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# International Journal of Soft Computing & Artificial Intelligence

## Aim & Scope

IJSCAI provides a new forum for dissemination of knowledge on both theoretical and applied research on Artificial Intelligence and Soft Computing with an ultimate aim to bridge the gap between these two non-coherent disciplines of knowledge. The Journal offers survey and review articles from experts in the field, promoting insight and understanding of the state of art, and latest trends in the field. The content includes original research and innovation ideas, applications from all over the world.

All published papers are also available freely with online full-text content. This forum accelerates interaction between the above two bodies of knowledge, and fosters unified development in next generation computational models for machine intelligence. Special Issues devoted to topics of current interest will be published occasionally.

# International Journal of Soft Computing & Artificial Intelligence

(Volume No. 13, Issue No. 2, May - August 2025)

## Contents

# DISEASE MECHANISM EVALUATION AND FORECASTING FOR DOCTORAL REFFERAL

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## A B S T R A C T

*The majority of apps in India have integrated both hardware and software innovations from the modern era. The medical industry has also evolved and is prepared to embrace the shifts in therapy that come with the virtual mode. Even so, there are numerous internet applications that mislead consumers when seeking medical advice and treatment. People are becoming anxious and perplexed when choosing the best hospital and physician for their care. Furthermore, the majority of loved ones are too shocked to think clearly, complicating the process of selecting the best hospital. To choose the best hospital, most individuals prefer to consult with a well-qualified person they know. In certain cases, a person receiving treatment for one disease may not benefit from the same treatment for a different ailment. There is very little chance of healing someone even if they are transported in some way to the nearest hospital. As a result, the person's time, money, and health will all be directly impacted. The suggested method, which uses a machine learning approach to analyze and forecast the patient's physical symptoms and make recommendations for the hospital, may be useful in such circumstances.*

***Keywords -*** *Personalized Health Suggestions, Health Information, Machine Learning, Healthcare Recommendations*

## I. INTRODUCTION

Finding a hospital with the greatest expertise to treat our illness is crucial when facing health issues. Locating hospitals with the right personnel to effectively treat an illness often relies heavily on recommendations from friends, which are usually based on trust and personal opinions.

However, hospitals possess large volumes of data about patients and their health indicators. Therefore, a practical method for medical practitioners to efficiently utilize this information is required. By offering a precise analysis of hospitals, a recommendation method aims to eliminate the uncertainty and reliance on anecdotal suggestions.

These systems are designed to assist healthcare providers in meeting their objectives and enhancing the patient experience. A medical recommendation engine could bridge this gap by searching the database for individuals with similar health criteria based on a patient's current status, medical history, present medications, symptoms, and previous treatments.

In this work, we describe a recommender system that helps users find appropriate treatments for medical issues. This system can identify patient similarities and recommend doctors and hospitals that best match the patient's profile.

The objective is to illustrate the current options available to healthcare professionals to enhance the hospital selection process and choose the best treatment for their patients. Section 2 provides an overview of the platform and the recommender system; Section 3 presents the findings of an initial experimental assessment; and Section 4 offers recommendations and outlines future work. The application of recommender systems in the healthcare industry is essential to assist medical professionals and end-users in making more accurate and efficient health-related decisions.

We present a comprehensive review of the literature on healthcare recommender systems in this paper. Unlike other existing overview articles, this work offers insights into various recommendation methodologies and scenarios. Examples include recommendations for food, medications, health status forecasts, healthcare services, healthcare professionals, and hospital recommendation systems.

Healthcare Recommender Systems (HRS) provide enhanced customization by offering detailed recommendations and improving users' understanding of their medical conditions. Besides improving patient experiences and health outcomes, these systems promote healthier lifestyle choices. HRS utilize medical resources to help make more accurate recommendations for patients.

## II. LITERATUREREVIEW

Many optimization strategies for regression and classification algorithms have been proposed to improve the precision of data analysis with continuous features. To store large volumes of structured data, the operations must be divided into big bases, such as those found in Hadoop, Cloud computing, reduction techniques, and technologies based on Apache Spark.

Neural networks and population density predictions by the IBM artificial intelligence system enhance practicality. For instance, Watson Health can already recommend a patient's optimal course of treatment based on evidence-based medicine and historical patient outcomes.

Working with both structured and unstructured data requires technologies like data mining, deep learning, reinforcement learning, evolutionary learning, supervised learning, and unsupervised learning.

The queuing model (Qm) and the agent-based model (ABM) are used to examine patient flow and access via emergency departments. An agent-based simulation technique is utilized to schedule patientcentered appointments. Technologies such as neural networks, real-time databases, recommendation engines, Raspberry Pi, Google Firebase, deep neural networks, and Python are commonly employed. Additionally, data analysis, natural language processing, and sentiment analysis are also used.

In the field of IoT, technologies such as RDF query language (SPARQL) queries, simple protocols, and description logic (DL) are employed to analyze data. A range of technologies, including supervised reinforcement learning, dynamic therapeutic regimens, and deep sequential recommendations, were used in the development of the Hospital Recommendation System (HRS). [1].[3].

## III. PROPOSEDMETHODOLOGY

CatBoost is an algorithm for gradient boosting on decision trees. It is developed by Yandex researchers and engineers and is utilized in various applications such as search, recommendation systems, personal assistants, self-driving cars, weather prediction, and more. Yandex and other companies, including CERN,Cloudflare, and Careem taxi, use it. CatBoost is open source, making it accessible for use by anyone.

