A Proposed Intelligent Features Selection Method Using Meerkat Clan Algorithm

Noor Jameel, Hasanen S. Abdullah
University of Technology – Iraq
110443@uotechnology.edu.iq
110014@uotechnology.edu.iq

Abstract
The feature selection process stand to select the subset of feature from the set of datasets to get the relevant an important features and remove irrelevant features. The feature selection types are supervised, unsupervised or semi-supervised. The feature selection methods are divided into: traditional methods such as Correlation and Information Gain or others and intelligent methods such as fuzzy logic, or use the swarm intelligence methods in feature selection such as Ant colony and Bees colony. This paper proposes an Intelligent Features Selection method based on Meerkat Clan Algorithm (IFS\MCA) system, when it used the modern MCA as first time to use the algorithm in feature selection to select the best subset of feature. This proposal used four set of dataset which as (Fried_c4, Sonar, Scene, Satellite), the efficiency of the proposal in feature selection is powerful and high accuracy when comparing with other standard methods in feature selection which as Correlation and Information gain when use the same set of dataset. The proposed IFS\MCA system uses the Mean Absolute Deviation (MAD) as a proposed choice as a fitness function (which is used as a first time with feature selection process).

Keyword: Meerkat Clan Algorithm, Feature Selection, Swarm Intelligence, Information Gain, Correlation feature Selection.

1. Introduction
A feature is a stand-alone characteristic of being observed that can be read measured, a set of attributes can be used in machine learning algorithm for classification. Feature selection has been a useful and developing research field has work for select the relevant feature, removing limitation and irrelevant features [1]. Feature selection there are many contained traditional methods in feature selection which as Filter, wrapper, information gain or correlation feature selection [2], feature selection is consisted the three classified, supervised, unsupervised and semi-supervised, the supervised is used in the classification, the unsupervised is using in many times in clustering. Usually in feature selection using the semi supervised in label small datasets because the in many times is the best select because the supervised and unsupervised is not appropriate in all selected [3].

Artificial intelligence in feature selection, the aims is to obtain the subset of feature to describe the problem and in many applications is using in understand the data, storing the data, reduce size the data and improving the accuracy [4], feature selection is used many applications, but the swarm intelligence have effectively to find the subset of data with comparing of traditional methods [5].

In this paper presents many parts, firstly the related work of many algorithms in swarm intelligence, secondly offer the set of dataset when used the four types datasets from UCI repository machine learning and thirdly used the algorithm modern and one first time used in feature selection which as Meerkat clan algorithm and the details algorithm.
2. Related work

In this paper is presented the some works in approach from the Meerkat clan algorithm, this section is presented asymptotic studies.

A. Sibel Arslan and Celal Ozturk, in [6] 2019, they are introducing the method “Feature Selection for Classification with Artificial Bee Colony Programming”, the aim of this work to find the useful properties and limitation the noisy attribute, improvement the accuracy classification and reduce the size of dataset when to select the subset from the original large of dataset.

B. Huijun Peng, Chun Ying, Shuhua Tan, Bing Hu and Zhixin Sun, in [7] 2018, they produced the method “An Improved Feature Selection Algorithm Based on Ant Colony Optimization”, the proposed work is selected the subset dataset from the original large dimensional dataset to reduce the size of dataset and select the feature of relevant, discard the irrelevant feature, the proposed the ACOFS is improvement the path transfer by the fitness function of Ant algorithm to the update pheromone for this algorithm.

C. Huijuan Lu, Junying Chen, Ke Yan, QunJin, Yu XueandZhigang Gao, in [8] 2017, they produced the method” A Hybrid Feature Selection Algorithm for Gene Expression Data Classification” the goal of this proposed is reduce the dimensional from the original large dataset through to extract the relevant feature and remove the irrelevant feature, this work is increased the accuracy of classifier of feature and applied in many applications.

D. Waleed Yamany, Nashwa El-Bendary, Aboul Ella Hassanien and EidEmary, in [9] 2016, they presented the proposal ”Multi-Objective Cuckoo Search Optimization for Dimensionality Reduction” the goal of this proposed is to reduce the size of datasets, select the subset of relevant of attribute and select the optimal solution in fast, this proposed work is increase the effectives and improvement the accuracy.

3. The Set of Dataset in Proposed

In this paper of proposed IFS\MCA system use the four set of dataset to evaluate the selected feature for make sure the results of features selection, as follow the set of dataset.

