1. **Implied Volatility:**

   - The implied volatility of a Call option, given its observed price \( c_0 \) is the value of \( \sigma \) solving:
     \[
     c_0 = c(S, K, r, \sigma, T)
     \]
     under the usual notation.

   - There is no closed-form solution, then we will use the two simplest algorithms to solve this problem: bisection and Newton-Raphson algorithms.

2. **Bisection Algorithm:**

   Pseudocode (Wikipedia):

   ```
   'Bisection Method
   'Start loop
   Do While (abs(right - left) > 2*epsilon)
     'Calculate midpoint of domain
     midpoint = (right + left) / 2

     'Find f(midpoint)
     If ((f(left) * f(midpoint)) < 0) Then
       'Throw away right half
       right = midpoint
     ElseIf ((f(right) * f(midpoint)) < 0)
       'Throw away left half
       left = midpoint
     Else
       'Our midpoint is exactly on the root
       Exit Do
     End If
   Loop
   Return midpoint
   ```

3. **Newton-Raphson Algorithm**

   Recall:
• We want to solve: $f(x) = 0$. If $f$ is differentiable we can apply the process:

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$$

where $x_0$ is our first guess and we iterate until $|f(x_i)| < \epsilon$.

**Homework problems start here:**

1. Implement the bisection method and the Newton-Raphson algorithm using pointers to functions. (Try to solve this problem for any soft and continuous function).

2. Test your code with the function $f(\sigma) = c_0 - c(S, K, \sigma, T)$ in order to compute the implied volatility. Don’t forget to keep track of all the possible user errors (there is no sign-change in the objective function, there is no possible solution under the number of iterations, etc).

3. Test your final code with the following data:
   - Stock Price=50
   - Strike price=50
   - Interest rate=0.10
   - Time=0.5
   - Observed option price=2.5

4. Go to YahooFinance. Take the Closed price for IBM on Jan 30, 2014 as the $S_0$, and take all the call/put option prices (close prices on the same day) with different strikes, then calculate the implied volatilities for every call option and put option. Plot the implied volatilities against the strike prices respectively for call and put option. What do you observe? (You may work within the Black-Scholes framework and make reasonable values for interest rates and other parameters, but you need to explain every thing or assumptions you make clearly.)

Remark: you are required to use header files.