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Modified Grasshopper Optimization Algorithm in Machine Learning Application

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Certifications

This is to certify that the project work entitled “Modified Grasshopper Optimization Algorithm”, carried out by Paulos Bekana, Finally year Graduate thesis report M.Tech in Computer Science and Engineering of Institute of Technical Education and Research under Siksha ‘O’ Anusandhan University, Bhubaneswar, Odisha, India. He has successfully submitted her report and presentation on the topic.

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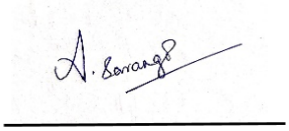	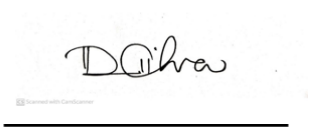

Self-declaration

Paulos Bekana undertaking M.Tech (Regd no: 1961012019) from ITER (S'O'A University) hereby declare that the matter embodied in this thesis report is original and has not been submitted for the award of any other degree else where.

Paulos Bekana

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Abstract

Abstract: A grasshopper optimization algorithm is a nature inspired metaheuristic optimization that based on the a group of Grasshoppers. The algorithm has some shortcoming slow convergence's and falling local optimum. The new proposed algorithm improved Grasshopper these optimization algorithms improve these limitations. This paper present on the part of the literature review discus modification, hybridization and different area application usage of the algorithm. It also presents two way improvement of the Grasshopper Optimization Algorithm. The first section paper introduce modification is using both crossover and polynomial mutation. The second section paper presents the new improvement using the methods of crazy factor. For test verification and validation both algorithm improvement implanted using unimodal and multimodal standard test benchmark function. For extra evidence the new proposed algorithm algorithm compared with popular intelligence algorithms. The test result projected by new algorithm in both paper Superior than others intelligence algorithms and classical Grasshopper optimization algorithm.

Keyword: Modified Grasshopper optimization algorithm, Improved Grasshopper Optimization algorithm, Grasshopper optimization algorithm, Crazy factor, Polynomial mutation.

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List Of Abbreviations

GOA —- Grasshopper Optimization Algorithm

MGOA—- Modified Grasshopper Optimization Algorithm

IGOA — Improved Grasshopper Optimization Algorithm

FA ——- Firefly Algorithm

ABC —- Anti Bee Colony

PSO —- Particle Swarm Optimization

SBX —- Simulated Binary Crossover

SI —— Swarm Intelligence

1 Introduction

Many optimization methods has been proposed for finding solution complex problem in various fields, like in machine learning, engineering application, energy, data mining, networks, text mining, medical, economics and others. The aim of this application to gain optimal solution by obtaining different optima solution and produce possible nominated solution to achieve or solve fundamental as can as possible. Most of Meta-heuristic optimization algorithm performing based of focusing the optimal value by reducing or increasing the value of the objective function to return best decision. The basic purpose of objective function is to find the best feasible solution value in the range specified boundary. A final outcome obtained by procedure of optimization from all possible alternative is optimal solution of optimization.

1.1 What is Optimization process in SI

The process optimization is a searching solution of problems along with highest cost effective or highest possible obtainable production using the resource in hand minimizing the unwanted items and increasing desirable ones. It can be simply example optimization process is doing something huge work with less time, resource and force. The solution finding with the least possible cost and highest possible benefit is called proper solution. Searching the most proper best solution from few alternative is considered us one of a complected process [2]. In the recent modern fast quickly growing information and communication era, the development of algorithm, techniques and approach of solving various type optimization problem is one of most focused scope and attractive area among the researcher's community.

1.2 Optimization Problem solver Algorithms

The remarkable and attractive phenomena behind of this field is an invisible hype of decrease the cost and resource for resolve difficult problems greatest force in academic and industries. For this reason various Artificial Intelligence(AI) mechanisms [3], Evolutionary algorithms(EA) approach[4], and Swarm Intelligence (SI)[5] algorithms have been developed for work out many types of optimization algorithms. In addition based inspiration exist from behavior, attribute quality, inter collaboration and performance of various natural creations many

types of AI techniques has been developed based to the targeted challenge in nature. The major developed AI technique such as Artificial Neural Network(ANN)[6], Fuzzy Logic (FL)[7], Genetic Algorithms(GA)[8], Genetic Programming(GP)[9], Artificial Immune system (AIS)[10], Experts systems(ES)[11] which can support for solving optimization problem or used for solving optimization problems.

1.3 Evolutionary Intelligence (EI)

Evolutionary algorithm is other sub field of Artificial intelligence techniques. The algorithm motivated form biological stage of living organisms specially from human being. This algorithm a population s based technique used solve complex problem by the mechanisms of trial and error procedure. The mechanism of performing these algorithm follow is first initialize (produce) search space solution then then update by each generation(iteration). While each generation the less feasible solution are released from the current solution of in search space and randomly produced mini changes are integrated to expand the solution space [12]. The most well known algorithm of subbranch evolutionary algorithm are Genetic Algorithm(GA), Genetic Programming(GP), Evolutionary programming(EP), Gene expression programming, Differential Evolution(DE) and others.

1.4 Swarm Intelligence (SI)

Swarm Intelligence (SI) broadly deployed popular and modern developed sub -branch of AI, it has got attentions of among scholars over prior few decades focused problems of optimization nature. SI basically inspired from a group of social Swarm, Bees, Ants, Worms, Termites, school of Fishes and flock of birds in their achieving goals. In addition a collective behavior can be shown by swarm individuals foraging, reproduction, living and division important task among the available individuals. The action of individual based in decentralized manner on local or specified information used as desired information is important for decision making [13]. Some example of SI algorithms used for optimization problems includes Particle Swarm Optimization(PSO)[14], Anti Bee Colony optimization (ABC)[15], Anti Colony optimization (ACO)[16], Cuckoo Search Optimization(CSO)[17], Firefly Algorithm(FA)[18], Bat algorithm(BA)[19]. An operational procedure of those techniques, a optimal search space

population created at the first and then updated attractively. During each generation, the less important solutions are detached from the solution search space and randomly generated bit changes are integrated to broad the solution search space[12].

1.5 Global and Local Search Space solution

While searching optimal solution of optimization problem, the area field of optimization function is called solution search space. In addition the number a group all considerable of feasible solution also called solution space of optimization problem. The characterization optimization problem different based upon different factors of the problem and the algorithm being used for solving problem[20]. In the process of searching solution space of searching optimal solution their two important mechanism things. Those are called local search and global search are used to reach the all possible chance solution in the problem. The local search is carried out by starting gradually from the local to the current solution to verify the local solution of the problem. although global search is a process of broadly to cover more diverse solution. Various optimization algorithm flow different mechanisms of execute local and global search process. For example Genetic algorithm(GA) utilizing Selection, Crossover and Mutation operators used for searching local and global optimal solutions, Anti Bee colony uses mechanism of employed bees, onlooker bees and scout bees utilized for carried out search process local and global optimal solution. The local and global search[21] optimization process algorithm also can be also explained by its exploitation and exploration capacity.

1.6 Approach of Nature Inspiration

Exploration means gathering new information and the exploitation means using the existing information for communication among different single of the swarms to better control their coordination. In the mechanism of optimization problem the exploration is the procedure increasing solution space to bring close different in the values of optimization function (collecting new information), although exploitation means targeting on the near solution check whether near by solution to enhance the search space to not jump the most optimal solution found in the local solution search space[22]. The exchange is needed between exploitation and exploration in order to find optimal solution during find search optimal solution in the region space

[23]. In swarm intelligence, the swarm of individuals appear a group behavior based on a self-organized and decentralized coordination system for reach different goals like reproduction, foraging, food search and other day to day activities. In this decentralized approach, the local information is collected by the individuals from the environment and this locally collected information contributes towards the overall decision making process of the whole swarm.

1.7 Classification of AI algorithms

The branch methahuerstic nature inspired algorithm can be divided to single solution based and multi solution based. Single solution based is performing in particular and improved for particular problem. Multi solution based basically have higher local optima avoidance, because of improving multiple solution during optimization process and in this process a trapped local optima can be supported by other solution to jump out of the local optimum. In addition to multi based solution algorithm have several advantageous they require more function evaluation. Most famous single solution based algorithm are Hill climbing (HC)[24], Simulated Annealing (SA)[25] both algorithm have the same similar idea. Tabu search (TB)[26] and Iterated local search (ILS)[27] are recent type single solution based algorithm. Genetic Algorithm(GA), Particle Swarm Optimization (PSO) and Anti Colony optimization(ACO) algorithm some of most popular multi based solution algorithms. GA is originated from Darwin theory of evaluation. In this algorithm genes are considered the base every individuals and parameter factors. The main inspiration is survival fittest of individuals assist to improve the solution. PSO algorithm originated based of foraging herd behavior of birds . In this algorithms search optimal solution by so far each particle and current best best solution of particle. The ACO algorithm mimic a group of behavior of ants searching for shortest path from nest to source of food.

Different swarm intelligence algorithm developed recently from various of natural behavior such as Dolphin Echolocation(DEL)[28], Bat Algorithm(BA), Grey Wolf Optimizer(GWO)[29]. DEL and BA mimic from echolocation of dolphin for searching prey and bats course respectively. GWO also a type of swarm optimization method that based the forage mechanism of Grey wolves. Last two decades many nature inspired algorithm developed and improved on existing algorithms. It very important to have more good despite of many algorithms proposed

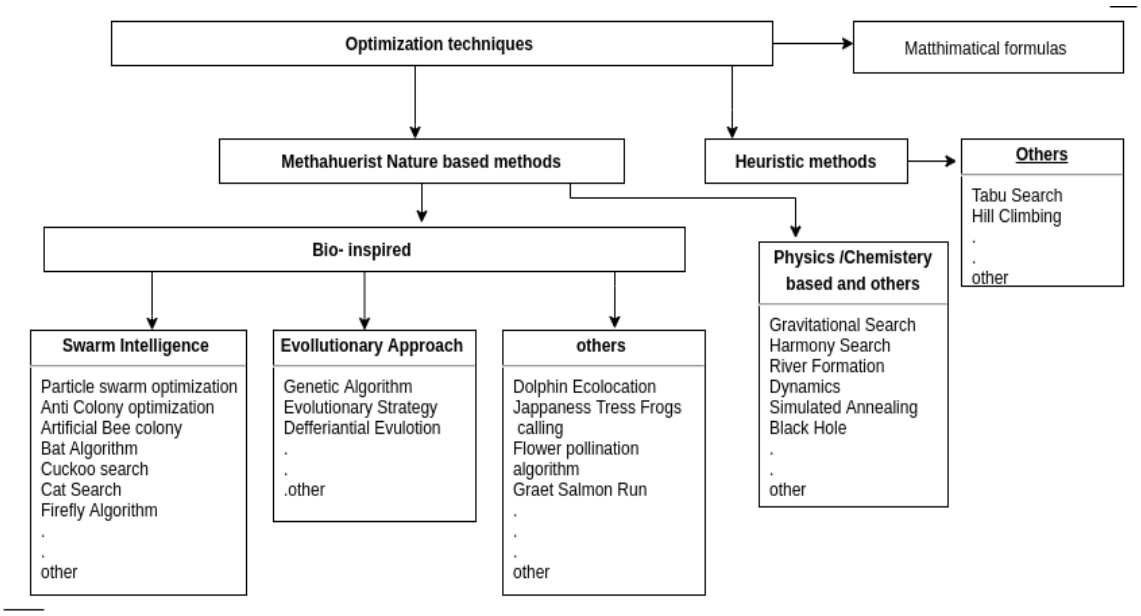

Figure 1: Classification of Optimization Algorithms in AI

because it has own efficiency in different optimization problems.

