ISSN (Print) : 0974-6846
**Indian Journal of Science and Technology,** *Vol 8(24), DOI: 10.17485/ijst/2015/v8i24/59219, September 2015* ISSN (Online) : 0974-5645

# A Brief Survey of Honey Bee Mating Optimization Algorithm to Efficient Data Clustering

**T. Chakaravarthy[1*] and K. Kalyani[2]**

[1]A.V.V. M. Sri Pushpam College, Poondi, Thanjavur-6, Tamil Nadu, India; tcvarthy@gmail.com
[2]T.U.K. Arts College, Karanthai, Thanjavur-2, Tamil Nadu,India; kkalyasingh@gmail.com

## Abstract

**Background:** In contemporary years Honey Bee mating Optimization algorithms have been extensively used as specific research and optimization tools in numerous domain that has critical issues related to Science, technology, commerce and Engineering. Due to the simple and flexible nature of the HBMO algorithm, it has been used in load profile clustering in present day situation. **Objectives:** This survey paper attempts to provide a comprehensive survey of research application of HBMO on load profile and elucidate the constraints and convergence properties of the algorithm and highlights its application in solving certain current issues by enhancing its approach with innovative changes that could be adopted within the context and requirement of the problem to be addressed. Through this survey paper It is shown that the Load profile clustering could be performed in an economical and efficient manner by applying HBMO algorithm with certain changes in time and length of metering and the results obtained through this method are quite promising and comparable well with the final results of the other approach.

**Keywords:** Clustering, Honeybee Mating Optimization Algorithm, Load Profile

## 1. Introduction

This paper has presents a brief survey on the previous approaches and techniques in load profile clustering using Honey Bee mating Optimization Algorithm (HBMO) under different context by various researchers and their merits and demerits are discussed[1–3]. Specifically, the method is compared with limitations of swarm intelligence features in similar application. Subsequently, the characteristics of HBMO in load profile clustering are identified to have better efficiency in addressing the current issue of metering for small customer. In our proposed work the HBMO is enhanced as CASEBO, RIBO and ERIBO. The implementation of the ERIBO algorithm to the LP-clustering problem requires some adaptation and specification. This algorithm implemented to the LP-clustering problem was studied for two distance metrics ETx and ERx. The extensive results indicate that ERIBO can effectively balance the energy consumption of the entire models such as Hbmo, Pso and Casebo, Ribo.

## 2. Clustering in Load Profile

The aim of cluster analysis is to bunch objects into clusters so that objects within one cluster share more in common with one another than they do with the objects of other clusters. Consequently, the purpose of the analysis is to arrange objects into relatively similar groups based on multivariate observations. Cluster exploration is a term used to designate a family of statistical measures specifically designed to notice classifications within complex data sets. Clustering data aims to capture the structure in heterogeneous group of data. These hierarchies define collections (or) clusters of data which are unambiguous inside a group and ambiguous between different groups. The final solution of a clustering

* *Author for correspondence*

algorithm or hierarchy depends in great extent on the classification used to partition of unambiguous and ambiguous data. Although, investigators in the behavioral and social sciences are often interested in clustering people, clustering nonhuman objects is common in other disciplines[4–6].

### 2.1 Application of Clustering Algorithms in Various Fields

The application of clustering algorithm includes the following:

- Marketing: finding groups of customers with similar behaviour given a large database of customer data containing their properties and past buying records;
- Biology: classification of plants and animals given their features;
- Libraries: book ordering;
- Insurance: identifying groups of motor insurance policy holders with a high average claim cost; identifying frauds;
- City-planning: identifying groups of houses according to their house type, value and geographical location;
- Earthquake studies: clustering observed earthquake epicentres to identify dangerous zones; WWW: document classification; clustering weblog data to discover groups of similar access patterns.

### 2.2 Significance of Load Profile Clustering

Though, Clustering algorithms are applied in different kinds of applications such as web optimization, finance, biology, image processing etc. The clustering problem defined in this paper refers to the load description based on electricity distribution network and one of the consumer models is Typical Load Profile (TLP).

