2018

Eco Friendly Management Of Myzus Persicae Sulzer On Cumin Cuminum Cyminum Linneaus

Tara Yadav
V.S. Acharya
Abhishek Yadav
Ajay Kumar
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जीरे, *क्यूमिनम साइमिनम* लिन. पर *माइजस परसिकी* (सुल्जर) का पारिस्थितिकी मित्र प्रबंधन

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As per the New Syllabus (2018-19) of
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Advanced
Mathematics
EE

Dr. Amber Srivastava | Dr. Rohit Mukherjee
Dr. Monika Malhotra | Dr. Vivek Kr. Sharma

Advanced Mathematics (EE)

Dr. Amber Srivastava | Dr. Rohit Mukherjee
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- Plenty of illustrations supporting the theoretical concepts.
- Large number of Solved Numerical Problems for real situation applications.
- Theory based review questions at the end of each chapter.
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Guru Poornima
27th July, 2018

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Syllabus

3EE2-01: Advanced Mathematics

Units	Contents of the Subject
Unit 1.	Numerical Methods: Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Gauss's forward and backward interpolation formulae. Stirling's Formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange'sformulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules. Solution of polynomial and transcendental equations-Bisection method, Newton-Raphson method and Regula-Falsi method.
Unit 2.	Transform Calculus: Laplace Transform: Definition and existence of Laplace transform, Properties of Laplace Transform and formulae, Unit Step function, Dirac Delta function, Heaviside function, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Fourier Transform: Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem. Z-Transform: Definition, properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.
Unit 3.	Complex Variable: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

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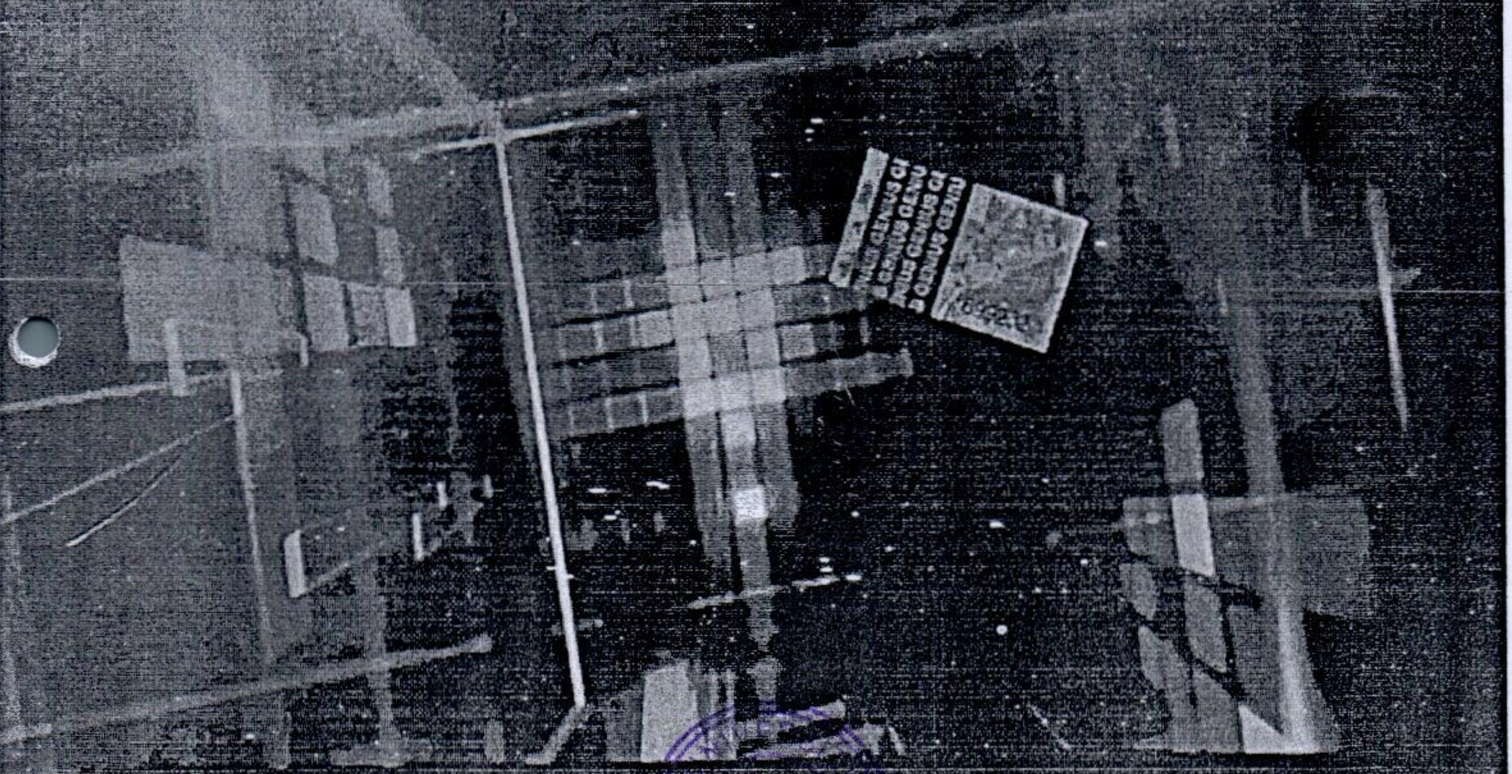

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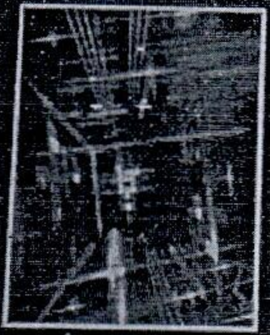

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Guru Poornima
27th July, 2018

Authors

Syllabus

3EC2-01: ADVANCED ENGINEERING MATHEMATICS - I

Units	Contents of the Subject
Unit 1.	Numerical Methods –1: Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Gauss's forward and backward interpolation formulae. Stirling's Formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange'sformulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.
Unit 2.	Numerical Methods – 2: Numerical solution of ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge-Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. Solution of polynomial and transcendental equations-Bisection method, Newton-Raphson method and Regula-Falsi method.
Unit 3.	Laplace Transform: Definition and existence of Laplace transform, Properties of Laplace Transform and formulae, Unit Step function, Dirac Delta function, Heaviside function, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs by Laplace transforms method.
Unit 4.	Fourier Transform:Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations only).
Unit 5.	Z-Transform:Definition,properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.
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Syllabus

3ME2-01: ADVANCED ENGINEERING MATHEMATICS - I

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Guru Poornima
27th July, 2018

Authors

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Syllabus

3IT2-01: Advanced Engineering Mathematics

Units	Contents of the Subject
Unit 1	Random Variables: Discrete and Continuous random variables, Joint distribution, Probability distribution function, conditional distribution.Mathematical Expectations: Moments, Moment Generating Functions, variance and correlation coefficients, Chebyshev's Inequality, Skewness and Kurtosis.
Unit 2	Binomial distribution, Normal Distribution, Poisson Distribution and their relations, Uniform Distribution, Exponential Distribution. Correlation: Karl Pearson's coefficient, Rank correlation. Curve fitting. Line of Regression.
Unit 3	Historical development, Engineering Applications of Optimization, Formulation of Design Problems as a Mathematical Programming Problems, Classification of Optimization Problems
Unit 4	Classical Optimization using Differential Calculus: Single Variable and Multivariable Optimization with & without Constraints, Langrangian theory, Kuhn Tucker conditions
Unit 5	Linear Programming: Simplex method, Two Phase Method and Duality in Linear Programming. Application of Linear Programming: Transportation and Assignment Problems.

Syllabus

3CS2-01: ADVANCED ENGINEERING MATHEMATICS

Units	Contents of the Subject
Unit 1	Random Variables: Discrete and Continuous random variables, Joint distribution, Probability distribution function, conditional distribution.Mathematical Expectations: Moments, Moment Generating Functions, variance and correlation coefficients, Chebyshev's Inequality, Skewness and Kurtosis.
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Engineering Mathematics-I

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Guru Poornima
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Syllabus

1FY2-01: Engineering Mathematics-I

Units	Contents of the Subject
Unit 1	Calculus: Improper integrals (Beta and Gamma functions) and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.
Unit 2	Sequences and Series: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions.
Unit 3	Fourier Series: Periodic functions, Fourier series, Euler's formula, Change of intervals,Half range sine and cosine series, Parseval's theorem.
Unit 4	Multivariable Calculus (Differentiation): Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.
Unit 5	Multivariable Calculus (Integration): Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Centre of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Contents

18

Modified Gbest Artificial Bee Colony Algorithm

Pawan Bhambu, Sangeeta Sharma and Sandeep Kumar

Abstract Artificial Bee Colony (ABC) algorithm is considered an efficient nature inspired algorithm to solve continues unconstraint optimization problems. It was developed by taking inspiration from food foraging behavior of honey bee. To get better speed of convergence in ABC, Zhu and Kwong anticipated an enhanced version of ABC, namely Gbest-guided ABC (GABC). But, both the algorithms, i.e., GABC and ABC could not perform well for solving constraints optimization problems. In this paper, a variant of GABC is proposed that may be able to solve constraint optimization problems as well as unconstraints optimization problems. In the proposed variant, namely modified GABC (MGABC), a strategy is proposed which adjusts the step size of the solutions, iteratively during the global optima search process. The competence and toughness of the newly anticipated MGABC are measured by testing it over 8 real-world complex optimization problems. The simulated results are compared with ABC, best-so-far ABC, GABC and modified ABC.

Keywords Constraint optimization problems · Nature inspired algorithm
Swarm intelligence · Optimization techniques · Soft computing

1 Introduction

The Artificial Bee Colony (ABC) algorithm was developed in 2005 by Karaboga [1]. The bee colony includes two types of swarm of bees, namely employed bees and unemployed bees. The employed bees gather nectar from the sources of food. If food source associated to a bee get exhausted then that bee is converted to the scout

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bee. The scout bee searches the food sources in different directions. The employed bee and onlooker bee phases are accountable for the intensification of the solutions in the feasible zone while scout bee phase is responsible for diversification of the solutions. For efficient searching, a proper balance is required between intensification and diversification properties in any swarm intelligence based algorithm. In ABC, the position update process in both the phases is highly depends on random components therefore, it always tends to explore the search space at the cost of chance to skip true solution.

Researchers are continuously improving the performance of ABC algorithm while trying to establish a proper balance between the intensification and diversification properties. In order to improve the exploitation, Gao et al. [2] proposed a new search strategy in which the bee searches just in proximity of the best solutions from preceding round by improving position update equation of ABC. Bansal et al. assimilated local search stratagem in ABC to improve the intensification potential of it [3]. Similar efforts are done by Sharma et al. in [4–6]. Banharnsakun et al. [7] suggested three key amendments in the best-so-far selection in ABC algorithm (BSFABC): The best-so-far method (collect information in relation to the finest solutions established up to now), an adaptable search radius (change radius of search in each iteration), and an objective value-based comparison in ABC (most of the algorithm compare fitness of function). Karaboga and Akay [8] used a different method in ABC strategy to get rid of constrained optimization problems. The newly anticipated strategy was named as Modified ABC (MABC) algorithm. In this sequence, in 2010, Zhu and Kwong [9] anticipated a new variant of ABC algorithm that is Gbest-guided ABC (GABC). The GABC algorithm improves the exploitation capabilities of basic ABC technique using information about best feasible solution in whole swarm that is termed as global best (Gbest) solution and modifies the position update equation. In case of GABC all the entities inspired from the global best solution that leads to problem of stagnation. The proposed GABC performed well for the unconstraints optimization problems but fails to establish its competitiveness to solve the constraints optimization problems. Therefore, in this paper, a new variant of GABC algorithm, namely Modified GABC (MGABC) is presented for the constraints optimization problems. The proposed strategy is tested over 8 problems. Through intensive statistical analysis, it is claimed that the MGABC is a competitive variant of ABC algorithm while solving complex real-world problems.

Section 2 of this paper explains basic ABC algorithm in detail. Section 3 explains the proposed MGABC algorithm. Section 4 discuss result for MGABC and analyze performance of the newly anticipated with the help of experiments. Section 5 concludes the paper.

2 Artificial Bee Colony (ABC) Algorithm

The key steps of ABC algorithm are summarized as follow:

Initialization of the swarm

$$X_{ij} = X_{\min j} + rand[0,1](X_{\max j} - X_{\min j}) \quad (1)$$

Here the ith food source in the swarm represented by x_i, the lower and upper bounds of x_i in jth dimension are $x_{min\,j}$ and $x_{max\,j}$, respectively and $rand[0, 1]$ is an evenly scattered arbitrary number in the range [0, 1].

Employed bee phase

$$X_{newij} = X_{ij} + \phi_{ij}(X_{ij} - X_{kj}) \quad (2)$$

This phase updates position of ith candidate solution. Here $k \in \{1, 2, \ldots, SN\}$ and $j \in \{1, 2, \ldots, D\}$ are arbitrarily selected indicators and $k \neq i.\varphi_{ij}$ is an arbitrary number in the range [−1, 1].

Onlooker bee phase: Based on fitness of food sources onlooker bees decides that which food sources are most feasible and select a solution with probability prob_i. Here prob_i may be decided with the help of fitness (there may be some other):

$$\text{prob}_i(G) = 0.9 \times \frac{\text{fitness}_i}{\max \text{fit}} + 0.1 \quad (3)$$

Here fitness_i represents the fitness value of the ith solution and max fit represents the highest fitness among all the solutions. Onlooker bees also select a solution and update it according to their probability of selection.

Scout bee phase: In this phase a food source considered as discarded and replaced by arbitrarily generated new solution if its location is not getting updated for a certain number of cycles.

3 Modified Gbest ABC Algorithm

It is proved in literature that the ABC algorithm is performing well for continues unconstraints optimization problems. The performance of ABC algorithm is further enhanced by Zhu and Kwong [9] in their proposed variant of ABC, namely GABC algorithm. But due to inefficiency of ABC to solve the constraints optimization problems, Karaboga and Akay [8] developed a variant of ABC for constraints optimization problems, namely modified ABC (MABC). In similar way, in this paper, a variant of GABC algorithm, namely Modified GABC (MGABC) is proposed to deal with the constraints as well as unconstraint problems. In the proposed MGABC algorithm, position update process of GABC algorithm is modified in employed as well as onlooker bee phase. In GABC, individuals update the positions using following equation:

$$xnew_{ij} = x_{ij} + \phi_{ij}(x_{ij} - x_{kj}) + \psi_{ij}(G_j - x_{ij}) \quad (4)$$

Here, ϕ_{ij} is a universal random number $\in [-1, 1]$, Ψ_{ij} is an evenly distributed arbitrary number in $[0, C]$ a positive constant C, G_j is the jth dimension of the current best solution, x_k is a neighboring solution, and x_i is the solution going to modify its position. It may be easily observed from position update equation of GABC (refer Eq. 4) that the solutions will be attracted towards the current best solution during the position update process. This may speed up the convergence speed with fear of premature convergence and stagnation. We know that a proper balance is required between the diversification and intensification properties of any search algorithm for better search process and diversification of the solutions to cover the search space is achieved by large step size whereas intensification of the solutions in the identified search area is achieved using small step size. To balance the step size of the solutions, the proposed MGABC modify the position update equations of employed as well as onlooker bee phase as follows:

(1) In employed bee phase of MGABC, following position update process is applied:

for $j = 1$ to D do

if$(\text{prob}_i \leq \psi_{ij})$then

$$xnew_{ij} = x_{ij} + \phi_{ij}(x_{ij} - x_{kj}) + \frac{(1-t)}{T} \times \psi_{ij}(y_j - x_{ij})$$

else

$$xnew_{ij} = x_{ij}$$

Here, t is a current iteration counter whereas T is the total iterations. In this solution search process, the part $B(\psi_{ij}(y_j - x_{ij}))$ influences to the solutions towards the global optima, hence improves the convergence speed while part $A(\phi_{ij}(x_{ij} - x_{kj}))$ includes the stochastic nature in the search process. As, in this process, in one iteration, depending on the probability, which is a function of fitness, multiple dimensions of the solution are changed as well as iteratively, the weightage to part B is reduced, hence, it will get better the diversification potential of the MGABC algorithm.