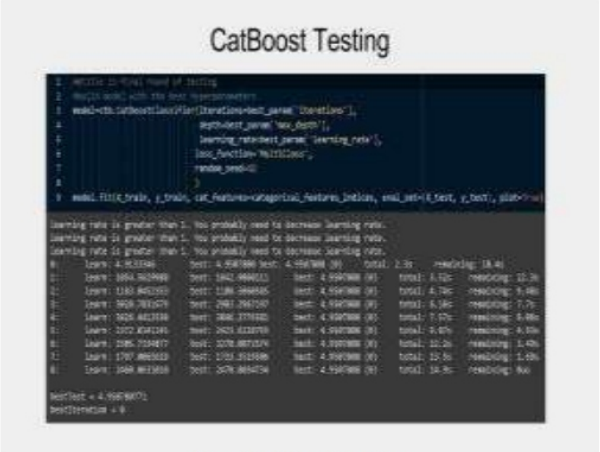


**Fig.:1CatBoostTesting**

## Results

```
Shrink model to first 1 iterations.
0.7705779134500875
Correct Prediction (%):  76.9
              precision    recall  f1-score   support

           0       0.77      0.99      0.87       771
           1       0.33      0.01      0.02       229

    accuracy                           0.77      1000
   macro avg       0.55      0.50      0.44      1000
weighted avg       0.67      0.77      0.67      1000
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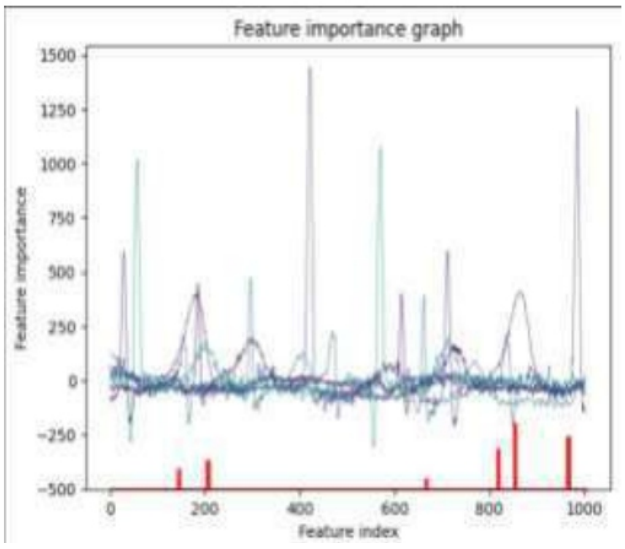

## IV. RESEARCH GAP

This study offered a thorough analysis of the literature for the Medicine Recommendation Engine, which is based on a graph database.

These inquiries can be divided into two groups:

Machine learning and data mining.

Ontology and rule-based methodology.

Numerous elements are involved in this, such as illnesses, platforms/technologies, interfaces, algorithms, data storage, data gathering, and data processing.

Most studies did not focus on any particular illnesses due to a lack of data.

Mobile-based systems are used to select hospitals in a city according to factors including distance, cost, doctor availability, and facility availability.

Population density is estimated using large-scale LBS data.

It is capable of estimating the current population and projecting changes at every hospital.

The hospital queuing suggestion system effectively schedules each treatment job queue, avoiding overpopulation.

This approach offers a successful treatment plan that reduces the total amount of time patients must wait.

For every patient, a practical and effective treatment plan is created along with a recommendation system for parallel hospital queuing.

Algorithms and HQR systems are used to achieve high performance and precision.

The diagnosis methodology for an intelligent illness suggestion system, which also provides a revolutionary artificial intelligence design approach based on smart healthcare systems, is used by medical diagnosis support systems.

A hospital recommendation system based on patient satisfaction surveys is introduced to discover links between patient demographics and their various satisfaction indicators.

The real-time hospital recommendation system serves as a proof of concept for the potential of neural networks in the healthcare industry.

User and patient feedback is taken into consideration by the medical recommendation system.

These techniques have demonstrated promising results when applied promptly to assess unstructured user or patient feedback.

Our recommendation algorithm suggests hospitals and specialists to the patient based on semantic similarities across illnesses.

A healthcare recommendation system sheds light on the range of situations for which these systems might make suggestions, including those pertaining to medication, food, physical activity, and health status predictions.

Automated identification of a patient's physiological risk factors using fuzzy ontology based sentiment analysis knowledge and type 2 fuzzy logic.

This technology may be incorporated into the current IoT-based healthcare monitoring infrastructure since it can control dietary and diabetic medication recommendations.

The dynamic treatment recommendation system integrates the evaluation signal and indication signal through supervised and reinforcement learning.

A state-of-the-art hospital depression treatment plan is launched.

That framework service is offered in accordance with each user's situation and customized data.

This article uses real-world applications to identify appropriate solutions when both class imbalance and overlap affect the domain.

Surgery performed during the COVID-19 period recommendation system dynamically segregated the infected and surgical patient groups to preserve life while maintaining high surgical standards.

The operating room claims that non-intensive care

## V. PROBLEM IDENTIFICATION

The number of people suffering from chronic illnesses is rising quickly, posing more difficult challenges to the healthcare sector. Additionally, the medical field faces numerous challenges in providing patients with the range of treatments that are currently available. A major issue of integration arises whenever a patient visits a hospital: how to allow the hospital to follow up on the recommendation process as soon as it is approved. This issue can be resolved by providing the patient with online treatment options so they can complete the admittance process before they even arrive at the hospital, allowing them to receive immediate treatment upon arrival.

Patient Treatment Time Prediction (PTTP) is one of the proposed systems that estimates how long a patient will have to wait for each treatment. A system known as Hospital Queuing Recommendation (HQR) can be implemented based on the waiting time determined by the PTTP. However, the concept of waiting times does not apply to emergency patients. Emergency patients are not permitted to wait in the patient queue because they require rapid attention. Thus, instead of considering waiting time for emergency patients, treatment priorities are taken into account. This system will primarily benefit residents of isolated places with limited access to medical professionals and facilities. Test report time is another issue that patients deal with, as it takes many hours to detect the disease's cause and obtain a diagnosis. Consequently, direct patient testing is carried out to ascertain whether the system satisfies patient demands. Providing patients access to intelligent medical diagnosis tools at the outset of the investigation will also help reduce the strain on physicians, medical staff, and various hospitals.

Patient satisfaction has been demonstrated to be one of the most reliable measures of service quality. Numerous healthcare providers request the analysis of patient satisfaction data to assess their varied services and patient experience. The majority of healthcare providers, from clinics and hospitals to doctors' offices, gather patient satisfaction surveys. The goal of the Med-Recommender system is to provide reliable hospital analysis by considering thousands of patient reviews posted on various web forums. It is crucial to comprehend the issue of patient satisfaction. Even if a patient expresses satisfaction or gives positive feedback about their therapy, a treatment plan designed for one patient may not be effective for another with the same illness due to individual differences in body types and conditions.

Our long-term objective is to evaluate how our system's recommendations can increase patient loyalty, ultimately saving money and time. We aim to acquire a more comprehensive dataset that includes information on whether patients returned to the hospital if medical services were required, and to investigate the correlation between customer loyalty and satisfaction identifiers using preliminary results reported in this paper. In this study, missing variables are imputed using a single imputation technique based on K-nearest neighbor (KNN). In the future, more popular methods for imputing continuous and categorical variables should be investigated, such as multiple imputations by chained equations (MICE). To more accurately distinguish between missing and non-applicable data, other methods for addressing skip questions should also be explored.

Although there isn't much data in this field to work with when designing the model, more and better data will readily increase its usefulness and performance. One of the main problems is the availability of data, especially in an appropriately structured manner. The data we currently have is either missing or inconsistent across different parameters.

## VI. SYSTEMDESIGN


**Fig.No.2 (Architecture of HRS)**

This is the Hospital Recommendation System (HRS) architecture, which comprises many distinct features.First, a variety of changeable devices with various sensors are used to gather real-time data from a patient's body. Additionally, data is gathered by visiting our facilities and participating in various tests. Subsequently, a patient's unique ID is produced, and a profile comprising all patient-related information is created. After that, this data is delivered to our data centers, where it undergoes cleansing and preparation. Following this, our data centers obtain patient history data gathered from several local hospitals.

The patient will then access our program and enter their issue if something goes wrong or if they have a critical illness. Using its algorithms, our application will look for patients similar to one that was treated in the closest hospital and suggest that facility to the patient.


**Fig. No. 3 (Proposed architecture)**

Our application is very easy to use; the user may either manually enter the problem or instruct themselves using voice commands. After all processing is complete, our application recommends a list of hospitals, and the user only needs to select one. Patients can then view a map displaying the closest hospital as well as the nearest ambulance. The hospital receives all the patient's data and reports directly, and the admissions procedure is completed in a matter of minutes before the patient even arrives. As a result, patients searching for and being admitted to the hospital save a great deal of time.

## VII. CONCLUSION

This study serves as an example of a smart hospital recommendation system created using deep learning, machine learning, and natural language processing technologies. Genetic algorithms are utilized in this application to compare various body types and group them based on commonalities. Future applications for this technology could include developing specialized hospitals for different types of therapy and data collection methods.

## FUTUREWORK

In cloud hospitals, a doctor can instantly connect to any other cloud hospital in case of emergency, perform any kind of surgery, and treat patients without physically being in the operating room. No special testing labs, pathology labs, CT scans, etc., will be available. A doctor will use the patient's 3D model from the metaverse to make a direct diagnosis.

*REFERENCE*

*[1] Raedi Alwafi Isril, Danang Junaedi, Anisa Herdiani, "Mobile-Based Hospital Recommendation According To Patient Needs Using SAW Method (Case Study: Banda Aceh)".*
*[2] Hanqing Chao, Yuan Cao, Junping Zhang, "Population Density-based Hospital Recommendation with Mobile LBS Big Data".*
*[3] Sharmila S Savanth, Dr. K. N. Rama Mohan Babu, "Hospital Queuing-Recommendation System Based On Patient Treatment Time".*
*[4] Youjun Li, Zhijiang Wan, Jiajin Huang, Jianhui Chen, Zhisheng Huang, Ning Zhong, "A Smart Hospital Information System for Mental Disorders".*
