Intelligent Feature Selection Methods: A Survey

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A B S T R A C T

Consider feature selection is the main in intelligent algorithms and machine learning to select the subset of data to help acquire the optimal solution. Feature selection used an extract the relevance of the data and discarding the irrelevance of the data with increment fast to select it and to reduce the dimensional of dataset. In the past, it used traditional methods, but these methods are slow of fast and accuracy. In modern times, however, it uses the intelligent methods, Genetic algorithm and swarm optimization methods Ant colony, Bees colony, Cuckoo search, Particle optimization, fish algorithm, cat algorithm, Genetic algorithm ...etc. In feature selection because to increment fast, high accuracy and easy to use of user. In this paper survey it used the Some the swarm intelligent method: Ant colony, Bees colony, Cuckoo search, Particle optimization and Genetic algorithm (GA). It done take the related work for each algorithms the swarm intelligent the ideas, dataset and accuracy of the results after that was done to compare the result in the table among the algorithms and learning the better algorithm is discuses in the discussion and why it is better. Finally, it learning who is the advantage and disadvantage for each algorithms of swarm intelligent in feature selection.

1. INTRODUCTION

Feature selection plays an important role in pattern recognition and data mining [1], Feature selection consist of discovering the related features and discarding the unrelated ones, and the goal is to get a subset of features that describe the given problem mainly with a minimum degradation of accuracy. There are two main parts that matter with feature selection: wrapper method and filter method [2].

The most damaging feature, however, is selection algorithms that suffer of stagnation in local optimal and/or computational high cost. Later feature selection has been presented as a global optimization problem. Its aim is to find in the subset the best accuracy of the original feature group under an evaluation criterion. The optimal solution of the feature subset is an NP hard problem. Many optimization algorithms satisfying genetic algorithms (GAs), particle swarm optimization (PSO) and genetic programming (GP) and neural methods, have been applied to solve feature selection problems due to their global search abilities, but they always consume very high running time when they are used to address the large data size problem. To overcome the limit, we concentrate on optimization issues that depend on feature selection of achieving as or even larger classification performance than other methods in shortest time [1]. In this the survey paper we present many of intelligent swarm algorithm, in feature selection, in the part two we present Ant colony, Bees colony, Enhance Cuckoo search optimization, Particle swarm intelligent and Genetic algorithm (GA). In Part three we present the related work of each algorithm of swarm algorithms in feature selection and offer the dataset of the techniques, in Part four we present the table of comparing among the algorithms of work and the results it, in Part five we present the discussion of results in the table and lastly in Part 6, we give the conclusion of the survey paper of algorithm swarm intelligent and acknowledge the advantages and disadvantage of each algorithm and acknowledge the best algorithm.

2. FEATURE SELECTION BASED ON SWARM INTELLIGENCE ALGORITHMS

In this survey paper, as improvement techniques, the swarm insight calculations are utilizing to take care of highlight choice issues. Depends on the imperatives, looking for a component subset with exceptionally assessment esteems is the streamlining complaint swarm knowledge (SI) is the arrangement of regular metaheuristics propelled by the assortment direct of decentralized and self-association swarms. SI generally models the collection intelligence methods in swarms for social insects, birds, or other animals. The collection intelligence of swarms manly relies on the information interchange among everyone in the set typical SI-relies computation algorithms contenting ACO, BCO, EC, PSO, GA and etc. These methods have control parameters and different operators. However, the essential works of SI-depends calculation calculations for the most part content instatement, assessment, update and selection. In term of accuracy, they have their very own advantages and disadvantage. SI-depends approaches are utilizing to address types streamlining techniques and apply to unravel genuine strategies in various ways Moreover, swarm intelligence calculations are additionally applying to highlight choice, which utilized as the inquiry devices among these calculations [1] and the results of swarm intelligence is good and strong with to compare the algorithms of the traditional methods.