(2) In Onlooker bee phase of MGABC, following position update process is applied:

Select a random dimension $j = U(1, D)$

$$xnew_{ij} = x_{ij} + \frac{(1-t)}{T} \times \phi_{ij}(x_{ij} - x_{kj}) + \psi_{ij}(y_j - x_{ij})$$

Here, symbols have their usual meaning. In this solution search process, weight to the part B is iteratively reduced, i.e., now search process is more biased by the part A. Therefore, this will get better the intensification potential of the MGABC algorithm.

4 Experimental Results

The performance of the MGABC algorithm is evaluated in this section.

4.1 *Considered Test Problems*

To authenticate the efficiency of the projected MGABC, 8 complex optimization problems (f_1–f_8) among which 05 problems (f_1, f_2, f_4, f_6, f_7) are unconstraints problems and (f_3, f_5, f_8) are constraints problems, are selected to check the performance of the anticipated MGABC. The considered problems are as follows:

Problem 1 (Neumaier 3 Problem (NF3)) This is a minimization problem of 10 dimensions as shown below:

$$f_1(x) = \sum_{i=1}^{D}(x_i - 1)^2 - \sum_{i=2}^{D} x_i x_i - 1$$

The search boundary for the variables is $[-D^2, D^2]$. The best known solution is $f(\bar{0}) = -(D \times (D+4)(D-1))/6.0$. The acceptable error for a successful run is fixed to be 1.0E−01 [10].

Problem 2 (Colville Function) This is a minimization problem of four dimensions as shown below:

$$\begin{aligned} f_2(x) =& 100(x_2 - x_1^2)^2 + (1 - x_1)^2 + 90(x_4 - x_3^2)^2 + (1 - x_3)^2 \\ &+ 10.1[(x_2 - 1)^2 + (x_4 - 1)^2] + 19.8(x_2 - 1)(x_4 - 1) \end{aligned}$$

The search boundary for the variables is [−10, 10]. The most feasible solution is $f(\bar{1}) = 0$. The acceptable error for a successful run is fixed to be 1.0E−05 [10].

Problem 3 (Compression Spring) The compression spring problem [11] concerns with minimization of the compression spring's weight, subject to some constraints. There are three main design variables for a compression spring: the diameter of wire x_1, the mean diameter of coil x_2, and the number of active coils x_3. A simple explanation of compression spring problem explained here. This problem mathematically formulated as follow:

$x_1 \in \{1,..70\}$ with granularity 1, $x_2 \in [0.6, 3]$, $x_3 \in [0.207, 0.5]$ with granularity 0.001 and four constraints $g_1 := \frac{8c_f F_{\max} x_2}{\pi x_3^3} - S \leq 0, g_2 := l_f - l_{\max} \leq 0,$

$g_3 := \sigma_p - \sigma_{pm} \leq 0, g_4 := \sigma_w - \frac{F_{\max} - F_p}{K} \leq 0$

where

$c_f = 1 + 0.75\frac{x_3}{x_2 - x_3} + 0.615\frac{x_3}{x_2}, F_{\max} = 1000, S = 189000, l_f = \frac{F_{\max}}{K} + 1.05(x_1 + 2)x_3,$

$l_{\max} = 14, \sigma_p = \frac{F_p}{K}, \sigma_{pm} = 6, F_p = 300, K = 11.5 \times 10^6 \frac{x_3^4}{8x_1x_2^3}, \sigma_w = 1.25$

The most feasible solution is $f(7, 1.386599591, 0.292) = 2.6254$. Here tolerable error is fixed to be 1.0E−04.

Problem 4 (Moved axis parallel hyper-ellipsoid This is a minimization problem of 30 dimensions as shown below:

$$f_4(x) = \sum_{i=1}^{D} 5ix_i^2$$

The search boundary for the variables is [−5.12, 5.12]. The best known solution is $f(x) = 0; x(i) = 5i, i = 1, \ldots D$. The acceptable error for a successful run is fixed to be 1.0E−15 [10].

Problem 5 (Pressure Vessel design without Granularity) The problem of pressure vessel design formulated as follows:

$$f_5(x) = 0.6224x_1x_3x_4 + 1.7781x_2x_3^2 + 3.1611x_1^2x_4 + 19.84x_1^2x_3$$

subject to

$$g_1(x) = 0.0193x_3 - x_1 \leq 0, g_2(x) = 0.00954x_3 - x_2 \leq 0,$$
$$g_3(x) = 750 \times 1728 - \pi x_3^2(x_4 + \frac{4}{3}x_3) \leq 0$$

where x_1, x_2, x_3 and x_4 are thickness of shell, thickness of spherical head, radius of cylindrical shell and shell length. The search boundaries for the variables are $1.125 \leq x_1 \leq 12.5$, $0.625 \leq x_2 \leq 12.5$, $1.0 \times 10^{-8} \leq x_3 \leq 240$ and $1.0 \times 10^{-8} \leq x_4 \leq 240$. The most feasible solution is $f(1.125, 0.625, 58.29016, 43.69266) = 7197.729$ [12]. Acceptable error for a successful run is fixed to be 1.0E−05.

Problem 6 (Lennard–Jones) The Lennard–Jones (LJ) problem is minimization problem. It minimizes a type of potential energy of a set of N atoms. In case of LJ problem the dimension of the search space is 3 N, as ith atom's position X_i has three coordinates. Practically the ones of the X_i form coordinates of a point X. Precisely, it can be written as $X = (X_1, X_2, \ldots, X_N)$, and we have then

$$f_6(x) = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \left(\frac{1}{\|X_i - X_j\|^{2\alpha}} - \frac{1}{\|X_i - X_j\|^{\alpha}}\right)$$

Here $N = 5$, $\alpha = 6$, and [−2, 2] is considered as search space [13].

Problem 7 (Frequency-Modulated sound wave) It is a 6D optimization problem where the vector to be optimized is $\overline{X} = \{a_1, w_1, a_2, w_2, a_3, w_3\}$. The problem is to produce a sound same as objective. Its minimum value is $f(X_{sol}) = 0$. The objective sound waves are given as:

$$y(t) = a_1 \sin(w_1 t\theta + a_2 \sin(w_2 t\theta + a_3 \sin(w_3 t\theta)))$$

$$y_0(t) = (1.0)\sin((5.0)t\theta - (1.5)\sin((4.8)t\theta + (2.0)\sin((4.9)t\theta))),$$

respectively, where $\theta = 2\pi/100$ and the parameters are defined in the range [−6.4, 6.35]. A run is considered as successful if error is less than 1.0E−05. The fitness function is defined as follows:

$$f_7(x) = \sum_{i=0}^{100} (y(t) - y_0(t))^2$$

Problem 8 (Welded beam design optimization problem) The welded beam design problem required to minimize cost, subject to some constraints [14]. The main goal is to reduce the cost of fabricating the welded beam subject to constraints on bending stress σ, shear stress τ, buckling load P_c, end deflection δ, and side constraint. x_1, x_2, x_3 and x_4 are four important design variables.

$$f_8(x) = 1.1047x_1^2 x_2 + 0.04822 x_3 x_4 (14.0 + x_2)$$

Subject to:

$$g_1(x) = \tau(x) - \tau_{max} \le 0, g_2(x) = \sigma(x) - \sigma_{max} \le 0, g_3(x) = x_1 - x_4 \le 0,$$
$$g_4(x) = \delta(x) - \delta_{max} \le 0, g_5(x) = P - P_c(x) \le 0$$
$$0.125 \le X_1 \le 5, 0.1 \le X_2, X_3 \le 10 \text{ and } 0.1 \le X_4 \le 5$$

where

$$\tau(x) = \sqrt{\tau'^2 - \tau'\tau''\frac{x_2}{R} + \tau''^2}, \tau' = \frac{P}{\sqrt{2x_1x_2}}, \tau'' = \frac{MR}{J}, M = P\left(L + \frac{x_2}{2}\right), \sigma(x) = \frac{6PL}{x_4x_3^2},$$

$$\delta(x) = \frac{6PL^3}{Ex_4x_3^2}, P_c(x) = \frac{4.013Ex_3x_4^3}{6L^2}\left(1 - \frac{x_3}{2L}\sqrt{\frac{E}{4G}}\right), R = \sqrt{\frac{x_2^2}{4} + \left(\frac{x_1 + x_2}{2}\right)^2},$$

$$J = \frac{2}{\sqrt{2}x_1x_2\left[\frac{x_2^2}{4} + \left(\frac{x_1+x_2}{2}\right)^2\right]}$$

$P = 6000$ lb, $L = 14$ in., $\delta_{\max} = 0.25$ in., $\sigma_{\max} = 30{,}000$ psi, $\tau_{\max} = 13600$ psi, $E = 30 \times 106$ psi, $G = 12 \times 106$ psi.

The most suitable solution is $f(0.205730, 3.470489, 9.036624, 0.205729) = 1.724852$. The maximum permissible error is 1.0E−01.

4.2 Experimental Setting

The considered test problems (TP) are solved using a penalty function strategy. The penalty function approach redefine the original problem to by adding a penalty term leads defining unconstrained optimization problem in case of constraints breach as described here:

$$f(x) = f(x) + \beta \tag{5}$$

where $f(x)$ is the basic function value and β is the penalty term (here 10^3). The experimental results of *MGABC* analyzed by comparing results with MABC [15], BSFABC [7], GBestABC [9] and basic ABC. Comparison based on success rate (SR), mean error (ME), standard deviation (SD) and average number of function evaluations (AFE). For the experiments, following parameter setting is adopted.

- Simulations = 100, Number of solutions $SN = 25$ [6],
- Limit = $D \times SN$ [9], $C = 1.5$ [18], $\alpha = 30$.
- The terminating criteria: Acceptable error or achieve upper limit of function evaluations (predefined as 200000),

The parameter settings for other algorithms taken from their original paper.

4.3 Analysis of Experimental Results

Numerical results for problems f_1–f_8 are shown in Tables 1, 2, 3 and 4 by means of the recommended experimental settings as discussed in previous subsection. After in depth analysis of results, it can be observed that MGABC algorithm is superior

Table 1 Comparison based on AFE, TP: test problem

TP	ABC	BSFABC	GABC	MABC	MGABC
f_1	198449.49	200022.9	127452	199685.01	39512.26
f_2	198798.6	163406.61	149232.24	148585.62	15162.67
f_3	194506.44	199868.29	178018.13	181138.43	107684.61
f_4	62508.5	71352	59902	39639.5	28612
f_5	200024.75	200031.95	200026.39	200025.02	200023.36
f_6	70769.21	153149.56	200031.9	97169.96	91955.94
f_7	200032.98	200031.63	199853.34	190675.86	112249.61
f_8	200018.02	53813.47	31698.69	126909.03	4329.3

then other competitive algorithms as reduce ME (thus it is more accurate), improve SR (thus more reliability) and reduce AFE (results in more efficient algorithm). In order to prove that newly proposed algorithm is better than other algorithm a few additional analytical test like the Mann–Whitney U rank sum test, boxplots analysis and acceleration rate (AR) [16] have been done.

4.4 Statistical Analysis

The numerical results of MGABC are compared with basic ABC, BSFABC, GABC and MABC based on AFE, ME, SD and SR to prove that performance of MGABC is better than these considered algorithms. It can be easily observed from the results shown in Table 1 that MGABC costs less in terms of AFE on 6 test functions (f_1, f_2, f_3, f_4, f_7 and f_8) among all the considered algorithms. For f_6, AFE of MGABC is less that the all the considered algorithm except ABC. The f_5 problem could not be solved by any of the considered algorithms; therefore the algorithms are compared on basis of mean error. It is clear from Table 3 that the error reported by MGABC is significantly low than the other considered algorithms for this problem. The box-plots [17] for AFE have been depicted in Fig. 1. Boxplot shown in Fig. 1 can proficiently characterize the experimental distribution of outcomes. Figure 1 demonstrates that MGABC algorithm is very efficient.

It can be easily observed from box plots that MGABC is very efficient in comparison to ABC, BSFABC, GABC and MABC, i.e., MGABC's has different results from the other considered algorithms. In order to prove that new algorithm is really good a non-parametric statistical test named Mann–Whitney U rank sum [18], a non-parametric test performed for AFE. This test compares non-Gaussian data. Here level of significance is taken 0.05 (α). Test performed between MGABC–ABC, MGABC–BSFABC, MGABC–GABC, and MGABC–MABC. The outcomes of the Mann–Whitney U rank sum test for the AFE of 100 runs are shown in Table 5. In Table 5 the important variation observed first, i.e., is there significant difference between two data sets. If the null hypothesis is accepted then sign '=' appears and when the null hypothesis is rejected, then perform comparison

Table 2 Comparison based on SR, TP: test problem

TP	ABC	BSFABC	MABC	GABC	MGABC
f_1	3	0	96	2	100
f_2	2	38	50	46	100
f_3	4	1	22	20	74
f_4	100	100	100	100	100
f_5	0	0	0	0	0
f_6	100	89	0	83	95
f_7	0	0	1	14	59
f_8	0	99	100	65	100

Table 3 Comparison based on ME, TP: test problem

TP	ABC	BSFABC	MABC	GABC	MGABC
f_1	7.95E−01	3.53E+00	1.00E−01	1.51E+00	9.87E−02
f_2	1.63E−01	2.24E−02	1.29E−02	1.63E−02	8.18E−03
f_3	1.38E−02	2.91E−02	4.70E−03	8.69E−03	1.93E−03
f_4	9.24E−16	6.62E−16	9.19E−16	9.27E−16	9.14E−16
f_5	1.85E+01	2.30E+01	1.55E+01	5.40E+00	2.68E−01
f_6	8.52E−04	9.89E−04	4.51E−01	1.09E−03	9.05E−04
f_7	5.63E+00	9.95E+00	2.69E+00	3.51E+00	4.46E+00
f_8	2.45E−01	9.56E−02	9.47E−02	9.98E−02	9.46E−02

Table 4 Comparison based on SD, TP: test problem

TP	ABC	BSFABC	MABC	GABC	MGABC
f_1	6.71E−01	3.87E+00	1.83E−02	1.72E+00	2.24E−03
f_2	9.42E−02	2.17E−02	9.94E−03	1.25E−02	1.84E−03
f_3	1.11E−02	6.06E−03	5.89E−03	9.56E−03	3.02E−03
f_4	7.65E−17	2.44E−16	7.48E−17	7.45E−17	7.75E−17
f_5	1.11E+01	2.01E+01	9.74E+00	3.36E+00	1.81E−01
f_6	1.44E−04	7.00E−04	1.46E−01	6.98E−04	2.25E−04
f_7	5.27E+00	5.11E+00	3.09E+00	5.06E+00	5.43E+00
f_8	7.99E−02	5.13E−03	4.90E−03	1.06E−02	4.79E−03

between the AFEs. If MGABC takes less AFE then put '+' sign and put '−' sign for more AFE than the other considered algorithms. In Table 5, '+' represent that MGABC is considerably superior and '−' demonstrate that MGABC is notably of inferior quality. Out of 32 there are 27 '+' signs in Table 5. It indicates that the outcomes of MGABC are efficient than ABC, MABC, GABC, and BSFABC for measured test problems.

