

Churn Prediction in Telecom using Classification Algorithms

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ABSTRACT

The term churn is said to be when customers or people move from one telecom service provider to another. Churn prediction is the process of predicting whether there is a chance for any customer or people to change from one telecom service provider to another. In recent times, the problem can be predicted using advanced algorithms like support vector machine, logistic regression, random forest algorithm. Churn rate can also be analyzed by several case machine learning algorithms. In this paper, we have summarized a comparative study on rate of churning of customers using different algorithms.

KEYWORDS:

Random forest approach, Logistic Regression, Support Vector Machine, Data Visualization

1. INTRODUCTION:

Customers have a wider range of telecom services and they choose among the best possible services from the telecom industry and switching from one service to another is called churn^[2], increased customer churn is always a major concern today^[3]. The accuracy rate also makes us to know about the customers who are not willing to switch over to the other telecom using churn prediction^[4]. Logistic regression research indicates that the modern churn prediction is also possible with the help of clustering algorithm^[5]. Here the factors affecting the churn prediction rate for the given telecom service is given with the algorithms namely:

Random forest

Logistic regression

SVM

2. DATA PREPROCESSING:

2.1. EXPLORATORY DATA ANALYTICS:

Exploratory Data Analytics is the way of visualizing the output from the data's in a understandable way, here the basic use of data visualization is mainly to help and analyze out the characteristic features of each separated dataset together. Also the charts, comparative analysis have been very well developed with the calculation by using the Exploratory Data

Analyticsthusmakesustopredictthebehaviorofchurnandmakesustoapplythevariousmethodologies.

2.1.1. PSEUDOCODE FOR EDA:

$D_0 \leftarrow$ Generate M individuals (the initial population) randomly

Repeat for $l = 1, 2, \dots$ until a stopping criterion is met

$D_{l-1}^N \leftarrow$ Select $N \leq M$ individuals from D_{l-1} according to a selection method

$\rho_l(\mathbf{x}) = \rho(\mathbf{x}|D_{l-1}^N) \leftarrow$ Estimate the probability distribution of an individual being among the selected individuals

$D_l \leftarrow$ Sample M individuals (the new population) from $\rho_l(\mathbf{x})$

FromthegivenIBMWATSONdataset,monthtomonthcontracts,absenceofonlinesecurityandtechsupportseemto bepositivelycorrelatedwithchurn.While,tenure,twoyearcontractsseemtobenegativelycorrelatedwithchurn. Interestingly,servicessuchasonlinesecurity,streamingTV,onlinebackup,techsupport,etc.withoutinternet connectionseemtobenegativelyrelatedtochurn.Wewillexplogetherpatternsfortheabovecorrelationsbelowbefore wedelventomodelingandidentifyingtheimportantvariables.

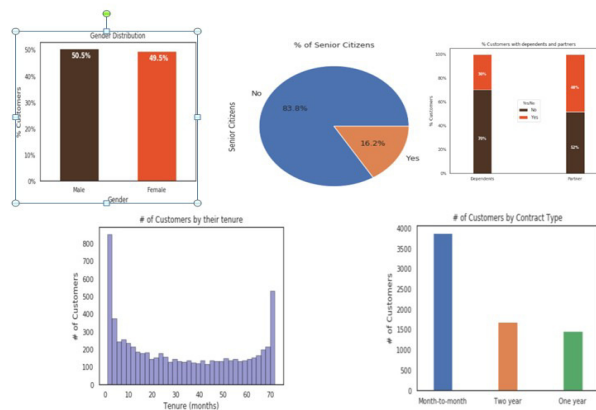


Fig. 2. Ishowsthegenderdistribution,percentageofseniorcitizens,percentageofcustomerswithdependentsand partners,customersbytenureandcontracttype.

Theabovementionedhistogramsgivesusadetailedunderstandingaboutthedistributionratesaccordingwiththe genderandthepopulationofseniorcitizensabout16.2%peoplewhoareunderseniorcitizencategoryand83.8%of peopleareyounger.Thusitgivesustheclarityofunderstandingaboutthedifferentagegroups.Wecananalyzethat amongthecustomerswhohaveapartner,onlyabouthalfofthemalsohaveadependent,whileotherhalfdonohave anyindependents.Additionally,asexpected,amongthecustomerswhodonothaveanypartner,amajority(80%)of

them do not have any dependents. So we can say that about 30% of total customers are dependent while 50% have partners. It is clear from the above observation. It is known that most of the customers are under month-month contracts, and where there are equal no of customers in both two year and one year contract.

2.2. TENURE OF CUSTOMERS BASED ON CONTRACTS:

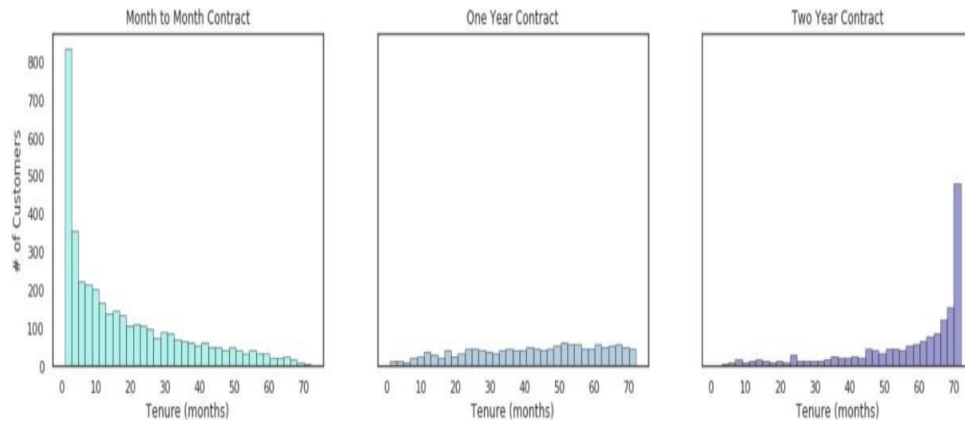


Fig 2.2 Showing customer contract in terms of Tenure

From the above mentioned histogram it is clear that, most of the monthly contracts last for 1-2 months, while the 2 year contract tends to last for about 70 months. This shows that the customer staking a longer contract are more loyal to the company and tend to stay with it for a longer period of time.

2.3. DISTRIBUTION OF VARIOUS SERVICES USED BY CUSTOMER:

From the given histogram below, we have an idea of the various services used by customers they are phone service, online security, tech support, multiple lines, online backup, streaming TV, internet service, device protection, streaming movies.