1.8 Objective and Motivation

Grasshopper Optimization algorithm is one of the basic widely applied optimization problems and used by many authors recently. It is gradient free, simple, high local avoidance and new recent nature inspired it have been focused and select for more improvement and applies many widen in science and industry. For sake simple easy and most powerful for solving complex problems, this area of optimization algorithm inspiration me to my thesis, additionally Swarm Intelligence algorithms gaining good results and best quality performance in field of constructing engineering for complex problems. The aim of this research paper going to survey recent available literature particle swarm optimization algorithm including enhanced, modified, hybridized, optimized and currently applications areas of recently published.

The rest of paper organized as follows Section II present Literature review, Section III present A New Approach for Modification of Grasshopper Optimization Algorithm for Machine Learning, Section IV present Improved Grasshopper Optimization Algorithm using Crazy factor and Section V Conclusion and future work.

2 Literature Review

Grasshopper Optimization algorithm has been re outmoded for different application and used various research domain's to solve problems by making modification and changes(binary, modified, hybridized and others) it's tried to discussed individually as follows

2.1 Variant Grasshopper Optimization Algorithm

2.1.1 Binary GOA

Feature selection is one of machine learning application to reduce the number of selected feature by removing non-important feature and performing highest classification accuracy. Feature selection observed as one of a difficult in machine learning work. Since of the problem of this challenge and have high number of alternative solutions, Random based meta-heuristic algorithms are promote technique to implement this selection procedure. the technique binary version according on a GOA algorithm proposed [30] to select best sub branch of feature a classification purpose align ta cover based order. The two methods have been implemented to perform binary GOA algorithm. The first method is Sigmoid structure function and second is V-shaped function. The second method used to make separate the better solution obtained so far. Additionally mutation method used to increase exploration finding procedure in the GOA algorithm. The introduced method analysed and verified using 25 dataset form UCI repository. The result compared with known swarm intelligence algorithms. The result obtained proposed technique shows better performance compared to other related techniques compared.

In a field of engineering science various application of hard optimization challenges would be solved intelligently. A collection class of this problem is called called NP-hard and the solution can be found hardly by full mechanism . Since developing binary based algorithms on swarm intelligence is in demand domain operational and artificial intelligence researchers. Binary based technique proposed [31] based of the theory percentile. Grasshopper optimization algorithm used with percentile theory to find solution the problem multi directional knapsack optimization challenges. The experimental test shows the effective of ratio theory in binarization kind. Additionally the simulation result of introduced algorithm tested using bench mark

cases. The gained result provide that binary Grasshopper algorithm attained better result that compared to with other related optimization art methods.

Various of such same meta-heuristic problem solved in industrial areas, type conjunction (order of set member)branch and sub-branch not less than Np hard class. A concept of optimization algorithm used to solved challenges is according to successive all metahuiristic optimization method type intelligence; it is one of needed in the industrial domain. Most of binarization methods based optimization meta-heuristic algorithm introduced [32] according percentile theory. Grasshopper optimization algorithm incorporated with percentile theory for sake of to address the set wrap problem. The experiment conducted and performed with object illustrate the primer of the ratio idea in binarization version. As well as the simulation of introduced algorithm is achieved through high standard instance. The result displayed by the binary mechanism of GOA algorithm obtained is better result when matched to with other techniques.

2.1.2 Hybrid GOA

The hybridization of GOA algorithm including opposition based learning procedure suggested [33] for finding solution of two optimization issue(benchmark test function and engineering application challenges). The introduced algorithm have two phase. The first step is initialize the solution producing and its rival according the opposition learning structure. Secondly phase GOA algorithm integrated with opposition based procedure with each iteration. However opposition based learning strategy used to stabilize section of population to reduce the experiment computation time. To compare the efficiency of introduced hybrid Grasshopper algorithm and opposition based learning strategy, six cluster of experiment group have been used and four engineering problems as well as 23 standard benchmark function conducted. The report result experiment of suggested hybrid algorithm get high ranking matched to popular published optimization algorithm. Finally the proposed hybrid opposition based learning grasshopper optimization algorithm confirmed better result for solving engineering problem in versus to other popular optimization algorithms.

The integrated classification method using support vector machine(SVM) with grasshopper algorithm(GOA) is proposed in [34] for computerized capture exposure in EEG named GOA-

SVM technique. Various controlling factors are chosen to implement as head to train the support vector machine based radial assist kernel function classification method. GOA algorithm used to selecting the important feature particle class and best values assist support vector machine parameters purposes to enhance power full EEG classification. The test result investigated the proposed method can be to well known data of epileptic capture and it can able enhance the examination epilepsy with good efficiency common subject. Additionally the proposed technique conducted with particle swarm optimization with support vector machine and other utilizes radial support vector function kernel function. The result of proposed techniques discuses that proposed method gain better result regarding to classification and superior with other compared techniques.

Biological inspired swarm intelligence algorithm are performing highly in the field of optimization technique over the period decades. Many different novel of swarm intelligence algorithm are also proposed. The present optimization algorithm also focused the direction or either hybridizing and modifying with some component or integrating local search procedure. A new of local exploitation search based is introduced in [35] approach of the on the skipping procedure of the grasshopper optimization algorithms. The suggested search mechanism is discussed as GH local search strategy. Additionally the proposed procedure is hybridized with well known swarm intelligence algorithm (Artificial bee colony optimization). The introduced integrated algorithm is tested on 37 numerical benchmark function. The result manifested that introduced hybrid algorithm better technique for addressing numerical problems. R. Purushothaman [36] hybridized Gray Wolf Optimization with GOA for text feature selection and clustering. The hybridized algorithm perform good convergence rate and required minimum computational time and minimum to trapped to local optima from text documents, Additional the selected optima clustered using fuzzy c-means algorithm. Grasshopper optimization algorithm have been modified hybridized and improved after 2017 by many scholars. X.Chen [37] proposed the new hybridized GOA with combining Gaussian and Chaos theory. Initialized using Sinusoidal chaos space solution and Gaussian logistic for updating position. The hybridized algorithm perform good more than GOA, PSO and ALO on eight benchmark function and Tree bar truss problem design. Feng and Hangwei [38] Enhanced GOA by using Non linear convergence for c parameter that affect the step size this to prevent the algorithm

fail to local optima and Niche mechanisms idea used to solve the grasshopper interaction each other. The B-hill climbing technique applied to overcome additionally algorithm recover from holding by local optimal problems. T. Teng [39] Introduced the hybridization based on Gray Wolf Optimization (GWO) and GOA for cycle traffic light timing optimization. The algorithm improved the problem to minimize waiting time of vehicles and maximize the vehicle arriving the destination with certain time of period. Huanlong Zhang [40] hybridized Teaching Learning Based Optimization(TLBO) and GOA for sudden motion tracking. Adaptive Grasshopper optimization (AGOA) algorithm implemented by replacing linear mechanism to non -linear strategy based on tangent function. Both AGOA TLBO used for avoiding local trapping and exploitation operator fast convergences respectively. GOA used to optimize the parameters of under frequency load shading(LS).X. Yue [41] Improved GOA by hybrid with a Invasive Wide Optimization (IWO) named IWGOA. The IWO improve the search precision and making fast convergence rate. A. Annamraju [42] proposed strategy of load balancing and generation by Hybrid Micro grid Grasshopper Optimization algorithm based on Robust PID controller.

2.1.3 Modification of GOA

An modification type of Grasshopper optimization introduced [43] for addressing two optimization problem, financial stress forecast(prediction) and continuous optimization problem. As it discussed earlier Grasshopper optimization algorithm inspired by the group of grasshopper in real life. The algorithm confirmed to be useful in solving various global optimization constrained and unconstrained problem. However their some limitation in the original version algorithm such as trapped to local optima and less convergence speed to global optima. To overcome the mentioned limitation, Grasshopper optimization algorithm modified utilizing tree collaborative search factors(procedure) methods to gain more balanced between the search strategy such as local and global search. The first method using Gaussian mutation operators is utilized to enhance diversification solution, which can provide the ability to make powerful exploit search ability in the grasshopper optimization method. The second method is levy flight strategy is used to enhance the diverse or volatilises of search space, that can make strong global find in the grasshopper optimization algorithm. The third and last an opposition learning strategy is implemented in to grasshopper optimization algorithm to make strong search space. As test process result shows the suggested search strategies increased the efficiency of

Grasshopper optimization algorithm as well as the suggested learning system improved a better fixed kernel model with superior execution compered to other optimization popular algorithm. Zhangze Xu [44] Introduced orthogonal designed Adaptive Grasshopper optimization algorithm(OAGOA). The algorithm was the combination of orthogonal learning to classical GOA improve the diversity of agents and chaotic exploitation where used for update the position of grasshopper in limited local regions. M. Talaat [45] projected Grasshopper Algorithm optimization for load management under the frequency load shading(UFLS). The integrated algorithm have exploitation capability. S. S. Guo [46] Improved GOA by hybrid with a Invasive Wide Optimization (IWO) named IWGOA. The IWO improve the search precision and making fast convergence rate. The integrated algorithm have exploitation capability. H. Hamour [47] introduced improved GOA to overcome the the limitation poor low convergence in GOA. Proposed gravity search operator in to process optimization process GOA to get over problems of global exploration and to avoid local optima trapping. J. Huang [48] proposed improved Grasshopper optimization algorithm (IGOA) for estimating Hybridized active power filter (HAPF). IGOA perform balance between both exploration and exploitation by learning strategy and exampalor pool to replace the classical GOA. H. Liang [49]Introduced modified Grasshopper algorithm settled on multilevel thresholding for color image segmentation. The levy flight algorithm applied for the problem search of exploitation and exploration. G. Li, N [50] proposed Enhanced Grasshopper optimization algorithm (EGOA) with Gauss ion mutation and conventional strategy are applied to improve the search ability . The EGOA for modeling multi variable system with support vector regression (SVM). Jie Luo [43] improved GOA for continuous optimization and applied on financial prediction problem. The proposed algorithm to overcome the drawback GOA of falling local optima and slow convergences, by applying two strategies first one Gaussian mutation to increase the population diversity, to make stronger local search capability and the second Levy Flight to make randomness search agent , to make stronger search capability. Zakariya Yahya Algamal [51] improved the GOA for hyper parameter estimation and feature section in support vector reg-ration. Improved GOA used to control the parameter enhance the exploration and exploitation capability of GOA. The algorithm integrated with SVR for selection simultaneously. Ahmed A. [52] proposed improved GOA using Opposition Based Learning. The algorithm have two stages, first stage generate initial population using OBL strategy and second stage update the each state of iteration with OBL. Opposi-

tion Based strategy applied for reducing time complexity. Nikita Goel [53] proposed Modified Grasshopper optimization algorithm for observation(recognition) Autism spectrum disorder, the modified algorithm has the capability detect early diagnosis Autism disorder in all stage of life. R. Karthikeyan [54] developed using GOA to solve combined economic dispatch(CEED) problem incorporating with power flower constraints. Feng and Hangwei [38] Enhanced GOA by using Non linear convergence for c parameter that affect the step size this to prevent the algorithm fail to local optima and Niche mechanisms idea used to solve the grasshopper interaction each other. The B-hill climbing technique applied to overcome additionally algorithm recover from holding by local optimal problems.

