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Role and Performance of Different Traditional Classification and Nature-Inspired Computing Techniques in Major Research Areas

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Abstract

In the last few years, different machine learning techniques such as supervised, unsupervised, and reinforcement learning have been effectively employed to solve distinct real-life multidisciplinary problems. These techniques have been effectively applied to accurately predict the problems related to stock values, disease diagnosis, sentiment analysis, text processing, gene classification, crop prediction, and weather forecasting. The objective of this manuscript is to present the systematic review on the use of these techniques in five major domains i.e. agriculture, finance, healthcare, education and engineering. A standard review methodology has been adapted to include and exclude the related literature. The performance of different supervised and nature-inspired computing techniques have been accessed on the basis of different performance metrics. The publication trend on the use of machine learning techniques in these five research areas has been also explored. Finally, the gaps in the study have been identified that will assist prospective researchers who want to pursue their research in these areas.

Keywords: Machine Learning, Agriculture, Engineering, Education, Stock Forecasting, Disease Diagnosis.

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1. Introduction

Machine Learning(ML) is one of the major multidisciplinary research areas. As per Stanford University, Machine Learning is defined as a science that makes computer to perform some intelligent activities based upon existing data and without being explicitly programmed[1]. Machine Learning has been used in a wide sphere of life. There are three main categories of machine learning called supervised learning, unsupervised learning and reinforcement learning[2]. These techniques have been effectively used to solve a wide variety of classification, clustering and prediction problems. In supervised learning, the inputs are labeled and these labels are the desired outputs. These techniques assist in the data classification process. Disease diagnosis, stock prediction, sentiment analysis are some of the major application areas for supervised learning techniques. Traditionally, different techniques like naïve Bayes, decision tree, random forest and support vector machine have been dominantly used to solve different data classification problems. On the contrary, an unsupervised learning technique also known as clustering techniques deals with unlabeled data. No extra information is provided for grouping the data that's why these are called unsupervised techniques. Reinforcement learning is concerned with the behavior of software agents. There are some functions associated with these agents and they perform their operations in the specified environment to achieve the reward[3].

In the last few years, exponential growth in the use of machine learning techniques has been observed. Different machine learning techniques have been

Table 1: Summary of Supervised Learning (Traditional) Techniques

Author, Year	SVM	Naïve Bayes	Decision Tree/ C4.5/ID3(Iterative Dichotomise)	Logistic Regression	MLP	Neural Networks	ANN	CART	Ada Boost	Autoencoders	SKN	Ensemble Modeling	Application	Accuracy
Farzaneh Sajedi-Hosseini(2018)[38]												✓	Risk Assessment of nitrate groundwater contamination	Above 80%
Shubham Jain et al.,(2018)[47]					✓								Stock Analysis	Not mentioned
Jagath Sri Lal Senanayaka et al.,(2017)[57]	✓												Bearing Fault Classification	96%
Mustansar Ali Ghazanfar, et al.,(2017)[50]									✓				Prediction of Stock Exchange Index	Not mentioned
Nanxi Wang (2017)[49]	✓					✓				✓			Bankruptcy Prediction	Not mentioned
Sentkil Kumar Thangavel et al.,(2017)[54]												Logistic regression+Decision tree+Naïve Bayes+ Metabagging classifier+Classification via Regression	Student Placement Analyzer	84.42%
Lovenoor Aulck et al,.(2016)[52]				✓									Student Dropout	66.59%
X.E. Pantazi et al.,(2016)[39]											✓		Wheat yield	91%
T. Vafeiadis et al.,(2015)[45]	✓												Customer Churn	97%
T. K. Das (2015)[68]		✓											Customer Classification	95%
Jigar Patel et al.,(2014)[69]		✓											Stock Analysis	90.19%
Nashwa El-Bendary(2014)[35]												SVM+PCA+LDA(Linear discriminant analysis)	Tomato ripeness	90.2%
Avat Shekoofa et al.,(2014)[37]								✓					Maize Grain yield	Not mentioned