I.   *Ant colony optimization for Feature Selection*

In this survey paper, meta-heuristic approach of feature selection (ACOFS) has been introduced that uses ant colony optimization, the main concentration of this method is the ACOFS that is reduced by the dimensional of datasets and select the subset of feature to obtain the optimal solution in fast, easy, and low cost. ACOFS uses search techniques in content the filter and wrapper. In this regard, ACOFS heuristic information measurement rules rely and modify the standard pheromone update. The reason of the novelty and clarity of ACOFS opposite other methods, ACOFS confirms not just the selection of several prominent features, but also the scoring of a minimum number for the (ACOFS) it has main high-accuracy solutions for FS from a given datasets [3].

II.   *Bee colony optimization for Feature Selection*

Unlike enhancement issues, when the potential solutions for the issues can be presented by real values and vectors, the up-and-comer answers for the element determination issues are spoken to by bit vectors. Every nourishment source is connected and a bit vector of volume M, where M is the summation number of features. The layer in the vector consider to the numbers of features to be evaluated if the position is referring to one this point is mean the position is part of the subset feature to be evaluated, otherwise the position refers the zero this point not part of the subset of features to be evaluated, overtime, each food source stocks its quality (fitness), which is obtained by the accuracy of the classifier using the feature subset pointed by the bit vector [5].

III.   *Enhanced Cuckoo Search for Feature Selection*

The main aim of feature selection (FS) substantially is determine the features of native feature vector to select the subset of relevance feature with discard irrelevant noisy and redundant feature this is helpful to get the optimal solution, easy and fast to obtain the solution low cost and fast with high accuracy. In this search, it uses the metaheuristic to find the better performance to select the subset of feature selection and extracting the better feature of dataset used in practical, the Cuckoo Search (CS) method Cuckoo search (CS) is one of the last nature-inspired metaheuristic algorithm evolution by Xin-She Yang and Suash Deb in 2009. The model feature selection approach called Enhanced cuckoo search, having different verses of host nest with binary eggs. It searches for the better feature subgroups that maximize the classification accuracy [7].

IV.   *Particle Swarm Optimization for Feature Selection*

PSO is an EC techniques suggestion by Kennedy and Eberhart in 1995. PSO is prepared by social conducts such as fish schooling and birds. The underlying phenomenon of PSO is that learning is optimized by social reactive in the population where thought this not just personal but so social. PSO relies on the based that each solution can be introduced as a particle in the swarm. Each particle has a layer in the consideration space. Particles move in the consideration space to search for the optimal solutions, each particle modernization its position and speed according to mostly experience and thus for its neighbors. The better previous lay of the particle is listed as the singular better *pbest*, and the best position get by the population that far is called *gbest*. It relies on *pbest* and *gbest,* PSO was primarily proposed for singular objective optimization. To search a PSO-based binary objective feature selection method, one of the more serious tasks is to fix a good leader (*gbest*) for each particle from a group of potential [9] experimental results turns out that PSO is a good option for rough set relies feature selection [13].

V.   *Genetic Algorithm for feature selection*

GA is based on the feature selection method to reduce the size of amount the dataset when it used in works where the high number of features in dataset leads to low the accuracy and hard work the classification where the accuracy be the low. While for work the feature selection to dataset the size of dataset is small, and the accuracy of classification become high. When the GA is consisted of the many steps is content the chromosomes when the binary number be '0, 1' when the '1' bit is selected the gen otherwise not selected it, also content the crossover between each two chromosomes the parents to getting up the best result. Later the work mutation to select the elite chromosomes. In GA algorithm in FS content the fitness function to work the feature selection and select it the best feature in high accuracy and smaller number of features in low time [11].

3. LITERATURE SURVEY

Several works and techniques were suggested for intelligent features selection methods relies on swarm intelligence algorithms, here are the most interesting ones:

A. MonirulKabir, MdShahjahan and Kazuyuki Murase, in 2013 [3], they presented a work for Ant colony optimization based feature selection, the performance the ACOFS is used the experiments is using eight of datasets in the context types of famous datasets including the breast cancer, glass, vehicle, thyroid, ionosphere, credit card, sonar, and gene is existed in UCI machine learning repository is used the method to select the subset of feature and reduced the dimensional the datasets and show the results of the experiments the is reduced the dimensional and obtained the optimal solution in the easy way, low cost and very fast, the work is it observed in the proposed the different groups is large, medium and small is have the high accuracy. The results of the low standard deviations of the average classification performances so the average number of chosen features, offered the robustness of this method. On the other direction, in comparison with other notable FS methods, with just a few exceptions, ACOFS outperformed the others in expressions of a reduced number of chosen features and best classification performances.