*[5] Jianguo Chen, Ken Li, Zhuo Tang, Kashif Bilal, Keqin Li, "A Parallel Patient Treatment Time Prediction Algorithm and Its Applications in Hospital Queuing-Recommendation in a Big Data Environment".*
*[6] Vikas Kamra, Praveen Kumar, Masoud Mohammadian, "Formulation of an Elegant Diagnostic Approach for an Intelligent Disease Recommendation System".*
*[7] Mohammad Reza Khoie, Tannaz Sattari Tabrizi, Elham Sahebkar Khorasani, Shahram Rahimi, Nina Marhamati, "A Hospital Recommendation System Based on Patient Satisfaction Survey".*
*[8] Om Adideva Paranjay, Dr. Rajeshkumar, "A Neural Network Aided Real-Time Hospital Recommendation System".*
*[9] S. Swarnalatha, I. Kesavarthini, S. Poornima, N. Sripriya, "Med-Recommender System for Predictive Analysis of Hospitals and Doctors".*
*[10] Fedelucio Narducci, Cataldo Musto, Marco Polignano, Marco de Gemmis, Pasquale Lops, Giovanni Semeraro, "A Recommender System for Connecting Patients to the Right Doctors in the HealthNet Social Network".*
*[11] Thi Ngoc Trang Tran, Alexander Felfernig, Christoph Trattner, Andreas Holzinger, "Recommender systems in the healthcare domain: state-of-the-art and research issues".*
*[12] Farman Ali, Pervez Khan, Daehan Kwak, S.M. Riazul Islam, Niamat Ullah, Sang-jo Yoo, K.S. Kwak, "Type-2 Fuzzy Ontology–aided Recommendation Systems for IoT–based Healthcare".*
*[13] Lu Wang, Wei Zhang, Xiaofeng He, Hongyuan Zha, "Supervised Reinforcement Learning with Recurrent Neural Network for Dynamic Treatment Recommendation".*
*[14] Jared L. Katzman, Uri Shaham, Alexander Cloninger, Jonathan Bates, Tingting Jiang, Yuval Kluger, "DeepSurv: personalized treatment recommender system using a Cox proportional hazards*

*deep neural network".*
*[15] Miriam Seoane Santos, Pedro Henriques Abreu, Nathalie Japkowicz, Alberto Fernández, João Santos, "A unifying view of class overlap and imbalance: Key concepts, multiview panorama, and open avenues for research".*
*[16] S. Flemming, M. Hankir, R.-I. Ernestus, F. Seyfried, C.-T. Germer, P. Meybohm, T. Wurmb, U. Vogel, A. Wiegering, "Surgery in times of COVID-19—recommendations for hospital and patient management".*

# DEEP LEARNING - POWERED IMAGE FORGERY DETECTION: UNVEILING AUTHENTICITY WITH NEURAL NETWORKS

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## A B S T R A C T

*In addressing the prevalent issue of image forgery in the digital age, the study illustrates the need of authenticity and trust across a range of fields. The suggested method makes use of the ResNet algorithm, which is well-known for its outstanding performance in tasks involving images. A deep neural network based on ResNet is trained on a variety ofdatasets that include both real and fake images. ResNet excels at capturing complex features and solving problems like splicing, retouching, and copy-move. Through discriminative pattern recognition training, the model is able to differentiate between real and altered regions in images. During training, data augmentation techniques are used to improve the model's performance and generalization. The robustness and high accuracy of the algorithm i.e., 91.92% in detecting forged regions are validated through testing on an independent set of images. Thus, a potential remedy for the problems caused by complex image manipulations is the combination of deep learning methods and the ResNet architecture. With all factors considered, the suggested methodology effectively detects image counterfeiting, protecting the authenticity and integrity of digital content.*

***Keywords -*** *Image forgery detection, Binary classification, ResNet, Transfer learning, Image manipulation, Image forensics, Fake images*

## I. INTRODUCTION

The digital revolution has led to an unprecedented creation and sharing of visual media content on the internet and social platforms. Smartphone ownership exceeding 3 billion and continued improvements inbuilt-in cameras have enabled ordinary citizens to generate massive photographic data. The ubiquity of image editing software like Adobe Photoshop andGIMP provide easy manipulation capabilities. Meanwhile, social networks like Facebook and Redditallow instant propagation of images to millions of viewers.

While these trends have democratized image creation and dissemination, they have also given rise to amajor problem - digital forgery. The integrity ofonline visual content is under siege. Malicious actors have realized the power of fake imagery in shaping opinions, spreading misinformation, and underminingtrust in institutions. The presence of altered and completely synthetically generated faces, known as Deep Fakes, have been used for non-consensual pornography, financial frauds, and political disinformation campaigns.

The realism achieved via modern manipulation techniques like GANs can often fool the human eye.Studies have shown the inefficacy of casual human judgment in discerning original images from clever forgeries. This susceptibility to "change blindness" necessitates intelligent algorithms for image forensic analysis. Passive approaches are preferred as they don't require access to source data or

watermarks.

Image forgery detection has consequently seen surging interest from the research community. Earlier methods focused on hand-crafted feature extraction to expose statistical anomalies introduced by tampering. However, these techniques do not adequatelygeneralize for diverse and sophisticated manipulation methods.

The breakthrough of deep learning provides renewed hope. Deep neural networks can learn robust representations from raw image data, identifying intrinsic traces of forgeries. Our paper specifically explores transfer learning with the Resnet architecture for binary classification of real vs. fake faces. Themodel is integrated into a practical web applicationusing Flask. By developing intelligent forgery detection systems, we aim to combat the proliferation of visual misinformation that threatens to undermine public discourse. Timely and accurate identificationof fake imagery can help social media platforms, news agencies, and governments limit the impact ofmalicious digital tampering. Our work contributestowards restoring trust and accountability in thedigital public sphere.

## II. LITERATURE REVIEW

[1] An image manipulation identification approach is suggested by author using deep learning andcritical attribute- matching methods. By employing a pretrained AlexaNet convolutional neural network (CNN) model, deep-seated characteristics can be drawn from an original picture. Accordingly, these traits are compared using a modified adaptation of the Scale-Invariant Feature Alter (SIFT) scheme to recognize matching zones that are identical to certain fake areas. Ideally, competitive results are obtained and validated it with another recent state-of-the-art copy- move judgment test.

[2] The writer gives an account of the recognition of hazy blends, in which the act of interposingmaterial elements from one photograph into another is involved. The authors offer guidancethrough a model of what they refer to asan "application of CNN (Convolutional Neural Network)," which is meant to unravel the acts of blending. The spliced photographs which are derived from low-class original images chosenfrom over the web, are sieved by the computer in advance of treatment. The remainder of the body, now cleared of the gravels, is thus harvested in batches for placement under the evaluation of the neural network. Then at long last, the authors pronounce their experiments to success, and proceed to illustrate their accomplishments by treating us with two sets of photographic evidence.

[3] The process unearths an image with fraud with the assistance supplied by way of the profound machine mastering and switching transfermachine. Now, what it does is this. It has a pre educated AlexNet CNN model that is going to be used as feature extractor. Then, what we acquire from this AlexNet is a feature vector, which is 4096 dimensions, and it may be used in providinginformation to a reinforcement subset machine label to be expected.

[4] The paper suggests different ways to catch image fraud using error level analysis (ELA) andmachine learning (ML). ELA means examining how a picture gets recompressed to show any changes in the compression which may point to fakery. The author checked three ways to do so using convolutional neural networks, supportvector machines, and random forests on the CASIA dataset.

[5] The "ImageNet" is a comprehensive database for images that is founded on WordNet's structure.With this phrasing the aim of populating WordNet synsets with 500-1000 high- resolution images is introduced. In total, the ImageNet comprises 12 subtrees, 5247 synsets, and 3.2 million annotated images. With these numbers, the huge size, diversity and accuracy compared to existing datasets of ImageNet becomeapparent. The creation of the database was possible by employing the workforce of AmazonMechanical Turk for data collection. With applications like object recognition, automatic object clustering and image classification, the bouty of the ImageNet is being outlined. This little discussion show how useful ImageNet is in many computer vision fields and it poses the possibility of new opportunities for researchers toimprove on other pre-existing datasets.

[6] The paper highlights the significance of camera fingerprints in digital image forensics, with a focus on utilizing PRNU pattern as a unique camera fingerprint. The paper introduces a method for acquiring a camera type fingerprint, which is recognized as noise print. This method increases the contrasting parameters of the model, whilst reducing the information of the background. The techniques within the said approach use a Siamese network, which was trained using image patches from the same or different cameras and was primarily used to spot image forgeries. Numerous experiments and tests were conducted on the use of various images, all have proven, and hold to account that noiseprint based methods are one of the best in forecasting security.

[7] addresses the growing challenge of photographic manipulation in the digital age, emphasizing theerosion of trust in photographic evidence. It focuses on image composition or splicing as a prevalent form of manipulation and introduces a machine-learning-based forgery detection method. The proposed approach leverages subtle inconsistencies in the color of illumination, requiring minimal user interaction and no expert involvement for tampering decisions. Demonstrating promising results, the methodachieves detection rates of 86% on a newbenchmark dataset of 200 images and 83% on 50 images collected from the Internet using an SVM meta-fusion classifier.[8] addresses the challenge of copy-move forgery detection, emphasizing limitations when copied regions involve rotation or scaling. It introduces a novel rotation-invariant selection method called Same Affine Transformation Selection (SATS). SATS operates similarly to shift vectors but accommodates rotated copied regions, demonstrating improved performance over shiftvectors in experiments with three recent feature sets on ground truth data. Additionally, SATS explicitly recovers the parameters of the affine transformation applied to the copied region, providing a comprehensive solution to handle rotation in copy-move forgery detection.

