Original Article

Comparison Of Various Machine Learning Algorithms For Recognizing Text On The Medical Prescriptions

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Abstract

For the sake of enhancing quality of life, patient happiness is one of the most important Key Performance Indicator (KPI) Goals in the health care industry. Patients' satisfaction with healthcare providers would improve if waiting times were reduced. The recent success of AI and ML is unprecedented. It has made life easier and better for people overall. To determine whether or not it is worthwhile to alter the outpatient pharmacy process, a machine-learning-based framework for healthcare has been developed. Doctors' hectic schedules cause them to jot prescriptions in illegible handwriting, which might lead to confusion while trying to identify the correct medication. Before buying a medication, patients often want to know more about it. However, due to the poor handwritten of physician and the variety of their handwriting, no technique has led to complete recognition of medicine names; this has led us to machine learning, in which the system may discover different characters for exact drugs in order to identify new handwritings. Through the use of a mobile application that can read handwritten medicine names and provide a readable textual content of the medication and the dose, this work offered a system that provides a resolution for both the pharmacists and the patient. Multiple prediction methods are taken into account, and the results of the associated work's data sets are analyzed and compared.

Keywords- Doctor’s Prescription, Preprocessing, machine learning, prediction.

1. Introduction:

Emirates247.com claims that "Doctors handwriting causes 9,000 fatalities a year" (2012) [1]. It's a popular misconception that doctors have particularly unreadable handwriting. Everything appears to be running smoothly until one of the roughly 9000 people who sustain injuries each year goes about their daily lives. Misinterpretation of a doctor's order might have disastrous consequences for a sick person. [2] Information such as the required dosage, the duration of intake, and the title of the medication in the right prescribed dosage might help prevent the patient from taking too much of the drug. To get around this problem and improve patient safety, adjustments are being made to existing systems that could lead to lifetime certainty for patients, hence eliminating the possibility of human error due to illegible handwriting.

At present, e-Prescriptions in the United States typically entail the transfer of a prescription or information linked to a prescription between a prescriber and a pharmacist over an intermediate e-prescribing system [3, 4]. Consequently, prescriber offices can now send prescriptions to pharmacies by electronic means (e-Prescription) as well as the more common paper, fax, and mobile app methods. Internet pharmacies, often known as "e-Pharmacies" or "online pharmacies," provide a variety of delivery options for medications, including those requiring a prescription. Beginning in the late 1990s, the first e-Pharmacy sold both prescriptions and over-the-counter drugs [5]. In 2017, more than 6,000 websites in the United States offered prescription drugs for sale. Over 10000 in 2021, and the number is rapidly growing [7]. In 2021, researchers summarized their findings on e-Pharmacies of their use, showing that the trend is only growing [6].

There have been previous attempts to implement the proposed idea, but they were neither as widespread nor as successful and sufficient as the ones that did so because they relied on Character Recognition (OCR) and other techniques [8][9][10][11][12], which helped but didn't entirely eliminate the problem. Some nations have taken the simpler route of adopting electronic medical prescription forms, wherein doctors can write out their prescriptions directly into a computer system. Yet, Egypt has yet to implement this strategy. Regular users & pharmacists were polled to determine the app's potential usefulness, and the results indicated that Ninety-two percent of respondents overall found the app to be helpful and useful, while just 8% initiate it or else which is shown in figure 1. It's certain that the planned approach is likely to become widely used in India.

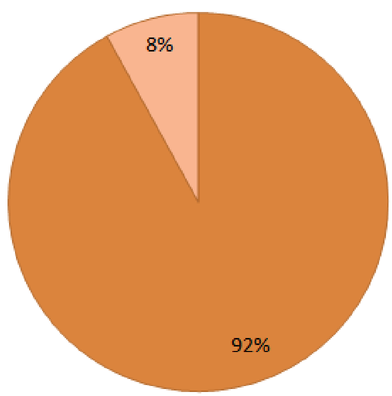

Figure 1. Survey Results of Reading Doctors Prescription Problem

2. Literature Survey:

When a patient's quality of life is negatively impacted by their medication regimen, we refer to this as a "critical" situation. Researchers led by Fernando looked at how well boosting adherence to prescriptions worked in general [13]. The expanding influence of technology in healthcare has made the problem of dispensing and following prescriptions urgent, hence this was started to address the issue. The waiting time, patient satisfaction, and compliance rate are three primary areas where this could be accomplished.