B. Huijun Peng, Chun Ying, Shuhua Tan, Bing Hu and Zhixin Sun. In 2018 [4], in their research, they produced the work of Ant colony optimization in feature selection that used to select the subset of the data and reduced the dimensional of dataset. In this work study, they used the dataset of KDD Cup 99 that, consist of large network of data and content 41 features each piece to describe one of the data used in the research, the purpose of this work is improve the algorithm the classification efficiency and high accuracy of results.

C. Mauricio Schiezaro and Helio Pedrini, in 2013 [5], the researchers produced the Bee colony optimization. The proposed algorithm is estimated by the method through the types of the datasets in the work that is taking the ten types of datasets in the UCI machine learning repository, that results show the performance high to select the subset of feature and reduce the dimensional the datasets, the performance has significantly increment even though the number of chosen features has significantly reduced. The proposed algorithm presented best results for the plurality of the checked data compared to other algorithms its performance was close to the other methods (94.26% against 91.13%).

D. Sibel Arslan and Celal Ozturk, in 2019 [6], the researchers prepared the work based on Bee colony optimization in feature selection to evaluate the performance the works such as the accuracy, complexity, reduce the dimensional the data, to find the optimal the solution in little time and very fast and to represented the subset of the data it used, in this work used the dataset in the UCI and consist of four types (WDBC, Dermatology, wine, horse colic) this work obtained higher success in feature selection and was high results.

E. M. N. Sudha and S. Selvarajan, in 2016 [7], the researchers introduced a proposal of the Enhanced Cuckoo search. The suggestion using total 508 (288 benign and 212 malignant) mammogram images were using as case samples. For the division, region growing method was using many feature selection algorithms were investigated for breast cancer classification, contenting the CS, HS and the proposed ECS. All these feature selection methods uses a minimum distance classifier, k-nearest neighbor classifier. ECS with k-NN Classifier for classification breast cancer out find well when compared to other methods. The suggestion feature selection algorithm for breast cancer classification shows best accuracy ECS with k-NN classifier totally selects 29 features and introduce 99.13% average classifier performance using Euclidean distance.

F. Mahmood Moghadasian, and Seyedeh Parvaneh Hosseini, in 2014 [8], they presented a proposed method of the Enhanced Cuckoo search. This proposed method used the data sets in this study contented of six gene express profiles, which were downloaded from http://www.gems system.org, we introduce a filter relies feature selection algorithm based on BCOA and information notion to choose a smaller number of features of high dimensional datasets and obtain similar or even best classification performance. This aim was obtained by developing a new feature selection method relies on BCOA the results proposed that the suggestion approach can significantly minimize the number of features whilst obtained similar or even best classification accuracy in almost all cases, the results of feature subset selected minimize at least 93% of the suitable features.

G. Neha and Jyoti Vashishtha, in 2016 [9], in this paper, they suggest the proposed approach of the Particle swarm optimization, this proposal uses PSO for feature selection to improve classification accuracy and to minimize number of features selected PSO. The suggestions used two types of the dataset of UCI relies methods on performance efficient and selecting optimal to feature subset. Existing methods, however, can be otherwise modified to obtained best results.

H. Sapiah Sakri, Nuraini Abdul Rashid and Zuhaira Muhammad Zain, in 2018[10]. The researchers introduced the work of the particle swarm optimization in feature selection that is to convert the large dimensional data to low dimensional by using the proposed method by the reduction to discard the irrelevant feature and increment the accuracy to select the subset of feature based on the suggested method. By using the dataset of breast cancer in the UCI, it was obtained high the accuracy and was the good results with compare other algorithms.