While achieving decent accuracy, ELA is limited by its dependence on image quality. The author then explores image pre-processing by dividing images into patches and classifying them as real or computer graphics before passing them into the VGG16 model. This approach obtains higher accuracy of 94.5%compared to 93.4% from prior work using standard CNNs. The patch classification method is promising for image forgery detection as it is unaffected by image quality and precisely locates tampered regions. Overall, the thesis demonstrates that combining ELA and machine learning can detect forged images, but preprocessing with deep learning achieves more robust performance.

## III. PROPOSED METHODOLOGY

The base model architecture used for transfer learning is ResNet50 as shown in figure 1. convolutional neuralnetwork, with over 50 layers. The core building block of ResNet50 is the residual block. Each

residual block consists of 3 convolutional layers, with batch normalization and ReLU activation applied to the outputs.

The key innovation is the shortcut connection that skips these layers and directly connects the input to the output of the block. Adding this input shortcut enables faster training by allowing gradients to flow freely across multiple residual blocks during backpropagation.

The overall ResNet50 architecture comprises 5 stages stacked end-to-end, with each stage consisting of chained residual blocks. The first stage uses 64 filters in each conv layer, second stage 128 filters, third stage 256 filters, fourth stage 512 filters and fifth stage 1024 filters. So the network depth increases through the stages.

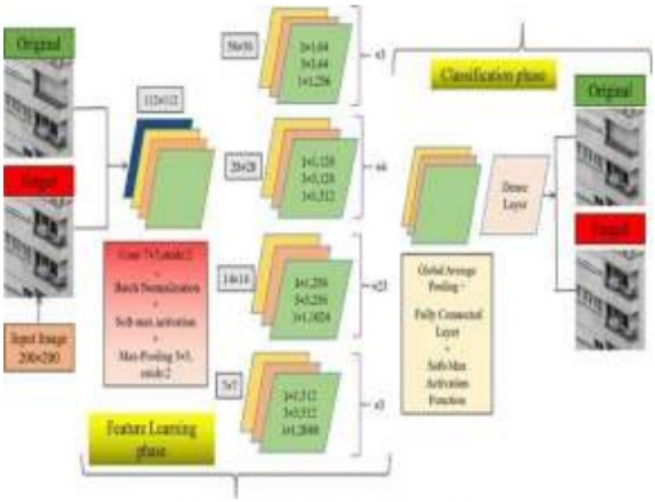


**Fig 1: ResNet50 Architecture**

Between each stage, down sampling is performed by convolutional strides of 2, halving the spatial dimensions. Average pooling further reduces the features before feeding into a fully connected classifier layer.

For this project, the pretrained convolutional base is leveraged as a fixed feature extractor[9]. The fullyconnected layer meant for ImageNet classification is discarded. Global average pooling and a new fullyconnected layer are added on top for binary fake vs real classification.

When training deep learning models, such as ResNet50, for the purpose of detecting image forgeries, data augmentation is an essential step. It involves altering the current dataset in a number of ways to actually expand and broaden it. To improvethe model's capacity to generalize and function well on untested data, a wider range of variations are intended to be introduced to it as shown in the figure 2.

**Fig 2: Data Augmentation**

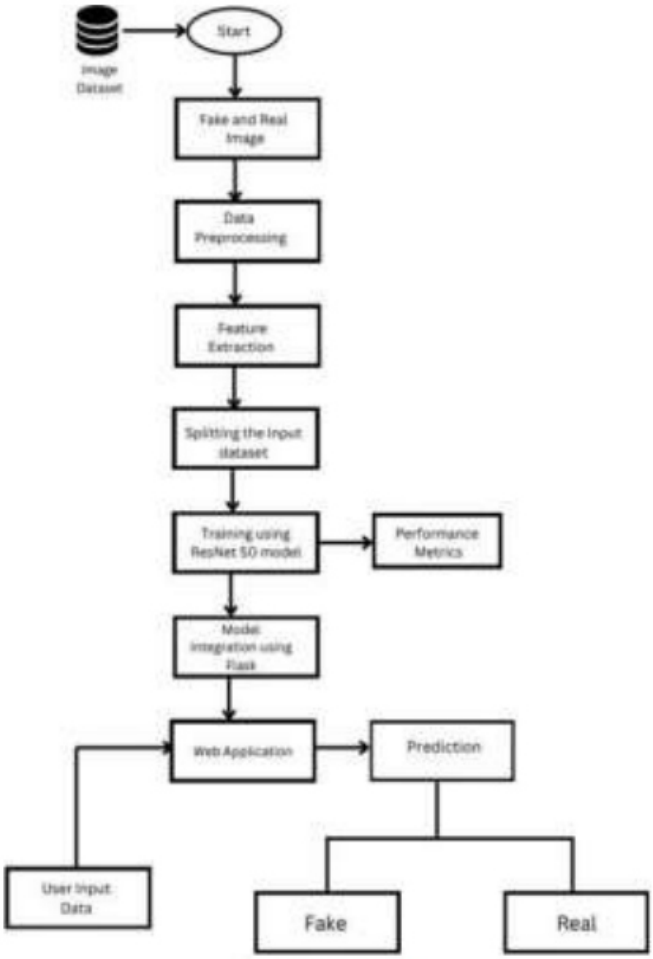


**Fig 3: Flowchart**

This flowchart in the figure 3 outlines the sequential steps involved in using the ResNet-50 algorithm forimage forgery detection, from the input image to detecting the fake or real image regarding its authenticity.

**Algorithm**

Algorithm: Image Forgery Detection using ResNet-50

Input: Dataset with required features

Output: Classify as Real or Fake

1.Load pretrained ResNet-50 model excluding the top layer:
Resnet_model = load_pretrained_model(top_layer_excluded=True)
2. Attach GlobalAveragePooling2Dlayer:
ResNet-50 = AttachGlobalAveragePooling2D(ResNet-50)
3. Add Dense layer (1024 units, ReLU activation):
ResNet-50 = AddDenseLayer(ResNet-50, 1024, ReLU)
4.Add Dropout layer (rate 0.2):
ResNet-50 = AddDropoutLayer(ResNet-50, 0.2)
5.Add Dense output layer (1 unit, sigmoid activation):
ResNet-50 = AddDenseLayer(ResNet-50, 1, Sigmoid)
6.Freeze pretrained ResNet-50 layers:
ResNet-50 = FreezeLayers(ResNet-50)
7.Compile model (Adam optimizer, binary cross-entropy loss):
ResNet-50 = CompileModel(ResNet-50, Adam, BinaryCrossEntroppy
8.Train model (20 epochs, batch size 16):
ResNet-50 = TrainModel(ResNet-50, 20, 16)
9. Evaluate model (accuracy, precision, recall, F1 score, confusion matrix):
EvaluationMetrics = EvaluateModel(ResNet-50)
10.Save trained model:
SaveModel(ResNet-50)
11.Serve model via Flask web application:
ServeModel(ResNet-50)
12. End Algorithm

This transfer learning approach combined with theResNet50 architecture aims to deliver an accurate anddeployable deep learning solution for image forgery detection.

## IV. RESULTS AND DISCUSSIONS

The Resnet model was trained for 20 epochs on a dataset of 1840 images (960 fake, 1081 real). Thetraining set consisted of 459 images and the validation set had 575 images.The training accuracystarted at 55% in the first epoch and steadily improved, reaching 97.7% by the 20th epoch. This indicates the model was successfully fitting the training data.The validation accuracy started lower at 52.29% inepoch 1 but also increased consistently, ending at91.92% in epoch 20. This suggests the model was generalizing well to new data not seen during training.

The training and validation loss values both decreased over the course of training. Lower loss indicates the model's predictions were getting closer to the true labels[10]. The convergence of training andvalidation loss is a positive sign that overfitting was avoided. The model achieved good results on asample test set, correctly identifying real and fake images. This demonstrates its ability to generalize to new data.

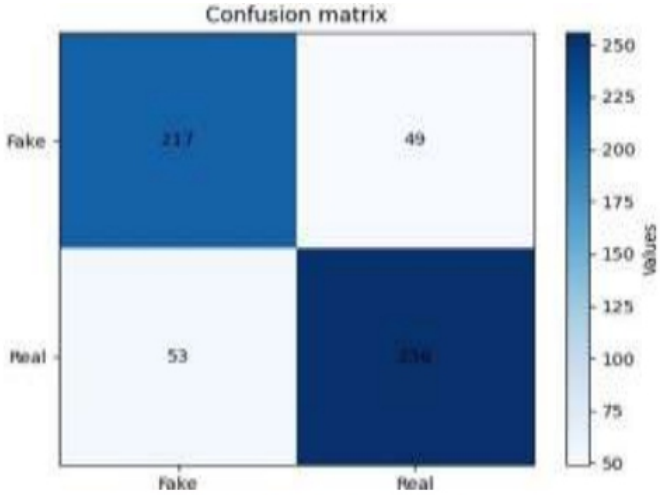


**Fig 4: Confusion Matrix**

The confusion matrix in the Figure 4 provides detailed performance metrics. The model made 256 true positive and 217 true negative predictions. There were 49 false positives and 53 false negatives. Thisbreakdown confirms the model's solid classification capability. Overall, the steady improvement in accuracy and loss metrics, along with the confusionmatrix results and sample predictions, validate the effectiveness of the model for classifying real versus fake images after training on the dataset. Key indicators like the high training accuracy, respectable validation accuracy, decreasing loss trends, andconfusion matrix metrics all support the model's success.

Figure 5 displays about the model accuracy, the training accuracy starts at 55% in the first epoch andsteadily increases with each subsequent epoch,reaching a high of 97.7% by the 20th epoch.

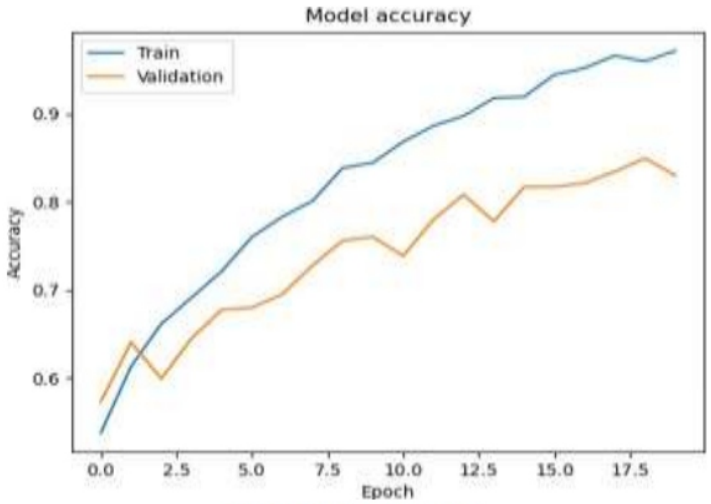


**Fig 5: Model Accuracy**

Figure 6 illustrates about the loss of the model, the training loss starts at 0.6863 in the first epoch anddecreases with each subsequent epoch, reaching 0.1127 by the 20th epoch.

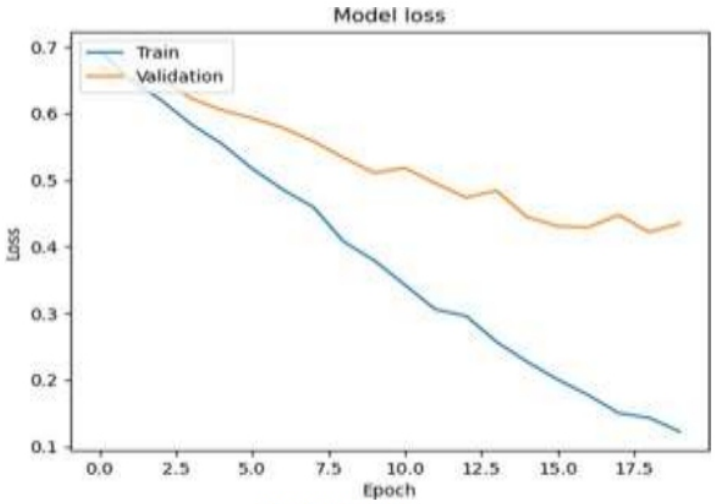


**Fig 6: Model Loss**

## Output

The first page in the front end interface is that an image file should be selected i.e., the input image is taken from the front-end interface is used to extract text from the image using google vision cloud API. The prediction of the image whether it is real or fake is shown in figure 7.


**Fig 7: Prediction**

The extracted text is filtered and then searched for the matches in the pre-defined dataset. Theresult is then displayed through the front-endinterface to the user asshown in the figure 8.

**Fig 8: Output**

## V. CONCLUSION

The ResNet-based image forgery detection model demonstrated promising performance during training and validation. The steady increase in training and validation accuracy over 30 epochs, reaching finalvalues of 97.7% and 91.92% respectively, indicates that the model was able to effectively learn from thetraining data and generalize well to new data. The confusion matrix provided a detailed breakdown ofthe model's balanced classification capabilities, with strong true positive and negative rates and manageable false positives and negatives[11]. Predictions on the sample image set further validated the model's ability to accurately distinguish real versus manipulated images.

Overall, the ResNet model serves as an effective deep learning architecture for binary image forgery detection on this dataset. However, future work could potentially improve performance further. Fine-tuning training hyperparameters, expanding the dataset diversity, leveraging additional data augmentation techniques, exploring ensemble methods, and deploying on GPUs could help boost accuracy, robustness and efficiency. Overall, the ResNet model provides a promising starting point for imageforgery detection, but continued refinement of the model training, architecture and data could further enhance its real-world reliability.

*REFERENCE*

*[1] M. Göçer, G. Öztürk, and G. Uyar, "Image Forgery Detection Using Deep Learning and Key Feature Matching," in Proc. 2019 Scientific Meeting on Electrical-Electronics Biomedical Engineering and Computer Science (EBBT), Istanbul, Turkey, 2019, pp. 1-4.*

*[2] M. Zampoglou, S. Papadopoulos, and Y. Kompatsiaris, "Detecting Image Splicing in the Wild (Web) Using Image Quality Measures and CNNs," in Proc. 2017 IEEE International Conference on Multimedia and Expo (ICME), Hong Kong, 2017, pp. 1255-1260.*

*[3] A. Doegar, M. Dutta and K. Gaurav Raj, "CNN Based Image Forgery Detection Using Pre-Trained Alexnet Model," in Proc. 2020 3rd International Conference on Intelligent Sustainable Systems (ICISS), Palladam, India, 2020, pp. 743-748.*

*[4] L. Alzamil, "Image Forgery Detection with Machine Learning," M.S. thesis, Dept. Comp. Sci., Central Washington Univ., Ellensburg, WA, USA, 2020.*

*[5] Deng J, Dong W, Socher R, Li L-J, Li K, Fei-Fei L (2009) ImageNet: a large-scale hierarchical image database. In: CVPR. https://doi.org/10.1109/WIFS.2010.5711472.*

*[6] Cozzolino D, Verdoliva L (2020) Noiseprint: a cnn-based camera model fingerprint. IEEE Trans Inf Forensics Secur 15:144–159. https://doi.org/10.1109/TIFS.2019.2916364R. A. D. Pugoy and V. Y. Mariano, "Automated rice leaf disease detection using color image analysis," in 3rd international conference on digital image processing.International Society for Optics and Photonics, 2011, pp. 80 090F–80 090F.*

*[7] de Carvalho TJ, Riess C, Angelopoulou E, Pedrini H, de Rezende Rocha A (2013) Exposing digital image forgeries byillumination color classification. IEEE Trans Inf Forensics Secur 8(7):1182–1194. https://doi.org/10.1109/TIFS.2013.2265677.*

