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An Analytical Review On Research Progression Of Cuckoo Search Algorithm (CSA)

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ABSTRACT: *Many researchers revealed that the Cuckoo Search Algorithm (CSA) was launched in 2009 and showed very good search capabilities in many optimization problems. As such, the CSA has proved effective and remains the simplest swarm-intelligence-based algorithm whose significant implementations have been efficient in solving many real-life problems. This review covered the progression of CSA research from 2013-2017, and explores additional features that other researchers do not consider.These features include, among others, performance evaluation and research progress review, which makes the current study a novel one. The study thoroughly explored current trends in CSA application in production planning, data clustering, precision data extraction, forecasting, and estimation. Certain topics discussed include problems related to architecture, construction and energy solving. The paper also disclosed CSA's importance and offered comprehensive research analysis that was expected to serve as a role model for future researchers.*

KEYWORDS:*Swarm Intelligence (SI), Cuckoo, Cuckoo search Algorithm, Optimization*

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I. INTRODUCTION

Recent studies have shown that swarm algorithms focused on intelligentsia are among the most promising[1, 2]. 3] Swarm Intelligence (SI) is valuable in that it involves the collective behavior of multi-agent systems and an efficient way of solving real-world optimization problems. Normally these multiple interacting agents follow simple local yet universal, evolving rules and self-organization; each agent is able to perform simple activities leading to collective intelligence.Several CSA applications were registered. For example,[4] has researched the CSA's production and applications. In the same vein,[1] analyzed the success of CSA 2010-2013 and anticipated contributions from individual publications to help readers in similar works. Such studies evaluated the various indicators; during the current study period, year of publication, category and country showed an exponential increase in the publishing patterns of CSA.This showed that the CSA was considered fresh, and in five years, its development remains remarkable. 5] researched the breeding behavior of cuckoo birds, shows the benefits, drawbacks, design and extended CS. 2]' Bio-inspired computation: recent development on CSA modifications' The main purpose is to assist prospective developers in choosing the most suitable variant for the cuckoo quest. In addition, to provide proper guidance in future changes and ease the selection of suitable CS parameters. In addition, the influences of different parameter settings regarding CS were provided. These will work with specific problem groups in the best environments.CSA's performance against other state-of - the-art optimization algorithms was compared. Compared with PSO, genetic algorithms, and other algorithms this algorithm was theoretically far more effective. The current analysis noted that CSA has outperformed in areas such as medical, clustering, data mining, image processing, economic load dispatch problems, engineering design, power and energy etc.[6] stressed that the CSA is one of the new metaheuristic algorithms influenced by nature based on the brood parasitism of some cuckoo species.

Optimization is a method of finding optimum values for several decision variables, leading to a solution to the optimization problem. This affects all disciplines for mitigating or optimizing effective decision-making, which is typically related to the approximation methods. There are two types of algorithms for optimisation; heuristic and meta-heuristic. Meta-heuristic is composed of algorithms focused on the evolution, swarm and trajectory. The evolutionary algorithms are subdivided into algorithms related to biology, equilibrium, differential evolution and genetic programming. Artificial bee colony (ABC), particulate swarm

(PSO), firefly algorithm (FA) and cuckoo search algorithms (CSA), etc., were included in the swarm. Tabu quest, simulated annealing, hill scaling, etc. are further applied to the trajectory-based algorithms, integrating two or more algorithms to solve a problem is called "hybridization." This is done purposely to strengthen the current algorithm's limitations and increase its processing speed or accuracy later on. 1] The purpose of optimization is the minimisation or maximisation of an objective function

This survey, however, is novel since it incorporates features from previous reviews and considered additional features such as performance evaluation and distribution of posts. Hence, the goal is to provide yet another detailed reference material in CSA's latest advancement. The current survey topology used[5] as a benchmark. The remaining survey is composed of 2. The CSA. 3. The scanning procedures for core cuckoo. 4. CSA's growth based on literature. There are 5 others. Variants of the CSA. 6. Applications for the cuckoo hunt cover different fields. 7. Hybridization, with 8. Conclusion & directions ahead

