

## Boolean algebra and harmonic function based computation analysis: a survey and analysis

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### Abstract

*Boolean algebra and harmonic function have been used in different field, including, data, science, statistics, medical and circuit domain. This paper aims to analyze the methods based on this function for the better computation analysis. For this several research studies have been considered and pointing the latest trend with the related summarization in different fields. It also explores the trends, the approach, area of applicability and produced output. It helps in the exploration in finding the gaps so that future efficient framework can be developed.*

### Keywords

*Boolean algebra, Harmonic function, Computation analysis, Data science.*

### 1. Introduction

Boolean algebra uses in the direction to signify the two values which is either yes (Positive) or no (negative). It is simple and used in wide varieties like programming, circuit design, law, specifications, mathematical proof, and reasoning in different domains [1]. It is also used widely as the indented entity without affecting the interpretation so it is used widely [2].

Simplification of Boolean expression has also been used for DNA computing [3]. It is used in several computations and in DNA computing it can apply to various primitive operations, for example logic or arithmetic operations [3].

There are several procedures have been suggested with this are in [4–6]. In [7] different packages have been discussed for the computation with the harmonic function. It is also used in robotics [8]. It is the solution for the Laplace equations [8]. It can be used with different applications and it can be merged with the extension in the future for the best results so that the extension can be used as the functional metrics [9–12].

It is also impactful if it is applied to the medical dataset with statistics in the prediction for example in the papers [13–15]. *Figure 1* shows the process flow of the approach.

The objective of this paper is to explore the opportunity based on the discussion of the previous published approaches based on the function for the computation.

### 2. Literature review

In 2006, Qian et al. [16] proposed a three-phase harmonic selective active filter with multiple adaptive feed forward cancellation (MAFC) for harmonic reference generation. It is the extracted from AFC method. The adaptive law is extracted from Lyapunov function. It is helpful in the extraction of fundamental and harmonic current information from nonlinear load current.

In 2012, Masa et al. [17] discussed the protection devices in terms of the power distribution system. They have proposed a high impedance fault (HIF) in multi-grounded distribution networks. Their HIF detection function in a pattern recognition method. It is better in detection faults.

In 2015, Cheng-wen et al. [18] discussed multiple view dimensionality reduction via harmonic function (MVDRHF). It is based on the on multiple view

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semi-supervised dimensionality reduction (MVSSDR). It provides the substitution of the soft label gained. It is helpful in preserving the prior information.

In 2016, Frolov et al. [19] discussed the appropriate data representation in a space of fewer dimensions. They have suggested factor analysis for this task as the most suitable. They have compared seven methods for Boolean factor analysis (BFA) in solving the bar problem (BP). Their results show that likelihood maximization attractor neural network with increasing activity (LANNIA) is the most efficient.

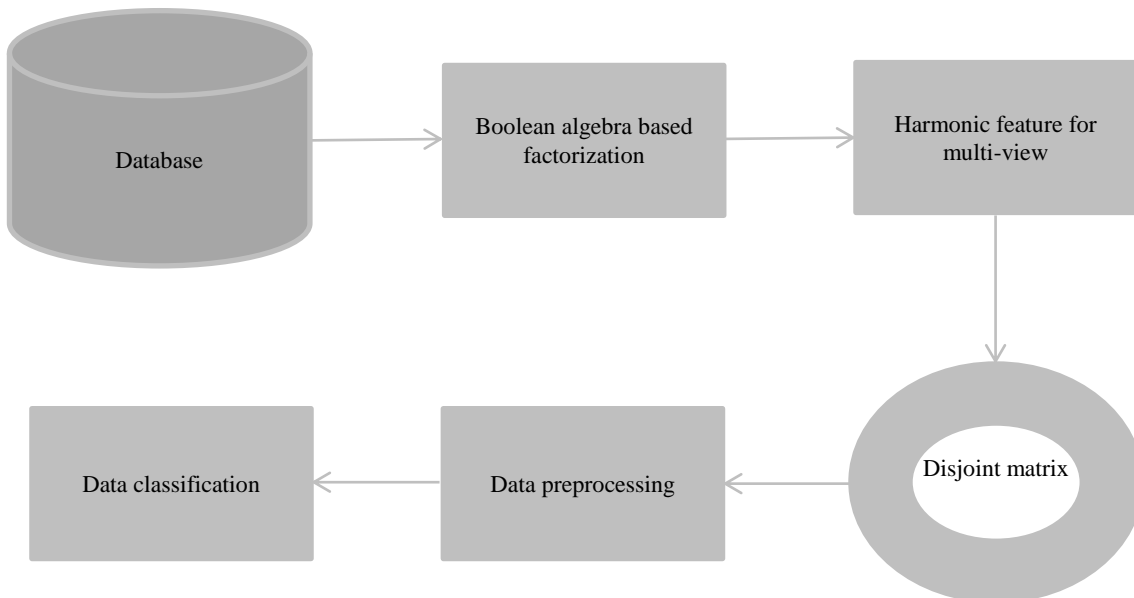
In 2017, Premalatha and Subasree [20] discussed the statistics and clustering algorithms for the medical datasets. They have discussed medical storage platform for data mining (MSPM), homogeneity similarity based hierarchical (HSH) clustering and K-harmonic means-overlapped k-means (KHM-OKM) clustering. Their framework is capable in the performance analysis of these algorithms.