*[8] Christlein V, Riess C, Angelopoulou E (2010) On rotation invariance in copy-move forgery detection. In: 2010 IEEEinternational workshop on information forensics and security, pp 1–6. https://doi.org/10.1109/WIFS.2010.5711472.*

*[9] Kandula, Ashok Reddy, R. Sathya, and S. Narayana. "Multivariate Analysis on Personalized Cancer Data using a Hybrid Classification Model using Voting Classifier."International Journal of Intelligent Systems and Applications in Engineering 11.1 (2023): 354-362.*

*[10] KANDULA, ASHOK REDDY, R. SATHYA, and S. NARAYANA. "COMPARATIVE ANALYSIS OF MACHINE LEARNING TECHNIQUES ON GENETIC MUTATION-BASED CANCER DIAGNOSIS DATA."Journal of Theoretical and Applied Information Technology100.6z*

*[11] Kandula, Ashok Reddy, et al. "Machine Learning Algorithms for Predictive Analysis in the Identification of ChronicLiver Disease." NeuroQuantology 20.15 (2022): 5951.*

# ARABIC DIGIT RECOGNITION

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## A B S T R A C T

*This paper design and implement Arabic digit recognition (ADR) using speech utterance. We will use the Saudi accented spoken digits data set, which is the KSU speech data set. (ADR) is the ability to accurately identifying digit from zero to nine. The Arabic digit is mostly used for authentication it can be used in smart houses or some speech-based application. Since there is a lack of Arabic application, we decided to work with the Arabic language. We used MelFrequency Cepstral Coefficients (MFCC) feature extraction technique. We try it with four modelling techniques. For implementation, we used python.*

## I. INTRODUCTION

Speech recognition is the capability of devices to recognize words and sentences in spoken language and convert it to let a machine read it. Speech recognition became important because of the technology revolution. The processing of Arabic numbers is very important and consequently depends on the economic and scientific future in the Arabic language. And the Arabic language-basedapplication. Speech recognition is a very difficult problem because the machine should identify accent, pronunciation, framing, pitch, volume, speed etc, all of this technique is one of these. Speech processing has a different direction shown in Figure 1.

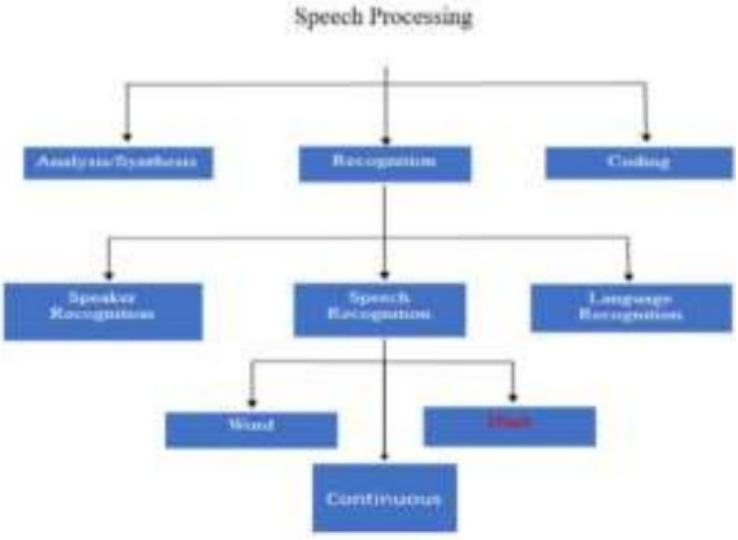



*Figure 1 Speech Processing*

Speech analysis/synthesis, speech recognition, speech coding we use it for mobile when anyone talks our speech transmit to other mobile is called coding. In the analysis, it's like convert text to speech we check what is going on in the speech to improve communication or recognize speaker or recognize accent, etc. Recognition is the opposite of analysis, it converts speech to text. There are three parts of recognition speaker recognition, speech recognition, and language recognition. Speaker recognition is the process of recognizing who is talking. Speech recognition deal with what the person is saying which is our focus in this paper. Language recognition, it well checks person speaks Arabic, English or any other language. In speech recognition, I use digit recognition. In digit recognition, a digit can be used in

many applications such as Security locks, air condition control, mobiles, computers, cars or other systems. All these things normally are related to machine learning. In machine learning, there are two parts those are feature extraction and modelling technique. These are very important in the paper. There are many Techniques used for Speech Recognition in this paper I use Mel Frequency Cepstral Coefficients (MFCC) technique. MFCC is one of the most popular feature extraction techniques in speech recognition.

## II. LITERATURE SURVEY

[1] Used (MFCC) feature extraction technique and Artificial Neural Network (ANNS) is a fundamental piece of deep learning algorithms, they are recorded 6 people voices and they did not write the accuracy.

[2] Used (MFCC) feature extraction, and Linear Prediction Coefficients (LPS) algorithm and used two machine learning algorithm that is ANN and HMM. It turns out that ANN better than HMM. They have recorded 17 people voices, they take Arabic numbers from 0-9. The Accuracy of this project 99.48%. This accuracy is maybe due to having less number of speakers.

[3] Discussed a new simple time alignment algorithm for an Arabic spoken digit recognizer. They collect data set from 17 native Arabic and they asked to utter from 0 to 9 also they used (MFCC) as feature extraction. The accuracy achieves 99.5% by using the Confusion Matrix Algorithm [3].

[4] Designed and implemented English digits speech recognition system using Matlab (GUI). That is based on the Hidden Markov Model (HMM), which provides a highly reliable way of recognizing speech. The system is able to recognize the speech waveform by translating the speech waveform into a set of feature vectors using Mel Frequency Cepstral Coefficients (MFCC) technique This paper focuses on all English digits from (Zero through Nine). This system had 34 speakers include 24 male and 10 female speakers belonging to different ages, genders, and races. The recognition rate in a clean environment was between 76% - 99%.

[5] The main aim of this paper is to compare, analyze, and discuss the outcomes of spoken Arabic digits recognition systems based on three recognition features [5]: the Yule-Walker spectrum features, the Walsh spectrum features, and the Mel frequency Cepstral coefficients (MFCC) features. The MFCC based recognition system achieves the best correct recognition. On the other hand, the YuleWalker based recognition system achieves the worst average correct recognition. a male Arabic native speaker was asked to utter all digits; each time the speech was recorded in a single file which was approximately 12 s long. The recognition rate was between 88.4% - 90.86 %.

[6] Used Two Techniques Pitch Detection Algorithm(PDA) and Cepstrum Correlation Algorithm(CCA) the dataset of 6 speakers 3 males 3 females they record from 0 to 9 the result for the male was 35.8% and for the female 31.8%.

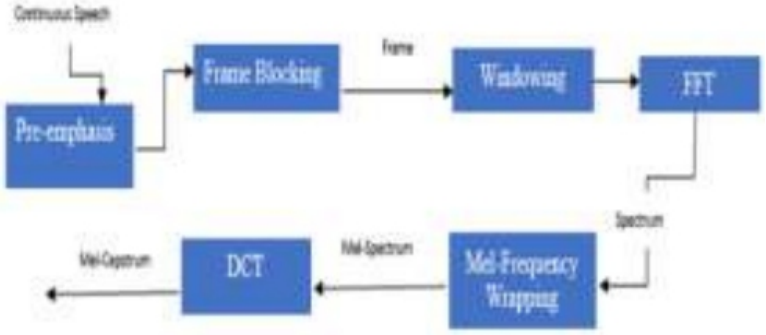
[7] Collected the database from 20 native speakers 10 male and 10 female. They uttered digits from 0 to 9, they used MFCC feature extraction technique accuracy was 95.15%.

[8] Used MFCC feature extraction and collect his dataset from 104 native Arabic speakers the speaker has to record from 0 to 9 then he applied the algorithm for training and testing which is RNN and LSTM

And Confusion Matrix the accuracy was 69%. As shown in table below this is summary of literature surveys.

## III. FEATURE EXTRACTION TECHNIQUE

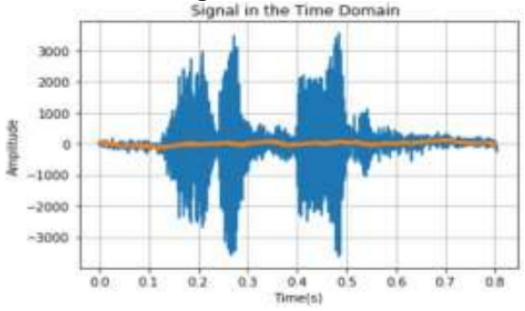
Is a method that selects/combines key characteristics of any object in order to make a model. It's processed to reduce raw data to a more manageable group for processing. MFCC is a technique that we use it to extract the speech features. It converts the human voice into signal so we can understand the pronounce of the letter. The steps in MFCC are pre-emphasis, framing, hamming windowing, fast fourier transform, mel filter bank processing, discrete cosine transform, delta energy and delta spectrum. like any recognition task, speech recognition process starting by extraction advantage from the input signal. The microphone takes the speech signal, the signal is converted to digital format frequency (16000)Hertz.



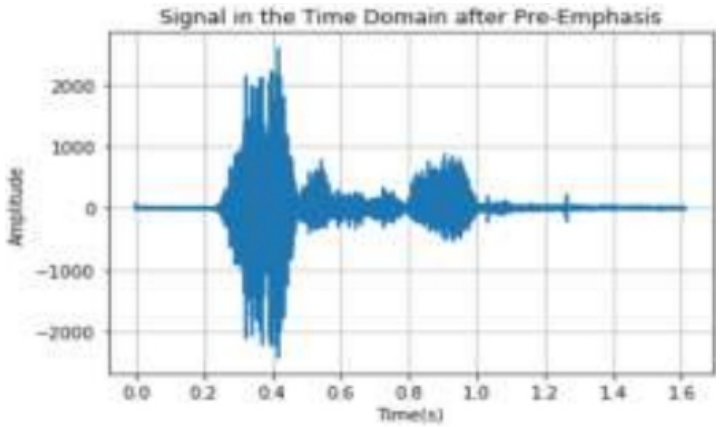

The feature are extracted by using many steps which are :

1) Pre-emphasis: when the person talk in this time may the voice will be high or low, so the goal for this is to get the word in the range (0-1), we don't do any things just reduce the scale, multiply every digit with 0.95.
2) Frame Blocking: is to cut the word into different part (get small part of it) then we can processeasy. The size of Frame equal 256 short samples.
3) Hamming Windowing: reduce this discontinuity we apply window function. Basically, the spectral distortion is minimized by using a window to taper the voice sample to zero at both beginning and end of each frame.
4) Fast Fourier Transform (FTT): is transforming on time domain to frequency domain (hearts).
5) Mel frequency wrapping: is filter it divide speech simples into their corresponding frequency level.
6) Discrete cosine transform (DCT): it's opposite FTT is to transforming frequency domain into time domain.

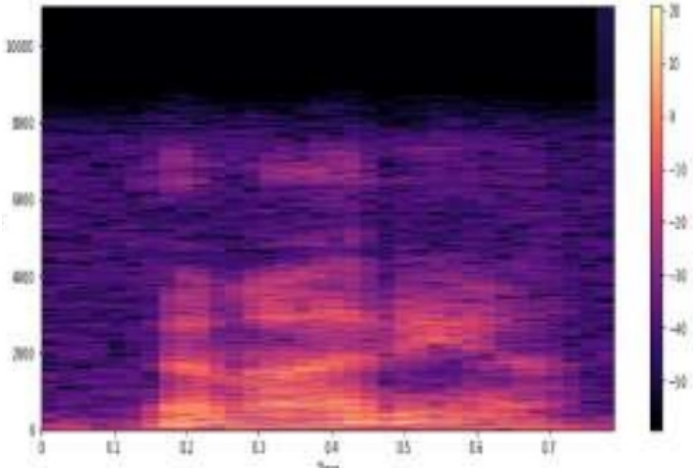
This is example for one digit, which shows signal in the time domain.



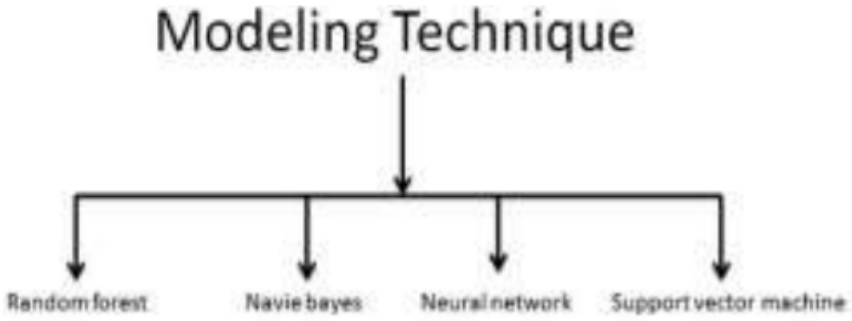
As shown below, this is signal after pre-emphasise.




As shown below, this is an example of spectrogram which can show signal strength or loudness at frequencies in waveform.



## IV. MODELLING TECHNIQUE



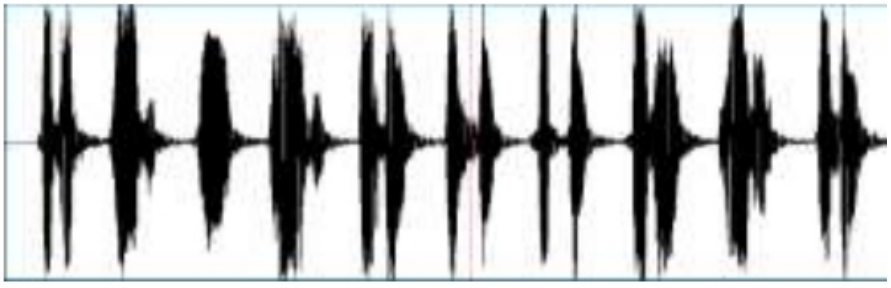

There are many modelling techniques in machine learning. These techniques are used to measure the performance and accuracy of recognition system. We used all these modelling techniques which is shown below.

First, Random forest (RF): it is a supervised classification algorithm. We can see it from its name, which is to create a forest by some way and make it random. There are four steps for Random Forest classifier: First, start with the selection of random samples from a given dataset. Next, this algorithm will construct a decision tree for every sample. Then it will get the prediction result from every decision tree. In this step, voting will be performed for every predicted result. At last, select the most voted prediction result as the final prediction result. Also RF classifier it has a good features which are : One of the most accurate learning algorithms available for most data sets, it has the power to handle a large data set with higher dimensionality, can handle lots of variables without variable deletion, it gives estimates of what variables are important in the classification, generated forests can be saved for future use on other data, it takes less training time as compared to other algorithms, avoid the over fitting problem.

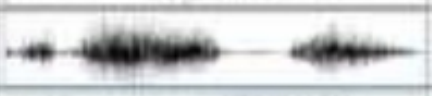
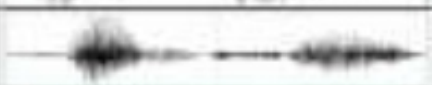