A TLP explain the hourly values of electricity consumption on a daily basis and associated to consumer category. TLP scan be delineated for residential, commercial, industrial and for seasonal factors. It can be established for seasonal factors of climatic conditions that are likely to occur in future using regressed technique. Most widely used approach to structure TLP consist of gathering actual LP for various consumer categories, metered in network supply points and process them using clustering algorithm to build TLPs. In order to setup a TLP portfolio for any public utility, it must define a set of TLP that can accurately provide load characteristics for all consumers in its self as a network. If the portfolio includes the maximum TLP and extensive consumers, then it is the best representation of consumers in terms of accuracy.

The customer load profile clustering method is used to make the TDLP to estimate the quarter hourly load profile of non-AMR customers. There were studies that examined the repeated clustering method in improving the ability to discriminate among the TDLP's of each cluster[7–9]. Clustering techniques are exceptionally useful for assisting the distribution service providers in the process of classifying electricity customer on the basis of load pattern shape.

## 3. Past Studies using Clustering Techniques in Load Profile

The past studies have demonstrated the possibility to reduce the size of the data used and put in the clustering procedure in order to store a smaller amount of data in the electricity company's database and to speed up the clustering calculations. In the 1980, Kohonen introduced the Learning Vector Quantization (LVO) based on competitive layers. In which neurons competes with each other for the right to respond to a given input vector. Individual neurons learn to become feature detection. Fuzzy methods entail work with data collections whose boundaries are not clearly defined by means of the so called membership functions. A SOM development is presented to achieve the segmentation and demand pattern classification for electrical customers on the basis of database measurements. Two different approaches can be used for load profile based on payment or the area model and the category model (EURELECTRUC ref, 2000). The category model requires the setting up of Typical Load Profile (TLPS) that represents coherent groups of consumers (Sanghvi, A.P., Levy, R 1985).

Birch AP and Ozverenc. S, (1992) proposed a methodology that is not time consuming and forms clear and representative groups. Since Clustering methods are a part of pattern recognition methods. They are a popular approach to unsupervised classification in which the pattern is assigned to a hitherto unknown class. In the pattern recognition literature, a lot of different types of clustering algorithms, such as Self-Organised Maps (SOMs), K-Means clustering (Km), Fuzzy C-means (FCM), Hierarchical Clustering (HC) etc, can be found each having its own advantages and limitations cluster validity measures tackle the problem of finding a natural or optimal number of clustering[17–19]. The study carried

out by Birch AP and Ozverenc.S, (1992) established how to develop a method of profile clustering for the design of tariffs and a process of classifying any given pattern in to these clusters using fuzzy reactions (Birch AP and Ozverenc.S, 1992).

### 3.1 Key Features of Load Profiling

- The amount of data to be handled by the network company will increase.
- The work related to handling of the profiling system is reduced or avoided.
- The supplier will have fewer amounts of time and money involved in the later correction of the balance settlement between the suppliers in the network.
- More or all customers get access to participate in the electricity spot market and to offer Demand Response by flexible loads, provided that their balances are calculated based on hourly metered data and not based on load profiles.
- The residual consumption is defined as the total consumption in the grid companies less the total of hourly measured/hourly settled end user consumption. The loss in the distribution grid is also included in the residualconsumption and is made up as an "ordinary" settlement of load profile on the consumption[14–16]. In other words the losses are handled as a profile customer belonging to the network company.

## 4. Honey Bees in Nature

A new optimization algorithm based on honey bee mating, first proposed by Afshar et al. (2007), has been used to solve difficult optimization problems such as optimal reservoir operation (Haddad et al, 2007) and clustering (Fathian et al. 2007). Honey Bee Mating Optimization Algorithm (HBMO) is a search based optimization algorithm that mimics the mating behavior of Honey bee. In this method, Distributed Generators and loads that do not have constant output are considered as the state variables, in which the differences between measured and calculated values are assumed as the objective function. Honey bees are considered to perform one of the most complex communication tasks, in the animal world. Indeed concepts of memory attention, recognition, understanding, interpretation, agreement, decision making, and knowledge as well questions about cognition and awareness have appeared regularly in honey bee literature. Bees are used to share info about location and nature of the resources.