II. CUCKOO SEARCH ALGORITHM (CSA)

There are over 1,000 (1000) species of birds typical in behaviors and characteristics. And, when mother birds lay eggs for protection in a nest. Instead of laying eggs in the nest of another species, the brood parasites known as "cuckoo birds" do not create their own nests, leaving the host to care for his offspring. The cuckoo bird tricks other birds by destroying eggs that the host has laid. It lays its own, matching pattern and color, in the host's nest. The cuckoo must be more successful in mimicking the host's eggs in the light of the struggle for survival. Before the host the cuckoo egg hatches and evicts host eggs out of the nest. If the host bird chick hatched first and then cuckoo later, then cuckoo chicks eat the most food so it gets bigger and host chicks die for hunger. Thus the care and food given for the chicks of cuckoos is increased. The chicks even imitate the host's chicks call to gain access to more chances of food. 7] Cuckoo is the cuculidae family which lay eggs in the nest of other species. It has two features in common; sound and figure-shaped. The cuckoo search is a meta-heuristic, nature-inspired algorithm based on some cuckoo species ' brood parasitism along with random levy flight walks.As it lays eggs on other nests, it also destroys the egg of other species and raises the chance of hatching, then its egg develops and becomes a mature cuckoo until removed by the host bird. 2, 3] Cuckoo is a scientific name; three large families of cuculiforms; Musophagidae, Cuculidae, and Opisthocomidae. There are over one hundred (100) cuckoo species. A cuckoo often feeds on insects, especially caterpillars, and its brooding parasitism has inspired him. The female cuckoo lays 16-22 eggs, which ranges in range from around 10.9-16.3 mm.The migration of cuckoo chicks is in group, converged when the best place for breeding is reached; the best place is regarded as the feature of objective. Thus, animals' flight behavior is identical for levy flight mechanism, random search for food, walk based on current state/location and the probability of transition to the next location. As such, the young cuckoo that has grown up live in an area of its own and community, but if the egg lies nearby, it may leave for a better habitat; eggs similar to host birds and food for their young. When cuckoo communities are created in different areas, the society with the best profit value is chosen (the goal) to move to other cuckoos and the process continues. The CSA was due to the natural behavior of cuckoo birds; brood parasitism for the laying of eggs in other host birds ' nests; This gave birth to three idealized rules based on the behavior of cuckoo birds implemented as a computer algorithm:• Each cuckoo lays one egg at a time, and dumps it into a randomly selected nest.

- The best nests with high quality eggs are delivered to the next generations.
- The number of available host nests is set, and a host bird with a probability pa (0, 1) may discover the egg laid by a cuckoo. In this scenario, either the host bird can get rid of the egg or simply abandon the nest and create a whole new nest.

The CS was implemented and described below in algorithm 1 is based on these rules:

Algorithm 1: Cuckoo Search algorithm

1: Objective function f(X);X = (x1; :::xd)T
2: Generate initial population of n host nests Xi(i = 1; 2; :::; n)
3: while t < Max iterations do
4: (t <MaxGeneration) or (stop criterion)
5: Get a cuckoo randomly by Levyflights
6: evaluate its quality fitnessFi
7: Choose _ nest among n (say, j) randomly
8: if Fi >Fj then
9: replace j with the new solution;
10: end if

11: A fraction (P_) of worse nests are abandoned and new ones are built;
12: Keep the best solutions (or nests with quality solutions);
13: Rank the solutions and _nd the current best
14: end while
15: Postprocess results and visualization

Further added, CSA is advantageous over other search techniques due to its fewer parameter settings:

TABLE I: Showing the Fewer Parameter Setting in CSA

Parameters	**Values**	**Ranges**	**Commonly used values**
Nest	N	[15 , 50]	N = 15
Fraction	Pα	[0,1]	Pα = 0.25
Step size	α	α > 0	α =1

III. THE BASIC CUCKOO SEARCH PROCEDURE

Yang and Deb suggested to the CSA three main ideas based on the behavior of the cuckoo, that each cuckoo lays one egg at a time and dumps it into a randomly selected nest. Nests with maximum quality eggs will pass to the next generation and the available host nest will be set and the egg laid by a cuckoo will be found by the host bird with the likelihood of leaving the worst nests (pa γ[0,1]). There are also two CSA procedures[5]; the CSA begins with an initial population of n host nests eq. 1–3. The cuckoo draws the nests of the initial host spontaneously using Levy Flights, and lays its eggs. Then evaluates the quality of the nest and compares it with the nest of another random host to choose among the best. The best host (new solution) is the location where egg laying takes place. If the host bird finds the egg with a probability of Pα π (0,1), the host either throws the egg out or leaves the egg and builds a new nest that preserves the egg for cuckoo. It also represents one answer, since the cuckoo lays only one egg. It increases the variety of new, potentially better, cuckoos and replaces them with the worst alternatives (abandoned nests) instead. On the other hand, in each nest the CSA uses multiple eggs to represent a set of solutions and establish a balance between discovery and exploitation.The CSA has the same weight as combining a Levy flight in order to generate new xt+1 solutions for, say, a cuckoo I a Levy flight:

$$x^{t+1} = x_i^t + \alpha \bigoplus \text{Levy}(\lambda) \qquad \text{Eq. 1}$$

- α >0 but in the majority of cases α= 1, the phase size should be connected to the scales of the interest problem.
- xti represents the current position xi t+1 (random walk and Markov chain) for next location.
- Product q signifies wise multiplications of entry (similar to PSO). In this scenario, however, random walks. Levy flight are more efficient for exploring the search space, as its length of phase is much longer in the long run.