I. Babatunde Oluleye, Armstrong Leisa, Jinsong Leng and Diepeveen Dean, in 2014[11], they presented the proposal Genetic algorithm based on feature selection. In this work, the two types of dataset; is the Flavia Dataset and Ionosphere dataset in UCI repository of machine learning the dataset is depended randomly to binary number when is the feature is exist refer to "1" but the feature is not exist is referring the "0", the goal is the proposed is reduced the size of dataset, select the optimal subset the dataset and limitation the bad attribute ,this proposed is extracting the feature is useful, improvement the classification, accuracy and high results with compare the other algorithms in swarm intelligence, when is the require the high results and the GAFS is reduced the error rate, easy to get the optimal solution after the compare with neighbors and shortest distance, in this work the first dataset is investigate has accuracy 70% but the second dataset 90%, the proposed is used in many applications because the improve the accuracy and inquire the high results compare with other algorithms in swarm intelligent in feature selection method.

J. Huijuan Lu, Junying Chen, Ke Yan, QunJin, Yu Xueand Zhigang Gao, in 2017 [12], they produced the method, a Hybrid feature selection algorithm for Gene Expression. In this work use six types of datasets are Colon, Leukemia, Prostate, Lung, Breast and SRBCT in UCI repository machine learning, the goal of this proposed is reduce the dimensional from the original large dataset, reduce the size of dataset through to extract the relevant feature and remove the irrelevant feature, this work is increase the accuracy of classifier of feature and applied in many applications in classification, pattern recognition, datamining and others, because is inquire the fast speed, select the shortest way to obtained the optimal solution and high effective of the results and accuracy, This work reach the classification accuracy rates higher than 80% for all datasets. This proposed is used in many works in life because is good example is inquiring the best easy with the comparing with the other algorithms in swarm of feature selection when the results are high rate and the rate error is low.

4. COMPARISON STUDY OF INTELLIGENT FEATURE SELECTION METHODS

In this part will comparing the works of the swarm intelligent methods in many techniques when be used in feature selection, we were taking the Ant colony, Bee colony, Enhanced Cuckoo search and Particle swarm optimization, and the below the table consist of methods swarm to comparing among the idea of Proposed, the dataset, techniques / Tools, and results

TABLE I: Comparing among feature selection methods using swarm intelligent (SI)

Ref.	The idea of Proposed	Used dataset	Techniques / Tools	Results
[3]	The proposed the Ant colony optimization in feature selection to use to reduce the dimensional of the data set and to get the subset of feature it.	Used the nine datasets of the UCI.	The Ant colony optimization in feature selection.	The high accuracy of result with compare other algorithms.
[4]	The proposed the Ant swarm optimization in feature selection to obtain the optimal solution of select subset of dataset.	Used the dataset of KDD Cup 99.	The Ant swarm optimization (ACO) in feature selection.	The accuracy is the high with comparing other algorithms.
[5]	The proposed the Bee colony optimization in feature selection to use to reduce dimensional the data set and the increment the fast accuracy of feature selection.	Used the ten datasets of the UCI.	The bee colony optimization in feature selection.	The accuracy of results is the (75.65% against 71.48%) with compare other algorithms.
[6]	The proposed the Bee swarm optimization in feature selection to get the low dimension of	Used the four types of dataset in the UCI.	The Bee swarm optimization (BCO) in feature selection.	The accuracy is 96.5% with compare other algorithm.

	dataset and select the subset of data with fast and accuracy.		
[7]	The proposed the Enhanced Cuckoo search in feature selection to extract the optimal feature from the dataset and reduced the dimensional it.	The digital image of breast cancer dataset.	The Enhanced Cuckoo search in feature selection.	The accuracy of results the features 34 is the 98.75% average accuracy but when the features 29 the produced 99.13% average accuracy.
[8]	The proposed the Enhanced Cuckoo search in feature selection to reduce the dimensional and to get the high accuracy.	The dataset used of the five types the download http://www.gems system.org.	The Enhanced Cuckoo search in feature selection.	The feature selection at least accuracy is 93% average.
[9]	The proposed the Particle Swarm optimization in feature selection to extract the subset of dataset of feature selection and reduced the dimensional dataset.	Used the two types of the dataset in the UCI.	The Particle swarm optimization (PSO) in feature selection.	The accuracy it 85% with comparing other algorithms.
[10]	The proposed the particle swarm optimization in feature selection to reduce dimensional dataset and extract relevance of subset feature.	Used the medical diagnosis of breast cancer of the UCI.	The particle swarm optimization (PSO) in feature selection.	The accuracy it highest with compare other algorithms.
[11]	The proposed the Genetic algorithm based on feature selection method to reduce the amount of size the dataset.	Used the Flavia dataset and Ionosphere dataset in UCI.	The Genetic algorithm (GA) in feature selection.	The accuracy for dataset1 is 70% and accuracy for dataset2 is 90%.
[12]	The proposed the Gen algorithm based on feature selection to select the best subset from the dataset.	Colon, Leukemia, Prostate, Lung, Breast and SRBCT in UCI	The Gen algorithm (GA) in feature selection	The accuracy to this algorithm is 80%.