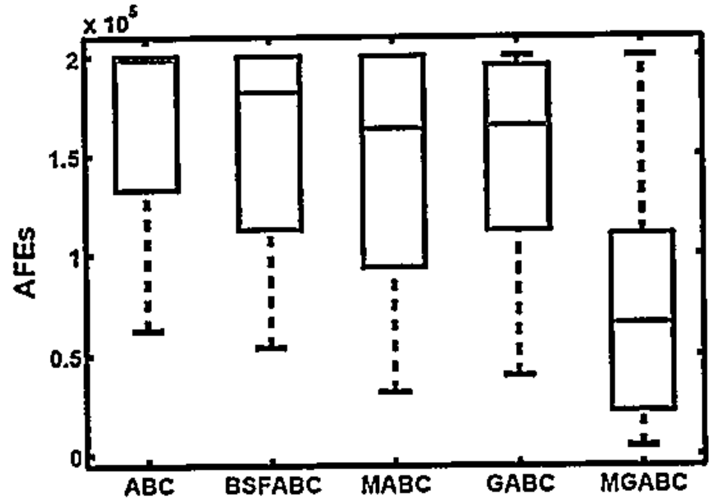

Fig. 1 AFE representation through boxplots

Table 5 The Mann–Whitney U rank sum test for AFE, TP: test problem

TP	Mann–Whitney U rank sum test with MGABC			
	ABC	BSFABC	GABC	MABC
f_1	+	+	+	+
f_2	+	+	+	+
f_3	+	+	+	+
f_4	+	+	+	+
f_5	=	=	=	=
f_6	–	+	+	+
f_7	+	+	+	+
f_8	+	+	+	+

Next, the convergence speed of MGABC measured. If AFE for some algorithm is small it means that it has high convergence speed. The convergence speed calculated by measuring the AFEs. The acceleration rate (AR) is used to compare speed of convergence, which is defined in this way; it depends on AFE of two algorithms ALGO and MGABC:

$$AR = \frac{AFE_{ALGO}}{AFE_{MGABC}} \tag{6}$$

where ALGO ∈ {ABC, BSFABC, GABC, and MABC} and AR > 1 indicate that MGABC is quicker other. The AR is measured for AFEs of the considered algorithms using (6). Table 6 demonstrates a comparison between MGABC and ABC, MGABC and BSFABC, MGABC and GABC, and MGABC and MABC in terms of AR. Table 6 demonstrates that the speed of convergence for MGABC is good than measured algorithms for most of the functions.

Table 6 Acceleration rate (AR) of MGABC as compared to the ABC, BSFABC, GABC, and MABC, TP: test problems

TP	ABC	BSFABC	GABC	MABC
f_1	5.02	5.06	3.23	5.05
f_2	13.11	10.78	9.84	9.80
f_3	1.81	1.86	1.65	1.68
f_4	2.18	2.49	2.09	1.39
f_5	1.00	1.00	1.00	1.00
f_6	0.77	1.67	2.18	1.06
f_7	1.78	1.78	1.78	1.70
f_8	46.20	12.43	7.32	29.31

5 Conclusions

This paper presents an improved variant of Gbest-Guided ABC (GABC) algorithm, namely Modified GABC (MGABC). The proposed variant is developed in view to solve the constraints as well as unconstraints optimization problems. In the proposed variant, position update process of GABC algorithm in employed as well as in onlooker bee phase is modified. In employed bee, to introducing fluctuations, multiple dimensions are allowed to update in a single iterations. The proposed is tested over 8 constraints as well as unconstraints optimization problems and compared with ABC, MABC, BSFABC and GABC algorithms. Through statistical analysis, it is proved that MGABC is a competitive variant of GABC algorithm.

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An Improved Spider Monkey Optimization Algorithm

Viren Swami, Sandeep Kumar and Sanjay Jain

Abstract Spider Monkey Optimization is the newest member of the Swarm Intelligence-based algorithm, which is motivated by the extraordinary behavior of Spider Monkeys. The SMO algorithm is a population-based stochastic metaheuristic. The SMO algorithm is well balanced for good exploration and exploitation most of the times. This paper introduces an improved strategy to update the position of solution in Local Leader Phase. The proposed algorithm named as Improved Spider Monkey Optimization (ISMO) algorithm. This method is developed to improve the rate of convergence. The ISMO algorithm tested over the benchmark problems and its superiority established with the help of statistical results.

Keywords Swarm intelligence · Natural-Inspired algorithm · Fission–fusion social structure · Unconstrained optimization problems · Metaheuristic

1 Introduction

Swarm Intelligence refers the natural system that are influenced by colonies of social insects like, fishes, bee, bird flocks, ant, etc. The definition introduced by Bonabeau for the swarm intelligence is "any attempt to design algorithms or distributed problem-solving devices inspired by the collective behavior of social insect colonies and other animal societies" [1]. These social creatures demonstrate some great ability while searching for food, security and mating in complex situations.

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The SMO algorithm is the latest population based strategy that is also stochastic in nature developed by Bansal et al. [2] to solve unconstrained optimization problems. The SMO is motivated by intelligent societal behavior of spider monkeys while searching for rich food sources. The SMO algorithm is based on fission–fusion structure of social living being spider monkey while searching for most suitable food source [2]. It consists of the intrinsic solution of population which denote food source of spider monkeys. The SMO Algorithm tries to keep proper balance between exploration and exploitation while searching for optimal solution. In exploitation it make sure that local optimum solution traversed properly and in exploration it explore global search space in order to avoid problem of trapping in local optimum. It has been observed that SMO is good in exploration of local search.

The recent trend in research is inclined toward algorithms that are inspired by nature in order to solve complex real world problems that are not solvable by classical techniques. The nature inspired algorithms includes algorithms that are inspired by biological process, physical actions and other natural activities. These algorithms show some unconventional approaches that are able to solve optimization problems in field of science, engineering and management. Many researchers have analyzed the behavior and design of the algorithm that can be used to solve nonlinear, non-convex, non-differential, and multi-model problems.

The SMO algorithm is comparatively young algorithm so there is not a large number of a literature. Pal et al. [3] used SMO algorithm in image segmentation and developed a new multi-level thresholding segmentation approach for gray scale images. Gupta et al. [4] carried out a comprehensive study of SMO after incorporating a new operator namely quadratic approximation and solved a large range of scalable and non-scalable benchmark problems and Lennard-Jones problem. Sharma et al. [5] divided the population of spider monkeys into different age groups. It is assumed that younger monkeys are more interacting and frequently change their position in contrast to older monkeys. Gupta and Deep [6] introduced a new probability calculation approach namely tournament selection in SMO algorithm. Gupta and Deep [7] analyzed the behavior of SMO algorithm under different perturbation rate schemes and proposed four editions of SMO are proposed analogous to constant, random, linearly increasing and linearly decreasing perturbation rate variation strategies. Singh et al. [8] developed a binary SMO algorithm and used it for thinning of concentric circular antenna arrays. Singh and Salgotra [9] introduced dual search strategy in SMO. The modified SMO used to synthesize linear antenna array. Sharma et al. [10] developed a new version of SMO with new local search strategy namely power law-based local search. The new strategy was applied to solve model order reduction problem. Al-Azza et al. [11] introduces SMO algorithm for the electromagnetic and antenna community. Agarwal et al. [12] used social spider algorithm in image segmentation and developed a new multi-level thresholding segmentation approach for grayscale images by deploying histogram-based bi-modal and multi-modal thresholding. Kumar et al. proposed three variants of SMO algorithm. Self-Adaptive Spider Monkey Optimization Algorithm for Engineering Optimization Problems [13] that require no manual setting, Fitness Based Position Update in Spider Monkey Optimization Algorithm [14] and Modified position update in spider monkey optimization algorithm [15]. The fitness-based SMO update position of current swarm based on their fitness. It is assumed that highly fitted solution has good solution in their proximity. Almost all variants of SMO are better than other nature-inspired optimization techniques (e.g., ABC, PSO, etc.) in terms of efficiency, accuracy, and robustness.

2 Spider Monkey Optimization

The SMO algorithm is a novel nature-inspired algorithm which is developed by Bansal et al. in 2013 [2]. It is stochastic in nature as it introduces some random component in each step. The SMO strategy mimics the fission–fusion structure of spider monkey. The major characteristics of fission–fusion social structure are described as follow:

Fission–fusion social structure animals survive in group of 40–50 monkeys that divide the member into subgroups for searching food in order to reduce competition.

Global leader (female) is responsible for searching the food source that generally leads in the group. These groups are divided into small subgroups to search for food independently.

Local leader (female) leads the subgroups and responsible for scheduling a well-organized plan for foraging route each day.

These group members search the food sources and modify their position based on the distance from food source.

These group members communicate with all group members to maintain social bond in case of stagnation.

2.1 *Phases of SMO Algorithm*

The SMO algorithm consists of six major phases followed by initialization phases. These phases suggest that how spider monkey updates their position based on their previous experience and behavior of neighbors.

2.1.1 Initialization of the Population

First, a population of N spider monkey is initialized. Initial population denoted by D-dimensional vector SM_i ($i = 1, 2, \ldots, N$). Every SMO represents the optimized solution of the problem under consideration. SM_i represents the population of spider monkey. SM_i is initialized as follows:

$$SM_{ij} = SM_{minj} + U[0,1] \times (SM_{maxj} - SM_{minj}) \quad (1)$$

where SM_{ij} represents the *i*th food source in the swarm, SM_{minj} and SM_{maxj} are lower and upper bounds of SM_i in *j*th direction respectively and $U[0, 1]$ is a uniformly distributed random number in the range [0, 1].

2.1.2 Local Leader Phase (LLP)

The second phase is Local Leader Phase. This phase modernizes the location of SMO based on experience of Local and Global group members. These members compare fitness of new location and current location and apply greedy selection. Position updates equation for *i*th SM of *K*th group as follow:

$$SM_{newij} = SM_{ij} + U[0,1] \times (LL_{kj} - SM_{ij}) + U[-1,1] \times (SM_{rj} - SM_{ij}) \quad (2)$$

where SM_{ij} represents the *i*th solution in *j*th dimension, LL_{kj} denotes the *j*th dimension of the *k*th local group leader position. SM_{rj} is the *r*th solution which is selected randomly from *k*th group such as $r \neq i$. U [0, 1] is a uniformly distributed random number in the range of 0–1 [2].

2.1.3 Global Leader Phase (GLP)

The GLP phase is just starts after finishing the LLP. Position gets updated according to previous experience of the Global Leader and Local group members with the help of Eq. (3).

$$SM_{newij} = SM_{ij} + U[0,1] \times (GL_j - SM_{ij}) + U[-1,1] \times (SM_{rj} - SM_{ij}) \quad (3)$$

where GL_j correspond to the *j*th dimension of the global leader position and $j \in \{1, 2, ..., D\}$ is randomly selected within the dimension. In this phase, the Spider Monkey (SM_i) updates their position that is based on probabilities ($prob_i$) which are calculated using their fitness [2]. There may be different methods for probability calculation but it must be function of fitness. The fitness of a function indicates about its quality, fitness calculation must include function value.

$$prob_i = 0.9 \times \frac{fitness_i}{fitness_{max}} + 0.1. \quad (4)$$

2.1.4 Global Leader Learning (GLL) Phase

In this phase, SMO modifies position of global leader with help of greedy approaches. Highly fitted solution in current swarm is chosen as global leader. It also performs a check that the position of global leader is modernized or not and modify Global Limit Count accordingly [2].

2.1.5 Local Leader Learning (LLL) Phase

Now in this phase location of local leader is modified with help of greedy approaches. Highly fitted solution in current swarm is chosen as Local Leader. It also performs a check that the location of local leader is modernized or not and modifies Local Limit Count accordingly [2].

2.1.6 Local Leader Decision (LLD) Phase

During LLD phase, decision is taken about the position of Local Leader, if it is not modernized up to a threshold also called as Local Leader Limit (LL_{limit}). In case of no change it randomly initializes position of LL. Position of LL may be decided with the help of Eq. (5).

$$SM_{newij} = SM_{ij} + U[0,1] \times (GL_j - SM_{ij}) + U[0,1] \times (SM_{ij} - LL_{kj}) \quad (5)$$

It is clear from the above equation that the updated dimension of this SM is attracted toward global leader and repels from the local leader.

2.1.7 Global Leader Decision (GLD) Phase

This phase takes the decision about position of Global Leader, if it is not modernized up to a threshold is known as Global Leader Limit (GL_{limit}), and then GLD creates subgroups of small size. During this phase, Local Leaders are created for new subgroups using LLL process [2].

3 An Improved Spider Monkey Optimization Algorithm

The Spider Monkey is a latest algorithm in different field of swarm intelligence. In literature there is very little research available on it. The newly proposed Improved Spider Monkey Optimization algorithm improves the performance of basic SMO algorithm. The ISMO suggested some improvement in Local Leader Phase of basic SMO. Position update equation in ISMO takes average of difference of current position and randomly generated positions. It generates a random position in given range for particular problem. This suggested modification accelerates the convergence rate and increase reliability. Here, it is assumed that better fitted solution has optimal solution in their proximity.

$$Y_{ij} = X_{ij} + \phi_{ij} \times (LL_{kj} - ISM_{ij}) + \phi_{ij} \times \left(\frac{SUM}{SN}\right) \quad (6)$$

where

$$SUM = SUM + (X_{ij} - X_{kj})$$

ϕ_{ij} is a uniformly generated random number in range [0,1].

Where ISM_{ij} denotes the jth dimension of the ith ISM, LL_{kj} ensures the jth dimension of the kth local leader group location. The SN represents the food source that is randomly generated by the position for food source. SUM is the average of difference for current position and randomly generated position. This equation updates highly fitted solutions through inspiration from best Swarm Intelligence. This new addition in SMO increases the balance between exploration and exploitation of most feasible solutions.

Algorithm of ISMO

```
Initialization LL_Limit, Sum, SN
For each K ∈ {1,2,.....,MG} do
 For each member SM_i ∈ K^h group do
  For each j ∈ {1,2,...,D} do
   For each M ∈ {1,2,...SN} do
    Sum = Sum + (ISM_ij − ISM_rj)
    If U[0, 1] ≥  pr then
       ISM_newij = ISM_ij + U[0,1] × (LL_kj − ISM_ij) + U[−1,1] × (SUM/SN)
    Else
           ISM_newij = ISM_rj
    End if
   End for
  End for
 End for
End for
```

4 Experimental Analysis

This paper checks the performance of Improved SMO algorithm over some well-known benchmark optimization function f_1 to f_6 (Table 1). The performance of newly proposed algorithm is compared with Basic SMO [2]. The performance comparison is based on standard deviation (SD), mean error (ME), average function evaluation (AFE), and success rate (SR) (Table 2).