A global explorative random walk by using Levy flights can be expressed as follows:

$$\text{Levy} \sim u = t^{-\lambda},\ 1 < \lambda \leq 3 \qquad \text{Eq. 2}$$

The π is the mean or expectation of the event occurring during the unit interval; creating a random walk method, generating new solutions by Levy walking around the best solution obtained to speed up local searching. A fraction of the new solutions, however, should be generated by far-field randomization and whose locations should be far enough away from the current best solution to ensure that the system is not trapped in an optimum locale.

The second technique centered on the cuckoo population with its randomly laid eggs in different nests held with a high similarity of the host eggs till hatching. The chicks will then grow (profit value) and new generated cuckoos will then look for the nests of new host with the best survival rate (select habitat for the goal). The new cuckoo population then migrates to its target habitat because its goal is while the host bird's mission is

to throw out the zero chance of survival / killing of the cuckoo's egg (less valuable eggs). The remainder of the eggs in the host nest may however complement the growth stages.If the earlier case occurred, cuckoo chicks would develop three times larger than host chicks, resulting in host chicks death due to hunger. Therefore it is noted that the aim is to move to a society with the highest profit value and to arrive in that setting soon after that cuckoos. The cuckoos can not be aggregated by their respective groups, as such K-means clustering of cuckoo is applied and the benefit value of cuckoos is measured. Thus the selection of a group with a maximum profit value as the target group decides the migration destination environment. This is supported by the fact that two parameters help cuckoo y find more locations in the π and π environment defined below:

$$\lambda \sim U(1,0) \text{ and } \varphi \sim U(-w,w) \qquad \text{eq. 3}$$

- λ = A random number (U) between 0 and 1
- ϕ = Radius of destinationand
- w = The control parameter of the deviation calculated by $\frac{\pi}{6(rad)}$

In the end, each cuckoo does not belong to either target point or new habitats, but for the freshly laid eggs the process repeats itself. Cuckoo with a better value for benefit will also survive; managed to decide a suitable nest for eggs or to be destroyed by predators. In short, the cuckoo search theory relies on three earlier components; globally searching for efficient solutions by integration with Levy flights. Local random walk manipulation to select the best solutions and retain them for entry to the restricted (as shown below).

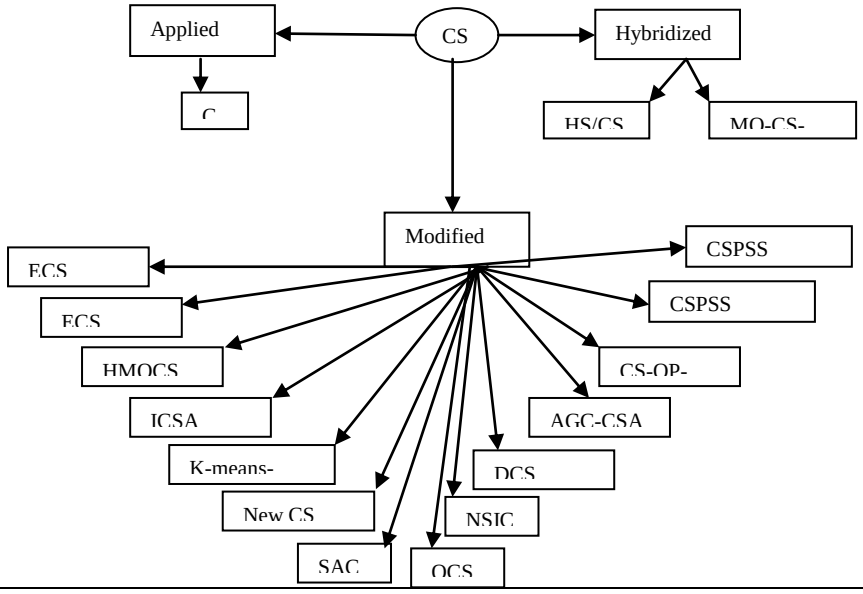
Algorithm 2: Optimization Cuckoo Search Algorithm

1: Initialize cuckoo habitats with some random points on the profit function
2: Dedicate some eggs to each cuckoo
3: Define ELR for each cuckoo
4: Let cuckoos to lay eggs inside their corresponding ELR
5: Kill those eggs that are recognized by host birds
6: Let eggs hatch and chicks grow
7: Evaluate the habitat of each newly grown cuckoo
8: Limit cuckoos' maximum number in the environment and kill those who live in the worst habitats
9: Cluster cuckoos and find the best group and select goal habitat
10: Let new cuckoo population immigrate toward goal habitat
11: If stop condition is satisfied to stop, if not go to 2

IV. THE PROGRESSION OF A CUCKOO SEARCH ALGORITHM (CSA)

This section narrates technologies which demonstrate CSA's popularity trends by adopting many of its variants. To further validate these, several papers have been widely published in three (3) folds; Applied, Revised, and Hybridized. Furthermore, figures showing the distribution of papers by reputable publishers, the CS taxonomy and the CSA trend over the study period were incorporated to support these CSA popularity trend:

Fig. 4.1: Taxonomy of CS



4.1 Application of aCuckooSearch Algorithm (CSA)

The implementation of CSA in order to solve optimal production planning (Unit Commitment) and numerical simulation results revealed that CSA provided the most suitable convergence in terms of response, computational speed, minimum production costs and accuracy better than GA and PSO. 9] proposed a new quest strategy based on an orthogonal learning approach to boost the basic CSA's capacity for exploitation. In order to verify the performance of this approach and experimental results indicated that CSA performs better as compared to state-of - the-art approaches. 10, 11] proposed a CSA-based reconfiguration methodology to minimize the active power loss and maximize voltagemagnitude. Despite less control parameters CSA emerged victorious in this. The same issue was tested on three different distribution network systems; the results showed that the task assigned to CSA was found to be efficient and promising. 12] introduced a new optimization technique called the Cuckoo Search (CS) algorithm for the optimum tuning of Load Frequency Control (LFC) controllers by means of a time-domain-based objective method for the robust tuning of PI-based LFC parameters... 13] suggested a Cuckoo Search (CS) algorithm for optimal Power System Stabilizers (PSS) configuration in a multi-machine power system, and better solved the problem under different operating conditions and disruptions. For the PSS design problem, an objective feature based on Eigen values involving the damping ratio, and the damping factor of the lightly damped electro-mechanical modes were considered. The findings are checked by evaluating the time domain, the Eigen values and the output indices. Only, CSA's efficacy in providing good damping properties is still verified. 14] CSA proposed to solve premature convergence with non-homogenous quantum mechanics-based search strategies to improve the searchability of the classical CS algorithm. Comparison with five current CS-based approaches and ten other state-of - the-art algorithms has been made yet the numerical results have shown that CS is considerably better. 15] Femtocells have been identified as an efficient solution for increasing cell coverage, enhancing spectral efficiency and providing mobile users with improved quality of service (QoS). This is of paramount importance in wireless broadband access networks, most indoor areas face serious problems with coverage. In the Orthogonal Frequency Division Multiple Access-Based Long Term Evolution (OFDMA-LTE) method, the study proposed a resource allocation technique-based cuckoo search algorithm RACSA for cross-tier interference mitigation. The simulation results show that RACSA mitigates cross-tier interference and increases system performance, and verified that RACSA offers (38 percent) and (21 percent) higher system throughput and (14 percent) and (35 percent) higher spectral efficiency and (55 percent) and (33 percent) lower probability of failure when compared with genetic algorithm and auction algo tests. Cross-level interference issues, however, remain the major technical challenge linked to femtocell deployment.16] proposed a new principle "Parallelism in CPU virtualization and scheduling using Cuckoo Search Algorithm" in which the processes allocated the resources for their implementation depending on the availability of those resources. If any resource can embrace several processes, then that resource can be allocated simultaneously for executing those processes. Therefore, throughput is maximized, systems are not idle for a long time and the allocation of resources has been better maximized. 17] CS was introduced and a new hybrid model was provided to predict the regular PM2.5 concentration on the basis of the main component analysis (PCA) and the lowest square vector support system (LSSVM). First PCA is implemented for removing original features and raising the input selection dimensions. An experimental study by correlation analysis showed that the proposed solution outperforms a standard LSSVM model with default parameters and a general neural network regression (GRNN) model in prediction of concentration of PM2.5.The proven model therefore proved potentially applicable to the air quality forecasting systems. The approach does not, however, shorten the running time of the forecasting model to make it more realistic and explore to predict certain air pollutant concentrations.

Table II: List of original cuckoo search algorithms

Topic	Author(s)
Production planning	[8]
Orthogonal learning strategy	[9]
Power Optimization	[10, 11]
Tuning Optimization	[12]
Pre-mature convergence	[14]
Resource allocation/scheduling	[15]

4.2 Modifications of a Cuckoo Search Algorithm (CSA)

Different modifications of the cuckoo search algorithm (CSA) were studied and presented based on the efforts of previous researchers. For example,[18] proposed a two-degree freedom controller (2DoF) called 2DOF –integral plus double derivative (2DoF–IDD) as a secondary controller and other parameters and are