In 2017, Qian et al. [21] discussed rough set theory in knowledge discovery, computational intelligence and decision analysis. They have proposed a feature selection method based on dominance-based rough sets. Boolean reasoning techniques have been used for the judgment theorems. For finding all the subsets they have used discernibility matrix. Their results show that the approach is efficient in feature selection.

In 2017, Gao et al. [22] discussed the big data on computational efficiency and storage capacity. They have suggested that the traditional methods fail in case of data analysis and computing. They have suggested the quantum systems unique and hyper acceleration for this purpose. So, they have proposed a quantum data mining. For storage they have proposed quantum method of data storage and retrieval for association rules mining based on Boolean matrix, name Q-Eclat. Their method outperforms in terms of storage capacity and computing ability.

In 2017, Hoschele and Zeller [23] discussed about the program processes and the structure of the input and the program structure. For this, different function is used for storing the variables. They have also used AUTOGRAM for tracing the data flow.

In 2018, Kocayusufoglu et al. [24] discussed the complex network processes in case of real-world applications. They have suggested the challenge like pattern discovery in complex data. For this they have summarized interpretable set of network pattern. For this they have formulated this problem as the Boolean matrix factorization with a network constraint. Then they have suggested the problem of systematically mine the exponential subgraph. For this they have devised two sampling algorithms based on Monte Carlo Markov Chain. Their results show the scalability in effective summarizes network processes.



**Figure 1** Boolean algebra and harmonic function-based computation analysis

### 3.Problem domain

The following gaps have been identified based on the related work discussion and study.

- 1) In most of the research work dynamic modeling is missing.
- 2) There is the need of quantum computing with these functions for the better computations.
- 3) There is the need of proper attribute characterization and function behavior analysis so that appropriate selection can be done.
- 4) There is the need of extension of Boolean algebra in case of detection of integrity violation item sets.
- 5) There is the need of factor analysis with feature selection for taking the advantage of both.

### 4.Analysis

In this paper several related works have been explored and discussed. The discussion is mainly focused on the domain, related parameters, impact and the methods used. It also concentrates and focused on the several aspects with their experimental issues and the major concern in the case of different parameter impacts. It also considered the pros and cons. Based on this some of the related scenarios which found to be more impactful is shown in analysis *Table 1*.