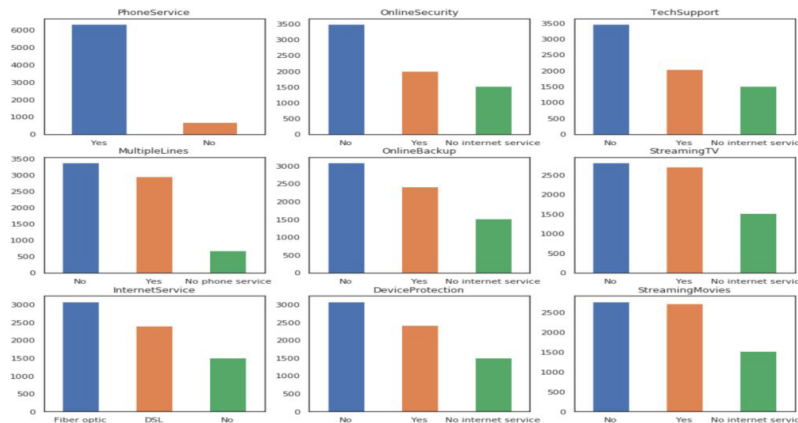


Fig 2.3 showing details on the various services offered to the customers

2.4. RELATIONSHIP BETWEEN MONTHLY AND TOTAL CHARGES:

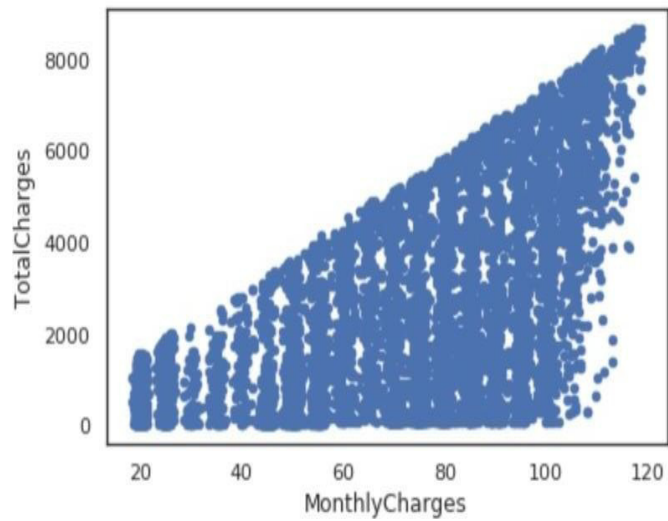


Fig2.4Applyinghyperlanesforthegiventwoattributes

2.5.INTERACTION OF CHURN WITH OTHER VARIABLES:

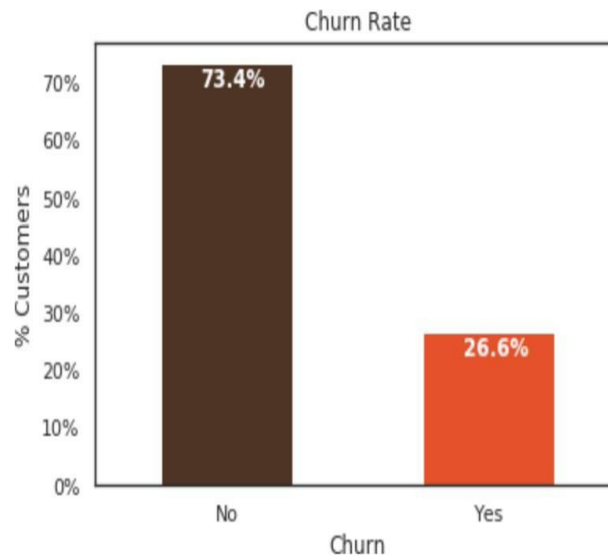


Fig.2.5.Ishowsthepercentageofchurnrateamongcustomers

Fromthetakendataset,itisknownthat26.6%ofcustomersarechurnedfromoneserviceprovidereto another,while73.4%ofcustomersdonotchurn.

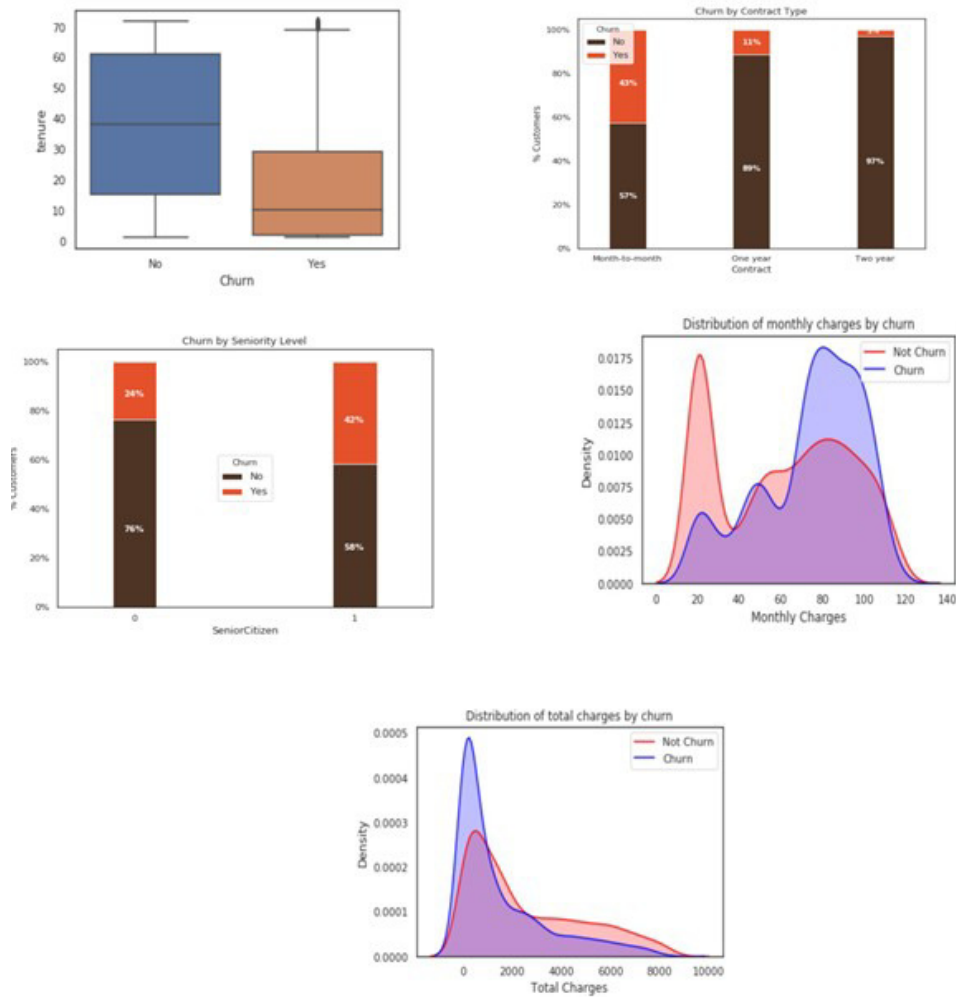


Fig.2.5.2.showstheinteractionofchurnvs.tenure,Churnbycontracttype,Churnbymonthlycharges,Churnbytotal charges

Customerswhodonotchurnisexpectedtohavealongservicewiththeirprevioustelecom.Thechurnrateisvery higherforcustomerswhohaveamonthtomonthcontract.Fromtheaboveplot,itisclearthattheseniorcitizens churnmorethanyoungerpeople.Bytheabovegraph,itisclearthatwhenthemonthlychargesarehigh,peoplechurn more.Theabovegraphshowsthatthereishigherchurnwhenthe totalchargesarelower.