optimized by CSA at the same time. The study received a much better response to the sensitivity analyzes than the others. In addition,[19] developed a multi-stage hybrid flow shop (HFS) scheduling problems, and an improved CSA was introduced to reduce the HFS make-up.Computational results showed that GA, ACO, SA, and PSO are superior to ICSA's. Nevertheless, this work was not applicable to other HFS problems related to performance measures related to the due date and was not expanded to HFS problems where devices are heterogeneous. Again,[20] proposed method with two new rules of mutation based on rand and best individuals 28 across the whole population. We balanced the use and discovery of the 29 algorithms; by a linear decreasing law of probability, the new rules are merged.Then, the setting of 30 self-adaptive parameters is introduced as a uniform random value to increase the population's 31diversity based on the relative success number of the proposed two 32 new parameters in the previous period. 16 standard 33 functions chosen from literature are used to check the efficiency of SACS, and experimental results suggested that the pro-34 presented approach performs better in terms of the quality of the solutions than the state-of - the-art 35 methods. In the last part 36 experiments on the Lorenz system and the Chen system were carried out to estimate the 37 parameters of these two chaotic systems. Results of simulation showed that the method presented pro-38 is very successful. In another way,[21] introduced a new algorithm called DCS to solve the problems of continuous optimisation. The technique has been extended and the CS improved by reconstruction of the solution population. The new category of cuckoos has solved combinatorial as well as continuous problems. The output of the proposed Discrete Cuckoo Search (DCS) is checked against a collection of symmetric TSP benchmark instances from the popular TSPLIB library.The test results suggest DCS is superior to other metaheuristic algorithms. Using the Optimally Pruned Extreme Learning Machine (CS-OP-ELM),[22] developed Cuckoo Search to forecast clear sky and real sky global horizontal radiation to improve forecasting, estimation and prediction. Cuckoo Check has also been employed to determine the correct weight coefficients.To check the approach's efficacy, hourly solar radiation data were obtained from six U.S. locations, and approaches such as ARMA (Auto Regression Moving Average), BP (Back Propagation) neural network, and OP-ELM compared to CS-OP-ELM. Experimental results with lots of neurons through the ELM system showed that CS-OP-ELM has the best performance in forecasting. Whereas[23] suggested directed cuckoo search (OCS) to solve the precision estimation challenges. Two different random distributions combine to dominate the global search power.To provide a thorough investigation, ten different random distributions are employed and compared to test suits from CEC2013, and it is shown numerically that the best performance was obtained by Lévy and Cauchy distributions. 24] proposed a novel cuckoo search based swarm intelligence algorithm (NSICS) to establish a precise equation for predicting ground vibration produced by blasting operations at Miduk Copper Mine, Iran. Several empirical equations were used for assessment purposes as well. In this regard, 85 blasting events were considered, and the values of two effective ground vibration parameters were calculated, namely the average load used per delay and the distance between the blast face and the monitoring station. In addition, in each blasting, peck particle velocity (PPV) values were reported as a descriptor of the vibration. Two performance indices; the root mean square error and multiple correlation coefficient (R2) were used to evaluate the output capabilities of the proposed models. Comparing the expected values the models showed that the proposed NSICS equation is more accurate in predicting the PPV than empirical equations. 23] The finding that WSN is an important component of a cyber-physical system, and the location of node information is a crucial issue. As such, given that the distance vector-hop (DV-Hop) method, one of the common range-free algorithms, is commonly used to estimate the position but it is difficult to estimate precision. So it was planned and proposed a new evolutionary algorithm called the directed cuckoo search algorithm (OCS). The computational and simulation results showed that as opposed to three algorithms, a combined Lévy with Cauchy obtained the best performance.

Table III: List of Modified cuckoo search algorithms

Topic	Author(s)
Multi-objective/Combinatorial	[18], [20, 21], [22]
Forecasting, prediction & estimation	[23], [24]etc
Feature extraction & data clustering	[25]
Scheduling	[26]

CS is useful in extracting and clustering features as[25] enhanced Cuckoo Search (ECS) is used to extract optimal features from breast tumours. The texture, strength histogram, characteristics of the radial distance form were extracted and the optimal feature set was obtained too. The latest ECS output is contrasted with CSA and Harmony Search yet the results show that the ECS algorithm is more effective in providing valuable medical pathology knowledge to the physician. 27] proposed a multi-objective hybrid CS (HMOCS) to solve multi-objective optimisation (MOP) problems. The HMOCS uses the non-dominated sorting technique and a local dynamic search. The former is useful for generating Pareto fronts and the latter focuses on enhancing

local search. Six (6) well-known benchmarks were used in the experiments to check the efficiency of the technique, and results showed that HMOCS outperforms three other multi-objective algorithms in terms of convergence, spread, and distributions. 28] proposed a novel metaheuristic approach (CSK) based on K-means and cuckoo search to find optimal cluster heads from Twitter's sentimental data set content. The effectiveness of a proposed method has been evaluated on various Twitter datasets and contrasted with methods such as PSO, DE, CSA, enhanced CS, Gauss-based CS and 2-N-grams.The experimental results and mean quantitative fitness from statistical analysis confirmed that the approach proposed outperforms the methods already used. The proposed method has theoretical implications for analysis of the data generated by social networks for future research. 26] introduced a new CS (NCS) algorithm NCSA to solve flow shop scheduling problems (FSSP) for optimal scheduling with CSA. Experimental study on a collection of benchmark instances of Tail lard has shown that NCS obtains better performance than the regular CS and some other meta-heuristic algorithms.