A. Fri_C4 dataset

The alternative dataset used to work was the fri_c4_1000_100 dataset from the University College London machine learning repository available at http://archive.ics.uci.edu/ml/datasets/fri_c4_1000_100. Inventor by The Friedman datasets by J.H. Friedman (1999), the dataset content the 100 features, the class is 101 and 1000 instance is numeric all features and instance but the class is nominal which as with a least label value as positive ('P') and all otherwise negative ('N'), not contain the missing values.

B. Sonar dataset

Sonar, Mines vs. Rocks, This is the data set use by Gorman and Sejnowski in 1988, The alternative dataset used to testing the work was the Sonar dataset from the University College London machine learning repository available at http://archive.ics.uci.edu/ml/datasets/Sonar, Every pattern is a set of 60 features and all feature contain numbers in the range 0.0 to 1.0 but the class linked with each record contains the letter "R" if the object is a rock and "M" if it is a mine (metal cylinder).

C. Scene dataset

This dataset scene in dataset from the University College London machine learning repository available at http://archive.ics.uci.edu/ml/datasets/Scene by Matthew R. Boutell, Jiebo Luo, Xipeng Shen, and Christopher M. Brown, in 2004, the current dataset is a binary classification problem considering just the ‘Urban’ class. This dataset consist from Instances is 2407, number of features is 299 and the class is 300, this dataset is contained the values is numeric unique value in 294 the vale is between [0,1], but contain the one class is Urban is having the two values are urban or not urban , this dataset is not contain the missing value.

D. Satellite dataset

This dataset Satellite in dataset from the University College London machine learning repository available at http://archive.ics.uci.edu/ml/datasets/Satellite, By Goldstein, Markus, and Seiichi Uchida, in (2016), the satellite dataset consists of features extracted from satellite observations. Contain the 36 number of features but the class is been the nominal are “P” or “N” and not contain the missing value.
4. The Meerkat clan Algorithm (MCA)
Meerkats are research animals living in big open networks with many entrances in which the animals leave just during the day. The Meerkat is an exceedingly friendly animal that occupies ranges in the abandon in bunches that more often than not contain in the near of 10 and 30 member, and comprise of three or four families of a male and female conformity [10], with their young. In the wake of standing up out of their tunnel to sunbathe in the early morning sun, more of the band heads out to rummage for sustenance while others either keep an eye on youthful. The Meerkats are social animals that live in groups of 5 – 30 members [11]. Being friendly creatures, they share both toilets and parental care duties. [12].

5. The Proposed Feature Selection Method Based on MCA
In this paper, we will presentation the feature selection in the three methods to reduce the amount of dataset, select the best feature, irrelevant the worst feature and reduce the noisy in dataset to get the high accuracy in least time, when it used the two methods traditional methods are Correlation evaluation (CFS) and Information gain (IG) and one method is swarm intelligent as Meerkat Clan algorithm (MCA), in next sections is explain the MCA in details.

5.1 The Proposed Design Method
In this paper, we used the proposed suggestion is the Meerkat clan algorithm in feature selection is one the animals of swarm intelligence, we attempted to work the animal swarm in feature selection to get the best solution and reduce the dimensional dataset, the Meerkat clan algorithm is consisted the many steps to work as figure (1) for structure the algorithm MCA in IFS. But the main steps for algorithm MCA when to use in FS is consisting as follow:

1. Generate the population in clan randomly for each solution.
2. Apply the equation of fitness function MAD to the clan.
3. Choice the best subset from the solution which as a Sentry.
4. Split the rest of clan into two a main sets (Foraging and Care).
5. Generate the neighbors for each solution in foraging group.
6. Replace the bad solution in foraging set with best solution in other set as care set.
7. Generate the new random solutions and replace with the bad solution in care set.
5.2 Generate Clan.

The initial population clan in this work is generated when we begin is reading the set of datasets (1, 2, 3, 4) by randomly represented by the matrix of dimension population size clan C, clan length is contained the only binary digits randomly but the value in the dataset is keep same it, but clan population is representing by binary number of matrix ‘0 and 1’ when the bit is ‘1’ if is select the feature in this matrix but otherwise ‘0’ is not selected, After the generation clan when the reading dataset is (Fri_c4, Sonar, Scene, Satellite), each dataset is represented in matrix, it is representing the clan of Meerkat algorithm.