2.1.4 Chaotic GOA

The computation of the non linear dynamics challenges chaos structure has been broadly applied to improve both search procedure(local and global search)[55]. Therefore most of chaos order has been successfully mixed with different swarm intelligence algorithm in for the sake of increase performance[56]. The grasshopper algorithm is recent latest meta-heuristic algorithm inspired from a group of grasshopper swarms. The chaos hypothesis structure are integrated into optimization procedure with Grasshopper optimization algorithm to enhance speed of global convergence[57]. The operation related to chaotic system to create fair and effective balance between exploitation and exploration of search strategy and decrease the operation force of repulsion and attraction between GOA algorithm strategy. The proposed chaotic grasshopper optoimized algorithm tested on on thirty three standard benchmark functions. The result evidence can provide collectively, chaotic system can relate effective in gaining better performance, specially the spiral structure is observed as the optimal structure in obtaining good results while execution GOA algorithm.

The innovation and growth of multi production strategy more useful for encouraging of smart intelligent grid technology , like including weight transfer, innate resource and cost minimization. The important result in smart grid one is have in contest on transfer development produced in specially with related compromising structure security. The introduced procedure is performed[58] a new communication growth produce optimal important response, the demand minimize cost by minimizing the tip amount of the mechanism. In disorder system used in

GOA algorithm to search the optimal result in communication enhance procedures. Generally the introduced prototype provide system engineering as well as the better network order report preparation and ability of finding the finest technique to used important feedback purpose for a system. Dwivedi [59] proposed choes Grasshopper optimization algorithm for protection and intrusion detection environment of network wireless infrastructure. The algorithm are combination of Chaotic Adaptive Grasshopper algorithm and Ensemble Feature Selection (EFS) used predict the networks traffic behavior.

Table 1: Grasshopper optimization algorithm variants summary

Category	**Problem**	**References**
Chaotic	Comprehensive Analysis	Zhangze Xu [44]
	Network Intrusion	D wivedi [59]
Hybridized	Benchmark Functions	X.Chen [37]
	Motion Tracking	Huanlong Zhang [23]
	Benchmark Functions	X. Yue [41]
	Benchmark Functions	S. S. Guo [46]
	Cyclic Light Trafficking	T. Teng [39]
	Frequency control	A. Annamraju [42]
Modified	Bin Packing Problem	Feng and Hangwei [38]
	Optimizing Power filter	J. Huang [48]
	Detection Autism Spectrum Disorder	Ahmed A. [52]
	Color Segmentation	H. Liang [49]
	Modelling Support Vector Machine	Li, N [50]
	Financial Stress Prediction	Jie Luo [43]
	Feature Selection	Zakariya YahyaAlgamal [51]
Multi Objective	Robot	Z. Elmi [60]

2.1.5 Multi objective GOA

Recently multi-objective Grasshopper optimization algorithm proposed in [61] which inspired by exploration a group of grasshopper in nature. Initially the computation mathematical representation model is performed to the communication between each individual grasshopper group of attractive, repulsive and comfort zone. Secondly relating the mechanism to encourage finding nearest best optimal solution in a single objective investigating in area space. Laterally the result of objective function are integrated with suggested grasshopper optimal algorithm to find Pareto optimal solution for multi-objective optimization algorithm. The experiment result performed to see the effectiveness of proposed algorithm, a group of various basic multi-objective finding result from conducted. The result compared with popular algorithm well known of multi objective with three criteria to show the proof of the result and diagram. The final result provide the multi objective grasshopper technique based algorithm give best solution in aspect of accuracy percentage of displayed solution and exploration.

Adjusting proper location of path Robot exploration and performance has been current critical challenge. Many different technique are proposed to adopt this discussed challenge in proper path robot. Some heuristic technique are effectively utilized in various problems and difficult optimization problems. The new algorithm for robot path ordering manner solid physical environment suggested[60]. The primer goal to perform a multi objective method through decreasing various measurement such as energy, cost,time and distance. The paper discussed effective operation through distance area, track regularity and controlling path robot are the core point alternative studied in the literature. The subscription of this suggested to calculate a fitting fitness function at each step iteration to get optimal result as yet. The obtained result performance comparison with other popular swarm intelligence algorithm. The suggested shows a best result of performance in case of path regularity and time than the other published algorithms.

2.2 Application of Grasshopper Optimization Algorithm

Different application of Grasshopper optimization algorithm have been developed from many in many fields such as like grasshopper optimization algorithm applied to search result solution

for benchmark function and real life world challenges. Additionally grasshopper optimization application discussed bellow.

2.2.1 Constrained and unconstrained test functions

The problem of contained and unconstrained function try to be solved by utilizing grasshopper optimization algorithm[35]. GOA algorithm can fit to solve the kind of problem of constrained and unconstrained test function. The proposed algorithm [62] can be performed adopting many various engineering application problems. Since the introduced grasshopper optimization algorithm original version was tested on on many different standard benchmark function, the studies validate and verify the efficiency of algorithm . The obtained result from introduced algorithm compared and examined with the actual result or best result of standard function.
Many different science, computer science, mathematical science and technical research include hard and soft optimization problems. Most of application optimization problem. Many optimization algorithm follow common basic search strategy used to obtain best optimal solution for a particular problem. This procedure are exploration and exploitation. In [63] on this paper proposed close optimal solution solution found that many optimization algorithm developed in recent researchers. The optimization algorithm selected for better optimal solution those are particle optimization algorithm, Bat algorithm and grasshopper optimization algorithm. The experimental result provide evidence the grasshopper optimization algorithm produce higher result compared to particle optimization algorithm and bat algorithm.

2.3 Machine Learning Application

2.3.1 Feature Selection

Support vector machine learning one of popular various powerful machine learning application algorithm used for wide search real world problems[40]. The importance support vector machine technique and building specially on the kernel structure as well as controlling parameters[64]. Additionally feature selection is basic subset of feature used for to teach support vector machine method and use for more factors that important to impact on its spread or classification precision. The choice of optimal sub-branch play a great role point in machine learning branch, specially when finding solution for multi dimensional data sets[65]. Many

recent studies focuses on those critical parameters separately[66].

A kind of hybrid [67] algorithm introduced using grasshopper to solve unsupervised learning feature selection problem. The purpose of proposed algorithm to determine the value parameter of support vector machine version and search better sub branch of features consequently. Above seventeen different benchmark datasets used with high and low dimension are used to judge the effectiveness of proposed algorithm. For far there evidence the proposed algorithm compared with well known in the domain optimization algorithm. Additionally the proposed algorithm tested with grid search, which is the basic in the method for controlling basic factors of support vector machine. The result of provide, proposed GOA algorithm obtain superior result compared to to other published domain algorithms. Specially in case of classification precision accuracy as well as minimizes during the number selection of features.

In Neurological is most known diagnosis for epilepsy, it is diagnosis using large electroencephalogram (EGG) used in healthy care environments, that may be fit mistakes, fallacy and computational time tasks. A novel technique of classification of epileptic seizure is introduced in [68]. For examining EEG signals, EGG signals drived into intrinsic method function using experimental method decomposition. A fusion chosen non-linear and spike characteristic from individual steps inherent technique function signal is contracted. To manage of variant basic machine learning method like K nearest neighbor , random forest, extreme learning pool, support vector machine and artificial neural network are optimized using with a group of basic feature removed by applying of GOA algorithm. The result confirmed that the combined(merged) classification methods got best performance compressionto each individual techniques of classification.

Feature selection is one the challenge in the main problem in domain of machine learning , which helps to search basic number of informative particle feature among space feature area that leads to increasing classification percentage. A new feature selection method proposed [69] based on the mathematical character coordination with Grasshopper optimization algorithm for finding source food. Many of the improvement where applied to Grasshopper optimization(GOA) algorithm to improve the execution performance algorithm more strong for answer-

ing selection problem in the features domains. The suggested technique is enhanced statistical test through out course of iteration to rapier the doubled feature more stimulating(informative) feature. The test experiment performed on twelve well known data sets and many recent modern feature selection published by other are analyzed and compered with enhanced algorithm. The result new proposed algorithm overcome and more accuracy compared to with other well known algorithms.

2.3.2 Data clustering

Data clustering is the mechanism one of machine learning technique that used for clustering related data or different data based the range distance estimation between data objects. Another way grouping same objects jointly or different objects divided into many classification as proper[70]. This method has been applied applied in many areas such as image segmentation, classifications, document retrieval, text categorization, decision making, machine learning, data mining and in big industry business as well as user traffic control and document management[71].

Splitting big data into different group of same structure is recognised as data clustering method to study a specified problem of data analysis and examining. This technique applied using computational technique and heuristic technique. The approach of heuristic technique often include of various object identified in nature as they identified to assist important part of active optimizer. The Grasshopper optimization algorithm utilized with this technique in [72] to create the accurate and effective data clustering. This paper discussed and full explanation with proposed algorithm, using grasshopper optimization algorithm for finding solution data challenges by utilizing investigation testing for a group benchmark data sets. In this study proved that the clustering mechanisms using with grasshopper optimization algorithm produced high accuracy precision percentage when compered with other method like k-means technique.

2.3.3 Neural network

Cancer is kind of deadliest disease in the world, it can be classified., however accurate classification required at the early stage. The early recognition of cancer disease is needed for a valid and accurate that provide the knowledge cancer case in the patient. That helps to make decision

making(risk controlling) by the doctors[73].

The Grasshopper optimization algorithm utilized for cancer classification[73] by using gene expression data. The proposed algorithm called namely DBN, based on deep knowledge neural network and Grasshopper optimization algorithm. This suggested technique more exact classifier by way of using application logarithm transmutation and method of Bhattacharya distance method. Logarithm transmutation is used to determine per-process step to survey genetic data. Additionally reduce the complexity connected with classification percent and Bhattacharya length chose the more informative genes. The weighted result is performed using Grasshopper optimization algorithm and Gradient decent method. The experimental result evidence provide that based on data from patient diagnosed leukemia and human colon. The proposed algorithm performed more better accuracy.

2.4 Engineering Applications

Grasshopper optimization algorithm has been used in many areas for finding solution for a number of different optimization issue. The areas of a problems that are raised in domain of engineering works such as image processing, scheduling challenges, controlling power system and others. The following section discussed the effectiveness of GOA algorithm for solving the engineering challenges.