Table 1 Test problems

Test problem	Objective function	Search range	Opt. value	D	AE
Six–Hump camel back function	$f_1(x) = (4 - 2.1x_1^2 + \frac{1}{3}x_1^4)x_1^2 + x_1x_2 + (-4 + 4x_2^2)x_2^2$	[−5, 5]	f(−00898, 0.7126) = −1.0316	2	1.0E−13
Hosaki problem	$f_2(x) = (1 - 8x_1 + 7x_1^2 - \frac{7}{3}x_1^3 + \frac{1}{4}x_1^4)x_2^2 \times \exp(-x_2)$	$x_1 \in [0, 5]$ $x_2 \in [0, 6]$	−2.3458	2	1.0E−06
Pressure vessel design	$f_3(x) = (1 - 8x_1 + 7x_1^2 - \frac{7}{3}x_1^3 + \frac{1}{4}x_1^4)x_2^2 \times \exp(-x_2)$ Subject to $g_1(x) = 0.0193x_3 - x_1$, $g_2(x) = 0.00954x_3 - x_2$, $g_3(x) = 750 * 1728 - \pi x_3^2(x_4 + \frac{4}{3}x_3)$	$1.125 \leq x_1 \leq 12.5$, $0.625 \leq x_2 \leq 12.5$, $1.0*10-8 \leq x_3 \leq 240$ and $1.0*10-8 \leq x_4 \leq 240$	f(1.125, 0.625, 55.8592, 57.7315) = 7197.729	30	1.0E−0.5
Rosenbrock	$f_4(x) = \sum_{i=1}^{i=D-1} 100(x_i^2 - x_{i+1})^2 + (1 - x_i)^2$	[−30, 30]	$f(0) = 0$	30	1.0E−01
Salmon problem	$f_5(x) = 1 - \cos(2\pi p) + 0.1 \times p$, where, $p = \sqrt{\sum_{i=1}^{D} x_i^2}$	[100, 100]	$f(0) = 0$	30	1.0E−01
Pathological	$f_6(x) = \sum_{i=1}^{D-1}\left(\frac{\sin^2(\sqrt{100x_{i+1}^2 + x_i^2}) - 0.5}{0.001(x_i^2 - x_i x_{i+1})^4 + 0.50}\right)$	[−100, 100]	$f(0) = 0$	30	1.00E−01

D Dimension, *AE* Acceptable error

Table 2 Comparison of result between SMO and ISMO

Test problem	Algorithm	MFV	SD	ME	AFE	SR
f_1	SMO	−1.03E+00	1.46E−05	1.90E−05	30783.45	41
	ISMO	−1.03E+00	1.52E−05	1.52E−05	22960.92	56
f_2	SMO	−2.35E+00	6.28E−06	6.04E−06	7831.09	85
	ISMO	−2.35E+00	6.06E−06	5.59E−06	3138.71	94
f_3	SMO	7.20E+03	9.49E−04	3.62E−04	28014.45	48
	ISMO	7.20E+03	3.35E−05	2.85E−05	23604.81	62
f_4	SMO	1.65E+00	1.03E+01	1.65E+00	14284.64	96
	ISMO	6.23E−02	5.22E−01	6.23E−02	11936.35	98
f_5	SMO	2.00E−01	7.80E−06	2.00E−01	6418.15	100
	ISMO	2.10E−01	3.00E−02	2.10E−01	15468.15	90
f_6	SMO	1.02E+00	4.47E−01	1.02E+00	50969.76	2
	ISMO	4.54E−01	3.41E−01	4.54E−01	38206.64	33

4.1 Experimental Setting

The proposed ISMO algorithm is compared with Basic SMO technique in order to prove its competence. It is programmed in C programming language with below-mentioned experimental setting.

The size of Swarm $N = 50$

MG = 5 (Maximum group limiting maximum number of spider monkey in a group as MG = $N/10$)

Global Leader Limit = 50

Local Leader Limit = 1500

Pr $\in [0.1, 0.4]$, linearly increasing over iteration.

4.2 Experimental Result Comparison

See Table 2.

5 Conclusion

This paper proposed a coherent and productive variant of SMO that improves the number of function evaluations in comparison to SMO Algorithm. By this algorithm, we can find the feasible solution to understand the swarm intelligence-based algorithm. This process is an extension of the position update in LLP. This algorithm has been tested; it will increase the accuracy and reliability through the average of convergence rate comparison to SMO algorithm. This approach is applied to the 6 benchmarks problems and results prove its superiority over basic SMO algorithm.

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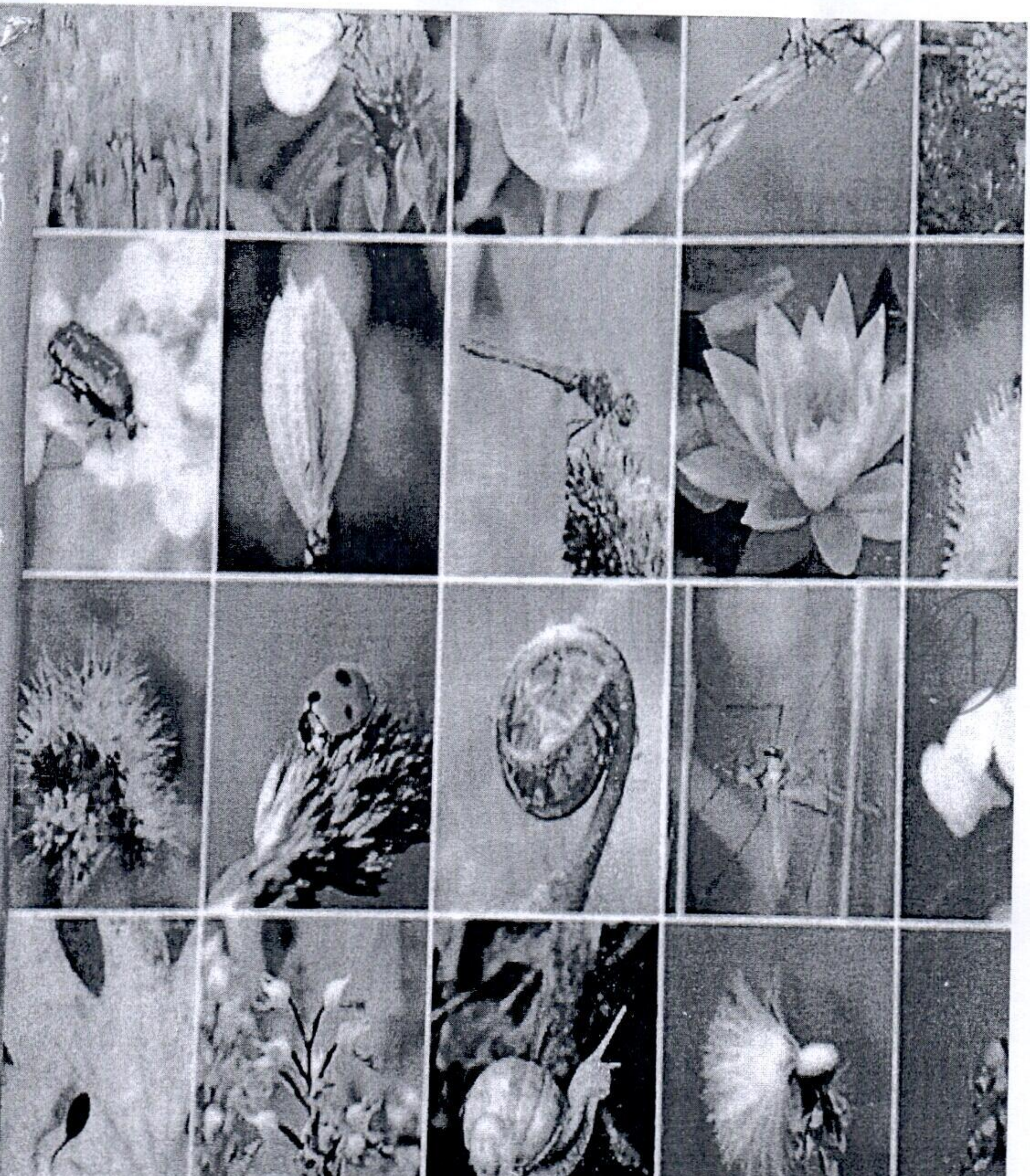

Biological Diversity - Sustainable Life

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Dr. Ranjeeta Soni

(29)

CONTENTS

BIODIVERSITY: IMPORTANCE AND THREATS

Dr. Ranjeeta Soni
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Abstract: Biodiversity means the existence of a large number of different kinds of animals and plants which make a balanced environment. According to convention on biological diversity (CBD) Biodiversity is present in terrestrial, ocean and aquatic ecosystem. This diversity present in between same species different and in different ecosystem. Genetic biodiversity is refers to the various kinds of genes which exists in any individual species. Genetic diversity is one of the key of successful agriculture. Species biodiversity is refers to the existence of diverse species within the same genera and also the variety of species with a region. It reflected by morphological, physiological and genetic features. Ecosystem biodiversity is refers to the various type of ecosystem and the variety of habitat.

Plant provides us food ,timber, fuel,wood ,drugs ,insecticides, essential oil, bamboos, grasses, , fibres, spices,pulses,gum,resin,rubber, coffee and many miscellaneous products. Animals provide lots of products like meat, eggs fur, medicine oil, dung, musk, ivory, sports. Animals are using in research areas. Animals are using in transportation and agricultural. Plants and animals are useful in ecological way. Plants maintain rainfall, humidity, temperature, wind velocity, prevent soil erosion and degradation, maintain ground water table, protection from global warming, natural sink for pollutants, act as a desert barrier etc. Animals maintain ecological balance in form of food chains and biogeochemical cycle. Animals act as scavengers and also help in pollination and seed dispersal. Many species of plants and animals have ethical values.

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1

21st Century Soft Skills: Pedagogy for the Digital Age

Gopika Kumar[1] and Vaishali Sharma[2]

ABSTRACT

Background: The digital age has witnessed the educational system preparing students for employability with 21st century skills which comprise of skills and abilities for success in the society and workplace (Ganzel, R. 2001). These skills are based on deeper learning and are non-technical in nature such as critical thinking, problem solving, interpersonal skills, communication, collaboration, creativity, innovation, flexibility, adaptability, self-reliance, and teamwork. (Mitchell, G.W., Skinner, L.B. & White, B.J. 2010). All these soft skills are instrumental for employability. This forms qualities for a progressive education, a movement with pedagogical transformative changes along with innovative training and delivery methodologies to make the youth future ready. (Robles, M.M. 2012). This paper studies the importance of integration of soft skills along with innovative methodologies, techniques and activities and thereby witness a transformative change in the pedagogy of soft skills for the 21st century.

Objectives

- To identify essential soft skills for the digital age.
- To identify innovative methodologies for soft skills training.

Methodology: The study undertakes an exploratory view by using secondary research on various essential soft skills required for the digital age. The extensive literature review extends an insight into new and innovative methodologies to be adopted as pedagogy for soft skill training by various educational institutions and corporates.

Findings/Results: The study has analyzed skills in the domain of soft skills and highlighted the employability skills for the digital age in the 21st century for skills. The study from various literature reviews have identified innovative methodologies for soft skills training for the digital age.

Implications: The study can benefit the educational institutions and corporates to adopt the experimental pedagogy approach for disseminating training on soft skills. The orientation from theories can change into experiences for academicians, professionals and students.

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1

TRANSFORMING MANAGEMENT EDUCATION

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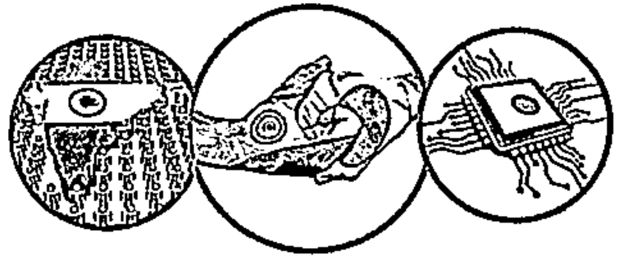

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ICT and Sustainable Development: Best Practices

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Abstract

Sustainable Development remains the focus of discussions at all international forums, as world leaders look for ways to find a balance between population growth and economic development on one hand and use of natural resources and ecosystems on one hand use of natural resources and ecosystems on the other . The development of innovative and affordable ICT (information and communication technology) has not only offered substitutes for travel and transportation of goods, but also has facilitated fast, cheap, equitable and resource efficient access to information, knowledge and learning opportunities for its users. ICT has enabled people across the globe to cooperate and perform various activities of human life and endevour. ICT empowers machine which in turn can be used extensively for making a meaningful impact towards sustainability of our environment and economy. This paper is an attempt to investigate, explore and compile examples from across the globe where IT giants have shown empirical proof that incorporation of environmental sustainability is good business sense and in the long run results into economic sustainability for the firm.

Keywords: sustainability, ICT, business processes, business environment, ecosystem

❑❑❑

A Study on Present Green Marketing Trends with Specific Reference to Indian Corporates

Dr. Bhawana Sharma[1] and Yuvnika Sogani[2]
[1, 2]Assistant Professor, Sophia Girls' College (Autonomous), Ajmer

Abstract

In today's era, green marketing is gaining a significant place in global perspective and it is becoming a popular area of research where lots of theories have been proposed in the context of consumer behavior. Hence, the awareness towards the green marketing has changed the attitude of multinational companies to design their products eco-friendly. It has also changed the consumer's attitude towards their lifestyle which may be known as green lifestyle. However, it imposes a serious challenge for the industries to keep the consumers in food and to fulfill their responsibilities towards the environment. Thus, consumers are also actively trying to remove the adverse impact on

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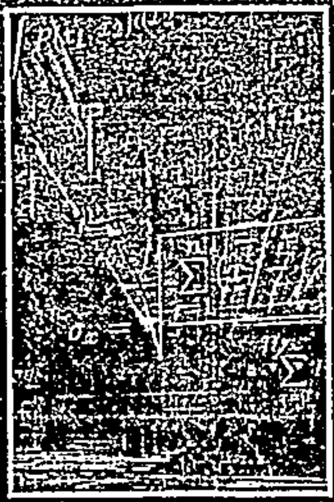

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Dr. Rohit Mukherjee | Dr. Amber Srivastava

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PREFACE

This self-contained and comprehensive volume of Advanced Engineering Mathematics covers the entire gamut of the course prescribed by Rajasthan Technical University, Kota and Bikaner Technical University, Bikaner for B.Tech. II semester.

This book is written in a lucid and easy style in order to facilitate the student with a clear and thorough presentation of the theory and application of the subject. In addition to the solved examples, a sample problem has also been given after every topic to let the students have an instant practice for a potent understanding.

Authors are hopeful that this 'new' exhaustive book will be useful to both student as well as the teacher.

Publisher of the book, Shri Ajay Goyal deserves special thanks for bringing out the book in this elegant form.

Despite the best efforts being put, some errors might have crept into the book. Report of any such errors and all suggestions for improvement of the book are welcome and will be gratefully acknowledged.

