# EE1103: Numerical Methods

## Programming Assignment # 8

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# 1 Line search optimisation ideas

Several optimisation problems can be formulated as functions with constraints. The goal of the ideas that follow is to determine the extrema of functions with one dependent variable in a given range.

## 1.1 Approach

We deal with three methods for our purpose:

- golden section search algorithm:
  For a given range of x, we first pick 2 points lying within it. We then determine the set of three consecutive points that contain the maxima and just discard the other unnecessary interval, thus reducing the range for the next repetition of the process.
- parabolic interpolation:
  This method is based on the assumption that a parabola resembles a function closely near its extrema. So, as the name suggests, we pick three points,which we know contains the extrema and is unimodal, fit a parabola and find the parabola's peak. This process can be repeated till a satisfactory estimate is obtained.
- Newton-Raphson method:
  Finding the extrema of a function is the same as root finding for the derivate of that function. Hence this open interval root finding approch can be used.

## 1.2 Results

for qn 1:
golden section search:2.328157
parabolic interpolation:2.310014
newton's method:2.326353

for qn2:
$f(x) = \sqrt{1 + x^2}$
golden section search:0.00013
parabolic interpolation:-0.000005
newton's method(with starting point x=0.9):0–in this case, newton's method converges.
newton's method(with starting point x=1.1):-inf–in this case, newton's method diverges.
The iterations in this case were:
-1.331
2.357949
-13.110014
2253.250488
-11440063488
1.49722E+30
-inf

$f(x) = x^4$
golden section search:0

parabolic interpolation:-0.086689(the result may not be very accurate because the number of iterations is restricted to 4 , given it is known that this method might sometimes be slow in converging.)
newton's method(with starting point x=0.9):0–in this case, newton's method converges.
newton's method(with starting point x=1.1):0–in this case, newton's method converges.

for qn3:
golden section search:31.184006

### 1.3 Inferences

- The use of golden ratio for the golden line searc algorithm helps in reducing function evaluations and also is advantageous over any other ratio because in every iteration, the points picked within the interval are in proportionate distances throught the execution of the routine. This is not possible with any other ratio.
- Note that the newton's method converges well when it does, but convergence is not guaranteed.
- It is also useful to note that it suffices to construct all these routines to deal exclusively with maxima, because finding minima of $f(x)$ is equivalent to determining maxima of $-f(x)$.

### 1.4 Contributions

I worked on this assignment independently.