2.4.1 Scheduling

One of a challenge in optimization problem related with energy system, economic dispatch that used for a discovery of optimal out perform distributed power , to fill the system loads, at the minimum level possible cost, managing alternative operation limitations[74]. Grasshopper Optimization algorithm implemented for optimal generation scheduling of thermal systems N. Rajput [75]. The research try to brings to the solution the economic dispatch (ED) problems connected electrical power systems. The GOA employed to verify the feasibility and validity at different label of economic dispatch by comparing small, medium and large scale power system. The performance GOA found the greater than other bio-inspired discussed techniques available literature's. To prove the effectiveness of Grasshopper optimization algorithm

it was used to address three types economic dispatch problems. The three categories are small, medium and large scale of energy system holding different complexity level. The test result prove that, the proposed grasshopper algorithm optimization is more promising labeling a different economic dispatch problems accurately.

2.4.2 Control power systems

A new method introduced for solving sequential highest arrangement systems and optimal classification production placement problem by reducing current power require [76]. The nature inspired stochastic optimization grasshopper motivated by the collection of grasshoppers, implemented to search best solution current solution to balance the discussed problem. The proposed method is tested on 33 and thirty 9 bus study cases. The obtained result compared and analyzed with other optimization algorithm. The comparison test shows the effectiveness of proposed method to find optimal solution

An integrated technique for economic emission is proposed in [77], a hybrid technique applied by using both traditional thermal and renewable energy source such us windmill are used with grasshopper optimization algorithm. The proposed system integrated with 6 thermic phases and pair wind domain is applied for test the dispatch from three different loads. GOA algorithm result are compared and analyzed with result of other recent published algorithm. The out performed result show the accuracy and efficiency of Grasshopper optimization algorithm matched in terms of reduced fitness function and convergence speed. The study of utilizing wind power cooperation and emission reduction more manifested by performance of GOA algorithm. A. M. Elsayed [78] Proposed for the optimal determination control constant and switched capacitor banks on arrangement system by GOA with power loss and rough set theory. P. M. Dash [79] Introduced Improved Grasshopper Optimization algorithm for power system Automatic generation control in the existence of unified power flow control. D. Tripathy [80] This article introduced GOA based fizzy PD-PI cascade controller for the Load frequency control of interconnected power system coordinator with renewable energy. H.A.Daya [81] the combined GOA and loss sensitivity factor used for solving problem of power distribution system in distributor generator and capacitor.

2.4.3 Micro grid power system

Grasshopper algorithm(GOA) applied to search best solution proportional integral controller parameters[82]. To check the and valid the efficiency of suggested architecture, its efficiency in controlling micro-grid voltage, wave length and energy property analyzed with modern artificial intelligence according power structure for similar purpose. The experimental test of introduced grasshopper optimization(GOA) algorithm is also valid by the test simulation with regard micro grid systems matched to various basic algorithm methods. The result evidence support provide that the grasshopper algorithm conducted solution compared to algorithm, which result is smallest energy and frequency overshoot.

A.A.El-Fergany [83] GOA applied for electrical characterization of proton exchange membrane fuel cells stack. In this study GOA used for estimating or minimizing the sum of square errors inequality constraint. The another method introduced load frequency power of multi area combined with micro grid power systems. Grasshopper(GOA) algorithm used for manage the controlling gains[84]. The proposed a new method load frequency of multi area interconnected micro grid power system using Grasshopper optimization algorithm. Grasshopper optimization algorithm used for tuning control gain and optimize Fuzzy PID controller. The comparison with other algorithms response the proposed optimized algorithm carried out more than PID controller. The system execution is tested and compared with and alone power backup techniques in micro grids. Method system function as well as examined with alternative parameters and distributed in random levels.

2.5 Image processing

Multi threshold is one kind of important technique of image segmentation in the field of image processing, which most attracted last recent in the ares among researchers. The entropy classification is implemented for good achievement and quality result. More over it is essential and provide sufficient outcome in case bi-level threshold. The growth new improvement the implementation complexity, also the number of threshold increases. To solve the above discussed problem, the grasshopper integrated algorithm employed in [85] for searching the optimal threshold values. An improved grasshopper optimization algorithm is deployed and provided effective multi level tsallis entropy and to decrease time complicity. The levy flight techniques

integrated to grasshopper optimization algorithm to make high quality on classical grasshopper optimization algorithm and to balance more exploration and exploitation search procedures of the grasshopper optimization algorithm. The experimental test was performed using with five popular other swarm optimization algorithm and including introduced grasshopper optimization algorithm to make image segmentation. For addition a evidence the proposed algorithm is compared and analyzed with threshold method based on the both class variance(Otsu) diagram and Renyi entropy categorization. The both class images are plant and real application images are used in the result analysis to test the efficiency of all deployed algorithm. The quality result shows that the proposed segmentation method performed fewer iteration and displayed higher segmentation precision vales.

2.6 Network Application

The communication in social networks have become an necessary component in today real world. There are challenges of security and confidentiality have a play great role to make communication through social network threatens. A new proposed architectural of decreasing anomyzation attack introduced by using the grasshopper (GOA) algorithm[86]. The measure anonymity more analyzed by grasshopper(GOA) algorithm which enable the relative node classify according to their identification speed. Generally the proposed grasshopper optimization algorithm power characterized according to finding solution charter division and security strategy improved that assist to protect the structural knowledge.

Variant of optimization algorithm techniques implemented to arrangement (distribution) system configuration such as particle swarm optimization, Gray wolf optimization, Artificial bee colony, Forging optimization and Genetic algorithm. The Grasshopper optimization algorithm is conducted in [47] to perform distribution network re-configuration to examining the fault less switch mixture for increasing energy waste reduction proceed into account to draw back of the organization la architecture. The proposed algorithm more take grant into feeder configuration inspired by character of grasshopper real existence and then applied to get optimal layout of network distribution arrangement. The introduced algorithm experimental analysis conducted using IEEE-33 bus radial conflagration system and perform the ideal configuration

problem with less time computation. The experimental simulation result shows harmonious result including less time computation and high efficiency of proposed algorithm compared to other popular optimization algorithm.

The increasing power cost generation and limited power restriction in fuel supplies play a great role to optimize distribution network. In this case , the wastage electrical energy decreased by optimal indicators, since enhancing charge outline in addition cost effective way. The paper [87] present the optimal network organization problem and a new technique proposed to direct optimal network layout problem of radial expansion using Grasshopper optimization algorithm. The enhanced technique utilized based two independent techniques. The first method small scale 26 bus organization and second method is large scale eighty five buss orders. The obtained result are tested and matched with other optimization GOA algorithm weather reducing the network misuse and improving whole profit during staying rise yearly load.

A network intrusion detection utilized based on support vector machine (SVM) with Grasshopper optimization algorithm Z. Ye [88] the nature inspired algorithms have been applied with support vector machine while they are vulnerable to fall to local into minimal with slow speed convergence, but the GOA-SVM improves more carried out than others traditional algorithms. A new network architecture of decision making for self driving vehicles settled on long short memory utilized using Grasshopper optimization algorithm Y. Shi [89] The proposed GOA-SLTM method long short term memory improved with support vector machine classifier optimized by the help of Grasshopper optimization algorithm. The experiment result improves accuracy result to compared to other decision technique methods self driving vehicles S.Moghania [90] proposed network intrusion detection using GOA and artificial neural network. GOA utilized for reducing intrusion detection errors.

2.7 Other Applications

A new technique proposed A. A. Amaireh [91] designing Linear Antenna Arrays for the problem of electromagnetic optimization. The algorithm introduced by using Grasshopper optimization algorithm and Anti-lion optimization algorithm. The algorithm utilized for mini-

Table 2: Summary of Grasshopper optimization algorithm applications

Application	**Year**	**References**
Load Management	2020	M. Talaat [45]
Network	2018	H. Hamour [47]
	2019	Z. Ye [88]
	2019	Y. Shi [89]
	2020	S.Moghania [90]
Electromagnetic	2017	A. A. Amaireh [91]
Micro grid Power system	2018	D. K. Lal [84]
	2018	A. Annamraju [92]
Voltage Regulator	2018	B. Hekimouglu [93]
Robot	2018	Z. Elmi [60]
Power System	2019	N. Rajput [75]
	2019	A. M. Elsayed [78]
	2020	P. M. Dash [79]
	2020	D. Tripathy [80]
	2019	H.A.Daya [81]
Energy System	2018	J. Liu [94]
Cloud Computing	2019	J. Vahidi [95]
Data Clustering	2019	S. Lukasi [72]
Medical	2019	B.U.Uma [96]

mizing side lobel level by optimizing current amplitude arrays. The comparison prove the optimization algorithm more perform optimal solutions. Grasshopper optimization algorithm applied with Partial Integral Derivative (PID) to determine Automatic Voltage Regulators systems B. Hekimouglu [93]. the technique GOA-PID is easy, simple and provide high quality optimal PID controllers parameters, and effectively search unkwon spaces. The method is effectively perform and robust to improve Automatic Voltage regulatory systems. Multi objective Grasshopper optimization algorithm used for Robot Path Planing static Z. Elmi [60]. heuristic algorithms have been applied effectively in multi dimensional and many complex problems. Here by using multi objective Grasshopper optimization algorithm it is possible to minimize different metric like cost, time, energy and distance space. The contribution of this multi objective algorithm to effectively calculate fitness function at each iteration and achieve optimal solution. The integration of both Grasshopper optimization algorithm and Weighted sum used for coordinated operation of multi -integrated energy system based on linear J. Liu [94]. The integrated strategy utilized to solve energy management problem, which improve wide energy efficiency and enhance regional coordination optimization. J. Vahidi [95] Proposed the optimization resource allocation n in cloud computing using GOA. Cloud computing resource vary large for this purpose the GOA applied based on pay-per-use model in order to optimize the problem of large user request allocation. S.Lukasi [72] Used Grasshopper optimization algorithm for data clustering. A. Annamraju [92] GOA used for frequency control in autonomous two area with hybrid micro-grid based robust PID controller. In this application GOA used us the searches parameters of PID controllers. The searching way is reduce the frequency deviation H. Abdel-Mawgoud [97] In this paper Chaotic GOA used for optimize location and size of distribution generation in radial distribution system.

B.U.Uma[96] GOA implemented with Artificial neural network for Epilepsy disease that affect human brain from disorder of central nervous system. GOA is used to classify the patient between healthy and seizure.

2.8 Problem Definition

The main limitation in Grasshopper optimization that most common in many optimization algorithms the theory of no free lunch theorem, this means no suitable optimization algorithm

exist to solve varieties optimization problems. The another drawback of Grasshopper optimization algorithms is low capability to manage complexity of multi-modal search procedure and the parameter (c) adjustment also tends to approach optimal solution. The another limitation of suffer from slow convergences. Getting to trapped to the local optimum. The new proposed method where enhanced to increase the outcome exploitation and exploration.

3 A New Approach for Modification of Grasshopper Optimization Algorithm for Machine Learning

3.1 Abstract

Abstract. This paper presents one novel approach for providing a modified version of the well known Grasshopper optimization algorithm. Since the Grasshopper optimization is highly demanded in the field of optimization, this idea tries to maximize the searching abilities of this algorithm. The new technique utilizes the binary crossover along with polynomial mutation for enhancement of quality of outcomes. These two concepts when added with the normal algorithm grasshopper optimization try to the increase in exploration as well as exploitation of available solution space. The simulation is done using standard unimodal in addition to multimodal functions for proving the superiority of the results. From the quality of results obtained after simulation, it can be clearly concluded that the newly planned modified grasshopper optimization algorithm is found fruitful in variety of real world engineering applications . Keywords: Grasshopper Optimization Algorithm, Modified Grasshopper Optimization Algorithm, Standard Benchmark function, Polynomial Mutation.