The table below is contained the variables or parameters when it used in this proposed of IFS\MCA system, the table (1)
Table (1): Parameters Used in Proposed IFS\MCA System

| MCA Parameter       | Value                  |
|---------------------|------------------------|
| Clan Length         | 50                     |
| Fitness Function    | Mean Absolute Deviation (MAD) |
| Size Foraging group | 60%                    |
| Size Care group     | 40%                    |
| Number of Iteration | 50                     |

The table(1) above is contained the main of variables when contain in the proposed IFS\MCA system the clan length is representing the population size of clan in based on N, the fitness function when it use in this proposed IFS\MCA system the MAD in used it to find the best subset of clan, the clan of algorithm is split for two main parts are foraging group, care group the foraging group is take the part on from the clan is representing the 60% but the care group is take the rest of clan and representing the 40%, but the number tournament in the proposed IFS\MCA system.

5.3 The Mean Absolute Deviation (MAD) Fitness Function

The Fitness function is one the equations of mathematical when is used in different applications is consisted of many parts and use in many applications, this fitness equation is proposal in first time in feature selection. It is found the fitness function by the steps:

- Find the summation all number in dataset.
- Find $a_i$ is equal the total number in dataset.
- Find the mean of dataset be the summation number divide by $a_i$, eq.(1).
- Find the absolute between every number in dataset mines of mean to dataset, eq.(2).
- The result of absolute is dividing on the mean, eq.(3).

The steps above is very important when we want to use the MAD of fitness function to help to find the best solution, use to evaluate the weights for best subset or sentry after when is find from the clan algorithm of feature when is applying the feature selection in the algorithm of Meerkat Clan (MCA), it work after the generate the clan of algorithm and representing the clan by binary number is entering the fitness function for stand up search in the clan about the results best feature, the driver for the MAD to find the best subset, the MAD function based on the maximum value of feature when the feature maximum value is the best feature is sentry, but the feature is least value is worst feature, the MAD function is solved the problem selection by using the mean to each feature in the dataset $a_i = (a_{i1}, a_{i2}, a_{i3}, a_{i4}, a_{i5}, \ldots, a_{im})$, by equation (1).

$$X_{i\bar{a}} = X_i/a_i \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$X_{\bar{a}} = \text{mean number}$$

$$X_i = \text{summation of number}$$

$$a_i = \text{total the number}$$

When find the mean number of the value of $a_i$ of feature in the set of dataset $1,2,3,4$, now apply it the in the equation MD,

$$MD = \sum \text{absolute} (A_i - X_{\bar{a}}) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$
\( A_i \) = every number in the feature.
\( X_{ii} \) = mean number.

The equation (2), stand of the take is absolute between every number of feature minus the mean of feature, after that applying the equation (3) below:

\[
\text{Fitness function } \text{MAD} = \frac{MD}{a_i} \tag{3} \tag{3} [13].
\]

\( \text{MAD} = \text{fitness function} \)

\[ \text{MD} = \text{Absolute} \left( A_i - X_{ii} \right) \]

\( a_i = \text{total the number} \)

The fitness function in the equation (3) to find the weight to each feature and to see where is the best feature, where the max value for feature representing the cost function, below proposed equation (4).

\[
\text{cost} = \text{MAD} \tag{4}
\]

After find the fitness function to every feature in every set of dataset, must be find the normalization to fitness to modified the scale to every dataset (1,2,3,4).

5.3.1 Applying Normalization to Fitness Function

When the MAD function is using only just work on the number of features on the set of dataset, while the fitness function MAD do not used the letter or word, just take the numbers therefore; it used applying the normalization on the fitness function and make the values between the number is [0, 1], when the results of the MAD fitness is equal ‘1’ become is max value but the ‘0’ number is become the min value in fitness function, the equation(5),

\[
\text{Normalization (MAD)} = \frac{\text{fitness(old)} - \text{minVal}}{\text{maxVal} - \text{minVal}} \tag{5} \tag{5} [14]
\]

\( \text{MAD} = \text{fitness function} \)

\( \text{minVal} = \text{min fitness} \)

\( \text{maxVal} = \text{max fitness} \)

When find the max value to fitness function is representing the best fitness or best subset is representing the sentry in the clan when the value of fitness is equal ‘1’ value, but otherwise is the min value is ‘0’ is representing the worst solution.