Second, Naive Bayes (NB): is a probabilistic machine learning algorithm based on Bayes Law that can be used in classification for binary (two-class) and multi-class classification problems. NB classifier can be trained easily and fast and can be used as benchmark model. But also it has disadvantages which are : need to calculate the prior probability, sensitive to the data, explain the results easily. Third, Support Vector Machine (SVM): The idea of this model is to creates a line which split the data into classes to find a maximum marginal hyper plane (MMH). SVM can be use in hand-written characters recognized. The SVM algorithm has been widely applied in the biological and other sciences. SVM classifiers offers great accuracy and work well with high dimensional space. SVM classifiers basically use a subset of training points hence in result uses very less memory. SVM classifiers do not work well with overlapping classes, it also doesn't perform very well, when the data set has more noise i.e. target classes are overlapping, the first and biggest limitation depends on the choice of kernel. Fourth, Multilayer perceptron neural network (MLP): A MLP neural network is an interconnected assembly of simple processing elements, units or nodes, whose functionality is loosely based on the animal neuron. It has capability to learn non-linear models. A MLP are complex models, which try to mimic the way the human brain develops classification rules. But also it has disadvantages which are take more time to run, need higher memory to run it, sensitive to feature scaling.

## V. DATASETS

In this paper we use King Saud University Arabic Speech Database was developed by Speech Group (SG) at King Saud University. We select 70 speakrs, 35 male and 35 female from session two. The utterances include all digits from zero to nine. The recordings were conducted in varied environments representing quiet and noisy settings. Release date was in February 17, 2014. The corpus was designed principally for speaker recognition research. However, other possible applications include first language recognition, mobile effect, multichannel effect, and use computer microphones. Each speaker was recorded in an office. The data was verified for missing recordings, problems with the recording system or errors in the recording process. As shown below this is our Experience of recording digits from zero to nine.

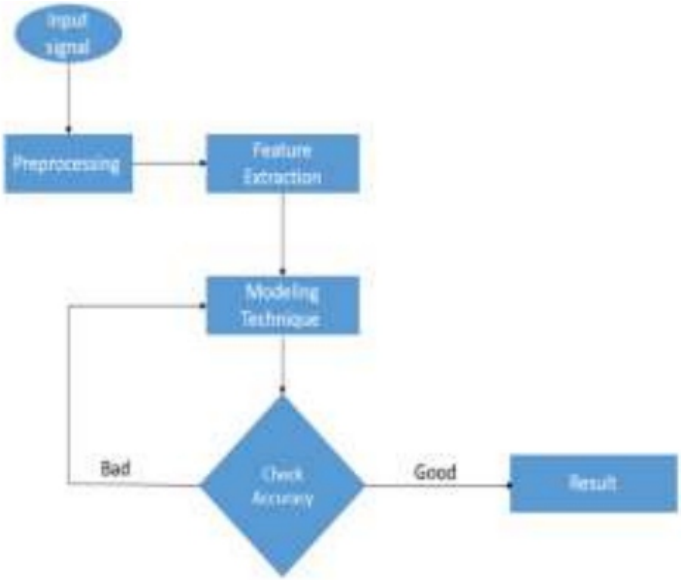


Also we split each digit individual as showing in next table. Then there are pronunciation for each digit, also how many syllabus are there for each digit and final there is a speaker signal.

| Digit | Arabic Writing | Pronunciation | Syllabus | Speaker Signal |
|---|---|---|---|---|
| 0 | صفر | Sêfr | 1 |  |
| 1 | واحد | Wa-hêd | 2 |  |
| 2 | اثنين | aath-nāyn | 2 |  |
| 3 | ثلاثة | tha-lāthah | 3 |  |
| 4 | أربعة | aar-ba-'aah | 3 |  |
| 5 | خمسة | kham-sah | 2 |  |
| 6 | ستة | sêt-tah | 2 |  |
| 7 | سبعة | sub-'aah | 2 |  |
| 8 | ثمانية | tha-mā-nyih | 3 |  |
| 9 | تسعة | Têsāh | 2 |  |

## VI. METHODOLOGY

Initially, we will have a spoken digit as the input speech signal. Later we extract digit, we take these digits one by one as the input signal. We later will divide the speech signal into frames. Then we will extract speech features from each frame. After that, There is feature extraction technique. Later we use a modelling technique to model the digits. After the training, we test the results of our system Presents the complete methodology of our paper.



## VII. RESULTS AND DISCUSSION

The digit recognition system presented in this paper is implemented and work with Python programming language and Weka software. The sound signal is recorded from 70 speakers, 35 females and 35 males.

| Algorithm | Fold | Result | Root mean squared error |
|---|---|---|---|
| Naive Bayes | 10 | 73.5% | 0.2005 |
| Neural Network | 10 | 87.3% | 0.1487 |
| Support vector machine | 10 | 93.1% | 0.1166 |
| Random Forest | 10 | 99.9% | 0.0136 |

In this paper, the accuracies of each pair of the four classifier and feature extraction techniques on the Arabic digit recognition are going to be presented.

Here we summarize all these experiments. First we try it with both male and female as shown below in the table. And random forest was a highest accuracy equal to 99.9%.

And then with females as shown below in the table. Just to check that wither there is gender different.

| Algorithm | Fold | Result | Root mean squared error |
|---|---|---|---|
| Naive Bayes | 10 | 73.5% | 0.201 |
| Neural Network | 10 | 87.1% | 0.1457 |
| Support vector machine | 10 | 89.7% | 0.1435 |
| Random Forest | 10 | 99.3% | 0.0406 |

After that we try it with just male as shown below in the table.

| Algorithm | Fold | Result | Root mean squared error |
|---|---|---|---|
| Naive Bayes | 10 | 73.8% | 0.2016 |
| Neural Network | 10 | 86.8% | 0.1492 |
| Support vector machine | 10 | 90.0% | 0.1413 |
| Random Forest | 10 | 99.5% | 0.0372 |

As you can see in the table of male result got better accuracy because male their tone voice very high and pronounce the things correctly, the female their tone voice very low and they talk in speedy way. In order to check our validity of our dataset we combine both and we check the result as shown in table of male and female. Even it's better with both because it is make the perfect model. The results show that the Random forest achieved the highest recognition rate (with accuracy equal to 99.9%). Then the support vector machine (with accuracy equal to 93.1%).

## VIII. CONCLUSION

In this paper, we successfully develop Arabic digit recognition (ADR) system. Our dataset has been taken from king Saud university we use the same speaker in training and testing phase we extract MFCC feature extraction and then we apply different kind of modelling technique which are naïve bayes, neural network, support vector machine and random forest which had a highest accuracy 99.9%. As you can see above in table of literature survey most of them had less speakers, just one had more speakers and the accuracy was low. So we decided to take more speakers and we got accuracy equal to 99.9% for 70 speakers, 35 male and 35 females.

*REFERENCE*


*[1] H. Satori, M. Harti, and N. Chenfour "Arabic speech recognition system based on CMUSphinx" International Symposium on Computational Intelligence and Intelligent Informatics - ISCIII 2007 Agadir, Morocco * March 28-30, 2007.*

*[2] Yousef Ajami Alotaibi "Spoken Arabic Digits Recognizer Using Artificial Neural Networks" college of computer & information system king Saud university (2008 A.D. / 1429 A.H.).*

*[3] Yousef Ajami Alotaibi "A Simple Time Alignment Algorithm for Spoken Arabic Digit Recognition", Eng. Sci., Vol. 20 No.1, pp: 29-43 (2009 A.D. / 1430 A.H.).*

*[4] Ahmad A. M. Abushariah, Teddy S. Gunawan, Othman O. Khalifa, and Mohammad A. M. Abushariah (2010), "English Digits Speech Recognition System Based on Hidden Markov Models", International Conference on Computer and Communication Engineering (ICCCE 2010), 11-13 May 2010, Kuala Lumpur, Malaysia.*

*[5] Ali Ganoun and Ibrahim Almerhag (2012), "Performance Analysis of Spoken Arabic Digits Recognition Techniques", JOURNAL OF ELECTRONIC SCIENCE AND TECHNOLOGY, VOL. 10, NO. 2, JUNE 2012.*

*[6] Anas Allosh, Nura Zlitni, Ali Ganoun "Speech Recognition of Arabic Spoken Digits" Hindawi Publishing Corporation Conference Papers in Engineering Volume 2013, Article ID 130473,6 pages.*

*[7] Agus Harjoko, Muhammed Fachrie "Robust Indonesian Digit Speech Recognition using Elman Recurrent Neural Network" Prosiding Konferensi Nasional Informatika (KNIF) 2015, Institut Teknologi Bandung 22 October 2015.*

*[8] Eng.Abdulaziz Saleh Ba Wazir "Spoken Arabic digits Recognition Using deep Learning" (2018) University of Malaya.*

# ONTOLOGICAL CLASSIFICATION BY USING SET THEORETIC NOTATIONS IN HYPERCUBE

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PM Excellence of Govt.PG college Satna

## A B S T R A C T

*Ontological classification is the process of organizing and categorization of entities, concepts or object based on properties /relationships and existence. Using set theoretic notation it provides a formal and rigorous framework for representing and reasoning about complex relationships between entities of interconnection network. Set-theoretic notations are an effective framework for conceptually describing many aspects of hypercube interconnection networks' structure and functionality. Logical representations to formalize and concisely characterize the structure, connectivity, and routing behavior of hypercube interconnection networks. They serve as the foundation for evaluating, creating, and optimizing hypercube networks for a variety of parallel and distributed computing tasks. To show relationships in a hypercube we can use a graph representation each vertex of the hypercube is represented by a string of length n, where n is the number of dimensions of the hypercube. The edge of the hypercube is represented by the hamming distance between the binary strings of the vertices they connect. The hamming distance is the number of position at which the corresponding bits are different for example.In a three-dimensional hypercube the vertices (000) and (001) are connected by an edge because they differ in only one bit position. Similarly the vertices (000) & (100) are connected by an edge because they differ in only one bit position similarly the vertices (000) and (100) are connected by an edge because they also differ in only one bit position.*

***Keywords -*** *ontological classification, set theoretic nototations, hamming distance , tripods…*

## I. INTRODUCTION

Set-theoretic notations are an effective framework for conceptually describing many aspects of hypercube interconnection networks' structure and functionality. Here's a logical description of typical set-theoretic notations used in hypercube networks:

1. Node Set (N): The set of all nodes in the hypercube network. Where each node is uniquely recognized by its binary address, with each bit position representing a dimension in the hypercube.

2. Edge Set (E): The set of all edges in a hypercube network. An edge joins nodes that differ by one bit position in their binary addresses' is mathematically defined as $\{(u, v) \mid u, v \in N$ and differ in exactly one bit position$\}$.

3. Vertex Set (V): The set of all vertices in a hypercube network. A vertex is a group of nodes in a network that have a common prefix in binary addresses. $V = \{V_i \mid V_i$ is a subset of N, and all nodes in $V_i$ share a common prefix.

4. Dimension Set (D): D refers to all dimensions in the hypercube network. Each dimension represents a bit location in nodes' binary addresses. D ismathematically defined as $\{d_i \mid 0 \leq i < \log_2|N|\}$.

5. Routing Function ®: R defines message routing behavior in the hypercube network. Maps source,

destination, and message nodes to network paths. R is defined mathematically as $N \times N \times M \rightarrow P$, with M representing all messages and P representing all paths in the hypercube network.

6. Fault Set (F): F includes all fault-prone components in the hypercube network. It includes nodes, edges, or vertices that may fail or malfunction. In mathematical terms, $F = \{f \mid f \text{ is a faulty node, edge, or vertex in the network}\}$.

7. Adjacency Matrix (A): A binary matrix representing node connection in a hypercube network. The entries A[i][j] are 1 if there is an edge between nodes i and j, and 0 otherwise.