3.2 Introductions

Generally optimization is the procedure of finding the finest values for variables to minimize or maximize the objective function for the problem under investigation. In most of the cases of engineering, a variety of constraints are associated with the objective function. These technical constraints are needed to be handled efficiently while addressing the particular optimizing problem. In the present world, a large variety of nature inspired computing algorithms are available for the solution of such complex optimization problems while fulfilling the desired constraints. But while meeting the required standard, few things are playing very important role in the computing world. The times of getting an efficient solution along with the computational complexity are playing vital roles when the algorithm is to be implemented for optimization as well as machine learning application. A trade off is to be decided between the complexity as well as time when the requirement is for the fast as well as simple implementation. So several simple as well as efficient modifications is generally done with the nature inspired algorithms to meet

the demand of real world of computation[98]. The grasshopper optimization algorithm is an effective computational technique that uses behavior of grasshopper swarm for solving various unimodal as well as mul- timodal optimization problems while handling different constraints. Similarly, the technique of crossover in genetic algorithm is generally proved to be highly efficient for increasing the diversity in solution space for acquiring better solutions. This concept of crossover and mutation are used along with the grasshopper optimization algo- rithm to make a provision of diversity enhancement for better exploration as well as exploitation. These features are since simple to implement so that computational complexity will not increase too much while achieving a superior solution. Since a variety of crossover techniques are present in genetic algorithm, only one simple but highly efficient crossover techniques are taken into consideration. The concept of polynomial mutation is utilized for increment of searching diversity. This paper pre- sents one newly modified grasshopper optimization techniques for different machine learning applications. The projected technique is simulated along with the original algorithm for verifying the usefulness utilizing some standard benchmarking functions having unimodal as well as multimodal features. Therefore, the next sections will discuss the details of technical background of the grasshopper optimization algo- rithm along with the newly planned modification version. The result analysis as well as the conclusion section will follow the previous section.

3.3 Grasshopper Optimization Algorithm(GOA)

Grasshopper are insects, can damage a large scale of farm productions and agricultural. They consider as sometimes nightmare farmers. GOA is a swarm depended nature stimulated algorithm proposed by Saremi S. et.al in 2017[1]. GOA mimics the communication behaviors of swarm individuals among grasshoppers. This algorithm models the living as well as movement pattern of grasshopper for providing solutions to different optimization problems. In this algorithm, the larval phase is providing slow movement with smaller incremental steps. Whereas the adult phase is responsible for long range with abrupt movement. It is a vital requirement to cover longer distance abruptly in the process of exploration as well as to move locally during exploitation in an efficient optimization algorithm. Similarly, nature motivated algorithms logically diverge the search process into two trends: exploration and exploitation. In the exploration

phase, grasshoppers tend to move quickly, while in the exploitation phase, they are encouraged to move locally. Both of these functions, as well as finding food sources, are naturally realized by grasshoppers. The grasshopper algorithm is found quite suitable for an efficient searching of solution space according to its nature of movement in different phases. GOA is tries to model mathematically to base of according the life movement nature inspired grasshopper. There are three things influence the movement grasshoppers: social interaction denoted Si, gravity force denoted by Gi and wind advections denoted by Ai. The equations as follows [1].

$$X_i = S_i + G_i + A_i \tag{1}$$

Where Xi represents the position of ith grasshoppers. The social interactions Si is presented

$$S_i = \sum_{j=1, j\neq i}^{N} s(|x_j - x_i|)\frac{x_j - x_i}{d_{ij}} \tag{2}$$

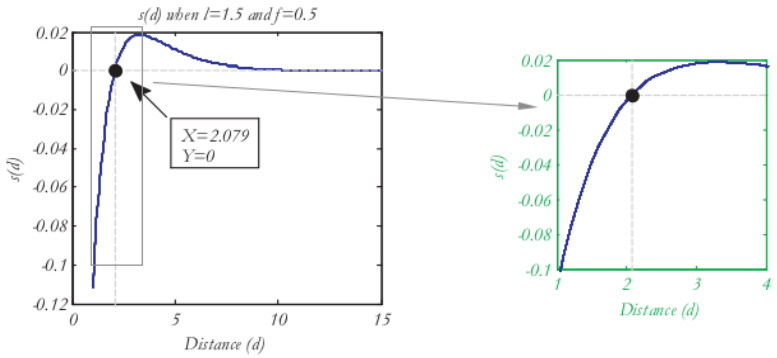

Figure 2: Function s when l = 1.5 and f = 0.5 (left) and range function s when x is [0,4] (right) [1]

The s is a functions social force calculated as follows

$$S(r) = fe\frac{-r}{l} - e^{-r} \tag{3}$$

Where the $d_ij = |x_j - x_i|$ is the Euclidian distance between i_th and j_th grasshopper, l and f are 1.5 and 0.5 respectively represents the parameters to adjust the social forces. The s function illustrated on the figure 1 is to show how it influence of social attraction and repulsion of grasshoppers. According seen from figure 1 distance 0 to 15 are considered. Repulsion occurs between interval of [0, 2.079] unit far form another grasshopper. At the point of 2.079 neither

attraction nor repulsion it mean the current grasshopper away from one another found on comfort zone. The distance d attraction grows from 2.079 to almost 4 and then slowly decrease. The change of parameters of l and f in equation 3 result different in social behavior in the artificial grasshoppers. To see the impact of of two parameters l and f, the s function re-figured

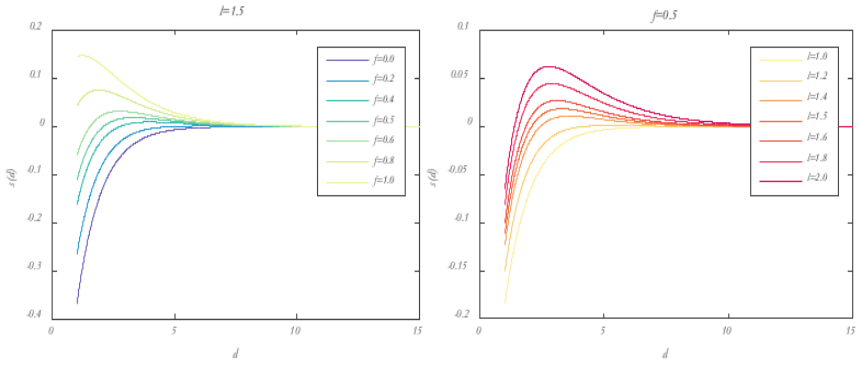

Figure 3: Behavior of function s for different values of l and f [1]

according figure 2. From figure it can be confirmed the change l and f individual can improve the comfort zone, attraction region and repulsion region. For instance at the values l=1.0 or f=1.0 attraction and repulsion very small. So from all values l=1.5 or f=0.5 selected. The

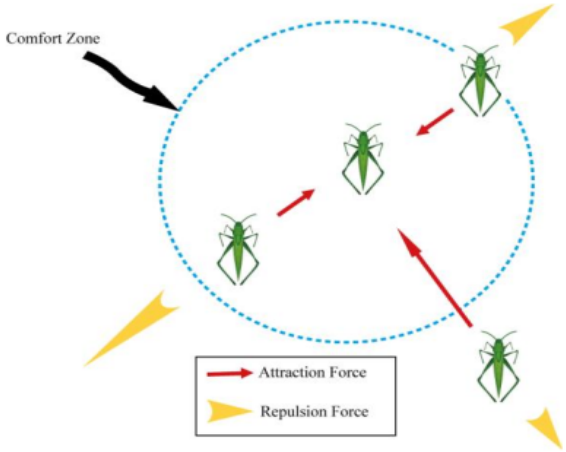

Figure 4: Social interactions between grasshoppers and the comfort zone

conceptual model graph representation of grasshoppers shown figure 4, here it can be noticed comfort zone, attraction force and repulsion force and how s function social communication

and force of some initial grasshopper grouping pattern. The gravity force given by equation 4.

$$G_i = ge_g \tag{4}$$

Where g is a constant and eg is a vector. Wind advection Ai can be given by equation **??**. since Nymph grasshopper have no wings their movement related to the wind directions.

$$A_i = Ue_w \tag{5}$$

Where u refers a constant and ew denote a vector. Substituting equation 2, 3, 4 and 5 to equation 1 the mathematical model extended as follows

$$S_i = \sum_{j=1, j\neq i}^{N} s(|x_j - x_i|)\frac{x_j - x_i}{d_{ij}} - ge_g + Ue_w \tag{6}$$

However nymph grasshopper moving on the land, their position will not go to maximum needed point and the mathematical model does not used directly because it prevent the algorithm from exploring and exploiting around the search spaces solution. The mathematical model modified us equation 7 flows [1].

$$X_i^d = c\left(\sum_{j=1, j\neq i}^{N} c\frac{ub_d - lb_d}{2} s(|x_j^d - x_i^d|)\frac{x_j - x_i}{d_{ij}}\right) + T_d \tag{7}$$

Where ub_d and lb_d denotes the upper and lower bound of d^th dimensions. T_d represent the a best position obtained so far, c is the most important decreasing coefficient to shrink comfort zone, attraction zone and repulsion zone, Here s almost same to equation 3 but we do not use the gravitational (G- component) and wind direction (A component). The next position grasshopper based defined according equation 7 current position, target position and all position grasshoppers. Here remarkable point is the first part of equation consider current position respect to to other grasshopper. Genuinely the status of each grasshopper is consider to determine around search agent and the target agent. As we conclude GOA updates or make change position of current agent on its location, global best and location of other search agents. Here based equation 8 there are two adaptive parameter c.

- The first outer parameter c is looks related the inertia weight (w) of that antiquated in the Particle Swarm Optimization (PSO). The main use of c is to decrease the motion grasshopper to nearest the best solution, as well as used to balance the local and global search process around best solution.

- The second d inner c parameter used reduce contraction zone, repulsion zone and comfort zone amon the grasshoppers. Here the component of $c\frac{ub_d - lb_d}{2}s(|x_j - x_i|)$ in the equation 7, $c\frac{ub_d - lb_d}{2}$ used to linearly reduce the space should investigate utilizing the exploration and exploitation methods. The component indicates weather grasshopper should be dismissed from explore or attracted to (exploit) the target.

Note that the inner c reduce attraction or repulsion among grasshopper to relative to one another . While the outer c make converges around target solution as number of iteration increase. Generally the first part equation 7 is analysis the position current position to remaining grasshoppers and simulate the communication. The second part T_d simulate the ability to move to ward to the source food. As well as c parameter improve the ability to slow movement to ward to source food and finally use it. To make random pattern both part equation 7 multiplied by random number values. The individual multiplication random number helps assist random behavior relation or ability to for ward to source food. The interest of to achieve the fairness exploration and exploitation in search strategies the factors decreased proportional as number of iteration increase. This method assist exploitation as iteration increases. The coefficient c decreased the comfort zone proportional to as number of iteration increased and calculated as follows.

$$c = cMax - l\frac{cMax - ccMin}{L} \tag{8}$$

Where Cmax denotes the maximum value 1, Cmin denote the minimum value 0.0001, t is the current number iteration and L is the maximum number of iterations.