3. ALGORITHMS :

3.1. SUPPORT VECTOR MACHINE:

SVMisthesupervisedlearningmodelthatanalyses thegivedatausedforthepurposeofclassificationand regressionapproach,mainlyherethedatasetsfromthechurnpredictionareanalyzedwiththetotaldependency betweenthe datasetsforthechurnedd data.SVMplaysapartbylistingthedatasetsforcalculatingthe classification andregressionanalysis

3.1.1. PSEUDOCODE FOR EXECUTING SVM:

Algorithm SVM-RCE-EC (input data D)

X = the training dataset

s = genes list (all the genes) or top n_g genes by t-test

n = infinity number

m = final number of clusters

d = the reduction parameter

While ($n > m$) do

1. n = Cluster the given genes S into clusters s_1, s_2, \dots, s_n using Ensemble Clustering (EC Clustering step)
2. For each cluster $i=1..n$ calculate its $Score(X(s_i), f, r)$ (SVM scoring step)
3. Remove the $d\%$ clusters with lowest score (RCE step)
4. Merge surviving genes again into one pool S

3.2. RANDOM FOREST ALGORITHM:

Random forest algorithm approach is a way of collection of different decision trees together without the process of disturbing the classification and prediction approaches being applied in the churn prediction process being a large number of datasets available within this process this random forest algorithm is useful. Random forest algorithm is implemented out there by using the multiple level of the decision trees and these decision trees are here constructed between the different factors of the churn prediction like: Telecom providers, Internet service, Call rates, Messaging services, etc. and the mode and the medians are calculated meanwhile consistency of the datasets are established and the datasets are recalculated and the regression rates are very well established here. The details of different data analytics algorithms are analysed and the accuracy values are provided here.

3.2.1. PSEUDOCODE FOR RANDOM FOREST PRECONDITION:

A training set $S = (x_1, y_1), \dots, (x_n, y_n)$, features F , and number of trees in forest B . 1 function RandomForest(S, F)

2 $H \leftarrow \emptyset$

3 for $i \in 1, \dots, B$ do

4 $S(i) \leftarrow$ A bootstrap sample from S

5 $h_i \leftarrow$ RandomizedTreeLearn($S(i), F$) 6 $H \leftarrow$

$H \cup \{h_i\}$

7 endfor

8 return H

9 endfunction

10 function RandomizedTreeLearn(S, F) 11 At

each node:

12 $f \leftarrow$ very small subset of F 13

Split on best feature in f 14 return

The learned tree

15 endfunction

3.3. LOGISTIC REGRESSION:

LogisticRegressionmethoddeterminesanoutcomebyanalyzingadatasetwithoneormore independentvariables.Itisastatisticalprocesswhichpredictstheprobabilityofanoutcomethatpossessesonly havetwovalues(calledasdichotomy).Thelogisticregressionissimilartothatofthelinearregression.In multiplelogisticregressionmodel,thedependentvariableisbinary(dichotomous)whereinthedatasetit contains1(true)and0(false)inthedatacode.Inlinearregression,thevalueswouldbepredictedoutsidethe rangeof0and1.Meanwhilethelogisticregressionproducescurvesinbetweenthevalues0and1.

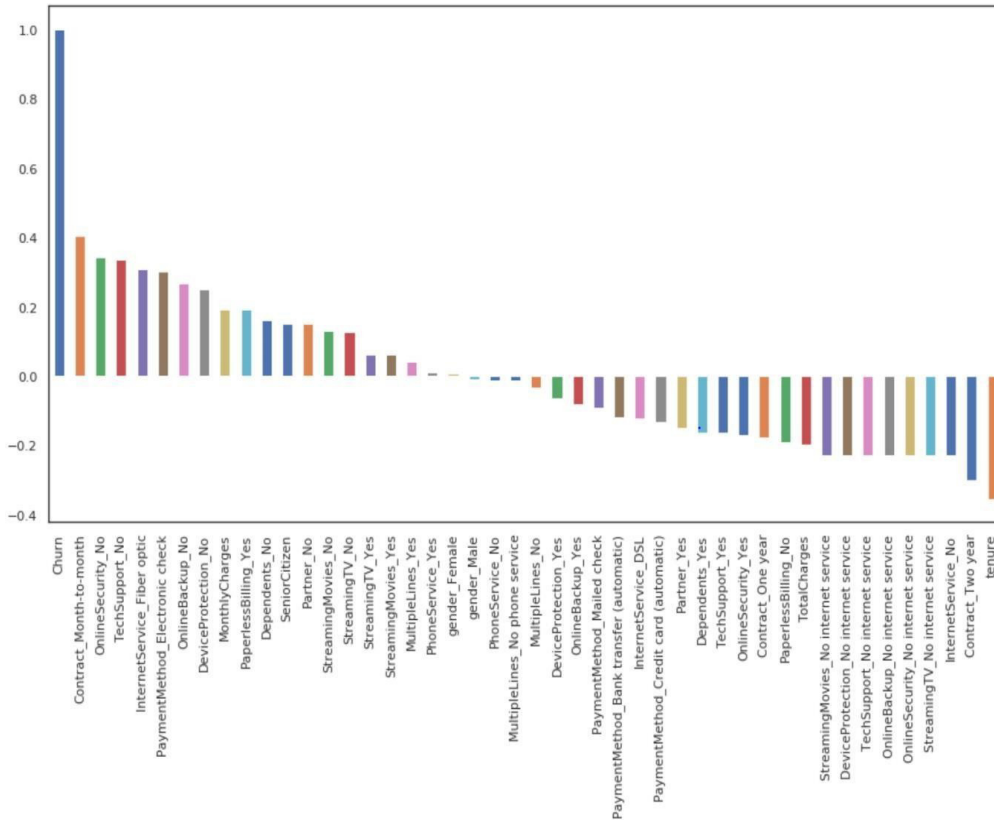


Fig3.3.showsthechurnrateusingrandomforest,SVM,LogisticRegression

An analysis on the above datasets has been made using data visualization, SVM and random forest algorithm. The dependency of various variables between the datasets has been found for churn prediction. The dataset holds the details of about 7000 customer details approximately, which could be easily analyzed by random forest algorithm which can handle large numbers of datasets. By mapping the entities, the relationship between the factors influencing churn prediction are found. The different datasets used different algorithms and the way of solving heterogeneity, scalability always plays a major role in this accuracy process. Here the datasets being large in number always maintaining a correct accuracy always plays an important role.

4. ACCURACY :

ALGORITHMS	ACCURACY
LogisticRegression	80.75%
RandomForest	80.88%
SupportVectorMachine	82%

Table4.representsaccuracy calculation.
*Highervaluesareinbold.

5. CONCLUSION:

The churn prediction technique and the data algorithms, data analytics plays a major part in the present digital era as the data's gathered out from the various machine learning algorithms and the data analytics covers a wide scope helping us to know about the different factors affecting the churning rate also it can bring out the predictive capacity of the customer's mind set enabling the various telecom service providers to change over to the new schemes possible, also it leaves us with the various innovative application of machine learning algorithms and the data analytics approach to solve out the present challenges facing the society also the various need for the data analysts and the importance of data's have been very well pictured out by the algorithms, This in turn also opens out a new gateway for the data analysts and the application of various innovative descriptive, predictive and prescriptive algorithms possible.

6. FUTURE WORKS:

Churn prediction and various factors causing the customer to switch over from one service provider to another circle is unavoidable and the above mentioned attributes and algorithms mentioned will be helpful in analyzing out the conditions causing the churn to occur. Churn prediction has wide applications in the near future making it an unavoidable component for the near future.