5. DISCUSSION

After the used to the feature selection by intelligent Swarm methods; Ant colony, Bee colony, Enhanced Cuckoo search, Particle Swarm optimization, Genetic algorithm, and the mention the related work to each of algorithm after that is been to compare among them in the table (1) above among the idea proposed, dataset used, Techniques /Tools and result .The obtained the strong and weak of points to the through the TABLE I the following results:

●The work of **[Ref. [3]** notice above the proposed of Ant colony is used the nine types of dataset to obtain the good and fast velocity of select the subset of feature selection and to make sure the results in feature selection, used the proposed to select the best sets of large, medium, and small, while this algorithm is failed in some fields when is alone. But when using in the feature selection good results and high accuracy, it works used in many fields because it has highly efficient and low cost, this proposed can reduce the size of subset and select parameters it uses in the work, this proposed is a sensitive the change in the size of set, the work of ACOFS is one consider improvement in the future it used this algorithm because it easily and efficiency with compare other algorithm.

●The work of **[Ref. [4]** the second proposed for Ant colony in this survey is used the good dataset is KDD CUP99 is aimed to select the subset of dataset and to access the optimal solution in short time and ways. Extracted the relevance feature and discard the irrelevance the features, this work is used to update the ways is existed in database. This proposed use improve classification for feature selection,

in many fields used this proposed which as classification, predication, detection because is easy, good work, high results and high accuracy in all cases with compare other algorithms in feature selection.

●The work of **[Ref. [5]** the proposed of Bee colony optimization is used the ten datasets from the UCI to make sure the results where the accuracy and number of features. This proposed based on the feature selection to select the subset of dataset, reduce the amount of size the dataset, high accuracy in classification, to select the relevance feature and eliminate the irrelevance features. This proposed use in many fields where help access to optimal solution and do not any problem exist in any field. This work used to convert the high dimensional to low dimensional easy study, so was applying easy, fast, effective, and low cost in all cases in all applications when compare with other algorithms.

●The work of **[Ref. [6]** the proposed of Bee colony optimization in feature selection used the four types in UCI to make sure the results in feature selection. This is very good to extract the relevant subset and remove the irrelevance the feature, when the select the subset feature is made the results is higher, accuracy in classification and predication. This proposed can access to best solution by easy the ways, this work is used in many fields because when applied do not happen any problem or difficult in applied. This proposed have highly efficient to select the subset of feature selection with comparison of algorithms.

●The work of **[Ref. [7]** the proposed of Enhanced Cuckoo search in feature selection is used the breast cancer of dataset to make the high of results, efficient in accuracy to select the best subset of data and reduce the amount size of dimensional the dataset where easy to select the subset of benefits feature and discard bad the feature. This proposed improve many fields such as classification, predication and it applied do not happen any problem or difficult when apply. It proposed have high good results and accuracy in access the optimal solution with compare another algorithm.

●The work of **[Ref. [8]** the proposed of Enhanced Cuckoo search in feature selection is used the five types of dataset in UCI. This proposed used to select the best subset from the dataset. This proposed achieve high accuracy, good results in select the subset of features and reduce the dimensional the data because easy to study. This proposed is applying in many fields and is using in improvement the algorithm such as classification, detection or any field do not happen any problem when it applies. This proposed achieve high results in all cases with compare other algorithms.