Honey bee mating algorithm (Figure 1.) can be considered as a general method based on insect behavior for optimization which, the search algorithm inspired from mating process in real bees life. Honey bee behavior is an interaction among genetic potential, physiologic and ecologic environment of hive social conditions and the hybrid of mentioned cases. A honey bee hive including: a queen with long life for laying eggs, about 10000 to 60000 worker bee, and up to hundreds of drone (according to the season). Queens have the main roll to generate some honey bee species, and laying eggs. Drones are the hive father. They are mono-sexual and intensify the mother genes without changing in their genetic combination. Worker bees do laying eggs and mother-craft. Queen bee would feed by "royal jelly" that is a milky white jelly. Worker bees hide the dietary substances and consume it for the queen. This kind of feeding makes the queen larger than the others. The queen lives between 5-6 year, while the worker bees live about 6 months.

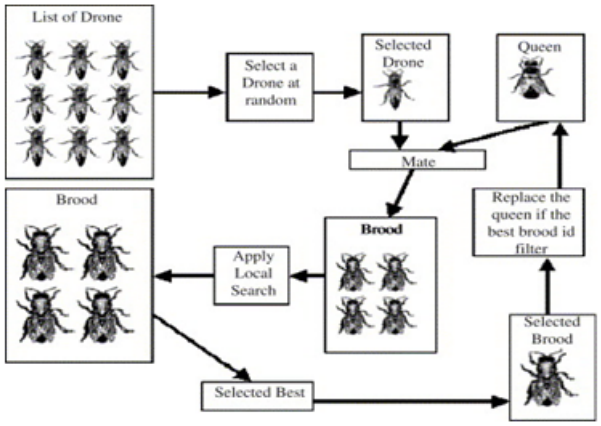


**Figure 1.** Honey Bee Mating Process.

Mating flight starts with a special dance by queen. Drones follow the queen and mate with her in the air. In a usual mating flight, she mates with about 7 to 20 drones. Sperms would collect in spermatheca and store there in any mating operation. Drones will die after mating, but their sperm would store in spermatheca. It means that queen will mate for several times and with several drones, but drones are able to mate for only one time. This kind of mating will make exclusive bees mating in comparison with the other insects.

At the beginning of mating flight, queen's energy is determined and at the end ofany iteration – when queen return to the hive – her energy may reduce. If her spermatheca has got full or her energy has reduced to

zero, the queen would return to the hive. Any worker as an investigative function, promote the generation or take care a set of broods. At the beginning of a mating flight, drones are generated randomly and the queen selects a drone using the probabilistic rule[20–22].

### 4.1 Mating Process

Abbas 2001a, Afshar et al. 2007, presented mating flight starts with a danced performed by the queen who then starts a mating flight during which the drones follow the queen and mate with her in the air. A drone mates with a queen probabilistically according to queen's speed & fitness of the queen and drone. Sperm of the drones will be deposited in the queen's spermatheca to form the genetic pool of potential broods to be produced by the queen. The mating process which is based on crossover and mutation operation.

### 4.2 Crossover Operator

The Second stage of evolutionary process starts after the genetic was filled with chromosomes and consists in breeding eggs with genetic information from spermatheca modified queen bee evolution model by using the weighted crossover operator and applied the algorithm for the tuning of input and output scaling factors. Karci (2004) proposed a crossover operator type inspired by the sexual intercourses of honey bees. The operator selects a queen bee as a parent of crossover by the best fitness, worst fitness and sequentially. A novel crossover operator type inspired by the sexual intercourses of honeybees. The method selects a specific chromosome in present population as queen bee. While the selected queen bee is one parent of crossover, all the remaining chromosomes have the chance to the next parent for crossover each generation once. For this purpose, we defined three honey bees cross over methods. They modified the method by a new recombination from crossover operator (Ramkumar et al. 2009).

- In the first method, the chromosome with the best fitness score this queen honey bee and it is a fixed parent for cross over in current generation.
- The second method handles the chromosome with the worst fitness score.
- Finally, queen bee is changed sequentially in each generation.

### 4.3 Mutation Operation

Final stage of evolution process consists in raising the broods generated during the second stage, and creating a new generation of bee based on mutation process.