REFERENCES

- [1]. Idris, A., Iftikhar, A. & Rehman, Z.. Cluster Computer (2017). <https://doi.org/10.1007/s10586-017-1154-3>
- [2]. Azeem, M., Usman, M. & Fong, A.C.M. Telecommunication System (2017) 66: 603. <https://doi.org/10.1007/s11235-017-0310-7>
- [3]. Sivasankar, E. & Vijaya, J. Neural Computer & Application (2018). <https://doi.org/10.1007/s00521-018-3548-4> [
- [4]. W. Bi, M. Cai, M. Liu and G. Li, "A Big Data Clustering Algorithm for Mitigating the Risk of Customer Churn," in *IEEE Transactions on Industrial Informatics*, vol. 12, no. 3, pp. 1270-1281, June 2016. doi: 10.1109/TII.2016.2547584
- [5]. N. Lu, H. Lin, J. Lu and G. Zhang, "A Customer Churn Prediction Model in Telecom Industry Using Boosting," in *IEEE Transactions on Industrial Informatics*, vol. 10, no. 2, pp. 1659-1665, May 2014. doi:10.1109/TII.2012.2224355.
- [6]. Deepa, V., A. Jenifa, and J. Pamina. "APPROACHES BASED ON DATA MINING IN NATURAL LANGUAGE PROCESSING."
- [7]. Raja, J. Beschi, S. Chentur Pandian, and J. Pamina. "Certificate revocation mechanism in mobile ADHOC grid architecture." *Int. J. Comput. Sci. Trends Technol* 5 (2017): 125-130.
- [8]. Raja, J. Beschi, and K. Vivek Rabinson. "IaaS for Private and Public Cloud using Openstack."

- International Journal of Engineering 5.04 (2016).
- [9]. Raja, J. Beschi, and V. Vetriselvi. "Mobile Ad Hoc Grid Architecture Based On Mobility of Nodes." International Journal of Innovative Research in Computer and Communication Engineering 2 (2014): 49-55.
- [10]. Uthayakumar, J., Metawa, N., Shankar, K., & Lakshmanaprabu, S. K. (2018). Financial crisis prediction model using ant colony optimization. International Journal of Information Management.
- [11]. Uthayakumar, J., Metawa, N., Shankar, K., & Lakshmanaprabu, S. K. (2018). Intelligent hybrid model for financial crisis prediction using machine learning techniques. Information Systems and e-Business Management, 1-29.
- [12]. Lakshmanaprabu, S. K., Mohanty, S. N., Shankar, K., Arunkumar, N., & Ramirez, G. (2019). Optimal deep learning model for classification of lung cancer on CT images. Future Generation Computer Systems, 92, 374-382.
- [13]. Lakshmanaprabu, S. K., Shankar, K., Gupta, D., Khanna, A., Rodrigues, J. J., Pinheiro, P. R., & de Albuquerque, V. H. C. (2018). Ranking analysis for online customer reviews of products using opinion mining with clustering. Complexity, 2018.
- [14]. Karthikeyan, K., Sunder, R., Shankar, K., Lakshmanaprabu, S. K., Vijayakumar, V., Elhoseny, M., & Manogaran, G. (2018). Energy consumption analysis of Virtual Machine migration in cloud using hybrid swarm optimization (ABC-BA). The Journal of Supercomputing, 1-17.
- [15]. Shankar K, Mohamed Elhoseny, Lakshmanaprabu S K, Ilayaraja M, Vidhyavathi RM, Mohamed A. Elsoud, Majid Alkhambashi. Optimal feature level fusion based ANFIS classifier for brain MRI image classification. Concurrency Computat Pract Exper. 2018;e4887. <https://doi.org/10.1002/cpe.4887>
- [16]. Shankar, K., Lakshmanaprabu, S. K., Gupta, D., Maselena, A., & de Albuquerque, V. H. C. (2018). Optimal feature-based multi-kernel SVM approach for thyroid disease classification. The Journal of Supercomputing, 1-16.
- [17]. Lakshmanaprabu SK, K. Shankar, Ashish Khanna, Deepak Gupta, Joel J. P. C. Rodrigues, Plácido R. Pinheiro, Victor Hugo C. de Albuquerque, "Effective Features to Classify Big Data using Social Internet of Things", IEEE Access, Volume.6, page(s):24196-24204, April 2018.
- [18]. E. Laxmi Lydia, K. Shankar, M. Ilayaraja, K. Sathesh Kumar, "Technological Solutions for Health Care Protection and Services Through Internet Of Things(IoT)", International Journal of Pure and Applied Mathematics, Volume 118, No. 7, page(s) 277-283, February 2018.
- [19]. E. Laxmi Lydia, K. Shankar, J. Pamina, J. Beschi Raja, "Correlating NoSQL Databases With a Relational Database: Performance and Space", International Journal of Pure and Applied Mathematics, Volume 118, No. 7, page(s) 235-244, February 2018.
- [20]. K. Shankar. "Prediction of Most Risk Factors in Hepatitis Disease using Apriori Algorithm", Research Journal of Pharmaceutical, Biological and Chemical Sciences (ISSN: 0975-8585, Volume 8, No. 5, page(s): 477-484, 2017.
- [21]. Haidi Rao, Xianzhang Shi, Ahoussou Kouassi Rodrigue, Juanjuan Feng, Yingchun Xia, Mohamed Elhoseny, Xiaohui Yuan, Lichuan Gu, Feature selection based on artificial bee colony and gradient boosting decision tree, Applied Soft Computing, Volume 74, Pages 634-642, January 2019.
- [22]. Baofu Fang, Xiaoping Guo, Zaijun Wang, Yong Li, Mohamed Elhoseny, Xiaohui Yuan, Collaborative task assignment of interconnected, affective robots towards autonomous healthcare assistant, Future Generation Computer Systems, Volume 92, Pages 241-251, March 2019.
- [23]. Noura Metawaa, M. Kabir Hassana, and Mohamed Elhoseny, "Genetic algorithm based model for optimizing bank lending decisions", Expert Systems with Applications, Volume 80, Pages 75-82, 2017.
- [24]. Elhoseny, M., Shankar, K., Lakshmanaprabu, S. K., Maselena, A., & Arunkumar, N. (2018). Hybrid optimization with cryptography encryption for medical image security in Internet of Things. Neural Computing and Applications, 1-15. <https://doi.org/10.1007/s00521-018-3801-x>
- [25]. Maselena, A., Hasan, M.M., Fuzzy Logic based analysis of the sepak takraw games ball kicking with the respect of player arrangement, World Applied Programming, vol. 2, Issue 5, May 2012, pp. 285-293.
- [26]. Maselena, A., Hasan, M.M., Skin Diseases expert system using Dempster-Shafer theory, International Journal Intelligent Systems and Applications, vol. 5, 2012, pp. 38-44.
- [27]. Mulung, B.R., Maselena, A., Proposed SMART Traffic signal control in Brunei Darussalam, Telkomnika, Vol. 15, No. 2, 2015, pp. 1-7.
- [28]. Huda, M., Maselena, A., Jasmi, K.A., Mustari, I., Basiron, B., Strengthening interaction from direct to virtual basis: insights from ethical and professional empowerment,