Fig. 4.2: Current Publication Trends in CSA

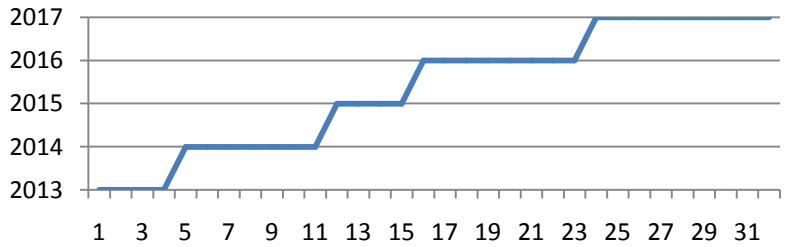
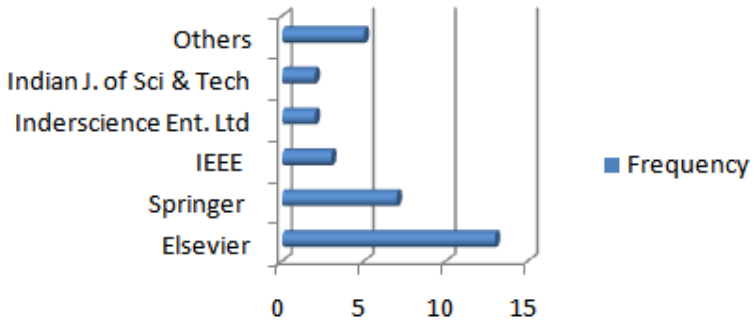


Fig. 4.3: Distribution of CSA by publishers



Figures 4.2-4.3 above showed that use of the search algorithm for cuckoo is on the rise from 2013-2017. It has also been announced that CSA is being applied and will continue to receive a potential application from researchers for obvious reasons mentioned earlier.

4.3 Reviews on a Cuckoo Search Algorithm (CSA)

This sub-section is an analysis focused on the cuckoo search algorithm (CSA) of many updated papers. This is intended to assess the contributions of past research reviewers. 3] A systematic report on the market for cuckoo: varieties and hybrids. Algorithms were divided into four classes in their study; Swarm Intelligence (SI), bio-inspired without SI, physics, chemistry and others. There was also the development of artificial immune systems. Of course not all algorithms are bio-inspired; some meta-heuristic algorithms also take their inspiring origins from physics and chemistry. This form of algorithm imitates other physical and/or chemical laws like electric charges, gravity, river systems, etc. These include inter alia Harmony Award (HA), Simulated Annealing (SA). Touching all algorithms in a single paper is not trivial, but the above three classes covered around 95 per cent of all the algorithms inspired by nature. The remaining 5 percent of algorithms are based on history, feelings, and social behaviour, some of which have even been influenced by theory, such as anarchic optimization of society.A theoretical study was suggested, based on CSA variants and hybrids. In addition, several open questions remain to enhance CS, including how to build self-adaptive CS, how to change the parameters more effectively, and how to manage these to achieve the best results. In engineering and industry, performing large-scale real-world applications will be very useful. 4] The optimisation goal is to find a set of

inputs that reduce or optimize a function. This may appear to be the norm if functions are minimized-it is always possible to create a question of maximization in terms of minimisation.The function to be minimized is known as the objective function, and space is called the solution space on which its inputs reside. Optimizers search the Objective function's solution space to find the minimum. As regards the inputs, optimizers have historically used the gradient of the objective function to decide the direction in which to look. The gradient can vary throughout the search space in highly nonlinear problems and may not point in the direction of the global minimum solution. 6] Cuckoo search has been conducted with promising efficiency in many fields of optimisation and computational intelligence. For instance, cuckoo search has superior performance in engineering design applications over other algorithms for a variety of continuous optimization issues such as spring design and welded beam design problems. Those wider CS applications allowed CS algorithms to remain the most appropriate optimizers. Through their study of the success of CSA,[1] the reviews from different publishers were intended to assist readers through similar works. Four-year review of the results showed an exponential increase and incredible growth in CSA publications. 5] conducted a detailed and thorough review of the metaheuristic swarm based CSA. They proposed Yang and Deb's approach to emulating cuckoo breeding behavior set in 2009. This survey addressed the plus, drawbacks, key architecture, and expanded CSA models. CSA materials were also categorized according to the structure: versions and modifications, year of publication, areas of application, and hybridization.The survey was conducted in order to remain important to its viewers and readers regarding current CSA research and its possible future directions. 2] Bio-inspired computation review: recent development of cuckoo search algorithm modifications.' The aim of the review was to assist potential developers in selecting the most suitable cuckoo search version, provide sufficient guidance in future modifications and ease the selection of the best parameters for cuckoo searches. Their analysis reviewed the most recent published CSA papers and considered the effects of the various parameter settings. They also calculated the estimate of the modified qualities and the percentage improvements resulting from CSA modifications. They revealed that the most commonly used modifications are population decline and use of a skewed random walk. They also suggested that both experienced and inexperienced researchers use their analysis to suggest directions for future development. Help users often find the best modifications and the correct optimum parameter setting for different problems at hand. Additionally, it can act as a test for further changes to the original cuckoo quest.