The mathematical model of GOA has capability exploration and exploitation search area. Although the method can change search procedure local and global vice verse is required. In real life grasshoppers initially move and find food near locally because larva has no wings. Then gradually progress easily in the space and search food in broad areas. In case stochastic optimization algorithm, global search come first in order to search for target region in search space. After that searching for promising region, exploitation must search agent locally to find the target approximation for global optimum .

- Initialization of the swarm, Xi(i=1,2,... n)
- Initialization of ccmax, ccmin and maximum number of iteration
- Calculation of the fitness search agents of X i

- Selection of best search agent
- While (l¡Max number of iteration)
  - Update cc utilizing related equation 8
  - for each search agent
    - Normalization of the distance between grasshoppers accourding equation 7
    - Update the location of the present search agent by the equation
    - Carry the current search agent back if it goes outside boundaries
  - end of for
  - Update the best search agent if there is a better solution
  - l=l+1
- end while
- Return the best search agent

The pseudo code shown above is GOA algorithms. GOA starts by initializing a set of random values solutions. The search agents update their position according to equation 7. The best target position obtained so far updated in each iteration as well as the parameter c is calculated using equation 8 and the distance interval between grasshopper adjusted in each iteration. The performance iteration continues until the target solution obtained and get end criteria. Finally the best position and fitness of target will be returned as best prediction for global optimal solution.

3.4 Modified Grasshopper Optimization Algorithm(MGOA)

The Modified GOA technique utilizes the binary crossover techniques for as an attempt for the increasing the exploration of the searching space. This crossover provides a swapping of the bits on random cross sites to create a wider diversity in the searching pattern. The binary crossover is followed by the utilization of polynomial mutation for increasing the exploitation along with creating diversity in the exploration of solution space. The polynomial mutation is one of efficient mutation technique used in the world of evolutionary computing algorithms

was suggested by Deb and Agrawal[99]. The user defined index parameter utilized for this recommended mutation is referred as m . The value of m adequately utilized by the majority of problems belongs to different category of applications is in the range [20, 100]. This case usually uses a polynomial probability distribution to agitate the solution in the vicinity of parents. Generally the distribution of probability in both the left as well as on the right hand side of a variable is subjected to adjustment so that no value should be available outside the specific range [a, b]. The range or bounds are usually created by the mutation operator. For every specified solution of parent, the solution after mutation that is O for a particular variable is produced for an arbitrary number r created inside [0, 1] can be specified as follows equation 9[100]:

$$\begin{aligned} \delta_L &= (2r)^{\frac{1}{1+\mu_m}} - 1 \qquad if r \leq 0.5 \\ \delta_R &= 1 - (2(1-r)^{\frac{1}{1+\mu_m}} \qquad if r \geq 0.5 \end{aligned} \tag{9}$$

where m is recognized as distribution index. The offspring solution O' is given by equation 10

$$O = \begin{cases} O + \delta_L(O - X_i^l) & if r \leq 0.5 \\ O + \delta_R(X_i^U - O) & if r \geq 0.5 \end{cases} \tag{10}$$

The method for calculation of the value is usually utilized for discovering the new values in the estimated variables. The probability distribution function utilized in this case is is polynomial and its outline is regulated by μ_m . Large values of μ_m provide elevated probabilities of generating young off springs inside the neighborhood of the parent. The small values permit distant solution to be generated. The distribution index μ_m produces a perturbation of the order $O(\frac{1}{\mu_m})$ in the normalized decision variable. This basically is responsible for large jumps in the solution searching space decision variable. This technique is very disruptive, but gives enhanced likelihood of escaping from local optima in addition to modifying a solution on the boundary itself. The pseudo code for the projected algorithm using Simulated Binary Crossover (SBC) and Polynomial mutation

1. Initialization of the swarm, Xi(i=1,2,...n)
2. Initialization of ccmax, ccmin and maximum number of iteration
3. Calculating X i using the SBC and Polynomial mutation Equations.
4. Calculation of the fitness search agents of X i

5. Selection of best search agent

6. While (l¡Max number of iteration)

7. Update cc utilizing related equation

8. for each search agent

9. Normalization of the distance between grasshoppers

10. Update the location of the present search agent by the equation

11. Carry the current search agent back if it goes outside boundaries

12. end of for

13. Update the best search agent if there is a good solution

14. l=l+1

15. end while

16. Return the best search agent

3.5 Result Analysis

The projected technique usefulness can be tested by the utilization of various model benchmarking functions [101] which are the representation of different category of optimization problems. The simulating experiment utilized the multimodal as well uni- modal functions for the effective testing of the proposed novel technique. The simulation process includes MGOA along with GOA. The results of the simulating experiment are presented by means of tables and figures. Minimization of the output of benchmarking functions by simulation is the important criteria. Both the Modified grasshopper optimization algorithm (MGOA) and grasshopper optimization algorithm (GOA) has been run 25 trials to obtain the simulated values listed in various tables . The tables presented in this section includes the finest value, worst value as well as and the mean value. Sample simulation profiles of all the utilized standard benchmarking functions are also presented in different figures to exhibit the improvement in the projected research. The standard parameters utilized in the simulation are such as dimension 30, Number of iterations is 500, Mutation probability is 0.8 as well as crossover probability is 0.2. The value of ccmax as well as ccmin can be taken as 1 and 0.00001 respectively.

Table of list of benchmark functions

Benchmark functions (Unimodal)		
Function	Dimension	Range
$f_A(x) = \sum_{i-1}^{n} \lvert x_i \rvert + \prod_{i-1}^{n} \lvert x_i \rvert$	30	[-10,10]
$f_B(x) = \sum_{i-1}^{n} i x_i^4 + \text{random } [0,1)$	30	[-1.28,1.28]
Multimodal functions (Multimodal)		
Function	Dimension	Range
$F_C(x) = -20\exp\left(-0.2\sqrt{\frac{1}{\pi}\sum_{i-1}^{n} x_i^2}\right) - \exp\left(\frac{1}{\pi}\sum_{i-1}^{n} \cos(2\pi x_i)\right) + 20 + e$	30	[-32,32]
$F_D(x) = 0.1\{\sin^2(3\pi x_1) + \sum_{i-1}^{n} (x_i - 1)^2[1 + \sin^2(3\pi x_i + 1)] + (x_n - 1)^2[1 + \sin^2(2\pi x_n)]\} + \sum_{i-1}^{n} u(x_i, 5, 100, 4)$	30	[-50,50]

Functions	Best	Worst	Mean
Funct_A	1.6108	1.6214	1.6112
Funct_B	0.01262	0.01354	0.01268
Funct_C	1.6456	1.6539	1.6462
Funct_D	0.010982	0.011036	0.010988

Table 3: Grasshopper Optimization Algorithm (GOA)

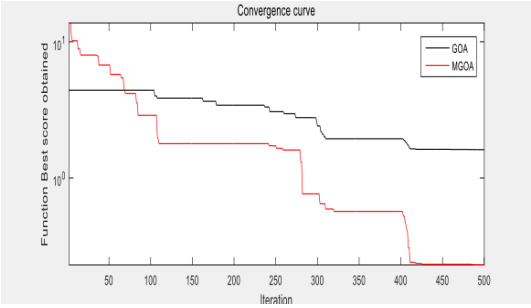

Figure 5: Profile for Function A

The simulating experiment results produced by combined simulation of the new modified GOA with the traditional GOA are listed in table 3 as well as table 4. In the simulation procedure two standard unimodal functions are taken along with two standard multimodal functions. The tables contain the best values of the different functions produced in the experiment. The most undesirable value is also listed in the table to provide an idea about the range as well as precision of the outcome of the involved algorithms. The mean value of all the 25 repeated

Functions	Best	Worst	Mean
Funct_A	0.22982	0.22998	0.22986
Funct_B	0.00025951	0.00025984	0.00025958
Funct_C	2.08E-05	2.26E-05	2.09E-05
Funct_D	8.78E-08	8.99E-08	8.88E-08

Table 4: Modified Grasshopper Optimization Algorithm (MGOA)

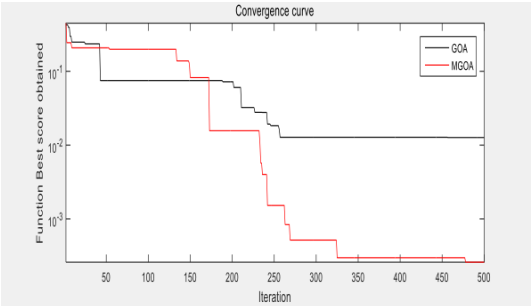

Figure 6: Profile for Function B

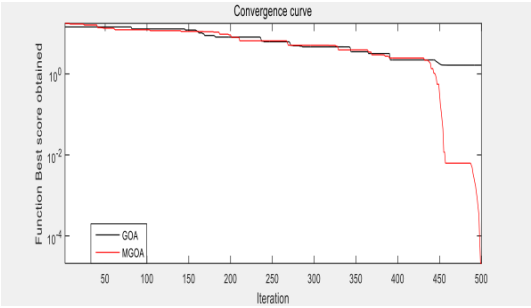

Figure 7: Profile for Function C

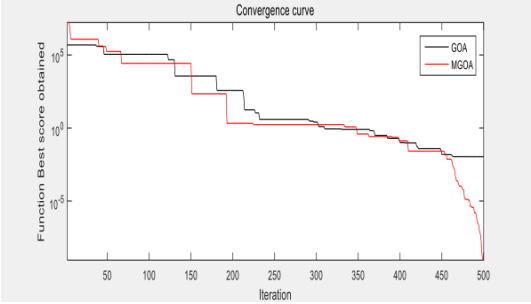

Figure 8: Profile for Function D

experiments are also listed to exhibit the utility of the proposed approach while repeating the technique again and again. According to the simulating results listed in tables, it can be easily stated that the Modified GOA is exhibiting a superior performance while comparing with the standard GOA technique. For the function A, the mean value of MGOA is 0.22986 while that for GOA is 1.6112. Similarly, for function B the mean values obtained by MGOA and GOA are 0.00025958 and 0.01268 respectively. The comparison of mean values for both the unimodal function clearly shows the enhancement of outcome produced by MGOA comparing to GOA. Similar conclusions can be drawn when best as well as the worst values are compared in both the tables. The most excellent along with the worst values obtained by MGOA are superior when compared to the GOA. In the same way, when both the algorithms i.e., MGOA as well as GOA are simulated involving the two multimodal functions, The best and the worst values obtained by MGOA are much better than GOA. For the function C and D, the average outcomes of the MGOA algorithm are 2.09E-05 and 8.88E-08 respectively. But for the same two functions, the GOA algorithms provides mean outcome which are 1.6462 and 0.010988 correspondingly. The finer average outcomes of MGOA are clearly dominating the standard GOA in all the domains. Along with the accuracy, precision of getting outcome is playing a vital role when the planned technique is going to be utilized in real world applications. Therefore, the ranges of outcomes i.e., the best as well as worst values are playing a vital role for the selection of a new strategy for any applications. In the simulating experiment, it is observed that the outcomes produced by the newly modified GOA are very close to each other. But the same is less found in case of the standard GOA algorithm. This phenomenon exhibits the finer precision of outcome obtained by MGOA in comparison to GOA. This precision is one of the most demandable requirements of any optimization algorithm for computational intelligence and machine learning applications. The new MGOA technique is providing higher precision of values for both the category of unimodal as well as multimodal functions. This precision of repeated measurements is a very important advantage of the newly modified algorithm. The result analysis section presents four figures describing the effectiveness in addition to the faster convergence of the newly modified version of the algorithm. In figure 5, the MGOA is exhibiting a faster convergence in comparison to GOA. This is clearly demonstrated by the fact that at around 450 iterations the gap between the convergence profiles of MGOA as well as GOA is quite high. Similarly in figure 6, the level attained by both the MGOA as well as GOA methods

are clearly distinguished at around 350 iterations. But when the simulation is done for the multimodal category of functions, the convergence profiles are demonstrating a different feature. In the preliminary iterations up to 400, the profiles of both the algorithms are almost competing each other. But, after the iteration more than 400, the MGOA is exhibiting a faster convergence in comparison to the existing GOA technique. So, in all these plots the newly projected MGOA is exhibiting a superior reduced cost while comparing to the standard GOA method. Moreover, the convergence profiles of new MGOA are excellent in comparison to the existing GOA for these four types of functions in two different categories. Also, the MGOA is providing a better-quality cost with reduced number of iterations. This attribute of accomplishment of reduced cost value at the lesser number of iterations in the recently projected customized version of algorithm in this paper saves a lot of time of computation for discovery for the solutions of composite engineering problems.