- International Journal of Applied Engineering Research, Vol.12, No. 17, 2017, pp. 6901-6909.
- [29]. Maseleno, A., Tang, A.Y.C., Mahmoud, M.A., Othman, M., Saputra, S., Muslihudin, M., Fuzzy AHP method to determine headache types based on symptoms, *Investigacion Clinica*, Vol. 58, 2017.
- [30]. Huda, M., Maseleno, A., Atmotiyoso, P., Siregar, M., Ahmad, R., Jasmi, K.A., Muhamad, N.H.N, Mustari, I.M., Basiron, B., Big Data Emerging Technology: Insights into Innovative Environment for Online Learning Resources, Vol. 13, No. 1, 2017, pp. 23-36.
- [31]. Muslihudin, M., Latif, A., Ipinuwati, S., Wati, R., Maseleno, A., A solution to competency test expertise of engineering motorcycles using simple additive weighting approach, *Int J. Pure Appl. Math*, Vol. 118, No. 7, 2018, pp. 261-267.
- [32]. Mukodimah, S., Mulihudin, M., Andoyo, A., Hartati, S., Maseleno, A., Fuzzy simple additive weighting and its application to toddler healthy food, *Int. J. Pure Appl. Math*, Vol. 118, No. 7, 2018, pp. 1-7.
- [33]. Muslihudin, M., Susanti, T.S., Maseleno, A., The priority of rural road development using fuzzy logic based simple additive weighting, *Int. J. Pure Appl. Math*, Vol. 118, No. 8, 2018, pp. 9-16.
- [34]. Irviani, R., Dinulhaq, I., Irawan, D., Renaldo, R., Maseleno, A., Areas prone of the bad nutrition based multi attribute decision making with fuzzy simple additive weighting for optimal analysis, *Int. J. Pure Appl. Math*, Vol. 118, No. 7, 2018, pp. 589-596.
- [35]. Oktafianto, Akbar, M.R.A., Fitriani, Y., Zulkifli, Sodikin, Wulandari, Maseleno, A., Dismissal working relationship using Analytical Hierarchy Process Method, *Int. J. Pure Appl. Math*, Vol. 118, No. 7, 2018, pp. 177-183.
- [36]. Susilowati, T., Anggraeni, E.Y., Fauzi, Andewi, W., Handayi, Y., Maseleno, A., Using profile matching method to employess position movement, *International Journal of Pure and Applied Mathematics*, Vol. 118, No. 7, 2018, pp. 415-422.
- [37]. Maseleno, A., Fauzi, Nungsiyati, Novianti, T., Muslihudin, M., Irviani, R., Optimal dengue endemic region prediction using fuzzy simple additive weighting based algorithm, *International Journal of Pure and Applied Mathematics*, Vol. 118, No. 7, 2018, pp. 472-477.
- [38]. Muslihudin, M., Wanti, R, Hardono, N., Shankar, K., Ilayaraja, M., Maseleno, A., Mustofa, D.R., Fauzi, Masrur, M., Mukodimah, S., Prediction of layer chicken disease using fuzzy analytical hierarchy process, *International Journal of Engineering & Technology (UAE)*, Vol. 7, No. 2.26, 2018, pp. 90-94.
- [39]. Maseleno, A., Pardimin, Huda, M., Ramlan, Hehsan, A., Yusof, Y.M., Haron, Z., Ripin, M.N., Nor, N.H.M., Junaidi, J., Mathematical theory of evidence to subject expertise diagnostic, *ICIC Express Letters*, Vol. 12, No. 4, 2018.
- [40]. Aminudin, N., Sundari, E., Shankar, K., Deepalakshmi, P., Irviani, R., Fauzi, Maseleno, A., Weighted product and its application to measure employee performance, *International Journal of Engineering & Technology (UAE)*, Vol. 7, No. 2.26, 2018, pp. 102-108.
- [41]. Putra, D.A.D, Jasmi, K.A., Basiron, B., Huda, M., Maseleno, A., Shankar, K., Aminudin, N., Tactical steps for e-government development, *International Journal of pure and applied mathematics*, Vol. 119, No. 15, 2018, pp. 2251-2258.
- [42]. Sugiyarti, E., Jasmi, K.A., Basiron, B., Huda, M. Shankar, K., Maseleno, A., Decision support system of scholarship grantee selection using data mining, *International Journal of Pure and Applied Mathematics*, Vol. 119, No. 15, 2018, pp. 2239-2249.
- [43]. Kurniasih, D., Jasmi, K.A., Basiron, B., Huda, M., Maseleno, A., The uses of fuzzy logic method for finding agriculture and livestock value of potential village, *International Journal of Engineering & Technology (UAE)*, Vol. 7, No. 3, 2018, pp. 1091-1095.
- [44]. Adela, H., Jasmi, K.A., Basiron, B., Huda, M., Maseleno, A., Selection of dancer member using simple additive weighting, *International Journal of Engineering & Technology (UAE)*, Vol. 7, No. 3, 2018, pp. 1096-1107.
- [45]. Maseleno, A., Sabani, N., Huda, M., Ahmad, R., Jasmi, K.A., Basiron, B., Demystifying learning analytics in personalised learning, *International Journal of Engineering & Technology (UAE)*, Vol. 7, No. 3, 2018, pp. 1124 -1129.
- [46]. Amin, M.M., Nugratama, M.A.A., Maseleno, A., Huda, M., Jasmi, K.A., Design of cigarette disposal blower and automatic freshner using mq-5 sensor based on atmega 8535 microcontroller, *International Journal of Engineering & Technology (UAE)*, Vol. 7, No. 3, 2018, pp. 1108 -1113.