5.4 The Sentry (Best Subset)

When the algorithm is generated clan is pushing to the fitness function MAD to evaluate the weights for the clan, if the results is max value of MAD is representing the sentry or best subset but the least value of MAD is not selected the sentry or not representing the best subset.

5.5 Foraging Group and Care Group

When is selected the best solution or best subset is representing the sentry after that, the clan is split to two parts as:

A. Foraging Group (FG)

When the clan is divided to two main parts is foraging group and care group, the foraging group is representing the important part from the clan is representing the first and longest part than care group, the foraging group is important so began search about the best subset or sentry in each dataset but not contain the best subset not exist sentry.
B. Care Group (CG)

The second group of clan or rest in the clan is representing the care group, the foraging group is contained the best subset but is not found in foraging group is began to replace the solutions with care group, the care group in some time is contain the best subset and begin replace it with the worst solution in foraging, but the care group is contained the worst solution begin for remove the solutions and generate new solution randomly.

5.6 The Proposed of Neighbors Foraging Group Generation

After that is began to generate the neighbors K for the foraging group to search about the best subset of solution, when generate the new neighbors K to foraging group where the new neighbors is pushing the generate_neighbors (c3,c4,c5) to the fitness function(F3, F4, F5) again the search in generate_neighbors to obtain the best solution where possible the generate_neighbors is contained the best solution, therefore; is entering again the (c3, c4, c5) to the fitness function, where find the best solution in generate_neighbors is began the replace with the old members in the clan are(r1, r2, r3) is care group, as show below the proposed equation(6):

\[ \min(fitness(f)) = \max(fitness(f+1)) \] \hspace{1cm} (6)

(f+1) =care group

While the care group is consisted the worst solution fitness is removed the solution and begin generate random solution, show the proposed equation (7).

\[ care(care_worst) = rand.sol \] \hspace{1cm} (7)

In the end, the begin search in the foraging group about the best solution in fitness function must be is high value is the sentry fitness, show proposed equation(8).

\[ best\_fitness = sentry\_fitness \] \hspace{1cm} (8)

5.7 The Implementation of Feature Selection Method Based On MCA

In this paper, after when the mention the details of algorithm MCA when work the feature selection where the algorithm of MCA is became as follow after work the feature selection.

Algorithm(1): MCA for IFS

Input
Set of dataset (1, 2, 3, 4)
N = size clan 30 to 50
M =size foraging group where M < N
C =size care group N-M-1
FR =worst foraging rate
CR =worst care rate
K= neighbours solution

Output
Sentry (Best subset of feature)

Begin
Step1: Generate clan randomly of feature to inspire a clan of solutions clan (N)
The algorithm above is containing the all steps of algorithm when starting the generate clan, applying fitness function of MAD, find the best subset which as sentry, after that split the clan to main groups such as Foraging group and care group, so starting to generate the neighbors for the foraging group and continue to find the sentry or best subset.

6. The Results and Discussion of Features Selection Methods

We will offering the results of proposed IFS/MCA system and comparing with the traditional methods in feature selection which as IG and CFS. So will offering the results of proposed system and comparing with the intelligent methods which is mention in section2 (Related work) which as Ant colony, Bees Colony, Cuckoo search and Genetic algorithm, as follow.
6.1 The Results of Proposed IFS\MCA System with Traditional Methods

In this section, is offering the results of the feature selection methods, when it use in three methods as proposed IFS\MCA system, IG and CFS to each dataset, each method and comparing between them about the number of features and accuracy, as follows the tables (2), (3) and (4)

*Table (2): The Results of Proposed IFS\MCA System with Set (1, 2, 3, 4) of Dataset*

| Dataset Name  | Feature Number | Number of Selected Feature | Accuracy of Selected Feature |
|---------------|----------------|----------------------------|----------------------------|
| Fri_c4 Dataset| 100            | 24                         | 87.5%                      |
| Sonar Dataset | 60             | 15                         | 93.33%                     |
| Scene Dataset | 299            | 70                         | 82.26%                     |
| Satellite Dataset | 36          | 12                         | 83.33%                     |

*Table (3): The Results of Information Gain with Set (1, 2, 3, 4) of Dataset*

| Dataset Name  | Feature Number | Number of Selected Feature | Accuracy of Selected Feature |
|---------------|----------------|----------------------------|----------------------------|
| Fri_c4 Dataset| 100            | 30                         | 73.33%                     |
| Sonar Dataset | 60             | 19                         | 84.21%                     |
| Scene Dataset | 299            | 79                         | 72.15%                     |
| Satellite Dataset | 36          | 13                         | 76.92%                     |