### 4.4 Honey Bee Mating Optimization Algorithm (HBMO)

Thus, an HBMO algorithm maybe constructed with the following five main stages:

- Table 1 explain the HBMO algorithm starts with the mating flight, where a queen (best solution) selects drones probabilistically to form the spermatheca (list of drones). A drone then selected from the list randomly for the creation of broods. Creation of new broods (cluster centers) by crossover the drone's genotypes with the queens.
- Use of workers (heuristics) to conduct local search on broods (trial solutions).
- Adaptation of worker's fitness, based on the amount of improvement achieved on broods.
- Replacement of weaker queens by fitter broods.
- Honey bee algorithm proposing is composed by three main a citrates.
- Exploration recruitment.
- Harvest.

**Table 1.** HBMO process

| Natural honey bee | Artificial honey bee |
|---|---|
| Queen | Best Solution |
| Drones | Incumbent solution |
| Broods | New trial solution |
| Worker | Heuristic Search |
| Mating, Breeding | Crossover |

## 5. Previous Studies and Application of HBMO

The Honey Bee Mating Optimization algorithm (HBMO) combines a number of different procedures. Each of them corresponds to a different phase of the mating process of the honey-bee that is presented in (Afshar et al. 2007).

Abbas (2001a) presented an optimization algorithm model based on the marriage in honey bees (MBO). Marinakis et al. (2008a) introduced a hybrid algorithm (HBMOVRP) based on Honey bees Mating Optimization for solving the vehicle Routing Problem, Which combines a Honey bees Mating Optimization (HBMO) algorithm and the multiple phase Neighbourhood Search-Greedy Randomized Adaptive Search Procedure algorithm. Markinakis et al. (2008b) used Hybrid Honey Bee Mating

Optimization algorithm (HBMO) combining MBO and GRASP for optimally clustering N objects into K clusters[10–13].

Honey Bee Mating Optimization algorithm (HBMO) provides more robust and acceptable solutions in reservoir operation optimization problem. Bazong Haddad and Afshar (2004) presented an optimization problem.

### 5.1 Key Advantages of HBMO

Due to the advantages of application of HBMO in real life problems, there has been an exponential increase in the number of research papers demonstrating the successful application of HBMO- based algorithm in a wide range of domains, including load profile clustering and electricity distribution network analysis.

The key advantages of HBMO algorithm are: Adaptability, Robustness, Scalability and integral simplicity.

- Adaptability: HBMO algorithm respond better to rapidly changing environments, with their capabilities to adapt in a flexible manner.
- Robustness: HBMO algorithm has the highest fault-tolerance capability and system keeps away from the risk of failure at most of the crucial circumstances.
- Scalability: HBMO algorithm are highly scalable; their remarkable capacities are generally maintained when using applied to a larger groups.
- Integral Simplicity: HBMO algorithms are fairly simple to perform the functions with sufficient potential emerge as a sophisticated algorithm without losing the integral functions of the system.

## 6. Overview of Proposed Work

The HBMO algorithm process the Probability of successful mating is based on the three parameters at each iteration, the optimal best fitness is identified based on probability. In our proposed work of Casebo algorithm, the fitness is enhanced based on the relationship of datas.

Table 2 explain the Fitness Function is evaluated with Parameters of Sustainability Energy, Receiver Energy and Transmission Energy and the distance of relationship between Cluster nodes to cluster head and Cluster Association.

The RIBO is proposed and enhanced with fitness f3 and f4, the following states the proposed procedures as follows.

Table 3 explain the RIBO algorithm the Fitness Function is evaluated with Parameters of Sustainability Energy, Receiver Energy and Transmission Energy and the distance of relationship between Cluster nodes to cluster head and Cluster Association.

**Table 2.** CASEBO

| **Cluster Association using Sustainable Energy Based On Bees Optimization Algorithm (CASEBO) :** |
|---|
| STEP: 1 Unequal Random Cluster should be formed by using enhanced KNN Algorithm. |
| STEP: 2 Sustainability energy is considered for each tuple to analyze the lifespan of the cluster. |
| STEP:3 Analyze the Relationship announcement array of data. |
| STEP:4 Analyze the Relationship Delivery array of data . |
| STEP:5 Predict a Cluster Head for each unequal cluster by using the sustainability Value which is calculated in Phase 2. |
| STEP:6 Derive the distance value of each clusters . |
| STEP:7 Predict the Best Fit in every iteration using the above Steps. |
| STEP:8 End. |