Patients in the emergency room were randomly assigned to either the control group (which got written prescriptions) or the experimental group. Data collection for prescription adherence and ad- hence took place over the course of a week of follow-ups. In cases of noncompliance, the underlying causes were compiled and analyzed. Electronic prescriptions were not linked to a rise in noncompliance, according to the method, which was conducted under controlled conditions to ensure its validity for both groups. Noncompliance was investigated further by reviewing the acquired data to determine causes, such as inaccessibility to or insufficiency of necessary medications. Waiting time was a significant issue, although there was no evidence of a link or causation. However, switching from paper prescriptions to electronic ones resulted in shorter wait times and happier customers[37][39].

Fernando's research not only pointed to where E-prescriptions may be made better and more effective, but also shed light on why some people still don't use them [13]. However, the results are important because of the implications they have for future research and the implementation of E-prescriptions in the medical sector, where sample is limited and hence the results cannot be used and generalized to a large extent[32][34]. A second study confirms the usefulness of machine learning; it surveyed the literature on the topic of machine learning's impact on patients' compliance with their prescribed medications. Due to the serious consequences of not taking prescribed medication, especially for chronic conditions, this was done[30]. The research aimed to evaluate and contrast the impacts of machine learning on medication adherence with those of more conventional data analysis powered by distribution strategies. Because there is not enough evidence from the past to verify its general applicability to all diseases, the hypothesis was predicated on deviating from the standard 78% adherence rate, which is considered to be reasonable. A "random and fit survival tree" was used to compile the information needed to identify patients at risk of hospitalization due to non-adherence and identify predictors of this risk[27][28].

According to the results of the study, the predictors used after patient identification revealed that different patients' marginal adherence thresholds varied widely. While a baseline of 80% was established based on previous studies, the actual adherence rate showed no consistent pattern and instead fell somewhere in the range of 46%-94%[29][31]. Thus, the study suggested that applying machine learning via algorithms could be effective in not just reducing hospitalizations but also better understanding the factors that contribute to them. Therefore, the study is extremely important for the development of the health sector, particularly for patient-specific assessment and action in comparison to a generic compliance threshold appliance [14]. The purpose of this research is to assess the viability of modifying the outpatient pharmaceutical workflow by comparing the predictive abilities of different machine learning-based models for preparing prescriptions in advance[25][26].

Using a smartphone app and a medication box equipped with Convolutional Neural Network (CNN) technology, Kamalanaban et al. 2019 [15] were able to read and understand doctors' handwritten prescriptions and provide them with a more legible, cohesive digital version. Our findings demonstrated that adding more data to the training model improved its performance. Photos with an emphasis on text line detection and verification can be easily detected using this method, Cneshova et al. [16] worn the fields recognition. Character classification was studied using a variety of datasets, including MIDV-500 and MNIST. Compared to the ensemble model's 0.23% and 0.14%, the non-ensemble model's 0.25% outcomes were improved through online augmentation[35][37].

Research by Xu et al. [17]) zeroed in on techniques for recognizing Chinese characters. Experiments demonstrated superior performance than "state-of-the-art approaches" when the Hidden Markov Model (HMM) was used for information preparation. Customized Completely CNN, layered lasting LSTM network, a record layer were also used in the framework that Zhu et al. [18] developed. Recognition can quickly distinguish characters from the backdrop, and experiments revealed that softer quality removal led to more connection faults. As an additional resource, Ra lasmi et al. [19] suggested a CNN supported model that splits handwriting recognition into an online and offline phase. In their study [20], Kumar et al. zeroed in on Multilingual texts that employ OCR to digitize handwritten characters. Experiments demonstrated the highest accuracy in English character recognition while using Linear-Support Svm Classifier, k-Nearest Neighbour (K-NN), & Multilayer Prescription (MLP) classifiers in the multi-lingual text phases. Using the field recognition stage, Chernyshova et al. 2020 [16] were able to recognize low-quality photos with a focus on text line identification and recognition. Character classification was studied using a variety of datasets, including MIDV-500 and MNIST. Compared to the ensemble model's 0.23% and 0.14%, the non-ensemble model's 0.25% outcomes were improved through online augmentation. Systems for recognizing handwritten Arabic text were proposed by researchers Etly et al. [21], Gulati et al. 2020 [22], Sneo et al. [23], & Hudani et al. [24] using methods such as an adaptive information preprocessing mechanism, a Hierarchical Clustering system and an N-gram Language form on the handwritten text in addition to an HMM. The images used fall into one of four categories: printed, mixed, other, or handwritten. The results demonstrated that the model was 99.5% accurate in its picture classifications[36][38].