Makar Sankranti
14th January, 2019

Authors

Syllabus

Engineering Mathematics–II

[2FY2-01]

Units	Contents of the Subject
Unit 1	**Matrices:** Rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.
Unit 2	**First order ordinary differential equations:** Linear and Bernoulli's equations, Exact equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.
Unit 3	**Ordinary differential equations of higher orders:** Linear Differential Equations of Higher order with constant coefficients, Simultaneous Linear Differential Equations, Second order linear differential equations with variable coefficients: Homogenous and Exact forms, one part of CF is known, Change of dependent and independent variables, method of variation of parameters, Cauchy- Euler equation; Power series solutions including Legendre differential equation and Bessel differential equations.
Unit 4	**Partial Differential Equations – First order:** Order and Degree, Formation; Linear Partial differential equations of First order, Lagrange's Form, Non Linear Partial Differential equations of first order, Charpit's method, Standard forms.
Unit 5	**Partial Differential Equations– Higher order:** Classification of Second order partial differential equations, Separation of variables method to simple problems in Cartesian coordinates including two dimensional Laplace, one dimensional Heat and one dimensional Wave equations.

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2nd Edition 2019

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Identification of Age, Gender, & Race SMT (Scare, Marks, Tattoos) from Unconstrained Facial Images Using Statistical Techniques

Publisher: IEEE

Rishi Gupta ; Sandeep Kumar ; Pradeep Yadav , Sumit Shrivastava All Authors

Abstract

Abstract:There has been a developing enthusiasm for programmed human statistic estimation i.e., Age, sexual orientation scare, marks, tattoos and race from unconstrained facial pi... View more

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Abstract:
There has been a developing enthusiasm for programmed human statistic estimation i.e., Age, sexual orientation scare, marks, tattoos and race from unconstrained facial pictures because of an assortment of potential applications in law requirement, security control, and human-PC cooperation. Bounteous writing has explored the issue of computerized age, sexual orientation, and race acknowledgement from unconstrained facial pictures. Nonetheless, in spite of the concurrence of this component, a large portion of the investigations have tended to them independently, next to no consideration has been given to their connections/Programmed statistic estimation remains a testing issue since people having a place with a similar statistic gathering can be tremendously unique in their facial appearances because of natural and extraneous elements. This paper shows a non-exclusive system for the programmed statistic (age, sexual orientation and race) estimation. The proposed approach comprises of the accompanying three principal stages, Preprocessing, Highlight Extraction and Prediction given a face picture. To start with it preprocesses the facial picture next concentrate statistic useful highlights and afterwards, it gauges age, sexual orientation, and race. Tests are directed on two open databases (MORPH II and LFW)[I] MORPH

(Craniofacial Longitudinal Morphological Face Database) [1] is one amongst the most important in public accessible longitudinal face databases. The tagged Faces within the Wild (LFW 4) [10] may be an information of faces that contains 13000 pictures of 1680 celebrities tagged with gender, demonstrate that the proposed approach has better execution analyzed than the cutting edge. The proposed method is evaluated based on evaluation measurement precision, recall, accuracy, and MAE. The proposed work gives stable and good results.

Published In: 2018 International Conference on Smart Computing and Electronic Enterprise (ICSCEE)

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Publisher: IEEE

▸ **ISBN Information:**

Conference Location: Shah Alam, Malaysia

Contents

I. Introduction

The human face is crucial for the identity of persons because it contains much information about personal characteristics. Thus, the face image is important for most biometrics systems. The face image provides lots of useful information, including the person's identity, gender, ethnicity, age, emotional expression, etc. he distinguishing proof normal for confronting pictures has been very much investigated in certifiable applications, including travel permits and driver licenses. Regardless of the broad investigation of individual distinguishing proof from confronting pictures, there is just a restricted measure of research [2] on the best way to precisely gauge and utilize the statistical data contained in face images such as age, gender, and race. "These applications embrace access management [3], re-identification in police work videos [4], the integrity of face pictures in social media [5], intelligent advertising, and human-computer interaction. law enforcement [6] These include, •

Security control: A programmed age estimation framework can be utilized to keep minors from acquiring liquor or cigarette from candy machines or getting to unseemly pages.

•

Law Enforcement: Programmed age estimation frameworks can decide the potential speculates all the more effectively and precisely by separating the display database utilizing the evaluated age of the info mugshot.

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Importance of RTM for Testing a Web-based Project

Publisher: IEEE Cite This PDF

Mamta Madan ; Meenu Dave ; Anisha Tandon All Authors

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Abstract:Requirements are the most important part of any software projects. Many software projects were failed due to incomplete requirements and lack of user involvements. It is ... View more

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Abstract:
Requirements are the most important part of any software projects. Many software projects were failed due to incomplete requirements and lack of user involvements. It is very important to define all requirements at the beginning of any new project so that all members of the team can easily find what goals they should be striving toward. Requirement Traceability Matrix (RTM) is a document that contains all requirements presented by the customer or development team at the end of the life-cycle. The main purpose of creating Requirement Traceability Matrix is to check that all test cases are covered and should not be missed any functionality while testing. In this paper, we are proposing a Requirement Traceability Matrix (RTM) for Worldwide Programming System (WPS), a web-based project. The WPS online manages the EDP devices by maintaining the license, cluster, user info, customer info of the distributor and end to end customers.

Published in: 2018 7th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)

Date of Conference: 29-31 Aug. 2018 INSPEC Accession Number: 18796520

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ISBN Information:

Publisher: IEEE

Conference Location: Noida, India

Contents

I. Introduction

Requirements are representations of the characteristics and functionalities of the software system. It is used to define what proposed system must do. Requirements carry out the expectations of the customer from the software product. It describes the needs which an information should fulfil [1]. It is very important to define all requirements at the beginning of any new project so that all members of the team can easily find what goals they should be striving toward [2].

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Effect of Microstrip Line Dimensions on Bandwidth Enhancement of a Regular Microstrip Antenna

Publisher: IEEE Cite This PDF

Amit Kumar Shrivastava ; Ranjan Mishra ; Raj Gaurav Mishra ; Ramesh Bharti All Authors

Abstract:Microstrip antennas suffer from limited bandwidth. The dimension of the microstrip feed line has a profound effect in proper impedance matching. A good matching results i... View more

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Abstract:
Microstrip antennas suffer from limited bandwidth. The dimension of the microstrip feed line has a profound effect in proper impedance matching. A good matching results in an enhancement of the bandwidth and return-loss. The present paper demonstrates the bandwidth enhancement of a microstrip antenna by using this method. The effect of feed dimension on the return loss and bandwidth is observed and presented in the paper. The simulations are conducted using ADS and the results of the simulation are presented in the paper. Furthermore, with HFSS, more results are discussed. The simulated results will compare with the measured result. A close proximity justifies the results obtained by this method.

Published in: 2018 3rd International Conference and Workshops on Recent Advances and Innovations in Engineering (ICRAIE)

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Date Added to IEEE *Xplore*: 09 May 2019 **DOI:** 10.1109/ICRAIE.2018.8710419

▸ ISBN Information:

Publisher: IEEE

Conference Location: Jaipur, India

Contents

I. INTRODUCTION

Microstrip patch antenna gains appreciable quantity of attention of researchers because of demand of its massive type of wireless applications in several fields. In these applications, there is an increasing demand for a considerable high bandwidth antenna with the ongoing spread of wireless communication. Microstrip antenna has the potential to meet this requirement owing to some of its salient features. [1]. Conventional microstrip antenna has a serious drawback that it accounts for low bandwidth typically around 5% of bandwidth. This poses a challenge to the researcher for upgrading in order to meet the high bandwidth [2], [3]. Researchers and antenna designers are engaged seriously to look into the improvement of the bandwidth of the microstrip antenna. Inserting a proper microstrip line of suitable dimension has a good hand in the bandwidth enhancement.

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2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT)

IAAS Trust in Public Domain: Evaluative Framework for Service Provider

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DOI Bookmark: 10.1109/ICALT.2018.00114 (https://doi.ieeecomputersociety.org/10.1109/ICALT.2018.00114)

Authors

Archana B. Saxena (https://www.computer.org/csdl/search/default?type=author&givenName=Archana B.&surname=Saxena)
Meenu Dawe (https://www.computer.org/csdl/search/default?type=author&givenName=Meenu&surname=Dawe)

Abstract

Trust has more prominence in cloud computing than any other technology. The prime reason behind this notion is the architecture of technology, where service consumer has to transfer critical business relevance data and information to unknown geographical locations called data centers. These data centers are in administration and management of cloud service Providers. Only verbal assurance regarding security and trust are not enough testimonies for cloud consumers. There is a need for textual confirmation, trust strengthening past performance, practical evidence, and tools to evaluate the trustworthiness of CSP (Cloud Service Provider). This paper provides a smart learning environment to assist cloud consumer, by offering a scope to evaluate the trustworthiness of cloud provider on the basis of security assurances by cloud provider through standards and Certification attainment. Various security related components are analyzed with standards and certifications accomplishment and trust value is computed for Service Provider.

Related Articles

- Operational trust in Clouds' environment (/csdl/proceedings-article/iscc/2011/05984007/12OmNAle6WQ)
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- A Heuristic Algorithm for Trust-Oriented Service Provider Selection in Complex Social Networks (/csdl/proceedings-article/scc/2010/4126a130/12OmNrYlmFa)
  2010 IEEE International Conference on Services Computing

- Establishing Trust in Hybrid Cloud Computing Environments (/csdl/proceedings-article/trustcom/2011/06120810/12OmNvqmUMy)
  2011IEEE 10th International Conference on Trust, Security and Privacy in Computing and Communications
- On Subjective Trust for Privacy Policy Enforcement in Cloud Computing (/csdl/proceedings-article/trustcom/2013/5022b573/12OmNwdtwdT)
  2013 12th IEEE International Conference on Trust, Security and Privacy in Computing and Communications (TrustCom)
- Towards a Trust Management System for Cloud Computing (/csdl/proceedings-article/trustcom/2011/06120922/12OmNwdtwib)
  2011IEEE 10th International Conference on Trust, Security and Privacy in Computing and Communications
- A Trust Label System for Communicating Trust in Cloud Services (/csdl/journal/sc/2017/05/07457329/13rRUwIF6bq)
  IEEE Transactions on Services Computing
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  IEEE Transactions on Cloud Computing
- De-Centralized Reputation-Based Trust Model to Discriminate between Cloud Providers Capable of Processing Big Data (/csdl/proceedings-article/bigdata-congress/2017/08029334/17D45XeKgqv)
  2017 IEEE International Congress on Big Data (BigData Congress)

Challenges related to information security and its implications for evolving e-government structures: A comparative study between India and African countries

Publisher: IEEE Cite This PDF

Harmeet Malhotra ; Ruchira Bhargava ; Meenu Dave All Authors

Abstract:The initiation of e governance leads to a new platform of digital innovation for dissemination of information between citizens of the country and the government. Although... View more

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Abstract:
The initiation of e governance leads to a new platform of digital innovation for dissemination of information between citizens of the country and the government. Although, governments of developing economies are investing huge outlay for making this project a big success but there are various threats related to this system that must be addressed but not much researches conducted on the issue. This paper examines various security issues related to e governance in India and its comparison to African countries. It also includes various suggestions pertaining to the issue.

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Publisher: IEEE

Conference Location: Coimbatore, India

Contents

I. Introduction

Information and communication technology has made it easier for government and other organizations to serve the citizens and other stakeholders in best possible manner. With the emergence of ICT it has become very much easier for government organizations to collect, filter, organize and generate data which was earlier thought of as the most difficult aspect of e-governance. The digital mode of information maintenance has enabled the departments to reach out to people of both rural and urban areas. The real time data is now available as and when required making it more economical and approachable for all. But maintaining such a large database brings many challenges also. The most difficult challenge is that of securing this highly confidential data from misuse. As more and more organizations are becoming dependent on this digital world, so the issue of cyber security is also becoming more crucial and is to be handled with utmost care. These days' cyber attacks are also becoming very popular and proper risk analysis has to be done before deploying Sign in to Continue Reading e-governance projects in real world scenario. The cyber attacks may have adverse effects on the economy of any country. Many countries have made different cyber laws for handling the problems related to the misuse of this cyber space. Many developing countries like India are initiating dialogues with other developed countries like USA and doing R&D on handling these cyber security issues more effectively. The developing countries are still going through the phase of business process reengineering and need to work on the risk assessment factor much in advance so as to avoid the challenges of information leakage, virus & malware attacks, cyber terrorism and other cyber threats. With the advancements in ICT, the complexity of web based networks is also mounting security challenges that might become a national security threat if not attended properly. India and other developing countries have to emphasize more on creating cyber security mechanisms that would help them in confronting the cyber challenges.

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Loss of trust at IAAS level: Causing factors & mitigation techniques

Publisher: IEEE

Cite This PDF

Meenu Dave ; Archana B. Saxena All Authors

Abstract

Document Sections

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Abstract:

Today the focus in IT has shifted to the cloud. The cloud offers a near perfect solution for the organization. It benefits the organization with minimum investment and overhead administration costs. Thus, many of the organizations are ardently trying to avail the benefits of cloud services. However, there are concerns which inhibit them from going ahead and adopting the cloud for conducting their business operations. The barrier is in terms of apprehension for lack of trust due to several inexplicable reasons. However, cloud service providers are undertaking various steps to address the issue but this is the domain in which the coordination of several stakeholders is warranted. For example, the government needs to regulate the working of the cloud service providers, research workers to explore options that can be implemented; hence, suitable actions are required which can be taken to develop the issues of trust and security of the business data in the cloud. This paper is an attempt to address the major issues that are affecting the security and ultimately causing distrust at IAAS. Through this paper, we have tried to propose some solutions or techniques, which if adopted and implemented, will go a long way in sustaining trust.

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Publisher: IEEE

Conference Location: Gurgaon, India

Contents

I. Introduction (Heading 1)

Cloud computing is the buzz nowadays. The cloud is a combination of various technologies like client-server computing, time-sharing, grid computing, utility computing, virtualization and SOA (Service Oriented Architecture) [1]. It is virtual computing environment that runs on geographically separated servers and is operated through the Internet. The working of cloud computing is different from conventional computing. In conventional computing, a user is presented with hardware and OS with the application installed on the machines. In the case of cloud computing, a machine with a minimum hardware, software [to run cloud] and Internet connectivity is a must. Other hardware, software and necessary infrastructure are provided by the data center. The mode and mechanism are carried out on the basis of charges which are applicable for different services. The mode of charges depends on the model as agreed between the service provider and the client. Generally, this is set on the basis of 'pay as per the usage'i.e., based on the amount of time spent for using the services.

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Routing protocols and security issues in MANET

Publisher: IEEE

Sandeep Kumar ; Monika Goyal ; Deepak Goyal ; Ramesh C. Poonia All Authors

Abstract:Mobile Ad-hoc Network (MANET) is an association of large number of sensor nodes and having self directed commands using the un protected wire less connections. The indivi... View more

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Abstract:
Mobile Ad-hoc Network (MANET) is an association of large number of sensor nodes and having self directed commands using the un protected wire less connections. The individual nodes in the network can accompany and leave the network with out any permission. MANET is an infrastructureless network. The network topology is rapidly change due to nodes mobility, resource constraint and bandwidth limitation of wireless medias. This nature of nodes leads to different types of security threats. MANET suffers from disruption so that node not able to take part in path finding methods with a target to spoil the full network functioning. A number of protocols have been found for efficient routing. There are many types of security attacks which disturb the net work operation. In this survey paper focuses of many proposed routing protocols for MANET and types of security attacks and a survey of the existing techniques of detection and prevention of attacks is presented.

