Computational Physics Exercise 1

# quadratic solver

There are many situations in physics which can be described by a quadratic equation: observing the motion of planets, (Newtonian) projectile motion, and various models of growth and decay, to name a few. Having a method to find the roots of these equations is therefore useful. It so happens that there exists a formula, derivable by completing the square, which does just that. I have written a program which prompts the user to enter a quadratic equation and then calculates the roots using this formula. The program has various checks and will return various numbers of real or imaginary solutions depending on the inputs. I have summarized a few examples showing all the different results the program can give in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| Coefficents entered | | | Program result |
| a | b | c |
| 1.67 | -12.9 | 2.335 | There are two distinct solutions: x=7.539090 and x=0.185461 |
| 2 | 4 | 2 | There is only one solution: x= -1.000000 |
| 7.6 | 3 | 45 | There is no real solution.  Imaginary solutions are -0.197368 + 2.45304i and -0.197368 – 2.425304i |
| 4.5 | K | -9 | One of the numbers you entered was not read in correctly.  Possibly you did not enter a number? |
| 0 | 6.2 | 3.4 | Equation is linear, not quadratic.  The line will intersect the x-axis at x= -0.548387 |
| 0 | 0 | 5.9 | The equation you entered is a horizontal line.  There are no solutions. |

# series expansion of an expression

All computers calculate trigonometric functions by using series expansions. I have written a program which calculates sin(x) from its taylor expansion:

As N tends to infinity, this sum will perfectly represent the sin() function. However the factorial of even a relatively small number is prohibitively big. Fortunately the expansion only has to be valid in the range –pi/2 to pi/2 and only has to be accurate to about 6 decimal figures. In order to find how many terms we need to sum, I first wrote a program which outputs data to a text file, which can then be plotted to see how many terms produce how good a fit. The columns produced are x, sin(x) as calculated by by

# root finding of a polynomial