**Table 3.** RIBO

| **Replacement In Bees Optimization Algorithm(RIBO) :** |
|---|
| Step 1:Unequal Random Cluster should be formed by using enhanced KNN Algorithm |
| Step 2:sustainability is calculated and considered for each tuple to analyze the lifespanof the cluster. |
| Step 3:Analyze the Relationship announcement array of data |
| Step 4:Analyze the Relationship Delivery array of data |
| Step 5:Predict a Cluster Head for each unequal cluster by using the sustainability Value |
| Step 6:Derive the fitness value of each unequal clusters |
| Step 7:F - is the final Fitness Value for the formed Unequal Clusters. |
| Step 8: Repeat Step 3 to Step 6 to form various unequal Clusters. |

Table 4 explain the ERIBO algorithm is proposed and

enhanced with fitness f5 and limit the iteration by best fit this enhance the time and enhance the RIBO algorithm as ERIBO algorithm.

**Table 4.** ERIBO

| **Enhanced Replacement In Bees Optimization Algorithm(ERIBO):** |
|---|
| STEP: 1 Form a Random cluster [C] by nearest neighbor approach on Load Profile data. |
| STEP: 2 Then assign a Random cluster head (RCH) to Each clusters.. |
| STEP:3 Calculate the Association transmission range of data from one X to X |
| STEP:4 Calculate the Association Receiving range(ARR) of data from one X to X |
| STEP:5 Sustainability is calculated for each X to analyze the living time of each X. |
| STEP:6 Calculate the fitness value of each random clusters. |
| STEP:7 Predict the Best Fit in every iteration using the above Steps. |
| STEP:8 Analyze find the best cluster options to arrange the X. |

## 7. Conclusion

From this abridged survey of load profile clustering using Honey Bee Mating Optimization Algorithm (HBMO) for metering solutions in the field of electricity market, it is illustrated that it has the potential to offer solutions to several other optimization problems by presenting a significantly desirable behavior in terms of strength and properties. Thereby, this little survey confirms that HBMO algorithm's broad applicability, ease of use, and global perspective are the important properties to conclude that the HBMO algorithm has greater potential in efficiently addressing the metering issues.

Furthermore, the algorithm is more efficient and uncomplicated with few operations it can be worked out to get desired output. In light of this fact, it has greater advantage over other techniques in addressing current issue of metering for small customer. In my proposed work, the HBMOhas been enhanced as CASEBO, RIBO and ERIBO. The implementation of the ERIBO algorithm to the LP-clustering problem requires some adaptation and specification[23–25]. This algorithm implemented to the LP- clustering problem has been studied for two distance metrics ETx and ERx. The extensive results indicate that ERIBO can effectively balance the energy consumption of the entire models such as Hbmo, Pso and Casebo, Ribo.

In future, the application of HBMO on load profile clustering in selected context and entity has been explored and there are other unexplored areas which is not addressed in appears to be a range of significant area for further investigation.

