



## A Modified Firefly Algorithm to Solve Systems of Nonlinear Equations

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One of the most explored problems in applied mathematics, engineering and sciences is finding multiple solutions of a set of nonlinear equations. Most numerical methods that are being used to solve systems of nonlinear equations require the differentiability of the functions and the need of acceptable initial guesses. These made them less usable in solving complex systems of nonlinear equations. However, some optimization techniques; most of which are inspired by nature, have overcome these problems, but they are unable to provide more than one root approximation simultaneously. This paper presents a modified firefly algorithm [MODFA] providing a good solution for these drawbacks. It treats the problem as an optimization problem, which is capable of giving multiple root approximations simultaneously within a reasonable range. The new algorithm does not concern initial guesses, differentiability and even the continuity of the functions. It is capable of finding almost all root approximations within a provided range. The algorithm was tested with more than 15 systems of nonlinear equations with different number of variables. For testing, we have used both random and benchmark systems of equations in the literature. The error tolerance (accuracy) of the approximation was  $10^{-2}$ . The execution time of the algorithm was also encouraging. Most of the numerical examples we have used, carry more than one solution. For a system of nonlinear equations, especially when the number of variables increases, it is hard to determine the number of roots within a given search space. When compared with the standard methods like Newton's method, it is worth mentioning here that our approach obtains almost all solutions within a single run. This is undoubtedly the main advantage of using the proposed algorithm.

Keywords: Firefly Algorithm, Systems of Nonlinear equations, Swarm Intelligence, Functions of several variables