- [47]. Assahubulkahfi, M., Sam, Y.M., Maseleno, A., Huda, M., LQR Tuning by Particle Swarm Optimization of Full Car Suspension System, *International Journal of Engineering & Technology (UAE)*, Vol. 7, No. 2.13, 2018, pp. 328-331.
- [48]. Amin, M.M., Maseleno, A., Shankar, K., Perumal, E., Vidhyavathi, R.M., Lakshmanaprabu, S.K., Active Database System Approach and Rule Based in the Development of Academic Information System, *International Journal of Engineering & Technology (UAE)*, Vol. 7, No. 2.26, 2018, pp. 95-101.
- [49]. Maseleno, A., Tang, A.Y.C., Mahmoud, M.A., Othman, M., Negoro, Y.S., Boukri, S., Shankar, K., Abadi, S. Muslihudin, M., The Application of Decision Support System by using Fuzzy SAW Method in Determining the Feasibility of Electrical Installations in Customer's House, *International Journal of Pure and Applied Mathematics*, Vol. 119, No. 16, 2018, pp. 4277-4286.
- [50]. Lydia, E. L., Kumar, P.K., Shankar, K., Lakshmanaprabu, S.K., Vidhyavathi, R.M., Maseleno, A., Charismatic Document Clustering through Novel K-Means Non-negative Matrix Factorization (KNMF) Algorithm using Key Phrase Extraction, *International Journal of Parallel Programming*, Springer, 2018, pp. 1-19.
- [51]. Susilowati, T., Dacholfany, M.I., Amini, S., Ikhwan, A., Nasir, B.M., Huda, M., Prasetyo, A., Maseleno, A., Satria, F., Hartati, S., Getting Parents Involved in Child's School: Using Attendance Application System Based on SMS Gateway, *International Journal of Engineering and Technology (UAE)*, Vol. 7, No. 2.27, 2018, pp. 167-174.
- [52]. Abadi, S., Huda, M., Hehsan, A., Ripin, M.N., Haron, Z., Muhamad, NHN, Rianto, R., Maseleno, A., Renaldo, R., Syarifudin, A., Design of student score application for assessing the most outstanding student at vocational high school. *International Journal of Engineering and Technology*, Vol. 7, No. 2.27, 2018, pp. 172-177.
- [53]. Aminudin, N., Sundari, E., Shankar, K., Deepalakshmi, P., Fauzi, Irviani, R., Maseleno, A., Weighted Product and Its Application to Measure Employee Performance, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.26, 2018, pp. 102-108.
- [54]. Abadi, S. Huda, M., Basiron, B, Ihwani, S.S., Jasmi, K.A., Hehsan, A., Safar, J., Mohamed, A.K., Embong, W.H.W., Mohamad, A.M., Noor, S.S.M., Novita, D., Maseleno, A., Irviani, R., Idris, M., Muslihudin, M., Implementation of Fuzzy Analytical Hierarchy Process on Notebook Selection, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.26, 2018, pp. 102-108.
- [55]. Anggraeni, E.Y., Huda, M., Maseleno, A., Safar, J., Jasmi, K.A., Mohamed, A.K., Hehsan, A., Basiron, B., Ihwani, S.S., Embong, W.H.W., Mohamad, A.M., Noor, S.S.M., Fauzi, A.N., Wijaya, D.A., Poverty Level Grouping using SAW Method, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 218-224.
- [56]. Abadi, S., Huda, M., Jasmi, K.A., Noor, S.S.M., Safar, J., Mohamed, A.K., Embong, W.H.W., Mohamad, A.M., Hehsan, A., Basiron, B., Ihwani, S.S., Maseleno, A., Muslihudin, M., Satria, F., Irawan, D., Hartati, S., Determination of the Best Quail Eggs using Simple Additive Weighting, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 225-230.
- [57]. Abadi, S., Huda, M., Hehsan, A., Mohamad, A.M., Basiron, B., Ihwani, S.S., Jasmi, K.A., Safar, J., Mohamed, A.K., Embong, W.H.W., Noor, S.S.M., Brahmono, B., Maseleno, A., Fauzi, A.N., Aminudin, N., Gumanti, M., Design of Online Transaction Model on Traditional Industry in order to Increase Turnover and Benefits, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 231-237.
- [58]. Susilowati, T., Teh, K.S.M., Nasir, B.M., Don, A.G., Huda, M., Hensafitri, T., Maseleno, A., Oktafianto, Irawan, D., Learning Application of Lampung Language based on Multimedia Software, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 175-181.
- [59]. Abadi, S., Nasir, B.M., Huda, M., Ivanova, N.L., Sari, T.I., Maseleno, A., Satria, F., Muslihudin, M., Application model of k-means clustering: Insights into promotion strategy of vocational high school, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 182-187.
- [60]. Septiropa, Z., Osman, M.H., Rahman, A.B.A., Arifin, M.A.M., Huda, M., Maseleno, A., Profile of cold-formed steel for compression member design a basic combination, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 284-290.

- [61]. Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maseleno, A., Gumanti, M., Fauzi, A.N., Application program learning based on Android for students experiences, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 194-198.
- [62]. Ristian, Pardimin, Teh, K.S.M., Fauzi, A., Hananto, A.L., Huda, M., Muslihudin, M., Shankar, K., Maseleno, A., Decision Support System Model for Selection of Best Formula Milk for toddlers using Fuzzy Multiple Attribute Decision Making, *Journal of Advanced Research in Dynamical and Control Systems*, Vol. 10, 02-Special Issue, 2018.
- [63]. Hamid, A., Sudrajat, A., Kawangit, R.M., Don, A.G., Huda, M., Jalal, B., Akbar, W., Onn, A., Maseleno, A., Determining basic food quality using SAW, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 4, pp. 3548-3555, 2018.
- [64]. Oktafianto, Kawangit, A.S., Kawangit, R.M., Don, A.G., Huda, M., Saputri, A.D., Latif, A.A., Maseleno, A., Determining housing location using weighted product, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 4, pp. 3563-3568, 2018.
- [65]. Fauzi, Huda, M., Teh, K.S.M., Haron, Z., Ripin, M.N., Hehsan, A., Abas, H., Rafiq, M., Irawan, J., Abadi, S., Maseleno, A., The Design of Fuzzy Expert System Implementation for Analyzing Transmissible Disease of Human, *International Journal of Pharmaceutical Research*, Vol. 10, Issue 4, 2018.
- [66]. Abadi, S., Huda, M., Teh, K.S.M., Haron, Z., Ripin, M.N., Hehsan, A., Sarip, S., Hehsan, M.R., Amrullah, M., Maseleno, A., Hazard Level of Vehicle Smoke by Fuzzy Multiple Attribute Decision Making with Simple Additive Weighting Method, *International Journal of Pharmaceutical Research*, Vol. 10, Issue 4, 2018.
- [67]. Kamenez, N.V., Vaganova, O.I., Smirnova, Z.V., Bulayeva, M.N., Kuznetsova, E.A., Maseleno, A., Experience of the use of electronic training in the educational process of the Russian higher educational institution, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 4, pp. 4085-4089, 2018.
- [68]. Vaganova, O.I., Zhanfir, L.N., Smirnova, Z.V., Chelnokova, E.A., Kaznacheeva, S.N., Maseleno, A., On the linguistic training of future teachers of unlike specialties under the conditions of Russian professional education, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 4, pp. 4090-4095, 2018.
- [69]. Vaganova, O.I., Kamenez, N.V., Sergeevna, V.I., Vovk, E.V., Smirnova, Z.V., Maseleno, A., Possibilities of information technologies to increase quality of educational services in Russia, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 4, pp. 4096-4102, 2018.
- [70]. Smirnova, Z.V., Zhanfir, L.N., Vaganova, O.I., Bystrova, N.V., Frolova, N.V., Maseleno, A., WorldSkills as means of improving quality of pedagogical staff training, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 4, pp. 4103-4108, 2018.
- [71]. Aminin, S., Dacholfany, M.I., Mujib, A., Huda, M., Nasir, B.M., Maseleno, A., Sundari, E., Masrur, M., Design of library application system, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 199-204.
- [72]. Aminudin, N., Huda, M., Kilani, A., Embong, W.H.W., Mohamed, A.M., Basiron, B., Ihwani, S.S., Noor, S.S.M., Jasmi, K.A., Higher education selection using simple additive weighting, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 211-217.
- [73]. Aminudin, N., Huda, M., Hehsan, A., Ripin, M.N., Haron, Z., Junaidi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maseleno, A., Gumanti, M., Fauzi, A.N., Application program learning based on Android for students experiences, *International Journal of Engineering and Technology(UAE)*, Vol. 7, No. 2.27, 2018, pp. 194-198.
- [74]. Maseleno, A., Huda, M., Jasmi, K.A., Basiron, B., Mustari, I., Don, A.G., and Ahmad, R. Hau-Kashyap approach for student's level of expertise. *Egyptian Informatics Journal*, 2018.
- [75]. Huda, M., Maseleno, A., Teh, K.S.M., Don, A.G., Basiron, B., Jasmi, K.A., Mustari, M.I., Nasir, B.M., Ahmad, R., Understanding Modern Learning Environment (MLE) in Big Data Era, *International Journal of Emerging Technologies in Learning (IJET)*, Vol. 13, No. 5, 2018, pp. 71-85.
- [76]. Maseleno, A., Tang, A.Y.C., Mahmoud, M.A., Othman, M., Shankar, K., Big Data and E-Learning in Education, *International Journal of Computer Science and Network Security*, Vol. 18, No. 5, pp. 171-174.