**Table 1** Comparative analysis

S.No	Reference	Method	Computation approach
1	[25]	K-harmonic means	They have discussed about k-harmonic means clustering algorithm (KHM). It is like k-means algorithm but uses the harmonic averages of the distances. It removes the drawback of initialization. But they suggested that it is easily trapped in local optima. They have proposed a hybrid data clustering algorithm DEKHM based on differential evolution (DE) and KHM. The DEKHM calculation not just helps KHM grouping escape from neighborhood optima yet additionally conquers the inadequacy of the moderate assembly speed of the DE calculation. The investigation results on three prevalent informational indexes represent the predominance and the power of the DEKHM grouping.
2	[26]	Soft harmonic functions	They have considered the conditional anomaly detection problem. Their main aim is to identify the data instances. They have developed a non-parametric approach. It is based on the soft harmonic solution. It may be helpful in the estimation of anomalous mislabeling. They have also considered boundary of the distribution support. They have considered UCI ML datasets. They have also considered real-world electronic health record for the experimentation.
3	[27]	Harmony search and k-harmonic means	They have discussed clustering technique. They have discussed about KHM and their problem of local optima. They have suggested that harmony search (HS) can solve this problem. They have suggested that it can be helpful in convergence speed of HS. So they have proposed a HSKHM based on HA and KHM combination. Their results also support the same.
4	[28]	Boolean methods	They have suggested that Boolean algebra can be helpful in the associations between pairs of random variables. They have discussed the implications and applicability has been described based on the heterogeneous cancer data sets. The impacts have been shown with the proper illustrations and the analysis has been described.
5	[29]	Matrix-based Apriori algorithm	They have discussed about association rule mining in the direction of interesting hidden associations discovery. They have highlighted the drawbacks like to scan the database numerous times and it may create tons of candidate sets. So, they have proposed an improved version for the removal of the drawbacks. It just needs to filter the database once to accomplish our objectives by including the idea of exchange loads and creating a value-based Boolean framework. In the wake of breaking down the models and playing out a few investigations in various factors, it demonstrated that the improved calculation was more effective than the first one.

### 5.Conclusion and future suggestions

This paper provides a detailed analysis based on the previous papers and their insight has been discussed with their main contributions. It highlights the methods with their approach, parameters, impact and

the applying procedures. In this paper different aspects like method combination, individual impacts and parameters impact have been highlighted.

This paper provides the explorative view of Boolean algebra and harmonic function in view of computational capability in several domains. Overall, this paper includes the background in this direction with the step by step exploration through review of literature and then methods have been explored with their capability to highlight the pros and cons in the applicable area.

Some of the future directions are as follows based on the review and analysis:

1. The impact of Boolean algebra and harmonic function both can be applied to the simultaneous impact.
2. Computational methods, threshold and distance factors can be examined and applicable through these functions.
3. The combination can be applied and can be validated on hidden patterns, medical dataset, integrity identification and multi view approach.

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#### Conflicts of interest

The authors have no conflicts of interest to declare.

