Fundamentals of Computer Science
Lab 9

Test #2 has taken much of our focus of attention this week. In the interest of balancing our workload, we will do something very simple for this week's lab.

This week's lab introduces you to numerical computing. We will write a computer program to solve the non-linear equation:

$$f(x) = x^2 - \cos(7x) - \frac{3}{2} = 0 \tag{1}$$
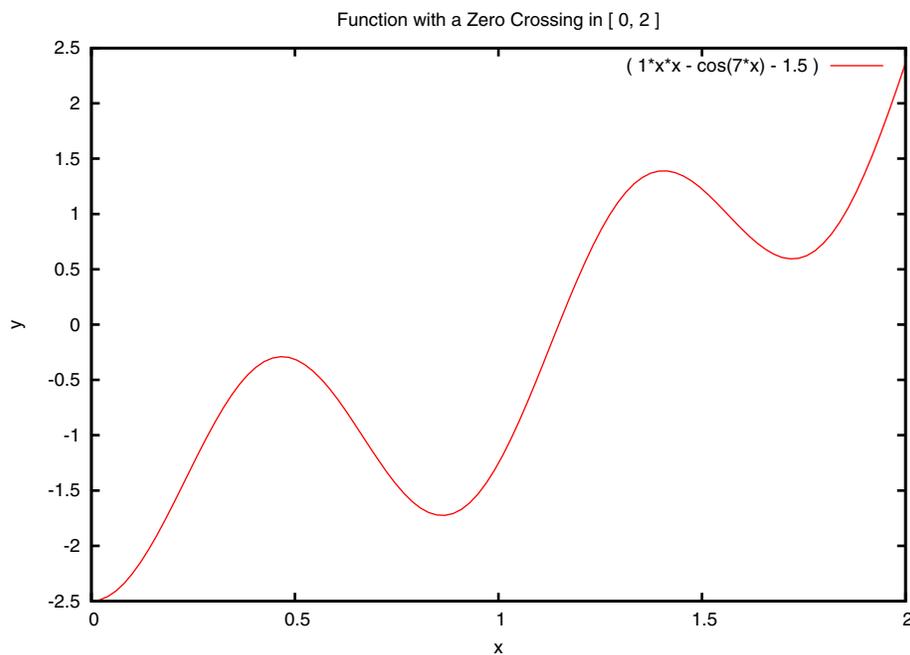
Figure 1 shows a plot of $f(x)$.

Figure 1: $f(x) = x^2 - \cos(7x) - \frac{3}{2}$

We wish to find a number x such that $f(x) = 0$. The point x is sometimes called a *zero crossing*[1]. A simple method for finding a zero crossing of a continuous function is called "bisection".

The method starts by knowing an interval $[a, b]$ in which the function changes sign. One way to guarantee a zero crossing is to check if $f(a)f(b) < 0$. In our example (shown in figure 1), $f(x)$ goes from negative to positive in the interval $[0, 2]$.

---

[1]Steely Dan has a song with a lyric reference to a *zero crossing*.

The steps of the method are then:

1. Compute the midpoint $u = (a + b)/2$

2. Check for the following 3 cases:

   (a) If $f(a)f(u) < 0$ then the function changes sign in the interval $[a, u]$.
   (b) If $f(u) == 0$ then we have found our answer.
   (c) If $f(a)f(u) > 0$ then the function changes sign in the interval $[u, b]$.

Each time these steps are repeated, the size of the interval containing the desired answer decreases by a factor of two. After k steps, the remaining error is:

$$\varepsilon = \frac{b - a}{2^k}$$

Find the solution to equation (1) with an error less than 10^{-6}. Use data type `double` throughout your computation.

Create a directory named Lab9. Keep all of your source and compiled programs in the directory Lab9.

Turn in: Change to the directory containing the sub-directory "Lab9". Create a file named "lab9.tar" using the command:

```
tar cf lab9.tar Lab9
```

Upload the file "lab9.tar" to your account on telesto.