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Date of Conference: 18-20 Dec. 2017 DOI: 10.1109/ICTUS.2017.8286119

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Conference Location: Dubai, United Arab Emirates

▸ ISBN Information:

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I. Introduction

Mobile Ad-hoc Networks are the networks of moveable computing machines connected in a wireless network without any centralized or fixed infrastructure. In MANET due to its dynamic topology any node can join and leave a network. Every node acts as both a host and router. Mobile Ad-hoc Network is a self-directed system of arbitrarily moving nodes. In case of MANET each node works like host as well as router also in order to keep availability of services. There are number of routing protocols in MANET but Ad-hoc on demand Distance Vector (AODV) is one of the most popular routing protocols.

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Sustainable Computing: Informatics and Systems xxx (2018) xxx–xxx

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Plant leaf disease identification using exponential spider monkey optimization

Sandeep Kumar[a,*], Basudev Sharma[b], Vivek Kumar Sharma[b], Harish Sharma[c], Jagdish Chand Bansal[d]

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[d] South Asian University, New Delhi, India

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Optimization

ABSTRACT

Agriculture is one of the prime sources of economy and a large community is involved in cropping various plants based on the environmental conditions. However, a number of challenges are faced by the farmers including different diseases of plants. The detection and prevention of plant diseases are the serious concern and should be treated well on time for increasing the productivity. Therefore, an automated plant disease detection system can be more beneficial for monitoring the plants. Generally, the most diseases may be detected and classified from the symptoms appeared on the leaves. For the same, extraction of relevant features plays an important role. A number of methods exists to generate high dimensional features to be used in plant disease classification problem such as SPAM, CHEN, LIU, and many more. However, generated features also include unrelated and inessential features that lead to degradation in performance and computational efficiency of a classification problem. Therefore, the choice of notable features from the high dimensional feature set is required to increase the computational efficiency and accuracy of a classifier. This paper introduces a novel exponential spider monkey optimization which is employed to fix the significant features from high dimensional set of features generated by SPAM. Furthermore, the selected features are fed to support vector machine for classification of plants into diseased plants and healthy plants using some important characteristics of the leaves. The experimental outcomes illustrate that the selected features by Exponential SMO effectively increase the classification reliability of the classifier in comparison to the considered feature selection approaches.

Introduction

Agriculture is one of the important sources of earning for human beings in many countries. A different variety of food plants are harvested as per the need and environmental conditions of land. However, a number of problems are also faced by the farmers such as shortage of water, natural disasters, plant diseases and many more. However, some of the problems may be reduced by providing technical facilities to the farmers. Automated plant disease identification and prevention system is one of such solutions that can aid the farmers. This type of system can overcome from the problems of lack of plants' disease knowledge as there are very few experts for the same [1,2]. Moreover, it may increase the food productivity by performing the on time prevention from the disease and there is no need to search for an expert. Such automated system will also be time and cost efficient. Therefore, this manuscript proposes a novel strategy to recognize the various plant diseases.

Generally, leaves of the plants are first source to detect the most of the plant diseases. Yellow and brown spots, primary and late blister, and other ailments caused by bacteria, virus and fungus can be detected automatically through efficient image processing techniques [3,4]. Therefore, this paper focuses on the plant disease identification using leaves properties only. However, plant disease identification through image processing is not an easy job because of the huge disparities available in the leaves of different and similar plants for instance size, texture, color, shape, etc. Various image processing strategies have been anticipated to overcome from such problems and normally all methods have two steps [3]. In the first phases prominent features are extracted from the input images of the leaves and in second phase, a particular classifier is used

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which categorise the images into healthy or diseased images. Major classification techniques that are popularly used for disease identification in plant are k-nearest neighbor (kNN) [5], support vector machine (SVM) [6], fisher linear discriminant (FLD) [7], neural network [8], random forest (RF) [9] and many more.

The performance of a classifier is generally relies on the extraction of important features. As per the contemporary, feature extraction methods for image analysis may be categorized into hand crafted and automatic generated (without human experts) features [10]. Hand crafted features may be shape-based, texture-based, color information-based features. To identify the four classes of rice grains, Sakai et al. [11] used geometrical attributes namely maximum length, area, perimeter, and many others. For similar type of leaves such as texture and color, beetle and pepper features were used [12]. In some of the literature, the combined texture and shape features have been used to identify the leaves. Although, hand crafted features shows good results for plant disease identification, however, it requires human expert knowledge and many features may be skipped or redundant features may be selected through this process. Therefore, many researchers proposed different machine learning based feature extraction methods that do not impose such constraint such as intra and inter-block dependencies (CHEN) [13] for Markov features, for spatial domain subtractive pixel adjacency model (SPAM) [14], bag of visual words [15], convolutional neural network [16] and many more. These methods automatically generate the high dimensional features without human experts. However, high dimensionality [17] is a major concern in case of images. An expending order of training data is mandatory to engender the high dimensional features, which increases the classifier's computational complexity. Moreover, the performance of a classifier may degraded due to generation of inappropriate and unnecessary features. Thence, there is a prerequisite for a competent technique for feature selection to solve the problem [18].

Generally an evaluation parameter is used by a feature selection method to obtain the optimal or sub-optimal feature subset. A number of search methods exists for selecting the prominent features. In case of exhaustive search, 2^N feature subsets are compared for N dimensional feature space. It shows a complexity of $O(2^N)$ which is impractical for large N [19]. For that reason, numerous approaches like filters, embedded methods and wrappers [20] have been introduced for feature selection to overcome these issue. The most efficient technique in these methods is filter technique that consider a set of features as class variables. On the other hand, for a specific classifier, it may do weakly [21]. The embedded methods use the information returned by a supervised classifier to pick the features like SVM with recursive feature elimination (SVM-RFE) [22] which eliminate the features, comprising minimum weight acquired from a trained SVM. Furthermore, Wrapper methods uses predictive models to appraise the feature subset and are more preferred than filtering techniques [20]. Greedy hill-climbing search approach is one of the popular wrapper technique and repeatedly eradicates the smallest relevant features is Sequential backward selection (SBS) [23]. Though, both the embedded and wrapper techniques are computationally expensive procedures [24].

To overcome the limitations of above mentioned methods, nature inspired algorithms have widely been used in the literature. Large number of methods have been evolved using nature inspired algorithms [25,26] for feature selection. Spider monkey optimization (SMO) [27], particle swarm optimization (PSO) [28], artificial bee colony (ABC) [29], gravitational search algorithm (GSA) [30], and grey wolf optimization (GWO) [31] are few popular meta-heuristic useful in feature selection.

The SMO is one the recently anticipated meta-heuristic based on the social activities of spider monkeys and is established by Bansal et al. [27]. As compared to other meta-heuristic algorithms, SMO shows better performance in searching the relevant features from high dimensional feature space. SMO uses the concept of fission-fusion social system (FFSS) of spider monkeys. Initially it explore the feasible search reason and exploits slowly, by the means of social organization of spider monkeys. A number of variants of SMO are also available in literature such as modified position update in SMO [32], modified SMO [33], fitness based position update in [34], SMO for constrained optimization [35], improved SMO [36], hybrid of SMO and GA [37] and many more. Perturbation rate is one of the important parameter of SMO which affects the convergence behavior of SMO. Generally, perturbation rate is a linearly increasing function. However, due to the availability of non-linearity in different applications, a non-linear function may affect the performance of SMO. Therefore, to improve the performance of SMO, this manuscript recommends a novel alternative of SMO, exponential spider monkey optimization (ESMO), with improved perturbation rate and desirable convergence precision, rapid convergence rate, and improved global search capability. The new variant ESMO, used in feature selection for plant disease identification. The SPAM method has been employed for extraction of features from the given database of leaf images. Further, the identified features are given to individual classifiers to categorise the leaves in the category of healthy or diseased leaves. The results of the anticipated technique has been measured with PSO, GSA, DE, and SMO. In addition, SVM, kNN, LDA, and ZeroR classifiers are used to classify the images into their respective categories.

The main contributions of this manuscript are listed here:

1. A novel exponential spider monkey optimization (ESMO) method has been introduced.
2. The extraction of relevant features from the considered leaf images done using SPAM.
3. A new approach for selection of feature subset has been anticipated based on ESMO.
4. For classifying the healthy leaf images and diseased leaf images, kNN, SVM, ZeroR, and LDA classifiers are analyzed.

The remaining manuscript is structured as follows. The SMO algorithm introduced in Section 2. Section 3 illustrates the anticipated image classification method. Experimental results of ESMO on standard benchmark problems and the proposed classification technique along with statistical analyses has been discussed in Section 4. Lastly the Section 5 conclude this manuscript.

2. Preliminaries

This section describes the basic spider monkey optimization (SMO) algorithm that is used for feature selection.

2.1. Spider monkey optimization (SMO)

The SMO is comparatively new algorithm based on the mathematical model of intelligent behavior of spider monkeys that follow the fission-fusion social structure (FFSS). According to FFSS, monkeys distribute themselves from bigger to minor groups and vice versa for foraging. The main characteristics of the FFSS are as follows [27]:

1. Initially, all spider monkeys persist in the groups of 40–50 individuals. Each initial group has a leader under whom the food sources are explored. It is termed as a global leader of that group.
2. In case of insignificant quantity of food, the global leader create smaller subgroups from larger group with each subgroup containing three to eight members to forage independently and each subgroup headed by local leader.

3. The decision of searching food in each sub-group is also decided by a leader, known as local leader.
4. The group members maintain social bonds and defensive boundaries by communicating among themselves and with other members of the group using a unique sound.

The mathematical model of foraging behavior of SMO for optimization problem has six different phases discussed in subsequent sections. Initially, SMO randomly generates a population of N spider monkeys. A D-dimensional vector used to denote a spider monkey. Let X_{ij} depicts the jth dimension of ith individual. In SMO, each X_{ij} is initialized as follows:

$$X_{ij} = X_{minj} + U(0,1) \times (X_{maxj} - X_{minj}) \quad (1)$$

where X_{minj} and X_{maxj} are lower and upper bounds in jth direction for X_i and $U(0, 1)$ denotes a random number in the range [0, 1]. The next section describe all six phases of SMO in detail.

2.1.1. Local Leader Phase (LLP)

In this phase, new position of an individual is attained on the basis of the knowledge from the local leader and individuals of group using Eq. (2). Quality of solution decided by their fitness value. The solution with higher fitness (the new position is better than the current position) selected for next iteration.

$$Xnew_{ij} = X_{ij} + U(0,1) \times (LL_{kj} - X_{ij}) + U(-1,1) \times (X_{rj} - X_{ij}) \quad (2)$$

where X_{kj} and X_{rj} denote the positions of jth direction of the local group leader and randomly chosen rth spider monkey from kth group respectively. In order to manage the perturbation in the present location, probability pr is used which is known perturbation rate. The steps of LLP are summarized in Algorithm 1.

Algorithm 1. Local Leader Phase (LLP) [27]

```
for each member X_i ∈ kth group do
  for each j ∈ {1, . . ., D} do
    if U(0, 1) ≥ pr then
      Xnew_ij = X_ij + U(0, 1) × (LL_kj − X_ij) + U(−1, 1) × (X_rj − X_ij)
    else
      Xnew_ij = X_ij
    end if
  end for
end for
```

2.1.2. Global Leader Phase (GLP)

All individual update their position based on information from global leader and all member of group as shown in Eq. (3) during GLP.

$$Xnew_{ij} = X_{ij} + U(0,1) \times (GL_j - X_{ij}) + U(-1,1) \times (X_{rj} - X_{ij}) \quad (3)$$

where GL_j shows the jth direction of the global leader. Furthermore, the probability $prob_i$ is used to select the particular dimension for updating the X_i and is calculated using the fitness values of each individual as depicted in Eq. (4).

$$prob_i = \frac{fitness_i}{\sum_{i=1}^{N} fitness_i}$$

Similar to LLP, the better solution from the newly generated position and old position of the SM are used for further processing. Algorithm 2 presents the steps of GLP.

Algorithm 2. Global Leader Phase (GLP) [27]

```
counter=0
while group size > counter do
  for ∀ X_i ∈ group do
    if U(0, 1) < pr then
      counter=counter+1
      Arbitrarily choose j ∈ {1,..., D}
      Arbitrarily choose X_r ∈ group and i ≠ r
      Xnew_ij = X_ij + U(0, 1) × (GL_j − X_ij) + U(−1, 1) × (X_rj − X_ij)
    end if
  end for
end while
```

2.1.3. Global Leader Learning (GLL) phase

The global leader acquire position with overall best fitness in this phase and a global limit counter used to keep the record of change in the position of global leader.

2.1.4. Local Leader Learning (LLL) phase

The position with best fitness within group assigned to local leader. Similar to GLL phase, if local leader's new position is same as the previous position, then the local limit counter updated by one.

2.1.5. Local Leader Decision (LLD) phase

If local limit counter of a local leader reaches to a threshold count, then the all group members re-initialized by using Eq. (5). The steps of LLD phase is presented in Algorithm 3.

$$Xnew_{ij} = X_{ij} + U(0,1) \times (GL_j - X_{ij}) + U(-1,1) \times (X_{rj} - X_{ij}) \quad (5)$$

Algorithm 3. Local Leader Decision [27]

```
if Local.Limit.Count > Local.Leader.Limit then
  Local.Limit.Count = 0
  for each j ∈ {1, . . ., D} do
    if U(0,1) ≥ pr then
      Xnew_ij = Xmin_j + U(0, 1) − (Xmax_j − Xmin_j)
    else
      Xnew_ij = X_ij + U(0, 1) × (GL_j − X_ij) + U(−1, 1) × (X_rj − X_ij)
    end if
  end for
end if
```

2.1.6. Global Leader Decision (GLD) phase

The global leader creates small size sub groups if her position not updated for a predefined number of iterations. In GLD, the local leaders of each group are elected by LLL process. The global leader merges all subgroups into a single group if its position not updated till pre decided threshold. This way, SMO mimics the FFS structure. Moreover, the complete SMO is presented in Algorithm 4.

Algorithm 4. Spider Monkey Optimization [27]

```
Initialize Population, pr, Global_Leader_Limit, and Local_Leader_Limit.
Calculate fitness.
Identify local and global leaders by employing greedy selection.
while Stopping condition is not contented do
  (i) Stimulate the new positions for the whole group by with knowledge of all
  individuals including themselves, local leader, group members with the help
  of Algorithm 1.
  (ii) Employ the greedy selection process for the whole group based on their
  fitness.
  (iii) Compute the probability prob_i of the whole group using Eq. (4).
  (iv) Identify new locations for all the members of group, selected by prob_i, by
  own previous knowledge and experience of global leader and group
  members using Algorithm 2.
  (v) Local and global leader update their position using greedy selection
  strategy for all groups.
  (vi) All the members of a specific group redirected for foraging by Algorithm
  3 if its Local leader is not able to update her position after a predefined
  number of times.
  (vii) A group further divided into smaller sub groups, with minimum size of
  each group four, if Global Leader not able to update her location for a
  predefined number of times.
end while
```

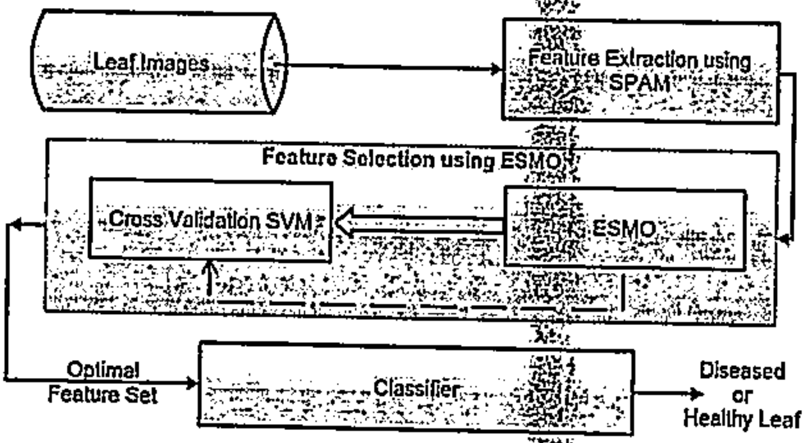


Fig. 1. The proposed leaf image classification method.