- [77]. Shankar, K., Lakshmanaprabu, S.K., Gupta, D., Maseleno, A., De Albuquerque, V.H.C., Optimal feature-based multi-kernel SVM approach for thyroid disease classification, *The Journal of Supercomputing*, Springer, Vol. 74, no. 259, 2018, pp. 1-16.
- [78]. Amin, M.M., Sutrisman, A., Stiawan, D., Maseleno, A., Design Restful Webservice of National Population Database for supporting E-health interoperability service, *Journal of Theoretical and Applied Information Technology*, vol. 96, issue 15, 2018.
- [79]. Surendar, A., Akhmetov, L.G., Ilyashenko, L.K., Maseleno, A., Samavatian, V., Effect of thermal cycle loadings on mechanical properties and thermal conductivity of a porous lead-free solder joint, *IEEE Transactions on Components, Packaging, and Manufacturing Technology*, 2018, pp. 1769-1776.
- [80]. Surendar, A., Samavatian, V., Maseleno, A., Ibatova, A.Z., Samavatian, M., Effect of solder layer thickness of thermo-mechanical reliability of a power electronic system, *Journal of Material Science: Materials in Electronics*, Springer, September 2018, Volume 29, Issue 17, pp. 15249-15258.
- [81]. Samavatian, M., Ilyashenko, L.K., Surendar, A., Maseleno, A., Samavatian, V., Effect of System Design on Fatigue Life of Solder Joints in BGA Packages Under Vibration at Random Frequencies, *Journal of Electronic Materials*, November 2018, Volume 47, Issue 11, pp. 6781-6790.
- [82]. Javanshir, I., Maseleno, A., Tasoujian, S., Oveisi, M., Optimization of suspension system of heavy off-road vehicle for stability enhancement using integrated anti-roll bar and coiling spring mechanism, *Journal of Central South University*, September 2018, Volume 25, Issue 9, pp 2289-2298.
- [83]. Surendar, A., Bozorgian, A., Maseleno, A., Ilyashenko, L.K., Najafi, M., Oxidation of Toxic Gases via Ge-B36N36 and Ge-C72 Nanocages as Potential Catalysts, *Inorganic Chemistry Communications*, Elsevier, Vol. 96, October 2018, pp. 206-210.
- [84]. Namdarian, A., Tabrizi, A.G., Maseleno, A., Mohammadi, A., Mossavifard, S.E., One step synthesis of rGO-Ni3S2 nano-cubes composite for high-performance supercapacitor electrodes, *International Journal of Hydrogen Energy*, Elsevier, vol. 43, Issue 37, 13 September 2018, pp.17780-17787.
- [85]. Motlagh, A.H., Klyuev, S.V., Surendar, A., Ibatova, A.Z., Maseleno, A., Catalytic Gasification of Oil Sludge with Calcined Dolomite, *Petroleum Science and Technology*, Taylor and Francis, pp. 1-5, 2018.
- [86]. Shankar, K., Elhoseny, M., Kumar, R. S., Lakshmanaprabu, S. K., & Yuan, X. (2018). Secret image sharing scheme with encrypted shadow images using optimal homomorphic encryption technique. *Journal of Ambient Intelligence and Humanized Computing*, 1-13. <https://doi.org/10.1007/s12652-018-1161-0>
- [87]. K. Shankar, MohamedElhoseny, E. Dhiravidachelvi, SK. Lakshmanaprabu, Wanqing Wu, , *IEEE Access*, Vol.6, Issue.1, page(s): 77145-77154, December 2018. <https://doi.org/10.1109/ACCESS.2018.2874026>
- [88]. MuthukumarMurugesan, Dr K. Karthikeyan. "Business intelligence market trends and growth in enterprise business." *International Journal on Recent and Innovation Trends in Computing and Communication* 4.3 (2016): 188-192.
- [89]. Singhal, Nitesh, ParijatSinha, NitinAgarwal, and MuthukumarMurugesan. "Systems and methods for facitiating card verification over a network." U.S. Patent Application 12/819,774, filed December 22, 2011.
- [90]. Murugesan, Muthukumar, and T. Ravichandran. "Evaluate database compression performance and parallel backup." *International Journal of Database Management Systems* 5.4 (2013): 17.
- [91]. Muthukumar, M., and T. Ravichandran. "Analyzing compression performance for real time database systems." *Int. Conf. onAdvanced Computer Engineering and Applications (ICACEA)*. 2012.
- [92]. Murugesan, Muthukumar, K. Karthikeyan, and K. Sivakumar. "Novel investigation methodologies to identify the SQL server query performance." *Indian Journal of Science and Technology* 8.27 (2015).
- [93]. Murugesan, C., and T. Ravichandran. "Real time database compression optimization using iterative length compression algorithm." *Int. Conf. on Computer Science and Information Technology*, USA. 2013.
- [94]. Muthukumar, M., and T. Ravichandran. "Optimizing multi storage parallel backup for real time database systems." *IJESAT*, ISSN: 2250-3676.
- [95]. Muthukumar, M., and T. Ravichandran. "Optimizing and enhancing parallel multi storage backup compression for real-time database systems." *International Journal of Computer Technology and*