3. Proposed Method:

The suggested approach begins with a scan of the medical prescription using a mobile device's camera, followed by a series of pre-processing steps such as picture removal, black-and-white conversion, noise removal, and image scaling. Once the data has been collected, it will be processed using a Convolution Neural Network (CNN) [23] to perform feature extraction for training purposes. In the final stage of processing, results will be compared against 20% of the raw data for quality assurance. Low-accuracy medicinal names were identified using OCR by comparing the results to a database containing all drug names.

First, photographs of scanned prescriptions are input into the system using the smartphone camera, with the PNG extension type selected as the input type. Second, the image is converted to black and white and any excess white areas are cropped to bring the size of the picture back to normal. As a third step, we use the morphological operations technique on the figure to create all the figures with the similar extent by comparing the relevant pixel in contribution picture to its neighbors. The prescription is then cropped into thirds using the cropping technique.

Convolutional neural networks (CNNs) undertake two jobs, feature extraction and classification, to accurately categorize images when the pre-processing phase is complete. The region in the middle contains the prescribed drugs. Features are extracted from an input image using the Convolution layers, the Relu piece, as well as the Max pooling layer, before the hidden layers are applied for classification and the resulting outcome is generated. (see Figure 2).

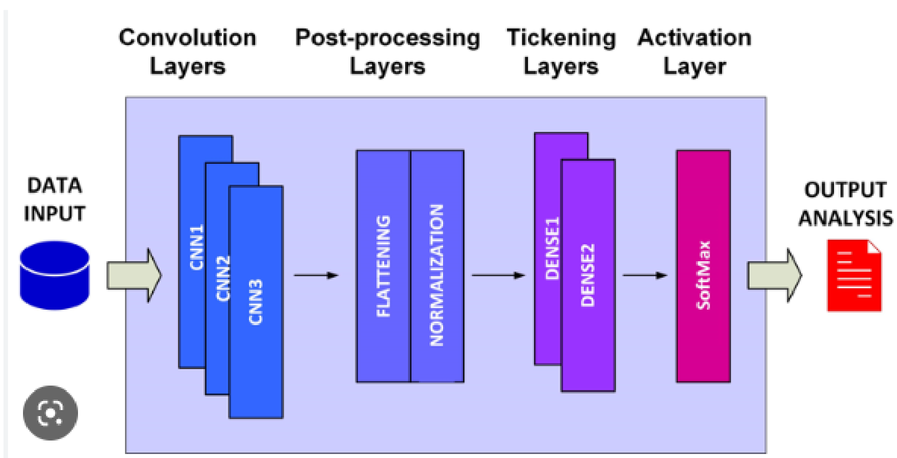

Figure 2.CNN Working Principle on any images

First, the image data, an aspect detector, and just a plot are used to initiate the convolution step, also recognized as the feature extraction step; As a second step, the precompiled middle picture is multiplied by the filter's applicability matrix pixels by pixel to finish off the feature map. To get to the first Convolutional layer, we must first generate several feature maps. Second, we'll use the Sobel operation to develop an edge detection filter. As a third layer in the network, the Rectified Unit (ReLU) layer adds nonlinearity by applying an foundation function to the characteristic map. Fourth, we employ max-pooling method to progressively shrink the source illustration range to location variance, which facilitates item detection and identification across the image. While reducing processing time and the number of parameters, pooling also helps keep overfitting under control. The final step is to flatten the pooled feature map[25] into a sequentially long vector, which is then fed into the input layer of the ANN for further processing.

Boosting the model's efficacy and precision, To ensure greater precision, more medical prescriptions will be collected in handwriting. Additional classification methods, such as visual Character detection (VCD), will be used to resulting output if precision is 48% or fewer to route characters by characters, with the VCD output being compared to a data set containing all the drugs in order to identify which drug in the dataset is closest to the output.

