International Journal of Innovative Computing, Information and Control
Volume **4**, Number **9**, September **2008**

ICIC International ©2008 ISSN 1349-4198
pp. 2161–2170

MULTIPLE SOLUTIONS FOR A SYSTEM OF NONLINEAR EQUATIONS

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Received August 2007; revised February 2008

Abstract. *Finding several feasible solutions for a constrained nonlinear system of equations is a very challenging problem. Fundamental problems from engineering, chemistry, medicine, etc. can be formulated as a system of equations. Finding a solution for such a system requires sometimes high computational efforts. There are situations when these systems having multiple solutions. For such problems, the task is to find as many solutions as possible. This task can be complicated by adding several inequalities and/or variable bound constraints. In this paper, we deal with such systems of equations, which have multiple solutions and we try to solve them using two different approaches. Both approaches transform the problem into an optimization problem. One approach uses a line search based technique and the other one an evolutionary algorithm technique. Several experiments are performed in order to emphasize the advantages and disadvantages of the two methods.*

Keywords: Polynomial systems, Multiple roots, Optimization, Line search, Evolutionary algorithms

1. Introduction.

A nonlinear system of equations is defined as:

$$f(x) = \begin{bmatrix} f_1(x) \\ f_2(x) \\ \vdots \\ f_n(x) \end{bmatrix}$$

where $x = (x_1, x_2, \ldots, x_n)$, $f_1, \ldots, f_n$ are nonlinear functions in the space of all real valued continuous functions on $\Omega = \prod_{i=1}^{n} [a_i, b_i] \subset \Re^n$.

Some of the equations can be linear, but not all of them. Finding a solution for a nonlinear system of equations $f(x)$ involves finding a solution such that every equation in the nonlinear system is 0:

$$\begin{cases} f_1(x_1, x_2, \ldots, x_n) = 0 \\ f_2(x_1, x_2, \ldots, x_n) = 0 \\ \vdots \\ f_n(x_1, x_2, \ldots, x_n) = 0 \end{cases}$$