- Applications 3.4 (2012).
- [96]. Murugesan, Muthukumar, and T. Ravichandran. "Performance Enhancement Evaluation in Database Decompression Using HIRAC Algorithm." *International Journal of Computer Science Issues (IJCSI)* 9.6 (2012): 35.
- [97]. M. MUTHUKUMAR, Dr.T. RAVICHANDRAN." Database Compression Performance Enrichment using HIRAC Algorithm",2012, Karpagam University Research Congress - 2012 (KURC 2012).
- [98]. M. MUTHUKUMAR, Dr.T. RAVICHANDRAN," Enhanced Database Compression and Decompression Techniques for Performance Improvement", 2013, State Level Seminar on "EMERGING TRENDS AND ISSUES", Kongu Arts and Science Colls. ERODE.
- [99]. Dr.MuthukumarMurugesan, Dr. K. Karthikeyan, Dr.K. Sivakumar, "Analyzing Integral Components of SQL ServerDatabases", *International Journal of Applied Engineering Research (IJAER)*, Volume: 10, Issue.9, Page(s): 24189-24200,2015.
- [100]. K.Karthikeyan M Muthukumar, SenthilPandian, "Analyzing and Improving the Performance of Decision Database with Enhanced Momentous Data Types", *Asia Journal of Information Technology*, Volume: 16, Issue.9, Page(s): 699-705, 2017.
- [101]. Sivaram, M., B. DurgaDevi, and J. Anne Steffi. "Steganography of two LSB bits." *International Journal of Communications and Engineering* 1.1 (2012): 2231-2307.
- [102]. Manikandan, v., v. Porkodi, aminsalihmohammed, and m. Sivaram. "Privacy Preserving Data Mining Using Threshold Based Fuzzy Cmeans Clustering." *ICTACT Journal on Soft Computing* 9, no. 1 (2018).
- [103]. Malathi, N., and M.Sivaram. "An Enhanced Scheme to Pinpoint Malicious Behavior of Nodes InManet's." (2015).
- [104]. Mohammed, Amin Salih, D. Yuvaraj, M. Sivaram, and V. Porkodi. "Detection And Removal Of Black Hole Attack In Mobile Ad Hoc Networks Using Grp Protocol." *International Journal of Advanced Research in Computer Science* 10, no. 6 (2018).
- [105]. Sivaram, M., D. Yuvaraj, Amin Salih Mohammed, V. Porkodi, and V. Manikandan. "The Real Problem Through a Selection Making an Algorithm that Minimizes the Computational Complexity."
- [106]. Porkodi, V., M. Sivaram, Amin Salih Mohammed, and V. Manikandan. "Survey on White-Box Attacks and Solutions." *Asian Journal of Computer Science and Technology* 7, no. 3 (2018): 28-32.
- [107]. Sivaram, M. "Odd And Even Point Crossover Based TabuGa For Data Fusion In Information Retrieval." (2014).
- [108]. Dhivakar, B., S. V. Saravanan, M. Sivaram, and R. Abirama Krishnan. "Statistical Score Calculation of Information Retrieval Systems using Data Fusion Technique." *Computer Science and Engineering* 2, no. 5 (2012): 43-45.
- [109]. Punidha, R., avithra K, Swathika R, and Sivaram M, " PreservingDDoS Attacks sing Node Blocking Algorithm." *International Journalof Pure and Applied Mathematics*, Vol.119, o. 15, 2018, pp 633-640. <https://acadpubl.eu/hub/2018-119-15/3/473.pdf>
- [110]. M, Sivaram, et al. "Securing the Sensor Networks Along With Secured Routing Protocols for Data Transfer in Wireless Sensor Networks." *Journal of Emerging Technologies and Innovative Research*, vol. 5, no. 10, Oct. 2018, pp. 316–321., doi:http://doi.one/10.1729/Journal.18612.
- [111]. Steffin Abraham , TanaLuciyaJoji , Sivaram M, D.Yuvaraj, "Enhancing Vehicle Safety With Drowsiness Detection Andcollision Avoidance" *International Journal of Pure and Applied Mathematics*, Volume 118 No. 22 2018, 921-927. <https://acadpubl.eu/hub/2018-118-22/articles/22b/39.pdf>
- [112]. Mahalakshmi.K, Sivaram.M, ShanthaKumari.K, Yuvaraj.D, Keerthika.R, "Healthcare Visible Light Communication", *International Journal of Pure and Applied Mathematics*, Volume 118 No. 11 2018, 345-348, <https://acadpubl.eu/jsi/2018-118-10-11/articles/11/41.pdf>.
- [113]. Punidha.R, Sivaram.M, "Integer Wavelet Transform Based Approach For High Robustness Of Audio Signal Transmission", *International Journal of Pure and Applied Mathematics*, Volume 116 No. 23 2017, 295-304, <https://acadpubl.eu/jsi/2017-116-23-24/articles/23/40.pdf>
- [114]. Deepa.S, Sivaram.M, "Enabling Anonymous Endorsement In Clouds With Decentralized Access Control", *International Journal of Scientific Engineering and Applied Science (IJSEAS)* - Volume-1, Issue-3, June 2015, 397-401.
- [115]. Sivaram.M, Obulatha.O, " Position Privacy Using LocX", *International Journal of Innovative Research in Engineering Science and Technology*, Vol. III,Issue 01,Pp 206-212.
- [116]. M. Sivaram, K. Batri, Amin Salih Mohammed and V. Porkodi, "Exploiting the Local Optima in Genetic Algorithm using Tabu Search", *Indian Journal of Science and Technology*, Vol 12(1), DOI: 10.17485/ijst/2018/v12i1/139577, January 2019.
- [117]. Sivaram M, Batri K, " Odd and Even Point Crossover Based Tabu GA for Data Fusion in InformationRetrieval", <http://hdl.handle.net/10603/38935>,10-Apr-2015.

- [118]. Sivaram.M, Yuvaraj.D, Amin Salih Mohammed, Porkodi.V “Estimating the Secret Message in the Digital Image” International Journal of Computer Applications, 181(36):26-28, January 2019.
- [119]. Mrs.V.Porkodi, Dr.D.Yuvaraj, Dr.AminSalihMohammed,V.Manikandan and M.Sivaram, “Prolong the Network Lifespan of Wireless Sensor Network by Using Hpsm”, International Journal of Mechanical Engineering and Technology, 10(01), 2019, pp.2039–2045.<http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=10&Type=01>
- [120]. Porkodi.V, Yuvaraj.D.,Mohammed,A.S, Sivaram.M and Manikandan.V,“IoT in Agriculture” Journal of Advanced Research in Dynamical and Control Systems, Pages: 1986-1991,14-Special Issue, Pages: 1986-1991,2018.
- [121]. Manikandan.V, Mohammed, A.S, Yuvaraj,D., Sivaram.M and Porkod.V, “An Energy Efficient EDM-RAEED Protocol for IoT Based Wireless Sensor Networks” Journal of Advanced Research in Dynamical and Control Systems, Pages: 1992-2004,14-Special Issue,Pages: 1992-2004, 2018.
- [122]. Mohammed, A.S., Kareem, S.W., Al Azzawi, A.K., Sivaram, M. “Time series prediction using SRE-NAR and SRE-ADALINE”, Journal of Advanced Research in Dynamical and Control Systems, Pages:1716-1726, 2018.
- [123]. Sivaram, M., Yuvaraj, D., Porkodi, V., Manikandan, V. “Emergent news event detection from facebook using clustering” Journal of Advanced Research in Dynamical and Control Systems, Pages:1941-1947, 2018.
- [124]. Nithya, S., SundaraVadivel, P., Yuvaraj, D., Sivaram, M. “Intelligent based IoT smart city on traffic control system using raspberry Pi and robust waste management”, Journal of Advanced Research in Dynamical and Control Systems, Pages: 765-770, 2018.
- [125]. Viswanathan, M., Sivaram, M., Yuvaraj, D., Mohammed, A.S. “Security and privacy protection in cloud computing”, Journal of Advanced Research in Dynamical and Control Systems, Pages 1704-1710, 2018
- [126]. Batri, K., Sivaram, M. “Testing the impact of odd and even point crossover of genetic algorithm over the data fusion in information retrieval”, European Journal of Scientific Research, 2012.
- [127]. SivaramYuvaraj Amin SalihMohamme M D V Porkodi. Estimating the Secret Message in the Digital Image. International Journal of Computer Applications 181(36):26-28, January 2019