Figure 3.Block Diagram of the Proposed Method in Detail

4. Results and Discussion:

Several actual examples from the dataset have been used in an experiment. Python is used for the actual implementation. Prescription drugs are categorized and extracted features using CNN. after several pre-processing steps, including image subtraction or normalization, have been performed on the data set. Our primary goal in compiling this dataset is to have as many unique prescriptions as possible for each medication, written by as many different doctors and pharmacists as possible. For the purpose of training the suggested model, the dataset was split 65/35 in favor of training. First, the doctor's name & specialty are listed up to the letter R; this information will be used to categorize the medicine according to the doctor's area of expertise, & third section, beginning after R, contains this same handwritten prescribed medicines, which will also be classified. Experiments with a Wide Range of Samples Figure 4 depicts a set of prescriptions.

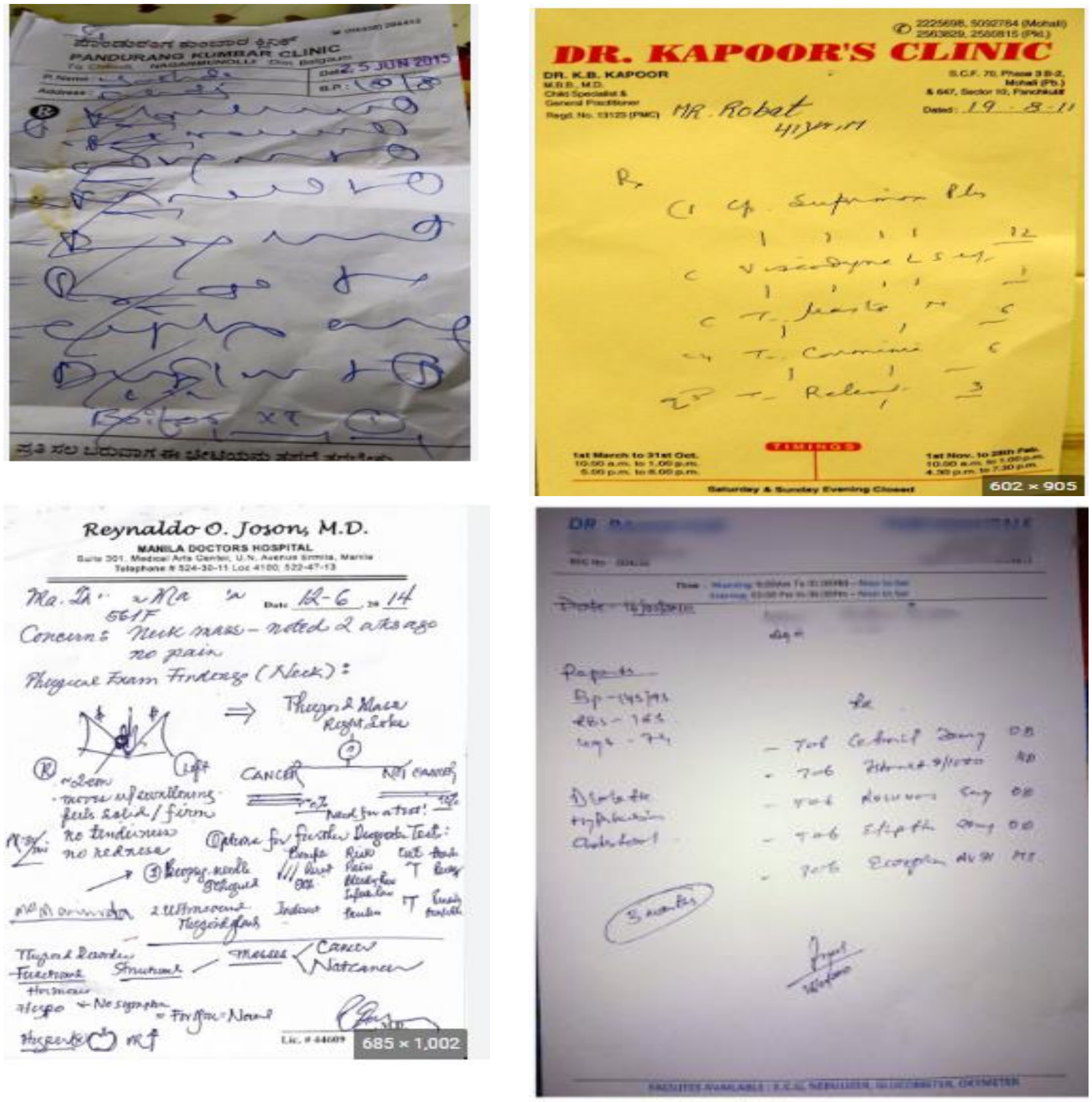

Figure 4. Sample Prescriptions available in our data set

We have used 3 popular machine learning (ML) Algorithms for evaluation the proposed system.ML algorithms used are Ransom Forest, Ada boost and Multi layer Perception for executing the proposed system. We have considered two popular parameters namely accuracy and precision for extracting the text and show it in an understandable format to the user. The evaluated results of the System as shown below table 1. In order to carry out the experiment at hand To guarantee that the scanned picture is clean and the content is visible, medical prescription should be scanned using a mobile phone with a good camera resolution, and the photos should be shot from an acceptable and zoomed in position.

Table 1.Evaluated Results of the three Algorithms

Name of the Algorithm	Accuracy (%)	Precision (%)