3. Proposed approach

The newly anticipated approach for image classification has three steps as depicted in Fig. 1: (1) 1st step uses SPAM for features extraction from the collection of leaf images, (2) 2nd step selects the distinguished features by the means of newly proposed feature selection algorithm using ESMO, and (3) Ultimately, the classifier is used to categorise the leaf images into diseased and healthy leaf images. Detailed description of these phases given in subsequent sections.

3.1. *Feature extraction*

The most important step in image analysis is feature extraction. The extracted features decide the success of a classifier. For an efficient image analysis algorithm, multi-dimension and divergent features must be extracted which can differentiate healthy leaf images from diseased leaf images. For the same, a number of feature extraction methods have been proposed. This paper uses SPAM for feature extraction from considered leaf images, which is discussed in the next sections.

3.1.1. *Subtractive Pixel Adjacency Matrix (SPAM)*

Peny et al. [14] introduced SPAM to extract the features in spatial domain images. SPAM is the most efficient technique for feature extraction as compared to other existing methods and is based on Markov chain features. It uses the information about the images that in general, an image does not have noise. Furthermore, short-range dependencies amongst noise segments inside an image are used by SPAM to extract the features. It obtains the confined inter-dependencies between dissimilarity of adjoining face rudiments and used them as a Markov chain to extract the features of images. This paper uses SPAM which extracts 686 features for leaf image data set.

3.2. *Feature selection*

SPAM extracts 686 features from image data set which is a high dimensional feature vector and requires high computational cost. These features may have redundant or irrelevant features and sometimes degrade classifier's performance. For that reason, these features are given to the feature selection phase to reduce the unwanted and unrelated features. The overall steps of the ESMO based feature selection are shown in Fig. 2.

The exponential spider monkey optimization (ESMO) lessens the inappropriate and repetitive features while selecting feature

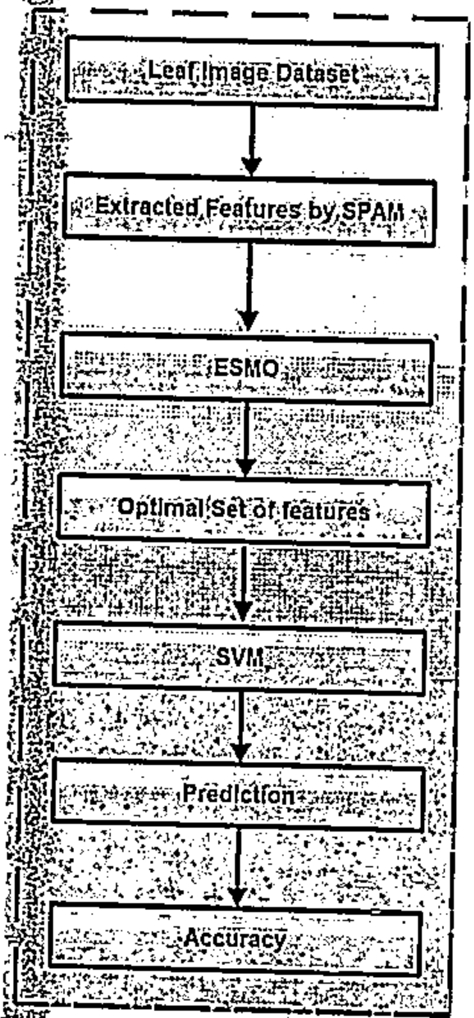


Fig. 2. The proposed ESMO based feature selection method.

The proposed ESMO first initializes randomly the positions of each spider monkey in the population. Each individual has a dimension identical to the quantity of features extracted using SPAM. The ith entity denoted by Eq. (6) if there are total n features extracted and total spider monkeys are N.

$$X_i = [x_1, x_2, \ldots, x_n]; \quad i = 1, 2, \ldots, N \tag{6}$$

Table 1
Benchmark functions.

Sr. No.	Equation	Dimensions	Range	Optimal value
1	$F_1(X)=\sum_{i=1}^{d} x_i^2$	30	[−100, 100]	0
2	$F_2(X)=\sum_{i=1}^{d}\lvert x_i\rvert+\prod_{i=1}^{d}\lvert x_i\rvert$	30	[−10, 10]	0
3	$F_3(X)=max_i\{\lvert x_i\rvert, 1\le i\le d\}$	30	[−100, 100]	0
4	$F_4(X)=\sum_{i=1}^{d}([x_i+0.5])^2$	30	[−100, 100]	0
5	$F_5(X)=\sum_{i=1}^{d} ix_i^4+random[0,1)$	30	[−1.28, 1.28]	0
6	$F_6(X)=-20\exp\left(-0.2\sqrt{\frac{1}{d}\sum_{i=1}^{d}x_i^2}\right)-\exp\left(\frac{1}{d}\sum_{i=1}^{d}\cos(2\pi x_i)\right)+20+e$	30	[−32, 32]	0
7	$F_7(X)=0.1(\sin^2(3\pi x_1)+\sum_{i=1}^{d}(x_i-1)^2[1+\sin^2(3\pi x_i+1)]+(x_d-1)^2[1+\sin^2(2\pi x_d)])+\sum_{i=1}^{d}u(x_i,5,100,4)$	30	[−50, 50]	0
8	$F_8(X)=\sum_{i=1}^{11}\left[a_i-\frac{x_1(b_i^2+b_ix_2)}{b_i^2+b_ix_3+x_4}\right]^2$	4	[−5, 5]	0.0003
9	$F_9(X)=4x_1^2-2.1x_1^4+\frac{1}{3}x_1^6+x_1x_2-4x_2^2+4x_2^4$	2	[−5, 5]	−1.0316
10	$F_{10}(X)=[1+(x_1+x_2+1)^2(19-14x_1+3x_1^2-14x_2+6x_1x_2+3x_2^2)]\times[30+(2x_1-3x_2)^2(18-32x_1+12x_1^2+48x_2-36x_1x_2+27x_2^2)]$	2	[−2, 2]	3
11	$F_{11}(X)=-\sum_{i=1}^{4}c_i\ \exp(-\sum_{j=1}^{3}a_{ij}(x_j-p_{ij})^2)$	3	[1,3]	−3.86
12	$F_{12}(X)=-\sum_{i=1}^{4}c_i\ \exp(-\sum_{j=1}^{6}a_{ij}(x_j-p_{ij})^2)$	6	[0,1]	−3.32

The value of each x_i, having an arbitrary value in among 0 and 1, is fixed to either 1 or 0 using predefined threshold for computing the fitness. The threshold value is fixed at 0.7 in this manuscript, after empirically analysis. Therefore, the value of x_i is fixed to 1 if it is higher than or equivalent to 0.7 if not then set to 0. Hence, simply the features, having x_i value one, are given to calculate the fitness function. To calculate the fitness value, SVM with ten times counter confirmation is used. In order to select prominent features, the fitness and actual value of spider monkeys are given to succeeding stages of ESMO.

3.2.1. Exponential Spider Monkey Optimization (ESMO)

Perturbation rate is one of the important parameter of SMO which affects the convergence behavior of SMO. Generally, perturbation rate is a linearly increasing function. However, due to the availability of non-linearity in different applications, a non-linear function may affect the performance of SMO. Therefore, to enhance the competency of SMO, this manuscript proposes a novel modification in SMO named as ESMO, with improved perturbation rate that leads to desirable efficiency for convergence, higher rate of convergence, and enhanced global search capability.

For a meta-heuristic algorithm, intensification and diversification are two imperative stages to achieve precise solution and escape from the local optima. In SMO, perturbation rate is one of the prime factors which affect the convergence behavior of SMO. In general, it is a linearly increasing function with the iterations. On the other hand, it has been observed that sometimes poor divergence in SMO leads to entrapping into local optimum. For that reason, in the anticipated optimization algorithm, the value of perturbation rate is customized exponentially in place of linearly.

In ESMO, the parameter, perturbation rate, is increased exponentially as shown in Eq. (7).

$$pr_{new}=(pr_{init})^{\frac{max\_it}{t}} \quad (7)$$

where max_it and t symbolize the maximum and the current iteration counter respectively, N stand for the number of spider monkeys and pr_{init} in initial perturbation, initialized randomly in between 0 and 1. Remaining steps of ESMO are similar to basic SMO as depicted in Algorithm 4.

3.3. Classification

Next step after selecting the relevant and non-redundant features is classification of the leaf images into healthy and diseased images and comparison of different classification techniques. For the same SVM, kNN,LDA, and ZeroR classifiers are used.

4. Experimental results

The result analysis of newly developed feature selection approach based on ESMO for image classification is given in a couple of phases. 1st phase shows the performance of new approach (ESMO) and second, analyses the effect of feature selection method for plant diseased identification.

4.1. Result analysis of ESMO

The performance of ESMO has been simulated on 12 standard benchmarks which are represented in Table 1 [38–40] along with their corresponding optimal value and range of decision variables. Moreover, the proposed ESMO algorithm has been compared with GSA, DE, PSO, and SMO meta-heuristics over the considered benchmark functions. All the algorithms use default parameter settings as mentioned in the corresponding literature except number of iterations (itr) and population size (N) which are taken 50 and 1000 respectively for all the methods. To reduce the inter-dependencies, mean fitness values of 30 runs have been compared.

Table 2
Comparison of mean fitness values.

Function	ESMO	PSO	GSA	DE	SMO
F_1	[illegible].69E−11	2.32E−07	1.12E−05	3.54E+03	1.88E−08
F_2	3.94E−10	3.02E−07	5.27E−04	0.68E+02	3.03E−08
F_3	1.11E−10	5.81E−05	2.47E+00	0.65E+02	2.16E−08
F_4	2.69E−08	1.15E−07	2.811E−05	3.68E+03	9.55E−09
F_5	2.01E−04	2.24E−01	7.13E−02	1.71E+00	2.18E−02
F_6	3.79E−11	1.99E+01	1.40E−04	1.53E+01	4.15E−08
F_7	1.80E−09	1.09E−02	3.39E−05	5.86E+07	1.83E−08
F_8	4.07E−04	2.03E−02	1.68E−03	9.78E−04	3.14E−04
F_9	4.69E−08	4.65E−08	6.23E−08	4.65E−08	4.83E−08
F_{10}	3.00E+00	3.00E+00	3.00E+01	3.00E+00	3.00E+00
F_{11}	−3.86E+00	−3.00E−01	−3.00E−01	−2.50E−11	−3.86E+00
F_{12}	−3.04E+00	−2.98E+00	−3.04E+00	−2.43E+00	−3.04E+00

Table 3
The wilcoxon rank sum test.

Function	ESMO-PSO			ESMO-GSA			ESMO-DE			ESMO-SMO		
	p-Value	h-value	SGFNT	p-value	h-value	SGFNT	p-value	h-value	SGFNT	p-value	h-value	SGFNT
F_1	1.2E−10	1	+	1.2E−10	1	+	1.2E−10	1	+	1.2E−10	1	+
F_2	1.2E−09	1	+	1.2E−10	1	+	1.6E−05	1	+	4.2E−07	1	+
F_3	1.1E−08	1	+	1.2E−10	1	+	1.2E−10	1	+	1.9E−07	1	+
F_4	1	0	−	2.4E−10	1	+	1.3E−10	1	+	1.1E−08	1	-
F_5	2.2E−07	1	+	6.5E−07	1	+	8.3E−08	1	+	2.4E−10	1	+
F_6	1.2E−10	1	+	1.2E−10	1	+	1.2E−10	1	+	1.2E−10	1	+
F_7	1.7E−08	1	+	2.4E−12	1	+	2.3E−06	1	+	8.3E−08	1	+
F_8	1.4E−06	1	+	1	0	−	1	0	−	1	0	−
F_9	1	0	−	1	0	−	1	0	−	1	0	−
F_{10}	1	0	−	1.3E−11	1	+	1	0	−	1	0	−
F_{11}	1.5E−08	1	+	1.2E−11	1	+	2.3E−06	1	+	1	0	−
F_{12}	2.4E−12	1	+	1	0	−	4.7E−09	1	+	1	0	−

The mean fitness values returned by the ESMO and considered methods have been presented in Table 2. The ESMO returns minimum mean values of all the benchmarks among PSO, GSA, and DE except F_4 and F_8 where, DE and GSA returns slightly better results. To confirm the outcome shown in Table 2, wilcoxon rank sum statistical test [41] has been conducted with NULL hypothesis that at 5% significance level, considered two algorithms are similar for respective benchmark. Table 3 shows wilcoxon rank sum test for proposed and existing methods. For $p < 0.05$, the null hypothesis is considered as discarded and denoted by '+' or '−' otherwise accepted and symbolized as '='. The '+' represents the significantly different result and ESMO returns better result while '−' sign shows significantly different but ESMO gives competitively pitiable results. Table 3 shows that for maximum functions, ESMO returns significantly different and better results except F_4 where DE shows comparatively better results. From Table 2 and 3, it can be seen that the mean values for F_8 with respect to DE is not significant. Therefore, it can be validated that the ESMO performs better than existing techniques for mean fitness values.

Moreover, the comparison of the computational time, taken by Exponential SMO and other considered methods, have been discussed in Table 4. From the table, it can be visualized that by introducing the exponential k-best in basic SMO does not affect the computational cost of the SMO. An average time taken by ESMO is 2.4385 s while SMO takes 2.3989 s average computational time. The computational time of DE is also almost similar to ESMO. However, PSO and GSA takes more than 3 s for getting the best function values. Furthermore, the convergence behavior of the proposed ESMO has been compared with the considered state-of-the-art algorithms. For the same, Figs. 3–4 depict the convergence graphs for all the considered benchmark functions over 1000 iterations. The best fitness values at every iteration are presented on y-axes in logarithmic scales. From the figures, it can be observed that the proposed ESMO has better convergence behavior as compared to other methods for almost all the benchmark functions. Sufficient iterations for exploration are taken by the proposed method before exploitation phase which help to achieve better objective values. Thus experimentally and statistically, it can be validated that the proposed ESMO returns the optimal solutions along with precise convergence behavior for various benchmark functions.

Table 4
Comparison of computational time in seconds.