3.6 Summary

This paper presents one novel modified type of the well known grasshopper optimization algorithm which is recognized as Modified grasshopper optimization algorithm. The efficiency of the projected approach is tested for both unimodal as well as multimodal type of problems. The testing in the domain of simulation proved the superiority along with the usefulness of the planned algorithm in comparison to the referred GOA. The convergence to finer outcome is obtained easily with a very minor increase in the computational complexity. The increase in time of execution is very less and can be easily tolerated as the quality of result produced is better. Another important feature obtained in this newly planned algorithm is that better results along with faster convergence to the optimal value is achieved with fewer amount of iterations. The newly modified version of the algorithm is exhibiting superior results both for unimodal and multimodal functions. The planned version is increasing the effectiveness of local search as well as global search. So, the newly modified algorithm MGOA is capable of giving better outcomes in the cost functions similar to the four standard benchmark functions utilized in the simulation. Therefore, the suggested version of the algorithm is well suited for handling complex engineering, scientific as a variety of real world applications.

4 New Improved Grasshopper Optimization Algorithm using Crazy Factor

4.1 Abstract

Abstract: This paper present the new Improved Grasshopper optimization algorithm (IGOA) using crazy factor. The crazy factor technique helps to make a sudden direction change and enhance diversity in the search space. This method helps to achieve the algorithm easily obtain global solution. The experimental result analysis performed using unimodal and multimodal standard benchmark test functions. For extra verification validation the new improved algorithm compared with other popular intelligence algorithms. The test result projected by IGOA Superior than other intelligence algorithms and including itself classical than GOA. Keywords: Grasshopper optimization algorithms, Improved Grasshopper optimization algorithms, Crazy factor

4.2 Introduction

Optimization algorithm approach is process finding best solution from complex and large problems. The field optimization studies with understanding and simulating the collective behaviors of organisms without a centralized control unit in nature. It is assumed that a population is made of simple agents that interact with each other a given environment. Such agents start to interact locally and often incorporate random mechanisms to achieve a goal globally. Optimization can be defined also in three technical things [102], first one the measure success of cost function which will be maximized or minimized, second the number tuple problems which are possible inputs to the problems represent referred as design variable, this instance can be subjected to constraints and bound to the possible values to explore. The third and last the set of solution which define the space to search in order to obtain best optimal solution. It is basically applied to obtain the optimal solution from many possible solution or decision values to perform a candidate solution for sake of solve the fundamental problem completely.

Optimization algorithms are from nature inspired algorithm that are set of new problems searching methodologies find solutions by the approach derived from natural process. This algorithm highly efficient for finding optimal solution to multi-dimensional and multi modal problems.

Grasshopper optimization algorithm is one type nature of based algorithm by natural process swarms proposed by Saremi S. et.al in 2017 [1]. The algorithms makes progress through accordance information of number of available solutions. However they have a common which two important techniques phase during the search process. These are Exploration and Exploitation [62]. Exploration is the capability to consider various areas in order to gate the promise regions, this enables hopefully to gate the global optimum solution. Exploitation is the capacity to concentrate search in specified location or position optimum preciously. Although there are many optimization algorithm developed in last two decades ABC[15], PSO[103], ACO[16], FA[18], but they have quite difference between optimization algorithm. Those types of search swarm algorithms, execute with a population system at each generation. The rest of this paper is organized as follows, Section 2 presents the Improved Grasshopper optimization algorithm (IGOA). Section 3 present the analysis result of test functions and compare the algorithm with different swarm intelligence algorithms. Section 4 present conclusion as follows.

4.3 Basic GOA

Grasshopper are insects, can damage a large scale of farm productions and agricultural. They consider as sometimes nightmare farmers. GOA mimics the communication behaviors of swarm individuals among grasshoppers. There are two categories grasshopper types in adult and larval based on the movement they make. The adult phase make movement abrupt in long range while larval move slowly in small steps. GOA is tries to model mathematically to base of according the life movement nature inspired grasshopper. There are three things influence the movement grasshoppers: social interaction denoted Si, gravity force denoted by Gi and wind advections denoted by Ai. The equations as follows [1].

$$X_i = S_i + G_i + A_i \tag{11}$$

Where X_i represents the position of i^th grasshoppers. The social interactions S_i is presented

$$S_i = \sum_{j=1, j\neq i}^{N} s(|x_j - x_i|)\frac{x_j - x_i}{d_{ij}} \tag{12}$$

The s is a functions social force calculated as follows

$$S(r) = fe_e \tag{13}$$

Where the $d_ij = |x_j - x_i|$ is the Euclidean distance between i_th and j_th grasshopper, l and f are 1.5 and 0.5 respectively represents the parameters to adjust the social forces. The gravity force given by

$$G_i = ge_g \tag{14}$$

Where g is a constant and e_g is a vector. Wind advection A_i can be given by

$$A_i = Ue_w \tag{15}$$

Where u refers a constant and e w denote a vector. Substituting equation 12, 13, 14 and 15 to equation 16 the mathematical model extended as follows

$$S_i = \sum_{j=1, j\neq i}^{N} s(|x_j - x_i|)\frac{x_j - x_i}{d_{ij}} - ge_g + Ue_w \tag{16}$$

However the mathematical model does not used directly because it prevent the algorithm from exploring and exploiting around the search spaces solution. The mathematical model modifies us flows equation 17 [1].

$$X_i^d = c\left(\sum_{j=1, j\neq i}^{N} c\frac{ub_d - lb_d}{2} s(|x_j^d - x_i^d|)\frac{x_j - x_i}{d_{ij}}\right) + T_d \tag{17}$$

Where ub_d and lb_d denotes the upper and lower bound of d_th dimensions. T_d represent the a best position obtained so far, c is the most important decreasing coefficient to shrink comfort zone and calculated as follows.

$$c = cMax - l\frac{cMax - ccMin}{L} \tag{18}$$

Where c_{Max} denotes the highest value 1, c_{Min} denote the lowest value 0.0001, t is the current number iteration and L is the maximum number of iterations.

4.4 Proposed Improved Grasshopper Optimization Algorithm

The concept of using different modification and hybridized techniques in the optimization algorithm is most valuable in intelligence algorithm and machine learning application.The proposed modified Grasshopper optimization algorithm modified by utilizing from abstraction of craziness. The improvement of Grasshopper optimization algorithm would enhance the performance result and execution time. The modification process was be by including some methods

by crazy factor functions and values. The proposed technique is executes by making effective change on both exploration and exploitation. Then this procedures are produce a better result and less execution time more than the classical algorithm. The modified algorithms start performing execution by common initialization agents and same parameters then next using this common values performing different techniques. The main objective implementing using different methods for comparison and proof of which method solve or provide better solution for specific problems.

4.5 Crazy Factor

GOA modified using crazy factor. Crazy factor is a method implemented in Bird flocking or fish schooling [104]. It used to make a sudden change the directions as well as to enhance the diversity movement in GOA, that's why the craziness factor operation added to GOA algorithms. The newly proposed method integrated to GOA by adding crazy factor according modification expression equation 19 as follows.

$$X_i^d = c\left(\sum_{j=1 j\neq i}^{N} c\frac{ub_d - lb_d}{2} s(|x_j^d - x_i^d|)\frac{x_j - x_i}{d_{ij}}\right) sign(r) + T_d(1-r) \tag{19}$$

Where r is random number uniformly taken from between 0 and 1. Sign(r) is defined as

$$sign(r) = \begin{cases} -1, & if r \leq 0.05 \\ 1, & if r \quad > 0.05 \end{cases} \tag{20}$$

The purpose of $sign(r)$ on equation 19 is used to introduce the change direction of grasshopper position suddenly. The integration of adding the craziness factor to GOA algorithm produce better result as well as bring good search ability and reduce time execution. The improved techniques mostly used many research papers and it improve also performance of intelligence optimization algorithms. The Improved Grasshopper optimization algorithm (IGOA) procedure of Crazy factor of Grasshopper optimization and flow chart schema described as follows.

1. Initialization positions
2. Finding target fitness and respective position
3. For condition termination not end
4. Update the location and normalize the distance

5. Update each position using crazy factor

6. Terminate condition

7. End

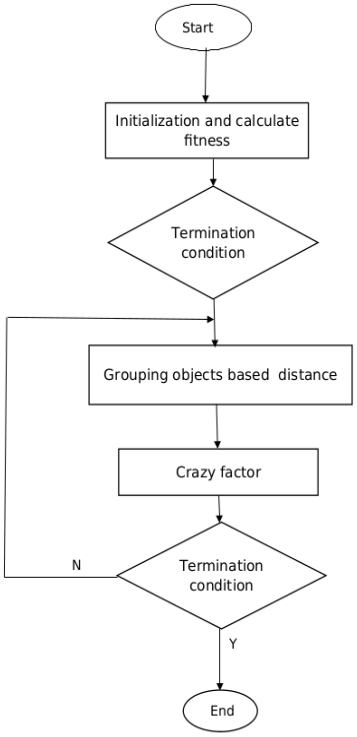

Figure 9: The schema diagram of proposed IGOA

4.6 Experimental Result Analysis

The experimental analysis five standard benchmark functions used in this paper to evaluate the performance of IGOA. Different algorithm implemented to proof the superiority if new proposed algorithm like ABC, PSO, FA and classical GOA as well as the simulation process includes those algorithms. The set parameters used to perform test are 100 iteration, 100 agents and 30 dimensions and the same parameters used for the other algorithm. The test experiment utilized unimodal function given as f_a, f_b, f_c and f_d as well as multimodal function are f_e and f_f. All the standard test functions run independently for 30 times. The version 2018a Matlab used for experimental analysis. The result numerical experiment presented by means of table and figures. The table presented includes the finest value, worst value and mean value. Sample

simulation convergence graph also presented in different figures to exhibit the improvement in the search process. Convergences accuracy and search ability of IGOA are better than the other intelligence algorithms for all used test functions in table. The search success of IGOA is apparently higher than other intelligence algorithms for both unimodal and multimodal test functions.