V. THE VARIANTS OF A CUCKOO SEARCH ALGORITHM

The CSA was intentionally developed to assist in comparison with the firefly algorithm (FA), artificial bee colony (ABC), Particle Swarm Optimization (PSO) and ant colony algorithms (ACO). Furthermore, this study reveals numerous updates on CSA by different researchers as extracted from its literature. The aim of this analysis was to cope with the complexity of the optimization problem search space and the same was tabled.

TABLE VI: Summary of recent variants of CSA

Variants	Action(s)	Objective achieved	Year published	Publisher
CSA	Applied	Optimal production planning	2013	Indian J. of Sci& Tech
CSA	Applied	Optimized strategy for tuning the CS parameters	2017	Elsevier
CSA	Applied	Parallelism in CPU virtualization and scheduling	2017	Int. J. of Grid &Distd Comp.
CSA	Applied	To approximate the structural responses	2017	Inderscience Ent. Ltd
CSA	Applied	Resource allocation technique	2016	Indian J. of Sci& Tech
CSA	Applied	To overcome the drawback of fallen into local optima	2016	IEEE Trans. Cybernetics
CS	Applied	Forecasting, monitoring and controlling PM2.5 concentration.	2017	Elsevier
CSA	Applied	Enhancing the performance of CSA using orthogonal learning method	2013	Springer
CSA	Applied	Distribution network reconfiguration for power loss minimization and voltage profile improvement using CSA	2015	Elsevier
CS	Applied	A Non-homogeneous CSA Based on Quantum Mechanism for Real	2016	IEEE

		Parameter Optimization		
CS	Applied	CSA based load frequency controller design for nonlinear interconnected power system	2015	Elsevier
CS-OP-ELM	Hybridized	Forecasting solar radiation	2015	Elsevier
MO-CS-PSO	Hybridized	To improve the performance of the clustering in terms of accuracy	2015	American Scientific Publishers
HS/CS	Hybridized	Hybridizing harmony search algorithm with CS for global numerical optimization	2014	Springer
K-means-CSA	Modified	optimum cluster-heads from the sentimental contents of a Twitter dataset	2017	Elsevier
AGC-CSA	Modified	Optimized system dynamic responses	2014	Elsevier
ICSA	Modified	minimize the makespan for the HFS scheduling problems	2014	Elsevier
ECS	Modified	To extract the optimal features from the breast tumors	2016	Authors & Sci. Res. Publ. Inc.
New CS	Modified	For solving flow shop scheduling problems (FSSP).	2017	Springer
HMOCS	Modified	For solving multi-objective Optimization problems (MOPs).	2017	Springer
OCS	Modified	Oriented CS to improve the precision of the performance of distance vector-hop method (DV-Hop),	2016	*J. Parallel Distrib. Comput*
SACS,	Modified	Modified CSA with self-adaptive parameter method	2014	Elsevier
NSICS	Modified	Application of CSA to estimate peak particle velocity in mine blasting	2016	Springer
CSPSS)	Modified	Optimal Power System Stabilizers design via CSA, Electrical Power and Energy Systems	2016	Elsevier
OCS,	Modified	A novel oriented CSA to improve DV-Hop performance for cyber-physical systems	2016	*Parallel Distrib. Comput*
DCS	Modified	Discrete CSA for the traveling salesman problem,	2014	Springer
CSA	Review	Review	2013	Inderscience Ent. Ltd
CSA	Review	Review on conducting intensive research survey into the pros and cons	2017	*Applied Soft Compg J.*
CSA	Review	Review on the Developments of CSA	2013	Elsevier
CSA	Review	Review on CSA Research progression	2014	Praiseworthy prize
CS	Review	Studies in Computational Intelligence'' (SCI)	2014	Springer
CSA	Review	Bio-inspired computation: Recent development on the modifications of the cuckoo search algorithm	2017	Elsevier

VI. APPLICATION OF A CUCKOO SEARCH ALGORITHMS IN VARIOUS DISCIPLINES

One of the most current SI algorithms is the Cuckoo Search Algorithm (CSA). It is based on the Cuckoo birds ' foraging behavior based on breeding and the Levy-flight. It is a superior algorithm, above PSO and GA[1]. Application areas of CSA include Nurse scheduling method, energy-efficient wireless sensor network and multi-modal objective function, combinatorial optimization problem of certain quantity principles, quantity-inspired algorithm on parallel machines, popular traveling salesman, manufacturing optimization problems (friction model) and scheduling in manufacturing system decoding efficiency and3] To summarize the value of CSA; to meet the regional convergence requirement; to support local and global search capabilities; and to use Levy flights as a global search strategy; It has been found useful in benchmarking optimization where

groups of functions can be used to evaluate the efficiency of any problem of optimization. These include restricted and unconstrained variables which are continuous and discrete. Some are uni while others are multimodal problems; production planning, data clustering, precision data extraction, forecasting, and engineering & design estimation and energy problems among others:

TABLE IV: Performance evaluation of CSA optimized metrics

Speed	Accuracy	Energy	Time	Prediction	Makespan	Rand	Weight	Distance
x	x	✓	✓	x	X	x	x	x
x		✓	x	x	X	x	x	x
✓	✓	x	x	x	X	x	x	x
x	✓	x	x	x	X	x	x	x
x	✓	x	x	x	X	x	x	x
x	x	x	x	✓	X	x	x	x
x	x	x	✓	x	X	x	x	x
x	x	x	✓	x	X	x	x	x
✓	x	x	x	x	X	x	x	x
x	x	x	x	x	X	x	✓	x
x	x	✓	x	x	X	x	✓	x
x	✓	x	x	x	X	x	x	x
x	x	x	x	x	✓	x	x	x
x	✓	x	x	x	X	x	x	x
x		x	x	✓	X	x	x	x
x	✓	x	x	x	X	x	x	x
x	x	x	x	x	X	✓	x	x
x	x	x	x	x	X	✓	x	x
x	x	x	x	x	X	x	x	✓
x		✓	x	x	X	x	x	x
x	✓	x	x	x	X	x	x	x
x	x	x	x	✓	X	x	x	x
x	x	x	x	x	X	x	x	x
x	✓	x	x	x	X	x	x	x
x	x	x	x	x	X	✓	x	x
x	x	x	x	x	X	x	x	✓

Key: √ for "*Yes*" and x for "*Not*" optimized

VII. HYBRIDIZATION OF A CUCKOO SERACH ALGORITHM (CSA)

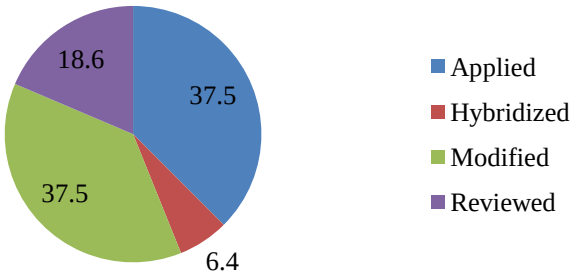
The CSA hybridization has continued to draw the attention of researchers from various fields around the globe, leading to different hybridizations to the basic CSA. This section studies specific CSA hybridization, demonstrating it is promising and interesting. Interestingly, shows is that it is used constantly by researchers in various fields. Again, simplicity, fewer parameters and ease of hybridization are its advantages over other optimization algorithms. 29] proposed an enhanced robust approach in this regard, known as harmony search–cuckoo quest (HS / CS) to solve optimization problems. In this technique, the harmony search (HS) pitch adjustment procedure was seen as a mutation operator applied to the cuckoo cycle for updating / speeding convergence. Several tests were used to validate the proposed method and had shown better than standard CS and other approaches. 30, 31] Recent optimization algorithms PSO-CSA-GSA-Hybrid Gravitational Search-Nelder mead algorithm (HGSANM), league championship algorithm (LCA), firefly algorithm (FA), bat algorithm (BA), internal search algorithm (ISA) and imperialist competitive algorithm enhanced crash efficiency of a thin-walled tunnel. But, using hybrid GSA as revealed by MAT / Law36, the lowest component mass is obtained at 1000 feature evaluation number (FEN).32] considered the data clustering to be one of the most important data mining techniques and a widely used method for obtaining useful data information. In this vein, the researcher claimed that as a result of using single steps, many of the datasets lack robustness. In order

to solve this problem, a "multi-objective clustering based on the hybrid optimization algorithm (MO-CS-PSO)" technique was again proposed, which used the two objectives; cluster validity index (I-index) and stability. In the fitness function of the hybrid optimization algorithm, the multi-objectives are implemented to boost the clustering performance in terms of precision.Ultimately, the experimental study is conducted to determine the viability of the proposed solution in various plants, along with animal data and health data, including blood transfusion data. The new MO-CS-PSO algorithm is evaluated on MatLab 7.12.0 on several data sets, and its output is compared with Genetic-K means, cuckoo quest and Fuzzy-PSO means. The simulation results show that the new method performs better than the Cuckoo test (4.70%), the Genetic-K mean (5.70%) and the Fuzzy-PSO mean (3.48%).

TABLE VI: List of hybridized cuckoo search algorithms

Topic	Author(s)
Multi-objective	[8, 27,30]
Data Clustering	[32]etc

Fig. 7.1: Percentage Distribution of CSA Articles



VIII. CONCLUSION &FUTURE DIRECTIONS

The research discussed the importance of CSA in many areas of human activity such as informatics, engineering, and economic development. As such, CSA remains a promising and fascinating algorithm and will continue to be commonly used by researchers across diverse fields as shown in the study and its advantages over other optimization algorithms, fewer parameters compared to other algorithms, and ease of hybridization with other optimization algorithms.The paper serves as a guidance tool for researchers working or will be working in this field, the paper also highlighted the weaknesses and strengths, and proved CSA's effectiveness.

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