Seema Sharma et al.,(2013)[70]			✓									Classification of datasets	75.06%
Yuqinq He et al.,(2013)[51]											PCA+Genetic Algorithm+ SFS(sequential forward feature selection)	Stock Market Analysis	94%
Tarigoppula V.S. Sriram et al.,(2013)[63]	✓	✓		✓							Random Forest+ KStar+AD(Alternating Decision)Tree+J48 +LMT(Logistic Model Tree)	Parkinson Disease Prediction	90.26%
Junichiro Mori et al.,(2012)[46]	✓											Business partners and building reciprocal relationships	Not mentioned
Saurabh Pal(2012)[71]			✓ ✓					✓				Dropout Rates of Engineering Students	85.7%
Ruchika Malhotra(2012)[60]											Random Forest+Adaboost+Bagging+MLP+SVM+GA+Logistic Regression	Fault Prediction	81.99%
Yakup Kara et al.,(2011)[72]												Stock Analysis	75.74%
Gianluigi Guido et al.,(2011)[73]												Direct Marketing Campaigns	83%
Ulrich Weiss et al.,(2010)[36]	✓			✓		✓						Plant species	99%
Dursun Delen et al.,(2010)[9]	✓		✓	✓							bagging ,boosing ,information fusion	Students retention management	82.10%
S. Kotsiantis et al.,(2010)[53]											Naive Bayes+ 1-NN(Nearest Neighbour)+ WINNOW	Students' performance in distance education	82%

Table 2: Summary of Nature-Inspired Computing Techniques

Gadekallu Thippa Reddy et al.,(2016)[88]											FF+ Neural Network(NN)	Diabetes Diagnosis	79%
Abdalla Mostafa et.al.,(2016)[89]								✓				CT liver image segmentation	93.73%
Esraa Elhariri et al.,(2015)[90]											GWO+SVM	EMG signals	90%
Chih-Feng Chao et al.,(2014)[91]					✓							Ultrasonic Supraspinatus	93.75%
Sidahmed Mokeddem et al.,(2013)[92]	✓											Coronary Artery Disease	85.50%
Chaehwan Won et al.,(2012)[93]	✓											Dividend policy forecasting	74.16
N. G. Bhuvaneswari Amma et al.,(2012)[94]											GA +Neural Networks	Cardiovascular Disease	94.17%
E.P.Ephzibah (2011)[95]	✓											Diabetes diagnosis	87%
Mostafa FathiGanji et al.,(2011)[96]											Fuzzy Classification system +ACO	Diabetes diagnosis	84.24%
Xianfeng Li et al.,(2010)[97]											ACO+SVM	Weed Identification	94%
M.Anbarasi et al.,(2010)[98]											GA+Naive Bayes+Decision Tree	Heart Disease	99.2%

Table 3: Role of NIC Techniques

Algorithms/Domains	Agriculture	Finance	Healthcare	Education	Engineering
Genetic Algorithm(GA)	17,000	16,800	16,200	31,400	298,000
Grey Wolf Optimization(GWO)	93	80	52	255	1500
Crow Search Algorithm(CSA)	30	19	29	62	396
Ant Lion Optimization(ALO)	21	16	19	65	395
Fire Fly Algorithm(ALO)	785	848	505	2720	13,700
Ant Colony Optimization(ACO)	4080	4250	2890	15,400	41,100
Whale Optimization	61	70	63	203	1140
Artificial Bee Colony(ABC)	1560	1700	1080	7040	18,100
Monkey Search	25	23	12	72	301
Cuckoo Search	726	714	634	2850	13,400
Multiverse Optimization(MVO)	0	1	0	3	19

Table 3 depicts the publication trend of different nature-inspired algorithms in five research areas viz. agriculture, finance, healthcare, education, engineering. It has been observed that ample amount of work has been published in these domains using Genetic Algorithms(GA), Ant Colony Optimization(ACO) and Artificial Bee Colony(ABC) algorithm and a relatively lesser number of articles have been published using other algorithms. Additionally, little attention has been paid to use of multiverse optimization in five major domains(agriculture, finance, healthcare, education, engineering).

Table 4 depicts the contribution of different authors, universities and the journals in publishing the different articles related to the role and performance of machine learning in five different research domains viz. agriculture, finance, healthcare, education, and engineering.