● The work of **[Ref. [9]** the proposed of Particle swarm optimization in feature selection for use two datasets to make sure the results in this work. Also study the work was obtained the high results, accuracy in select subset of feature selection. This work study easy to get the benefits features with discard bad features and achieve highly efficient in select subset. In this work was easy to extract the feature and convert the high dimensional to low dimensional of dataset to select the subset of data. This proposed is using in many applications because achieve better results and accuracy when comparing with other algorithms.

●The work of **Ref. [10]** the proposed of Particle swarm optimization in feature selection, this proposed is used the dataset of breast cancer when it reduces the dimensional of dataset and make work too fast for run in least time and select to subset of feature. After that to study the feature therefore easy; to achieve the low dimensional of the dataset, the high results, high accuracy and highest of effective the work but the feature selection when it work alone is difficult and slow the work but the feature selection when it work with PSO achieve high results and use in many application, all cases is had highest results, better accuracy and effective in classification, detection, predication with very fast and low cost with comparing other algorithms.

● The work of **[Ref. [11]** the proposed of Genetic algorithm based on feature selection methods is used to the two types of dataset in this work to make sure the results in this, reduce the dimensional size of dataset to make easy work in life and select the best subset from the dataset when it selects the relevant and important features and discard the irrelevant features from the dataset. This proposed for use in many applications in life and different ways to achieve the high results, high accuracy and very fast in execution. This work when use in classification is achieving higher accuracy, less little for user when use in this work in all applications in life which as the predications, detections, or other applications.

●The work of [**Ref. [12]** the proposed of the Genetic algorithm based on feature selection is used to the six types of dataset to make sure the results when obtained it, reduce the amount size of dataset when for select the best subset from dataset to achieve the higher accuracy and best accuracy because it when select the relevant and important features and discard the irrelevant features. This proposed use in many fields in life which as the classification is higher accuracy than before feature selection and used it in the detection and predications. This work in use many fields to easy the task and achieve the high accuracy when it uses.

6. CONCLUSION

In this survey paper, through the deep study of interesting in intelligent swarm optimization in feature selection processing methods, the access the conclusion after the discussion of the results in the table(1) above of each algorithm to obtained the results, the Ant algorithm is fast in execution, cost low, good results when select the subset from the dataset, work reduce the dimensional of dataset is used and is applied in some applications is success but other applications is take the high results, although the ACOFS used the many dataset also the accuracy is not very high is medium accuracy when comparing with other algorithms as Bees colony, Cuckoo search, Particle swarm and Genetic algorithm and used the proposed in the distinguishes between healthy and cancer patients based on their gene expression profile. The second algorithm Bee colony in feature selection is fast in execution, low cost and not take more places, can access the optimal solution in short ways, good accuracy is 75% and 96%. The proposed is applied in many applications, do not any problem existed in the fields, in all cases and the dataset is using many types although the many types of dataset but the results not high but high accuracy comparing with other algorithms Ant colony, Cuckoo search, Particle swarm and Genetic algorithm. This proposed is used to diagnosis of diseases in humans. The third algorithm Cuckoo search is very high, effective in work, used the little types of dataset and used the breast cancer of dataset. The ECFS is used to reduce the high dimensional of data the CS is get the highest fast, low cost and highest accuracy 96% but this algorithm do not any applications in some applications is success, many applications has failed comparing with other algorithms, Ant colony, Bee colony, Particle swarm optimization. Of the four algorithms, Particle swarm is the best method since it is fast compiler low cost, reduce the dimensional the dataset, PSO is used many datasets and so the algorithm in many applications in all cases is success but the accuracy is 85%, but the algorithm good when with comparing other algorithms Ant colony, Bee colony, Enhance Cuckoo search and genetic. This proposed used in the used in diagnosing and predicting various health-related diseases. The last algorithm in this survey the genetic algorithm is contents with the many types of dataset, execution in little cost and very fast in implementation the steps. This proposed is achieving the high accuracy to all dataset when it used which as the accuracy is 80% and 90% to each dataset when comparing other algorithms such as Ant colony, Bees colony, Cuckoo search, and Particle swarm. Where all the algorithms swarm intelligent is very good, high result and accuracy so is applied in many applications in life because fast in implementation in execution in feature selection with comparing other traditional algorithm.

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