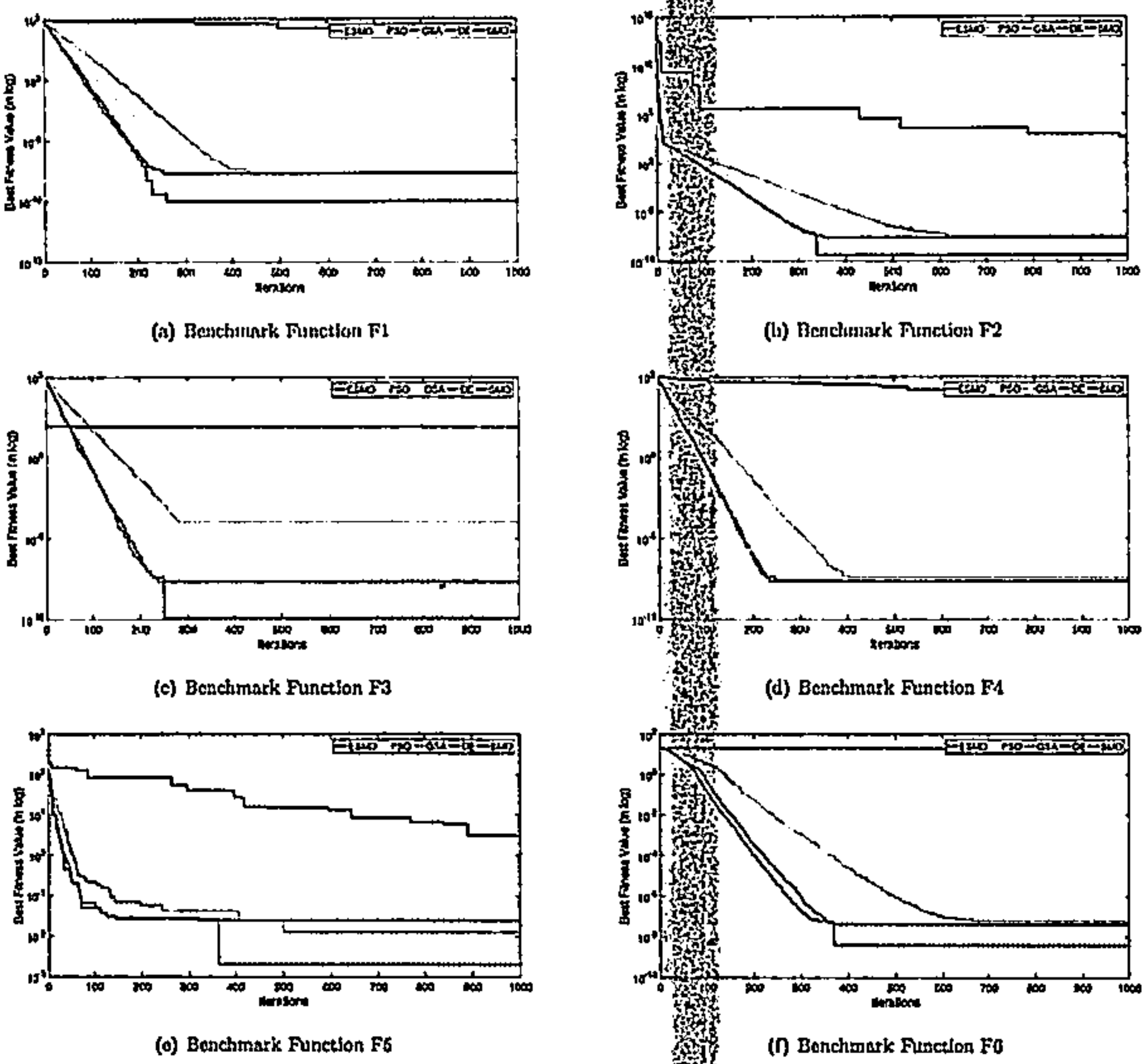
Function	ESMO	PSO	GSA	DE	SMO
F_1	2.6828	4.8514	3.7373	2.5380	2.3048
F_2	2.3369	4.0179	4.1698	2.7056	2.3397
F_3	2.2932	4.7995	5.6281	2.3437	2.3291
F_4	2.4616	4.4041	2.9849	2.3770	2.4155
F_5	2.7494	3.2745	2.9529	2.9738	2.747?
F_6	2.4834	3.2092	4.1470	2.4736	2.50?2
F_7	2.4275	4.7740	2.9563	2.7722	2.4045
F_8	2.3595	3.6840	2.6673	2.4534	2.3460
F_9	2.3661	3.3271	2.1040	2.3065	2.3288
F_{10}	2.2383	3.4384	2.1209	2.3694	2.2408
F_{11}	2.4322	3.1568	2.2077	2.0033	2.3858
F_{12}	2.4321	3.6273	2.4316	2.0026	2.4432
Average	2.4385	3.8804	3.1757	2.4433	2.3989

4.2. Result analysis of feature selection technique

The performance of the anticipated diseased leaf identification system has been tested on 1000 images from PlantVillage dataset [42]. The dataset consists of 500 healthy leaf images and 500 diseased leaf images. Some of the representative images from diseased and healthy categories are delineated in Figs. 5 and 6 accordingly. For each image, 686 features are extracted using SPAM. Furthermore, ESMO is employed for feature selection. The outcomes of ESMO for feature selection have been compared with PSO, GSA, DE, and SMO using the number of selected features and classifica-

Table 5
Comparative analysis of classifiers and feature selection methods.

Feature selection method	Number of features selected	Classification method	Accuracy
None	686	SVM	80.26
		LDA	72.37
		kNN	76.34
		ZeroR	42.29
PSO	97	SVM	89.54
		LDA	78.20
		kNN	82.13
		ZeroR	47.31
GSA	87	SVM	87.54
		LDA	77.66
		kNN	83.82
		ZeroR	46.54
DE	91	SVM	87.45
		LDA	78.77
		kNN	83.79
		ZeroR	47.54
SMO	84	SVM	89.55
		LDA	79.67
		kNN	[illegible]
		ZeroR	46.44
ESMO	82	SVM	92.12
		LDA	80.79
		kNN	84.76
		ZeroR	49.32



(a) Benchmark Function F1

(b) Benchmark Function F2

(c) Benchmark Function F3

(d) Benchmark Function F4

(e) Benchmark Function F5

(f) Benchmark Function F6

Fig. 3. The convergence behavior of proposed and existing methods for benchmark functions.

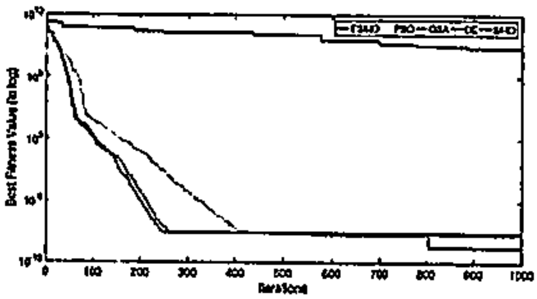
tion precision. Table 5 illustrate the outcome of both the feature selection technique and classifiers.

ESMO based feature selection technique returns 82 features which is the least number of selected features as compared to other feature selection techniques. From Table 5, it can be observed that approximately 88% features are reduced by ESMO from the 686 extracted features. This reduction of features is highest with respective to PSO, GSA, DE, and SMO which reduce 85%, 87%, 86%, and 87% respectively. From the feature reduction rates, it can be stated that all the considered algorithms along with ESMO eliminate almost same amount of features. However, relevancies of the selected features are tested by feeding them to a classifier for plant leaf disease identification.

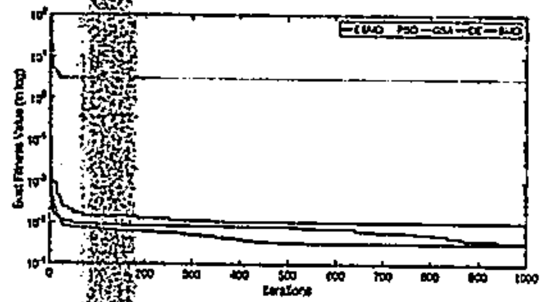
For the same, SVM, kNN, LDA, and ZeroR classifiers are used for comparative analysis of accuracies. The results of ZeroR classifier is measured as a reference line for all the feature selection techniques. From Table 5, it can be obtained that without feature selection method all the classifiers give lowest accuracies which validates the presence of redundant and irrelevant features in the set of extracted features from SPAM. After the applicability of feature selection method before identification of diseased leaves, the accuracy of each classifier increases. However, all the considered classifiers shows the best accuracies for the features identified by the anticipated ESMO. Among all the classifiers for ESMO based feature selection method, SVM gives the best classification accuracy of 92.12%. Consequently, it can be specified that the anticipated ESMO based feature selection approach returns minimum number of optimal features which gives better classification accuracy.

5. Conclusion

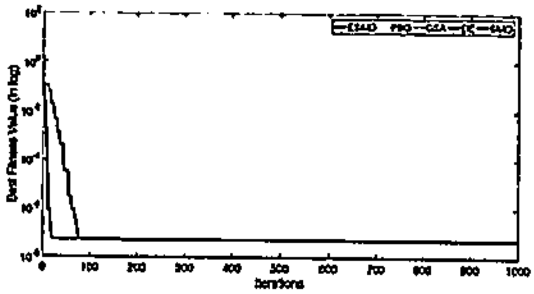
This paper anticipated a feature selection approach using novel exponential spider monkey optimization (ESMO) for plant disease identification. For the same, diseased and healthy leaf images have been used from plant village dataset. Furthermore, 686 features extracted using SPAM method from the considered image dataset. The performance of ESMO has been compared with PSO, GSA, DE, and SMO methods in terms of mean fitness values. The investigational and numerical outcome authenticate that the anticipated ESMO outperforms the considered approaches. Additional, the performance of newly anticipated feature selection process using ESMO has been contrasted with PSO, GSA, DE, and SMO based feature selection techniques. The anticipated technique extracts the minimum 82 features. The classification results have been analyzed over SVM, kNN, LDA, and ZeroR classifiers. In the midst of all the classifiers, SVM outperforms to classify the plant leaf images into diseased or healthy leaf images. Thus it can be validated that the anticipated feature selection technique minimizes the unrelated and superfluous features while, maintains the elevated classification precision. In future, the anticipated technique can be used for



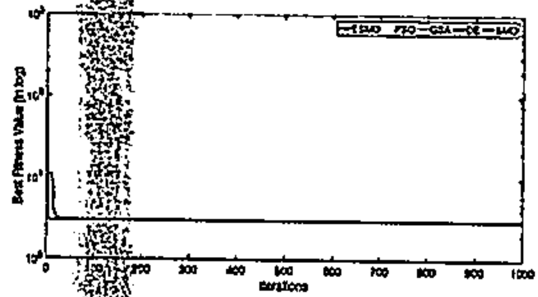
(a) Benchmark Function F7



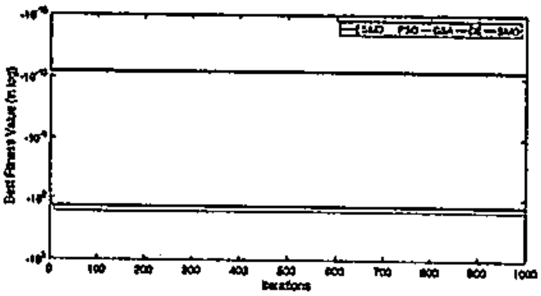
(b) Benchmark Function F8



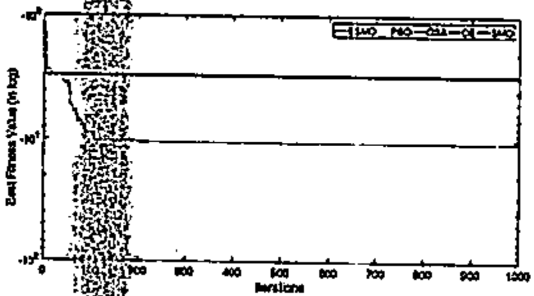
(c) Benchmark Function F9



(d) Benchmark Function F10



(e) Benchmark Function F11

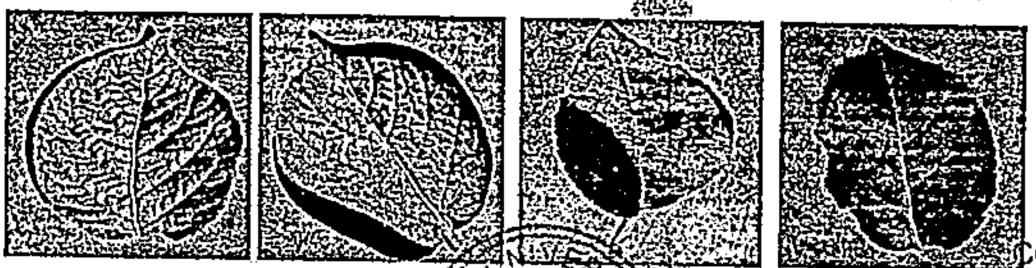


(f) Benchmark Function F12

Fig. 4. The convergence behavior of proposed and existing methods for benchmark functions.

(a) (b) (c) (d)

Fig. 5. The represented diseased leaf images of (a) potato, (b) potato, (c) apple, and (d) apple leaves taken from [42].



(a) (b) (c) (d)

Fig. 6. The represented healthy leaf images of (a) potato, (b) potato, (c) apple, and (d) apple leaves taken from [42].

multi-class problem where, the different plant disease categories can be identified.

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SPECIAL ISSUE

Automated soil prediction using bag-of-features and chaotic spider monkey optimization algorithm

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Abstract
A proper soil prediction is one of the most important parameters to decide the suitable crop which is generally performed manually by the farmers. Therefore, the efficiency of the farmers may be increased by producing an automated tools for soil prediction. This paper presents an automated system for categorization of the soil datasets into respective categories using images of the soils which can further be used for the decision of crops. For the same, a novel Bag-of-words and chaotic spider monkey optimization based method has been proposed which is used to classify the soil images into its respective categories. The novel chaotic spider monkey optimization algorithm shows desirable convergence and improved global search ability over standard benchmark functions. Hence, it has been used to cluster the keypoints in Bag-of-words method for soil prediction. The experimental outcomes illustrate that the anticipated methods effectively classify the soil in comparison to other meta-heuristic based methods.

Keywords Soil prediction · Bag-of-words · Clustering · Spider monkey optimization

1 Introduction

Agriculture is one of the important sources of earning for human beings in many countries. A different variety of food plants are harvested as per the need and environmental conditions of land. Soil category is one of the prime factors on which the type of crop is decided. Thats why, the different types of crops are produced in two different places, having significantly different soil. In general, the farmers do this soil analysis manually which may be improved by providing them an automated tools for the same. This will increase the productivity and quality of the crops. This type of system can overcome from the problems of lack of soil knowledge as there are very few experts for the same [1, 2]. Moreover, it may reduce the requirement of searching an expert. Such automated system will also be time and cost efficient. Therefore, this manuscript recommends a new method to predict the type of soil derived from various parameters.

Soil may be classified into seven categories [3, 4] namely; clayey sand, sandy clay, silty sand, clay, humus clay, clayey peat, and peat. Various soil classification methods are available in the literature [3, 5, 6]. Bhattacharya et al. [3] segmented the signals followed by boundary energy method for feature extraction. Furthermore, various classifiers for instance SVM, ANN and decision trees are used for classification. Generally, cone penetration test (CPT) is one of the accepted soil examination process [7, 8] which study the sub-surface soil and deep knowledge of soil samples. In case of CPT which results the overlapping of diverse classes of soil the mechanical behavior of soil and the soil composition correlation is always uncertain [9]. Moreover, Gordon surveys the efficiency of SVM classifier for image based soil classification.

The performance of a classifier is generally affected by the relevancy of the extracted features [10, 11]. A number of feature extraction methods have been introduced for soil image classification which can be grouped into two major classes; learning-based process and statistics-based process.

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