,"--------------------------------------------------------------------------");
    fprintf(fo,"\n\t\t\t---OK have a nice day :)----");
    fprintf(fo,"\n--------------------------------------------------------------------------");
    fclose(fo);
}
```