Table 4 : Details of Publications

Author Name	Citation	Journal	Country
Andrea Mannini, And Angelo Maria Sabatini(2010)[99]	538	Sensors	Italy
Christos A. Frantzidis et al.,(2010)[100]	131	IEEE Xplore	Greece
Youn-Jung Son, et al.,(2010)[101]	55	KoreaMed Synapse	Korea
Asha Rajkumar et al.,(2010)[102	136	Global Journal of Computer Science and Technology	India
Ulrich Weiss et al.,(2010)[36]	34	Ninth International Conference on Machine Learning and Applications	Germany
Edward W. Lowe et al.,(2011)[59]	5	IEEE Xplore	USA
Ketaki Chopde et al.,(2012)[42]	1	International Journal of Engineering and Advanced Technology	India
Wei-Yang Lin, et al.,(2012)[17]	120	IEEE Transactions on Systems	Taiwan
	255	International Journal of Bio-Science	India

Divya Tomar et al.,(2013)[7]		and Bio-Technology	
Yun Hwan Kim et al.,(2014)[13]	5	2013 International Conference on Future Software Engineering and Multimedia Engineering	Korea
Avat Shekoofa et al.,(2014)[37]	24	Plos|One	USA, Iran,Australia
Vanaja et al.,(2015)[62]	13	Journal of Computer Science	India
Shubham Bind et al.,(2015)[20]	14	International Journal of Computer Science and Information Technologies	India
Shweta H. Jambukia et al.,(2015)[22]	35	International Conference on Advances in Computer Engineering and Applications	India
Vivek Rajput et al.,(2016)[16]	3	International Journal of Computer Science and Mobile Computing	India
Subhadra Mishra et al.,(2016)[14]	10	Indian Journal of Science and Technology	India
Ernest Mwebaze et al.,(2016)[103]	10	IEEE Xplore	Uganda
M. Sharma et al.,(2017)[6]	6	Elsevier Masson	India
Wei-Chao Lin et al.,(2017)[5]	4	Emeraldinsight	Taiwan
Zachary W. Ulissi et al.,(2017)[104]	49	ACS Catalysis	United States
Hao Li et al.,(2017)[105]	38	International Journal of Photoenergy	USA and China
Jagath Sri Lal Senanayaka et al.,(2017)[57]	12	IEEE Xplore	Norway
Sentkil Kumar Thangavel(2017)[54]	6	IEEE Xplore	India
Ashish Sharma et al.,(2017)[18]	5	International Conference on Electronics, Communication and Aerospace Technology	India
Konstantinos G. Liakos et al.,(2018)[12]	5	Sensors	Greece
M. Sharma et al.,(2018)[106]	2	EAI Endorsed Transactions on Scalable Information Systems	India
Prableen Kaur et al.,(2018)[19]	1	International Journal of Pharmaceutical Sciences and Research	India
Prableen Kaur et al.,(2018)[21]	3	Proceedia Computer Science	India
ZhienZhang et al.,(2018)[107]	12	Journal of CO_2 Utilization	China
Joeky T. Senders et al.,(2018)[108]	12	Springer	USA
M.Sharma et al.,(2018)[109]	4	Data	India
O. Nadjemia et al.,(2019)[110]	26	Renewable and Sustainable Energy Reviews	Algeria

The articles published in the five domains are further examined and the details are mentioned in the Table4. It has been observed from the table that a number of researchers have done their research in these domains and the contribution of the researchers and their universities are highlighted in the table. On the average the rate of citations is in two digits. However, some special cases of three digits are also present.

6. Conclusion

This paper presents the systematic review of role and performance of machine learning techniques in five major research areas viz. healthcare, education, finance, agriculture, and engineering. Some of the major applications areas of ML techniques are highlighted. The research works of some of the key authors related to the use of ML techniques particularly in agriculture, finance, education, engineering, and healthcare has been examined and presented in this study. Furthermore, to examine the rate of publication, the publication trend of the related articles has been analyzed. From the last ten year of publication trend, it is observed that a significant amount of research work has been carried out for exploring the role and performance of different ML techniques in engineering. However, agriculture, finance, and healthcare still need more attention. Additionally, as far as nature inspired computing (NIC) techniques are concerned, more attention is required for multiverse optimization techniques. Moreover, the latest and emerging NIC techniques should also be employed in these areas and their performance need to be examined.

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