Function	Dimension	Range
$F_a(x) = \sum_{i-1}^{n} x_i^2$	30	[-100,100]
$F_b(x) = \sum_{i-1}^{n} \lvert x_i \rvert + \prod_{i-1}^{n} \lvert x_i \rvert$	30	[-10,10]
$F_c(x) = \sum_{i-1}^{i} \left(\sum_{j-1}^{i} x_j\right)^2$	30	[-100,100]
$F_d(x) = \max_i \{\lvert x_i \rvert, 1 \le i \le n\}$	30	[-100,100]
$F_e(x) = -20\exp\left(-0.2\sqrt{\frac{1}{n}\sum_{i-1}^{n} x_i^2}\right) - \exp\left(\frac{1}{n}\sum_{i-1}^{n} \cos(2\pi x_i)\right) + 20 + e$	30	[-5.12,5.12]
$F_f(x) = \frac{1}{4000}\sum_{i-1}^{n} x_i^2 - \prod_{i-1}^{n} \cos\left(\frac{x_1}{\sqrt{1}}\right) + 1$	30	[-32,-32]

It can be seen clearly from the last column of table 5 the result values performed by IGOA very less cost than for all used test functions respective to compared intelligence algorithms. This means new proposed cost effective to handle real problems and handle machine learning applications. The list of figures 10 to 15 plotted convergence graph IGOA exhibit superior reduced cost while comparing to ABC, PSO, FA and classical itself GOA. So it can be concluded that the new technique IGOA has better convergence accuracy, strong search ability and precision of repeated measurements that is a very important advantage of the newly improved algorithm.

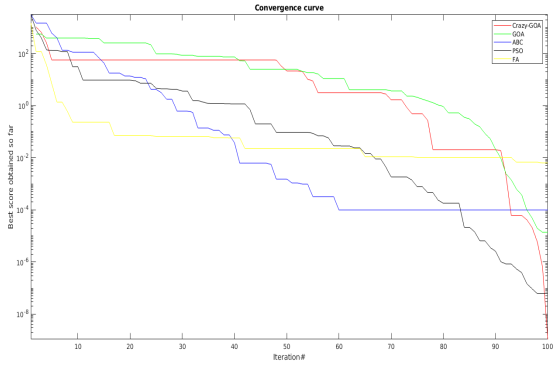

Figure 10: Function profile f_a

Functions	**result**	**ABC**	**PSO**	**FA**	**GOA**	**IGOA**
F_a	Best	0.00078175	3.3134E-09	0.0017947	0.00029378	3.2156E-11
	worst	0.0010168	6.9219E-09	0.0059972	0.0053852	9.2093E-11
	mean	0.000899275	5.11765E-09	0.00389595	0.00283949	6.21245E-11
F_b	Best	0.00083382	3.9911E-06	0.0054195	0.28134	2.738E-07
	worst	0.0021558	0.000011212	0.012184	6.7105	1.7966E-06
	mean	0.00149481	7.60155E-06	0.00880175	3.49592	1.0352E-06
F_c	Best	0.81962	0.000004211	0.0020475	0.00052277	1.7281E-10
	worst	4.8261	8.9175E-06	0.0057797	0.021993	8.9665E-10
	mean	2.82286	6.56425E-06	0.0039136	0.011257885	5.3473E-10
F_d	Best	0.29344	0.00042497	0.039322	0.0058842	1.7112E-06
	worst	0.38198	0.001888	0.047233	0.024287	0.000042273
	mean	0.33771	0.001156485	0.0432775	0.0150856	2.19921E-05
F_e	Best	0.029659	0.000073995	0.025932	1.6473	2.8887E-06
	worst	0.058692	0.00067228	0.056412	1.7905	0.000025817
	mean	0.0441755	0.000373138	0.041172	1.7189	1.43529E-05
F_f	Best	0.19654	0.051765	0.074749	0.27069	6.5036E-10
	worst	0.24303	0.22294	0.14843	0.30046	7.1136E-10
	mean	0.219785	0.1373525	0.1115895	0.285575	6.8086E-10

Table 5: Comparison test result of standard benchmark function to proposed algorithms

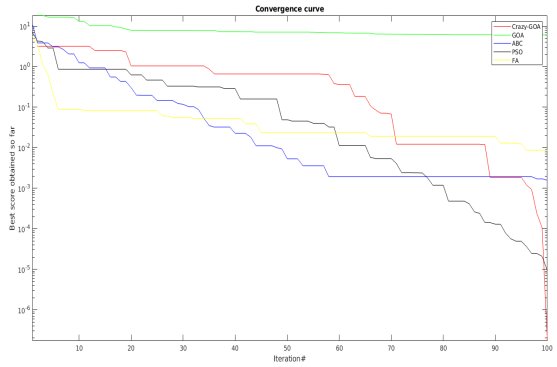

Figure 11: Function profile f_b

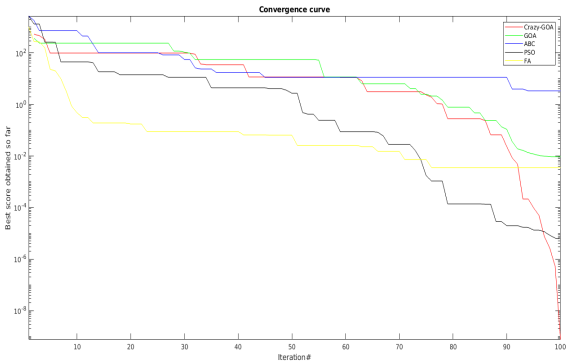

Figure 12: Function profile f_c

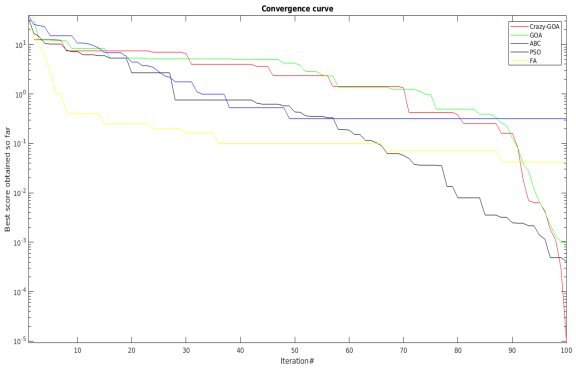

Figure 13: Function profile f_d

4.7 Summary

Improved Grasshopper optimization algorithm integrated from grasshopper optimization algorithm and Crazy factor from fish schooling. The improvement such techniques mostly used many research papers and it improve also performance of intelligence optimization algorithms.

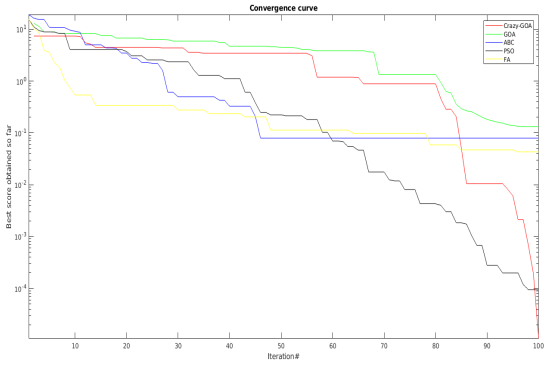

Figure 14: Function profile f_e

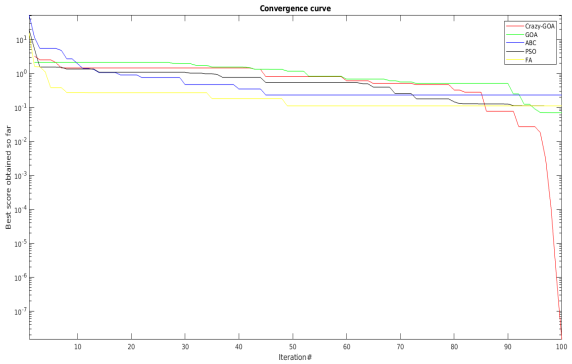

Figure 15: Function profile f_f

The new proposed tested on both Unimodal and multimodal standard benchmark functions. The simulation process obtained by IGOA algorithm was outperform results, which illustrate IGOA has exploration and exploitation capability. In addition to that with faster convergence to optimal solution within fewer iterations and increase time execution very less. The new IGOA compared with other popular intelligence algorithms and results indicates IGOA obtained reduced minimum cost function as well as simulate faster convergence rate to achieve optimal solution. Therefore, the suggested version of the algorithm is well suited for handling complex engineering, scientific as a variety of real world applications.

5 Conclusion and Future work

In this finding some limitation Grasshopper optimization algorithm tried to be targeted with proposed methods. Generally evolutionary intelligence and swarm intelligence algorithms terminate after reaching the maximum iteration number without obtaining the best optimal value in many cases. This problem is the result of imbalanced relationship between the exploration and exploitation capability of the solution search space. This challenge of imbalanced relationship between the two procedure can be resolved by developing some modifications in variant operational stages of the optimization algorithms. This solution does not give confirm of the improving the solution quality of the problem to the maximum instant in addition to its failure in identification of the problem location. For future works those directional areas solving problems will be good for researchers and findings. This study report is targeted on resolving the problem at the stoppage stage of the optimization technique and balancing exploitation and exploration.

This paper presents two novel modified version of the well known grasshopper optimization algorithm which is recognized as Modified and Improved grasshopper optimization algorithm. The first Modified Grasshopper optimization algorithm (MGOA) technique utilizes the binary crossover techniques for as an attempt for the increasing the exploration of the searching space. This crossover provides a swapping of the bits on random cross sites to create a wider diversity in the searching pattern. The binary crossover is followed by the utilization of polynomial mutation for increasing the exploitation along with creating diversity in the exploration of solution space. The efficiency of the projected approach are tested for both unimodal as well as multimodal type of problems. The testing in the domain of simulation proved the superiority along with the usefulness of the planned algorithm in comparison to the referred GOA. The convergence to finer outcome is obtained easily with a very minor increase in the computational complexity. The increase in time of execution is very less and can be easily tolerated as the quality of result produced is better. The second Improved Grasshopper optimization algorithm (IGOA) integrated from grasshopper optimization algorithm and Crazy factor from fish schooling. The craziness factor made a sudden change directions and diversity movement in search space. The simulation process obtained by IGOA algorithm was outperform results, which

illustrate IGOA has exploration and exploitation capability. The new IGOA compared with other popular intelligence algorithms and results indicates IGOA obtained reduced minimum cost function as well as simulate faster convergence rate to achieve optimal solution. Another important feature obtained in this newly both planned algorithm are better results along with faster convergence to the optimal value is achieved with fewer amount of iterations. The newly modified version of the algorithm is exhibiting superior results both for unimodal and multi-modal functions. The planned both MGOA and IGOA version are increasing the effectiveness of local search as well as global search. So, the newly modified algorithm MGOA and IGOA are capable of giving better outcomes in the cost functions similar to the four standard benchmark functions utilized in the simulation. Therefore, the suggested version of the algorithm are well suited for handling complex engineering, scientific as a variety of real world applications.

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