Random Forest	96.5	98.56
Ada Boost	94.6	97.12
Multi Layer Perception	92.7	95.23

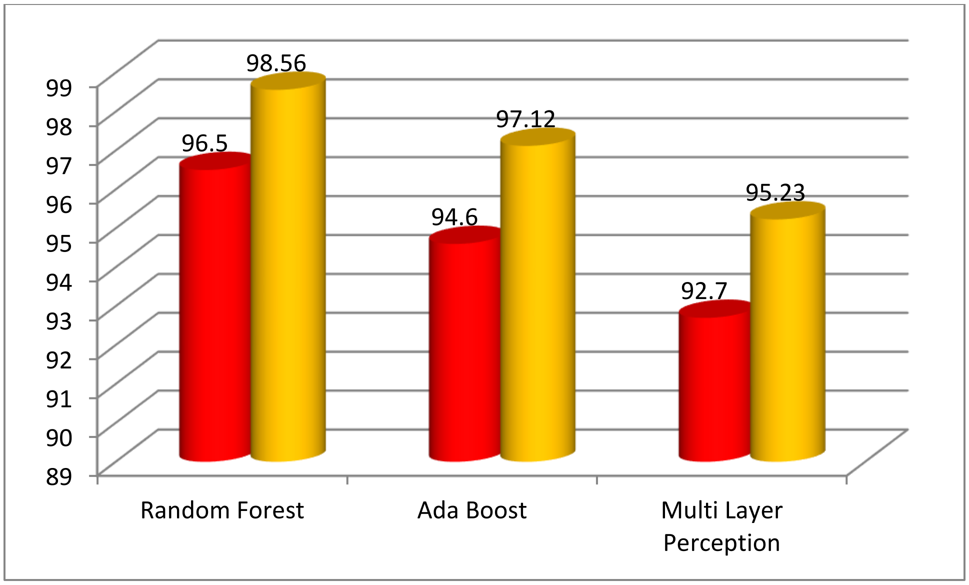

Figure 5. Results of the Comparison of three Algorithms

Figure 5 shows the graphical Representation of the three algorithm results. From the above graph it is evident that random forest algorithm performs well when compared to the remaining algorithms in terms of Precision and Accuracy.

5. Conclusion:

Patient happiness and the quality of health care as a whole can be significantly impacted by the length of time they have to wait while receiving treatment. Machine learning is rapidly emerging as a crucial tool for analyzing and modeling human-related work across many fields, but particularly in the healthcare industry. The primary objective is to develop a model to anticipate planning of pharmacy prescriptions, as the vast majority of patients show up at the pharmacy following their outpatient clinic visit. The accuracy and precision provided by Random Forest are the best across all algorithms. This method generally expedites the time it takes to receive the prescription. The quality of healthcare supplied to patients will improve thanks to the integration of machine learning with existing data.

References:

[1] M. V. Leijien, "Doctors' handwriting causes 7,000 deaths a year," Emirates247,4 November 2021.

[2] G.Duncan, "Day in the life: Dubai doctor is a medical detective at work," The National, 13 Febuary 2020.

[3] Surescripts, "The National Progress Report on E-prescribing and Safe-Rx Rankings,"2021.

[4] A.Gilligan,K. Miller, A. Mahoney, C. Montengro, J. Schwarz and T. Warholak, "Analysis of pharmicists' interventions on electric versus traditional prescriptions in 2 community pharmacies," Res Soc Adm Pharm, vol. 8, pp. 523-532, 2019.

[5] M.M.Makinen, P. T. Raupava and J. J. Forsstorm, "Do Ops fir European internal markets?," Health Policy , no. 72, pp. 245-252.