#### References

- [1] Hehner EC. From Boolean algebra to unified algebra. *Journal of Computers in Mathematics and Science Teaching*. 2000; 19(1):59-86.
- [2] Barnett JH. Applications of Boolean algebra: Claude Shannon and circuit design. <http://www.cs.nmsu.edu/historical-projects>. Accessed 22 November 2018.
- [3] Paul S, Sahoo G, Mesra BI. Simplification of boolean algebra through DNA Computing. *International Journal of Computer Applications*. 2010.
- [4] Fukagawa H, Fujiwara A. Procedures for multiplication and division in DNA computing. In *FCS 2006* (pp. 123-9).
- [5] Hug H, Schuler R. DNA-based parallel computation of simple arithmetic. In *international workshop on DNA-based computers 2001* (pp. 321-8). Springer, Berlin, Heidelberg.
- [6] Qiu ZF, Lu M. Take advantage of the computing power of DNA computers. In *international parallel and distributed processing symposium 2000* (pp. 570-7). Springer, Berlin, Heidelberg.
- [7] Axler S. Computing with harmonic functions. *arXiv preprint arXiv:1511.05986*. 2015.
- [8] Connolly CI, Grupen RA. The applications of harmonic functions to robotics. *Journal of Robotic Systems*. 1993; 10(7):931-46.
- [9] Singh D, Mahala H, Kaur P. Modeling & simulation of multi-pulse converters for harmonic reduction. *International Journal of Advanced Computer Research*. 2012; 2(5):24-32.
- [10] Kannan P. Harmonic analysis and design of embedded Z-source inverter for induction motor drives. *International Journal of Advanced Computer Research*. 2014; 4(14):32-8.
- [11] Seneviratne MD, Fernando KS, Karunaratne DD. Generation of relation-extraction-rules based on Markov logic network for document classification. *International Journal of Advanced Computer Research*. 2019; 9(41):94-111.
- [12] Jabar HA, Fayadh RA, Abud MM. Investigation of rain and haze attenuations impact on proposed SCM-SAC-OCDMA-FSO system with optical amplifier. *International Journal of Advanced Computer Research*. 2018; 8(39):342-53.
- [13] Dubey AK, Gupta U, Jain S. Breast cancer statistics and prediction methodology: a systematic review and analysis. *Asian Pacific Journal of Cancer Prevention*. 2015; 16(10):4237-45.
- [14] Dubey AK, Gupta U, Jain S. Epidemiology of lung cancer and approaches for its prediction: a systematic review and analysis. *Chinese Journal of Cancer*. 2016; 35(1).
- [15] Dubey AK, Gupta U, Jain S. Analysis of k-means clustering approach on the breast cancer Wisconsin dataset. *International Journal of Computer Assisted Radiology and Surgery*. 2016; 11(11):2033-47.
- [16] Qian L, Cartes D, Zhang Q. Three-phase harmonic selective active filter using multiple adaptive feed forward cancellation method. In *international power electronics and motion control conference 2006* (pp. 1-5). IEEE.
- [17] Masa AV, Werben S, Maun JC. Incorporation of data-mining in protection technology for high impedance fault detection. In *power and energy society general meeting 2012 Jul 22* (pp. 1-8). IEEE.
- [18] Cheng-wen Z, Xin-qin C, Yan Z, Xiao-yan C, Chui-zhen Z. Multi-view dimensionality reduction via harmonic function. In *advanced information technology, electronic and automation control conference 2015* (pp. 925-9). IEEE.
- [19] Frolov AA, Húšek D, Polyakov PY. Comparison of seven methods for Boolean factor analysis and their evaluation by information gain. *IEEE Transactions on Neural Networks and Learning Systems*. 2015; 27(3):538-50.
- [20] Premalatha P, Subasree S. Performance analysis of clustering algorithms in medical datasets. In *international conference on electrical, computer and communication technologies 2017* (pp. 1-6). IEEE.
- [21] Qian W, Shu W, Liu J, Wang Y. Feature selection based on discernibility function in incomplete data with fuzzy decision. In *international conference on tools with artificial intelligence 2017* (pp. 899-904). IEEE.
- [22] Gao Q, Zhang F, Wang R, Zhou F. Association rules mining with quantum computing and quantum storage. In *international conference on big data computing and communications 2017* (pp. 354-60). IEEE.
- [23] Höschele M, Zeller A. Mining input grammars with AUTOGRAM. In *proceedings of the international*

- conference on software engineering companion 2017 (pp. 31-4). IEEE Press.
- [24] Kocayusufoglu F, Hoang MX, Singh AK. Summarizing network processes with network-constrained Boolean matrix factorization. In international conference on data mining 2018 (pp. 237-46). IEEE.
- [25] Tian Y, Liu D, Qi H. K-harmonic means data clustering with differential evolution. In international conference on future biomedical information engineering 2009 (pp. 369-72). IEEE.
- [26] Valko M, Kveton B, Valizadegan H, Cooper GF, Hauskrecht M. Conditional anomaly detection with soft harmonic functions. In international conference on data mining 2011 (pp. 735-43). IEEE.
- [27] Song A, Chen J, Tuyet TT, Bai X, Xie J, Zhang W. Clustering gene expression data based on harmony search and k-harmonic means. In international symposium on distributed computing and applications to business, engineering & science 2012 (pp. 455-60). IEEE.
- [28] Sinha S, Dill DL. Deciphering cancer biology using Boolean methods. In international high level design validation and test workshop 2016 (pp. 150-4). IEEE.
- [29] Yang Q, Fu Q, Wang C, Yang J. A Matrix-Based Apriori Algorithm Improvement. In international conference on data science in cyberspace 2018 (pp. 824-8). IEEE.



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