These logical representations use set-theoretic notions to formalize and concisely characterize the structure, connectivity, and routing behavior of hypercube interconnection networks. They serve as the foundation for evaluating, creating, and optimizing hypercube networks for a variety of parallel and distributed computing tasks. To show relationships in a hypercube we can use a graph representation each vertex of the hypercube is represented by a string of length n, where n is the number of dimensions of the hypercube.

The edge of the hypercube is represented by the hamming distance between the binary strings of the vertices they connect.

The hamming distance is the number of position at which the corresponding bits are different for example.

In a three-dimensional hypercube the vertices (000) and (001) are connected by an edge because they differ in only one bit position. Similarly the vertices (000) & (100) are connected by an edge because they differ in only one bit position similarly the vertices (000) and (100) are connected by an edge because hey also differ in only one bit position.

## Ontological Classification in a hypercube on the basis of relational connectivity

**$2^0$=1 one node, which is connected to itself**

**Fig 6.1 processor possessing one node (Monon)**

**Two nodes i.e. $2^1$=2**


**Fig 6.2 processor possessing two nodes (dion)**

Table 6.1 Binary connectivity of two nodes

| | V1 | V2 |
|---|---|---|
| V1 | 1 | 1 |
| V2 | 1 | 1 |

**3. Three nodes $2^3=8$**

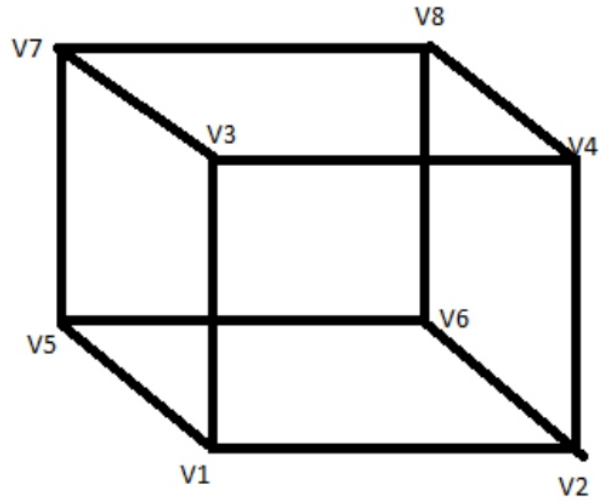


**Fig 6.3 processor possessing eight nodes (hypercube)**

8- Node connectivity matrix between nodes (node-node)

**Table 6.2 Binary connectivity of eight nodes**

| | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 |
|---|---|---|---|---|---|---|---|---|
| V1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| V2 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| V3 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| V4 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| V5 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| V6 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| V7 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| V8 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |

V1= {v1, v2, v3, v4, v5, v6, v7, v8}
={1,1,1,0,1,0,0,0}

**V1= {v1, v2, v3, v4, v5, v6, v7, v8}**
**={1,1,1,0,1,0,0,0}**

**V2= {v1, v2, v3, v4, v5, v6, v7, v8}**
**={1,1,0,1,0,1,0,0}**

**V3= {v1, v2, v3, v4, v5, v6, v7, v8}**
**={1,0,1,1,0,0,1,0}**

**V5= {v1, v2, v3, v4, v5, v6, v7, v8}**
**={1,0,0,0,1,1,1,0}**

**V1 shows relationship with V1, V2, V3, and V5**

**V1= {v1, v2, v3, v5}**
**= {1, 1, 1, 1}**

**V2= {v1, v2, v4, v6}**
**= {1, 1, 1, 1}**

**v3= {v1, v3, v4, v7}**
**= {1, 1, 1, 1}**

**v5= {v1, v5, v6, v7}**
**= {1, 1, 1, 1}**

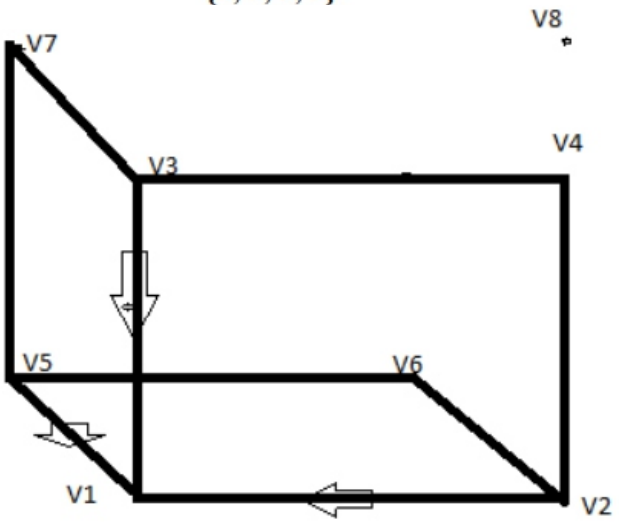


**Fig 6.4 New form of 3-D hypercube on the basis of binary connection (Septaon)**

**V2= {v1, v2, v3, v4, v5, v6, v7, v8}**
**={1,1,0,1,0,1,0,0}**

**v1= {v1, v2, v3, v5}**
**= {1, 1, 1, 1}**

**v2= {v1, v2, v4, v6}**
**= {1, 1, 1, 1}**
**v4= {v2, v3, v4, v8}**
**= {1, 1, 1, 1}**
**v6= {v2, v5, v6, v8}**
**= {1, 1, 1, 1}**

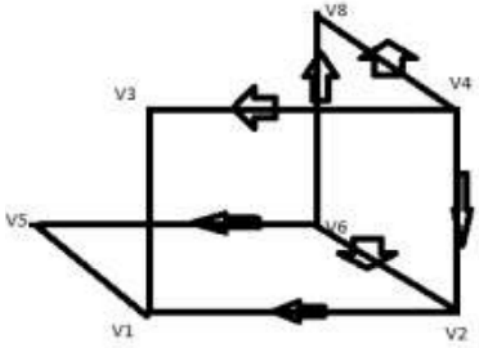

**Fig 6.5 New form of 3-D hypercube on the basis of binary connection (Septaon)**

**v3= {v1, v3, v4, v7}**
**= {1, 1, 1, 1}**

**v1= {v1, v2, v3, v5}**
**= {1, 1, 1, 1}**

**v3= {v1, v3, v4, v7}**
**= {1, 1, 1, 1}**

**v4= {v2, v3, v4, v8}**
**= {1, 1, 1, 1}**

**v7= {v3, v5, v7, v8}**
**= {1, 1, 1, 1}**

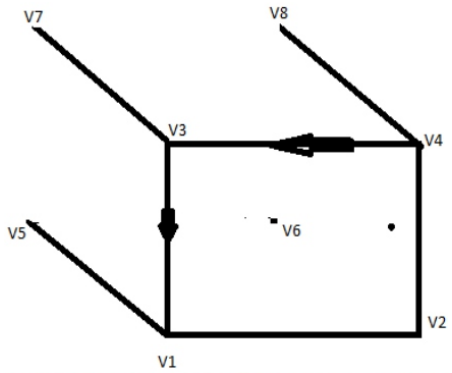


**Fig 6.6 New form of 3-D hypercube on the basis of binary connection (Septaon)**

**v4= {v2, v3, v4, v8}**
**= {1, 1, 1, 1}**
**V2={v1,v2,v4,v6}**
**={1,1,1,1}**

**V3={v1,v3,v4,v7}**
**={1,1,1,1}**

**V4={v2,v3,v4,v8}**
**={1,1,1,1}**

**V8={v4,v6,v7,v8}**
**={1,1,1,1}**

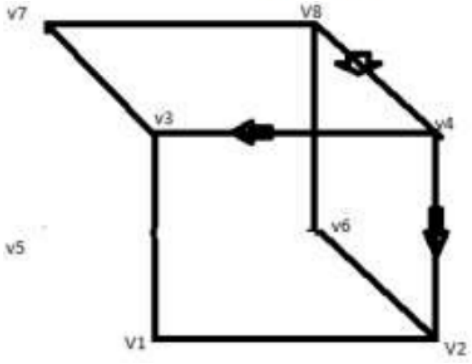

**Fig 6.7 New form of 3-D hypercube on the basis of binary connection (Septaon)**

**v5={v1,v5,v6,v7}**
**={1,1,1,1}**

**V1={v1,v2,v3,v5}**
**={1,1,1,1}**

**v5={v1,v5,v6,v7}**
**={1,1,1,1}**

**V6={v2,v5,v6,v8}**
**={1,1,1,1}**

**V7={v3,v5,v7,v8}**
**={1,1,1,1}**

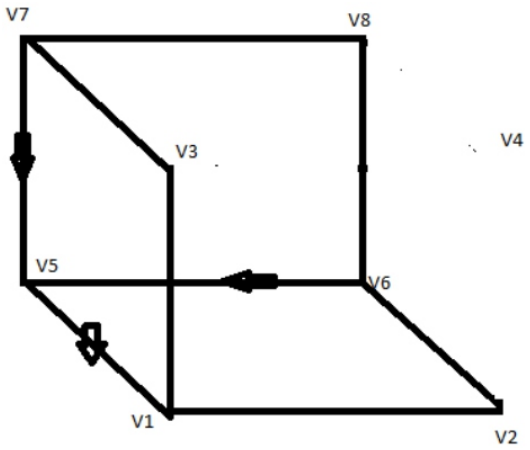


**Fig 6.8 New form of 3-D hypercube on the basis of binary connection (Septaon)**

**V6={v2,v5,v6,v8}**
**={1,1,1,1}**

**V2={v1,v2,v4,v6}**
**={1,1,1,1}**

**V5={v1,v5,v6,v7}**
**={1,1,1,1}**

**V6={v2,v5,v6,v8}**
**={1,1,1,1}**

**V8={v4,v6,v7,v8}**
**={1,1,1,1}**

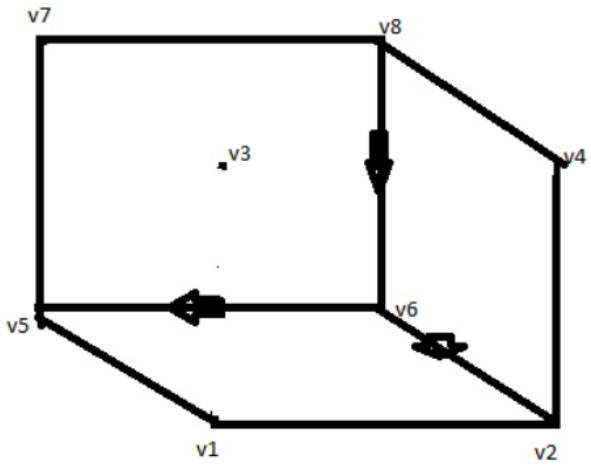


**Fig 6.9 New form of 3-D hypercube on the basis of binary connection (Septaon)**

**V7={v3,v5,v7,v8}**
**={1,1,1,1}**

**V3={v1,v3,v4,v7}**
**={1,1,1,1}**

**V5={v1,v5,v6,v7}**
**={1,1,1,1}**

**V7={v3,v5,v7,v8}**
**={1,1,1,1}**

**V8={v4,v6,v7,v8}**
**={1,1,1,1}**

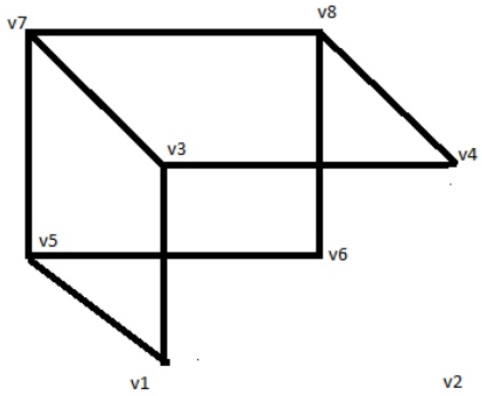


**Fig 6.10 New form of 3-D hypercube on the basis of binary connection (Septaon)**

**V8= {v4, v6, v7, v8}**
**= {1, 1, 1, 1}**

**v4= {v2, v3, v4, v8}**
**={1,1,1,1}**

**V6={v2,v5,v6,v8}**
**={1,1,1,1}**

**V7={v3,v5,v7,v8}**
**={1,1,1,1}**

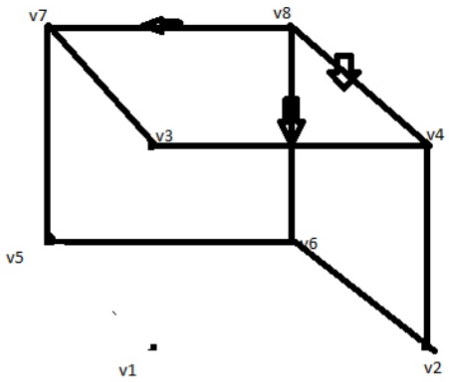


**Fig 6.11 New form of 3-D hypercube on the basis of binary connection (Septaon)**

## II. CONCLUSION

In ontological categorization, set-theoretical notation within a hypercube is used to organize entities into sets based on their qualities, which are then represented within a hypercube multidimensional framework. Each hypercube dimension represents a distinct feature or attribute, and intersecting hypercube dimensions correspond to certain combinations of properties that define various groups of things. A hypercube parallel computer is a network of processors, each with only local memory, whose activities are coordinated by messages sent by the processors themselves. An n-dimensional hypercube has 2n processors, and the communication network corresponds to the edges of the dimensional cube. Each vertex or node is a processor. Each node is uniquely identifiable by and binary digits and the binary tags of any two neighbors differ by exactly one bit. Thus, each node has degree d to represent the interconnectedness. This scheme considers the hypercube of dimension 0 from the illustration above.

*REFERENCE*

*[1] Katare R. & Chaudhari N.,Study of Topological Property of Interconnection Networks and its Mapping to Sparse Matrix Model.Int. J. Comput. Sci. Appl., 6, 26-39 2009.*

*[2] Katare R. K.and, Chaudhari N.S.," Some P-RAM Algorithms for Sparse Linear Systems", Journal of Computer Science 3(12):956-964, 2007.*

*[3] Katare R. K., Bharti S., Begum R., Sharma P., Kumari M., "Study of Butterfly Patterns of Matrix in Interconnection Network", International Journal of Scientific & Engineering Research, Volume 7, Issue 12, 320, ISSN 2229-5518, 2016.*

*[4] KatareR.,Vector Operationon Nodes of Perfec tDifference Network using Logical Operators, International Journal of Advanced Research in Computer Science. 10. 29-39. 10.26483 2019.*

*[5] KatareR.,Vector Operationon Nodes of Perfec tDifference Network using Logical Operators, International Journal of Advanced Research in Computer Science. 10. 29-39. 10.26483 2019.*

*[6] Bhuyan L.N., "Generalized Hypercubes structure for a computer network," IEEE Trans. on a computer's, Vol. C 33 no.4, APR 1984.*

*[7] Hwang Kai, Briggs F. A., "Computer Architecture and Parallel Processing," McGrawHill Book Co. International Edition, 1985*

*[8] Bhuyan L.N., Agrawal D.P., "Design and Performance of Generalized Interconnection Networks," IEEE Transactions on Computers, Vol. C-32, No. 12, December 1983.*

*[9] Tiwari, Sunil, Gaharwar P. S., and Katare R. K. "A Study of Structural Analysis of Perfect Difference Network (PDN).",Research Journal of Science Engineering and Technology Volume 10 Issue 2 [Year 2020]ISSN 2454-3195.*

*[10] Tanenbaum, Andrew S.; Steen, Maarten van (2002).Distributed systems: Principles and paradigms.Upper Saddle River,NJ:Pearson Prentice Hall. ISBN 0-13-088893-1.*

# INTEGRATED METEOROLOGICAL SENSING: A SYNERGISTIC FRAMEWORK OF IOT-DRIVEN EATHER STATIONS AND ADVANCED MACHINE LEARNING ALGORITHMS

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## ABSTRACT

*This research focuses on the implementation of an automated weather forecast station using IoT technology. The system uses advanced forecasting methodologies like ARIMA and deep learning to provide immediate insights into weather conditions. The system uses environmental sensors for seamless data gathering and an intuitive user interface. The research extends its application to smart urban centers and industrial sectors, prioritizing safety and resilience in the context of climate change. K-Medoids clustering, Naïve Bayes algorithm, and ARIMA models enhance the system's resilience. This research contributes to the advancement of weather forecasting technologies and fostering a resilient society.*

***Keywords -*** *IoT (Internet of Things), ARIMA, Deep learning, Weather forecasting, EDS (Exploratory Data Analysis), Random Forest, Convolutional Neural Networks*

## I. INTRODUCTION

The building industry, heavily dependent on outdoor work, is susceptible to weather-related calamities due to its high reliance on weather. Unpredictable weather has been linked to increased deaths at construction sites, impacting worker safety, project timeliness, and efficiency. About 45% of building projects are affected by weather.

Delays in work and safety concerns may affect project team members, leading to accidents, injuries, or fatalities due to miscommunication, weather ignorance, or carelessness on the construction site [1]. Severe weather caused significant issues at Wimbledon, a popular global tennis tournament attended by top players, news organizations, and viewers [2].

The unpredictable British weather causes challenges at summer events, particularly in rainy weather, which can ruin games and reduce spectator and player experience [3]. Wet grass increases the risk of falling, leading to postponements or rescheduling, potentially affecting the organization's finances. The IPL 2023 GT and CSK championship games were affected by such weather in Gujarat.

The players were forced off the field due to heavy wind and rain, resulting in puddles that took over an hour to clear. The rain could have contributed to heat stroke and hyperthermia, which can cause disorientation, behavioural changes, nausea, and vomiting. Heat stroke, caused by overheating and inability to cool down, can be fatal if not treated promptly and appropriately [4]. Effective relaxation and hydration are crucial for reducing mortality rates, which can be achieved through emergency supplies, winter activities, water consumption, and adequate ventilation and cooling equipment [5].