[6] G.Orizio,A.Merla,P.J. Schulz and U. Gelatti, "Quality of online pharmacies and websites selling prescription drug, a systematic review," J. Med. Internet Res , vol. 12, no. 3, p. e74, 2021.

[7] Mark Monitor, "Webcitre MarkMonitor Finds Online Drug Brand Abuse is Growing.," Businesswire.com, 2021.

[8] Ming Liang, and Xiaolin Hu. https://ieeexplore.ieee.org/document/7298958 “Recurrent Convolutional Neural Network for Object Recognition”. In: (2019).

[9] Matthew Y.W. Teow. https://ieeexplore.ieee.org/document/8123441 “A Minimal Convolutional Neural Network for Handwritten Digit Recog- nition”. In: (2020).

[10] Y. LeCun, K. Kavukcuoglu, and C. Farabet. https://ieeexplore.ieee.org/document/5537907 “Convolutional networks and applications in vision”. In: (2018).

[11] Sepp Hochreiter and Ju¨rgen Schmidhuber. https://www.mitpressjournals.org/doi/abs/10.1162/neco.1997.9.8.1735 "Long Short-Term Memory". In: (2016).

[12] D. O. Sales, D. Feitosa, F. S. Osorio and D. F. Wolf. https://ieeexplore.ieee.org /document /6227651 "Multi-agent Autonomous Patrolling System Using ANN and FSM Contro". In: (2018).

[13] BRIEF REPORT Effect of Electronically Delivered Prescription- son Compliance and Pharmacy Wai Tasha J. Fernando, 2017.

[14] Lo-Ciganic WH, Donohue JM, Thorpe JM, Perera S, Gellad WF. Using Machine Learning to Examine Medication Adherence Thresholds and Risk of Hospitalization. Med Care. [Internet]. 2020.

[15] Kamalanabanand E. Gopinathand M Premkumar. https://www.sciencepubco.com/index.php/ijet/article/view/18785/8585 "Medicine Box: Doctor's Prescription Recognition Using Deep Machine Learning". In: (2018).

[16] Y. S. Chernyshova, A. V. Sheshkus, and V. V. Arlazarov. https://ieeexplore.ieee.org/document/8999509 "Two-Step CNN Frame- work for Text Line Recognition in Camera-Captured Images". In (2020)

[17] L. Xu et al. https://ieeexplore.ieee.org/abstract/document/8771222/ "Recognition of Handwritten Chinese Characters Based on Concept Learning". In (2019).

[18] Y. Zhu et al. https://ieeexplore.ieee.org/abstract/document/8565866/ "SCUT-EPT: New Dataset and Benchmark for Offline Chinese Text Recognition in Examination Paper".In (2019).

[19] M. Rajalakshmi, P. Saranya and P.Shanmugavadivu, https://ieeexplore. ieee.org/document/ 8951342 " Pattern Recognition- Recognition of Handwritten Document Using Convolutional Neural Networks," In (2019).

[20] M. Kumar and S.R. Jinda. https://link.springer.com/article/10.1007/s11831- 019-09332-0 "A Study on Recognition of Pre-segmented Handwritten Multi- lingual Characters". In (2019).

[21] M. Eltay, A. Zidouri, and I. Ahmad. https:// ieeexplore.ieee.org /document / 9091836 " Exploring Deep Learning Approaches to Recognize Handwrit-ten Arabic Texts". In (2020).

[22] T. M. Ghanim, M. I. Khalil, and H. M. Abbas. https://ieeexplore.ieee.org/document /9093056 "Comparative Study on Deep Convolution Neu- ral Networks DCNN-Based Offline Arabic Handwriting Recognition". In (2020).

[23] Sangamithra, B., Manjunath Swamy, B.E., Sunil Kumar, M. (2022). Personalized Ranking Mechanism Using Yandex Dataset on Machine Learning Approaches. In: Kumar, A., Ghinea, G., Merugu, S., Hashimoto, T. (eds) Proceedings of the International Conference on Cognitive and Intelligent Computing. Cognitive Science and Technology. Springer, Singapore. https://doi.org/10.1007/978-981-19-2350-0_61

[24] Burada, S., Swamy, B.E.M., Kumar, M.S. (2022). Computer-Aided Diagnosis Mechanism for Melanoma Skin Cancer Detection Using Radial Basis Function Network. In: Kumar, A., Ghinea, G., Merugu, S., Hashimoto, T. (eds) Proceedings of the International Conference on Cognitive and Intelligent Computing. Cognitive Science and Technology. Springer, Singapore. https://doi.org/10.1007/978-981-19-2350-0_60.