*Table (4): The Results of Correlation Feature Selection with Set (1, 2, 3, 4) of Dataset*

| Dataset Name  | Feature Number | Number of Selected Feature | Accuracy of Selected Feature |
|---------------|----------------|----------------------------|----------------------------|
| Fri_c4 Dataset| 100            | 30                         | 73.33%                     |
| Sonar Dataset | 60             | 19                         | 84.21%                     |
| Scene Dataset | 299            | 79                         | 75%                        |
| Satellite Dataset | 36          | 13                         | 76.92%                     |

- Notice above the table (2) is contained the original number in each dataset when used in proposed system, number of selected feature after work the feature selection and accuracy for each dataset after when comparing with traditional methods as IG and CFS, we notice the results of proposed system the number of feature is less than IG and CF for each dataset and accuracy is high when comparing with accuracy in traditional methods for every dataset.

- The table (3) notice the number of selected feature in IG for each dataset is more than proposed system but accuracy is low than proposed system.
The table (4) the number of selected feature in CFS is more than proposed system so the accuracy is less than the proposed IFS\MCA system.

Notice above the three tables (2, 3, 4) the results of proposed IFS\MCA is best than IG and CFS where the selected number of feature and accuracy for all dataset.

### 6.2 Comparing the Results of Proposed IFS\MCA System with Related Work

We will the offering the results of proposed system and comparing with the results of intelligent methods (related work) when mention in section2 which as Ant colony, Bees colony, Cuckoo search and Genetic algorithm about the accuracy, as follow in table (5).

**Table (5): Comparing the Results of Proposed IFS\MCA System with Related Work**

| Researcher Name and Year | Techniques | Accuracy |
|--------------------------|------------|----------|
| 1- Sibel Arslan and Celal Ozturk, 2019 [6] | Feature Selection for Classification with Artificial Bee Colony Programming | Accuracy is dataset1 is100 %, dataset2 is 93% |
| 2- Huijun Peng, Chun Ying, Shuhua Tan, Bing Hu, and Zhixin Sun, 2018 [7] | An Improved Feature Selection Algorithm Based on Ant Colony Optimization | 98% |
| 3- Huijuan Lu, Junying Chen, Ke Yan, QuinJin, Yu XueandZhigang Gao, 2017 [8] | A Hybrid Feature Selection Algorithm for Gene Expression Data Classification | 80% |
| 4- Waleed Yamany, Nashwa El-Bendary, Aboul Ella Hassanien and EidEmary, 2016 [9] | Multi-Objective Cuckoo Search Optimization for Dimensionality Reduction | 80% |
| 5- The Proposed IFS\MCA System | Intelligent features selection method using MCA | Accuracy for dataset1, 2, 3, 4 are (87.5%, 93.33%, 82.26%, 83.33%) |

Notice above the table (5) is contained the results of intelligent methods in feature selection and have been comparing with the results of proposed IFS\MCA system. Where was the results of first work the accuracy, it was for dataset1 is 100% but dataset2 is 93%, the second work the accuracy is 98%, the third work accuracy is 80%, the fourth work of accuracy is 80% and lastly work the accuracy of proposed IFS\MCA system where the accuracy are (87.5%, 93.33%, 82.26%, 83.33%) for dataset (1, 2, 3, 4), where the proposed accuracy was higher than third work and fourth work and the proposed IFS\MCA system contained four type of dataset where was more resolution than other work.

### 7. Conclusion

Through the working of proposed IFS\MCA system to reduce the dimensional the size of the set of dataset when it used and obtained the results from the system implementation, where use the fitness function MAD in this proposed IFS\MCA system helps to reduce the dimensional size of dataset and extract the only important features and remove the irrelevant features and help to easy access to the best subset in less time and high results, use the normalization to the fitness function MAD is important to
modify the scale to the results for the fitness function and the scale must be between [0, 1] to upgrade the fitness function working with any dataset and make it more powerful and achieving the proposed IFS\MCA system is getting least the number of features to each dataset and the high accuracy to each dataset when it use as 87.5% to dataset1, 93.33% to dataset2, 82.26% to dataset3 and 83.33% to dataset4 when comparing with the traditional methods as IG and CFS methods.

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