## 8. References


1. Application of Honey Bee Mating Optimization Algorithm to Load Profile Clustering Mihai Gavrilas, Gilda Gavrilas "Gh.Asachi" Technical University of Iasi Iasi, Romania, Calin Viorel Sfintes, EFE Energy Buzau n Buzau, Romania .
2. Figueiredo V, Rodrigues F, Vale Z, Gouveia JB. An electric energy consumer characterization framework based on data mining techniques. IEEE trans power syst. 2005; 20(2):596–602.
3. Chicco G, Napoli R, Piglione F. comparisons among clustering techniques for electricity customer classification. IEEE trans power syst. 2006 May; 21(2):933–40.
4. Gavrilas M, Ivanov O, Gavrilas G. Load profiling with fuzzy self-organizing. proceedings of the 9th symposium on neural network applications in electrical engineering NEUREL; 2008 Sep 25–27; Belgrade. CD-ROM, ISBN: 978-1-4244-2903-S.
5. Verda SV, Garcia MO, Senabre C, Marin AG, Franco FJG. Classification, filtering and identification of electrical customer load patterns through the use of self-organizing maps. IEEE trans power syst. 2006 Nov; 21(4):1672–82.
6. Asperic G, Smon I, Gubina F. Determining the load profiles of consumers based on fuzzy and probability neural networks. Proc Inst Elect Enmg Gener Trans Distrib. 2004 May; 151(3):395–400.
7. Abbass HA, Teo J. A true annealing approach to the marriage in honey-bees optimization algorithm. Int J Comput Intell Appl. 2003; 3:199–211.
8. Afshar A, Bozorg Haddad O, Mario M, Adams B. Honey-bee mating optimization (HBMO) algorithm for optimal reservoir operation. J Franklin Inst. 2007; 344(5):452–62.
9. Fathian M, Miri BA, Maroosi A. Application of honey-bee mating optimization algorithm on clustering. Applied Mathematics and computation. 2007; 190:1502–13.
10. Karaboga D. An idea based on honey bee swarm for numerical optimization. Technical report –tr06, erciyes university Engineering faculty, computer Engineering Department; 2005.
11. Olague G, Puente C. The Honebee Search Algorithm for Three Dimensioinal Reconstruction. 8-th European workshop on Evolutionary Computation in Image Analysis and Signal Processing ,EvolASP 2006, LN in Computer Science, 3907. Springer Verlag; 2006. p. 427–37.
12. Gerbec D, Gasperic S, Gubina F. Determination and alloca-

tion of typical load profiling to the eligible customers. proc. IEEE Bologna Power Tech; 2003 Jun 23-26; Bologna, Italy. p. 3023.
13. Chicco G, Napoli R, Piglione F, Scutariu M, Postolache P, Toader C. Load pattern-based classification of electricity customers. IEEE Trans Power Syst. 2004 May; 19(2):1232–9.
14. Gerbec D, Gasperic S, Smon I, Gubina F. Determining the load profiles of consumers based on fuzzy logig and probability neural networks. Proc Inst Elect Eng Gener Transm Distri. 2004 May; 151(3):395–400.
15. Ozveren CS, Vechanjan C, Birch AP. Fuzzy classification of electrical load demand –a case study. Proc IEEE Power System Management Control; 2002 Apr 7-19. p. 353–8.
16. Chicco, Napoli R, Piglione F. Application of clustering algorithms and self organizing maps to classify customers. Proc IEEE Bologna Power Tech; 2003; Bologna, Italy.
17. Gerbec D, Gasperic S, Smon I, Gubina F. Allocation of the load profile to consumers using probabilistic neural networks. IEEE Trans power Syst. 2005 May; 20(2):548–55.
18. Chen, Hwang CS, Huang JC. Application of load survey system to proper tariff design. IEEE Trans Power Syst. 1997; 4:1746–51.
19. Verdu SV, Garcia MO, Senabre C, Marin AG, Franco FJG. Classification, filtering, and identification of electrical customer load patterns through the use of self-organization maps. IEEE Trans Power Syst. 2006 Nov; 21(4):1672–82.
20. Afshar A, Hadded BO, Marino MA, Adams BJ. Honey-bee mating optimization (HBMO) algorithm for optimal reservoir operation. Journal of the Franklin Institute; 2006.
21. Kennedy J, Eberhart RC. Particle swarm optimization. Proceedings of the 1995 IEEE International Conference on Neural Networks. 1995; 4:1942–8.
22. Amiri B, Fathian M. Integration of Self Organizing Feature Maps and Honey Bee Mating Optimization Algorithm For Market Segmentation. Department of Industrial Engineering, Iran University Of Science And Technology Journal Of Theoretical And Applied Information Technology; 2007.
23. Kalyani K, Chakravarthy T. Load Profile Clustering: An Algorithmic Approach with Improved Replacement In Bee Optimization Algorithm. Ictact Journal on Soft Computing: Special Issue on Soft – Computing Theory. 2015 Jan; 5(2). ISSN: 2229-6956(Online).
24. Kalyani K, Chakravarthy T. Cluster Association Using Sustainability To Load Profile Determination. International Journal of Advanced Scientific and Technical Research. 2014; 6(4).
25. Kalyani K, Chakravarthy T, Kaveri E. An Algorithmic Approach with Bee Colony Optimization to Load Profile Clustering. IJERT. 2013 Sep; 2(9). ISSN: 2278-0181.