[25] Anantha Natarajan, V., Kumar, M. S., & Tamizhazhagan, V. (2020). Forecasting of Wind Power using LSTM Recurrent Neural Network. Journal of Green Engineering, 10.

[26] Kumar, M. S., Siddardha, B., Reddy, A. H., Reddy, C. V. S., Shaik, A. B., & Ganesh, D. (2022). APPLYING THE MODULAR ENCRYPTION STANDARD TO MOBILE CLOUD COMPUTING TO IMPROVE THE SAFETY OF HEALTH DATA. Journal of Pharmaceutical Negative Results, 1911-1917.

[27] Sangamithra, B., Neelima, P., & Kumar, M. S. (2017, April). A memetic algorithm for multi objective vehicle routing problem with time windows. In 2017 IEEE International Conference on Electrical, Instrumentation and Communication Engineering (ICEICE) (pp. 1-8). IEEE.

[28] Balaji, K., P. Sai Kiran, and M. Sunil Kumar. "Resource aware virtual machine placement in IaaS cloud using bio-inspired firefly algorithm." Journal of Green Engineering 10 (2020): 9315-9327.

[29] A. T. Sahlol et al. https://ieeexplore.ieee.org/document/8976177 "Hand- written Arabic Optical Character Recognition Approach Based on Hy- brid Whale Optimization Algorithm With Neighborhood Rough Set". In (2020).

[30] M. Hamdani, A. E. Mousa and H. Ney, https://ieeexplore.ieee.org/document/6628628 "Open Vocabulary Arabic Handwriting Recognition Using Morphological Decomposition," In (2020).

[31] Ramu, M. M., Shaik, N., Arulprakash, P., Jha, S. K., & Nagesh, M. P. (2022). Study on Potential AI Applications in Childhood Education. International Journal of Early Childhood, 14(03), 2022.

[32] Esraa Hassan, Habiba Tarek, Mai Hazem, Shaza Bahnacy, Lobna Shaheen, Walaa H.Elashmwai. "Medical Prescription Recognition using Machine Learning", 2021 IEEE 11th Annual Computing and Communication Workshop and Conference (CCWC), 2021.

[33] Prasad, Tvs Gowtham, Anil V. Turukmane, M. Sunil Kumar, N. Bindu Madhavi, C. Sushama, And P. Neelima. "Cnn Based Pathway Control To Prevent Covid Spread Using Face Mask And Body Temperature Detection." Journal Of Pharmaceutical Negative Results (2022): 1374-1381.

[34] R. M. Chevdumoi. "Prediction Of Soil Ph From Remote Sensing Data Using Gradient Boosted Regression Analysis." Journal Of Pharmaceutical Negative Results (2022): 29-36.

[35] Kumar, M. Sunil, et al. "Deep Convolution Neural Network Based solution for Detecting Plant Diseases." Journal of Pharmaceutical Negative Results (2022): 464-471.

[36] Kumar, M. S., Siddardha, B., Reddy, A. H., Reddy, C. V. S., Shaik, A. B., & Ganesh, D. (2022). APPLYING THE MODULAR ENCRYPTION STANDARD TO MOBILE CLOUD COMPUTING TO IMPROVE THE SAFETY OF HEALTH DATA. Journal of Pharmaceutical Negative Results, 1911-1917.

[37] Natarajan, V. Anantha, et al. "PREDICTION OF SOIL PH FROM REMOTE SENSING DATA USING GRADIENT BOOSTED REGRESSION ANALYSIS." Journal of Pharmaceutical Negative Results (2022): 29-36.

[38] Tamizhazhagan, V., Tangudu, N., & Kumar, M. S. (2022). Analysis of Groundwater Level Fluctuations and its Association with Rainfall Using Statistical Methods. JOURNAL OF ALGEBRAIC STATISTICS, 13(3), 1895-1904.

[39] D. Ganesh Macha Babitha. "Machine Learning Based Identification of Covid-19 From Lung Segmented CT Images Using Radiomics Features." Biosc. Biotech. Res. Comm. Special Issue 14.07: 350-355.