Heatstroke, a serious health issue, can occur in animals overfed, kept in the sun, or in a horsebox. Symptoms include tachycardia, coughing, fever, and larynx. To prevent heatstroke, animals should be placed in cold water, electrified, and kept in shade. In the 1995 Chicago heat wave, 58 patients needed critical care for severe heat stroke [6].

The system utilizes machine learning and the internet to create a weather forecast station, enhancing its efficiency and effectiveness by incorporating data from previous research [7]. The device's weather indicator panel displays graphically the current weather conditions, including heat waves, storms, and heavy rains, based on the user's location [8]. Boards promote caution, public safety, emergency management, transportation, awareness, and education by reading weather parameters and influencing display technologies like LED matrices, LCD displays, and digital signs. They also provide current situation forecasts [9]. Open climate models and various reliable sources offer weather products through APIs on websites, providing accurate weather forecasts [10].

The system provides accurate weather information in various locations, including public areas, educational institutions, and museums, promoting public understanding of climate-related concerns. Weather boards are crucial for providing safety advice, alerts, and warnings regarding severe weather.

Arduino-based techniques analyse DHTT11 and BMP280 sensors data, incorporating models into machine learning algorithms to track environmental factors like humidity, temperature, and pressure, and identify meteorological data [11]. The module transmits observed data wirelessly to an open-source platform, including observable graphs, for production, which requires object descriptions and a cloud sensing and retrieval system [12]. The data is collected and processed into a machine learning model for weather forecasting and analysis using the ARIMA Time Series Analysis approach. Deep learning methods are applied to determine the optimal climate prediction model for any scenario, using convolutional layers for image assessment focusing on local weather to attract users [13]. The model provides industry data such as time, weather location, pressure, temperature, and altitude, which can be used to accurately forecast weather [14]. The Internet of Things (IoT) is enabling the integration of home automation, smart city, and industrial applications [15], providing users with crucial safety information and actionable insights.

| Sr. No. | Year | Author's | Parameters/focus on the paper | Key point coverage | Technique Used | Result | Prediction |
|---|---|---|---|---|---|---|---|
| 1 | 2019 | M.H.Yen et al. | Hourly collection of atmospheric pressure, temperature, humidity, wind direction, sea level measurements, and precipitation. | Cognitive Computing | Echo State Network (ESN) and Deep Echo State Network (DeepESN). | DeepESN Rainfall Prediction • Outperforms ESN, BPN, SVR. • Demonstrates superior efficacy. | Precipitation Forecasting |
| 2 | 2019 | N. Singh et al. | Temperature, Humidity and Pressure | machine learning, Weather forecast, Raspberry Biosensor, confusion matrix[19] | Ensemble Decision Tree Classification | A precision rate of 87.90% was attained. | Precipitation Forecasting |
| 3 | 2020 | Zi-Qi Huang | Temperature, humidity and light intensity | weather prediction, bus systems, machine learning[20] | Long Short-Term Memory (LSTM) Model and The Multilayer Perceptron (MLP) Model) | Provides accurate one-day weather forecasts. | 24-Hour Predictions: Temperature , humidity, air pressure. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | 2019 | Kanghui Zhou et al. | Temperature, pressure, humidity, and winds | deep learning, convective weather, convolutional neural network, forecasting [21] | convolutional neural network (CNN), SCW forecasting | The deep CNN algorithm can efficiently extract SCW features and exhibit great predictive skill | Heavy rain, hail, convective gusts, and thunderstorms are common weather conditions. |
| 5 | 2019 | A. Parasha at al. | Pressure, Humidity, Rainfall, Temperature, Dust Particles And Light | machine learning, Internet of things, Regression, data collection through sensors[22] | Multifactor Linear Regression Model | Precision rate: 94% for minimum temperature, 93% for maximum temperature. High accuracy: 95% for mean temperature. | Superior Performance in Predicting Average Temperature . |
| 6 | 2020 | A H M Jakaria at el. | Involves temperature, humidity, atmospheric pressure, wind speed, directional indicators. | Machine Learning, Weather forecast, data pre-processing [13] | machine learning techniques | Wider range of nearby cities. Extended weeks. | Predict temperature levels at a specific hour in the coming day. |

**Table. 1. Comparison of technique, dataset used, and remarks**

In 2015, Ankita Joshi and Bhagyashree Kamble developed a data-driven method using decision tree algorithms to predict extreme weather with an 82% precision. This innovative approach improves weather forecasting capabilities and mitigates the impact of weather-related disasters, resembling philosophical discourse in its compactness [16].

In 2017, Prashant Viradare et al. introduced a new climate forecasting method that combined K-Medoids clustering with the Nave Bayes algorithm, benefiting industries like aviation, military, and agriculture. This system enhances resource utilization, efficiency, and safety by providing relevant information to local decision-makers [17].

Purnima and Pushpalatha developed an "Intensified LSTM-Networks" model in 2019 for predicting rainfall, outperforming previous methods. The model's advantages in rainfall forecasting have implications for agriculture, emergency preparedness, and water resource management [18].

M.H. Yen et al. (2019) utilized deep learning techniques like Echo State Network (ESN) and Deep ESN to forecast rainfall. They found ESN depth precipitation forecasts more accurate than other methods, demonstrating the potential of deep learning in improving rainfall forecasting, flood forecasting, and water management [19].

A 2020 bus system study by Zi-Q Huang utilized temperature, humidity, and light intensity data to predict weather conditions. The accuracy of one-day weather forecasts was improved using multilayer perceptron and LSTM models, demonstrating machine learning's potential for reliable navigation services [20].

The integration of data mining, machine learning, deep learning, and digital resources has significantly improved weather forecasting accuracy and reliability. These advancements are applicable across sectors like disaster preparedness, transportation, agriculture, and utilities. As technology advances,

sophisticated models and methodologies are expected to revolutionize weather forecasting and disaster management, requiring a paradigm shift in strategies. This advancement is expected to have a significant impact on meteorological research and analysis.

## III. EXPERIMENTAL RESULTS

The precision metric is the ratio of true positives (TP) to the sum of true positives and false positives (FP) in a dataset [23].

$$Precision = \frac{TP}{TP + FP}$$

A true positive indicates the number of correctly classified weather forecasts, while a false positive indicates the number of incorrectly classified forecasts.

The recall metric is the ratio of true positives (TP) to the sum of true positives and false negatives (FN)[23].

$$Recall = \frac{TP}{TP + FN}$$

False negatives in weather forecasting involve incorrectly classifying a parameter as mild weather when it is actually adverse weather.

Accuracy is a metric that indicates the proportion of accurate weather prediction models or poor models among all the models in the dataset.

$$Accuracy = \frac{TN + TP}{TP + FP + TN + FN}$$

True negatives (TN) are the accurate classification of benign weather instances as benign.
The execution metric measures the time spent training and testing a weather prediction machinelearning model to ensure accurate and timely forecasts.
The F-measure metric evaluates the weather prediction model's performance in terms of false positives and false negatives, providing a balanced evaluation[24].

$$F - Measure = \frac{2TP}{2TP + FP + FN}$$

I. Storage

ARIMA images are small, constrained coefficients and parameters for time series analysis. CNN models can vary significantly depending on architecture complexity, layers, and filters. Deep learning models, like LSTM or GRU networks, can have larger models with controlled weight and bias. Random forests have moderate sample sizes and multiple decision trees, but are generally larger than ARIMA but smaller than deep learning models.

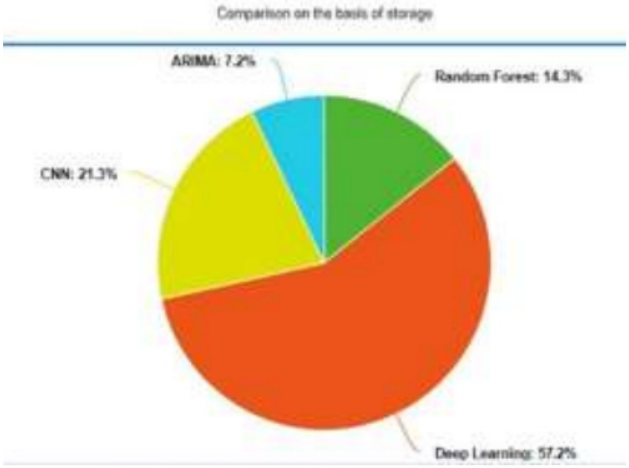


**Figure.1 Comparison based on storage**

ii. Training Time

The ARIMA model is known for its short training procedure for univariate time series data, compared to complex machine learning models. Convolutional neural networks may take more time due to network complexity, depth, and image loading. Short-term memory (LSTM) and gated recurrent unit (GRU) networks have longer training times due to additional neural network loads and biases. Completing models can be time-consuming, especially for complex topologies and large datasets. Random forest models provide less training time and have a faster scalable training method, though it takes more time.

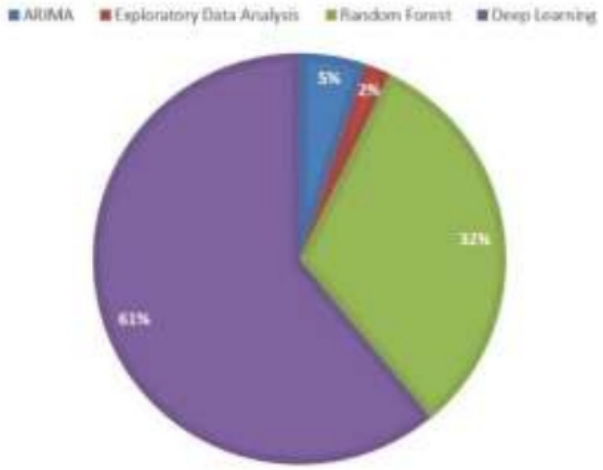


**Figure.2 Training time comparison**

iii. Different Sample Sizes

Weather prediction models serve specific purposes, with ARIMA being useful for short-term forecasts but not for intricate patterns or spatial connections. Convolutional Neural Networks (CNNs) are ideal for visual-based weather prediction, but require large, spatially ordered datasets and may overfit smaller ones. Deep learning models like GRU or networks are flexible and adaptable to various data sources, but require larger datasets for improved performance. Random Forest is a flexible ensemble technique that can handle various data types and intricate interactions but may not capture temporal connections as well as time series models.

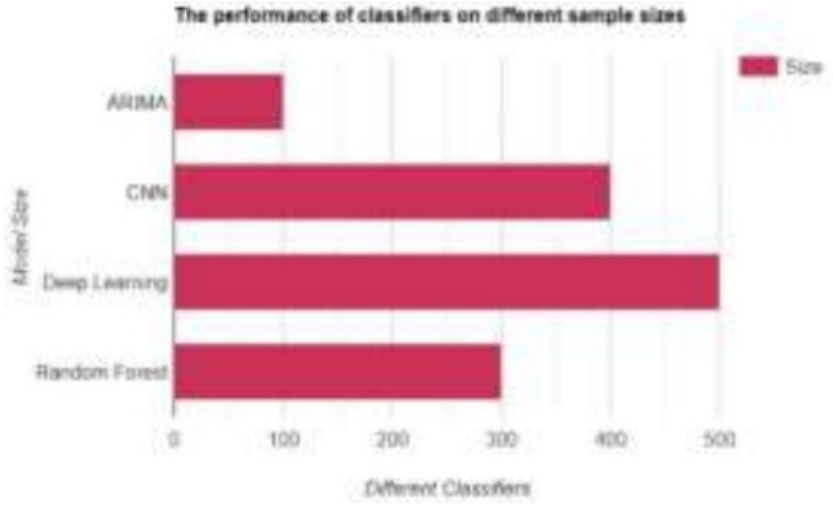


**Figure.3 The performance of classifiers on different sample sizes**

| Sr. No. | Feature Method | Mean Squared Error (MSE) | Mean Absolute Error (MAE | R-squared (R2) | Time (s) |
|---|---|---|---|---|---|
| 1 | ARIMA | 331.8955472 | 13.83383591 | 0.012631838 | 15 s |
| 2 | Random Forest | 0 | 0 | 1 | 6 s |
| 3 | Deep Learning | 0.028073866 | 0.113883712 | 0.999863628 | 93 s |
| 4 | Exploratory Data Analysis | 6.62E-26 | 2.05E-13 | 1 | 178 |

**Table.2. Comparison of Results based on their internal factors**

## IV. CONCLUSION

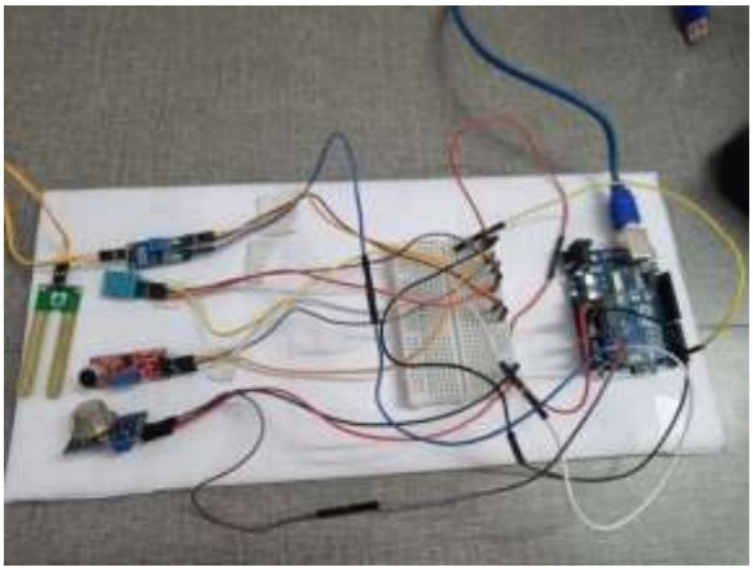

**Figure.4 Weather prediction using multiple-sensors**

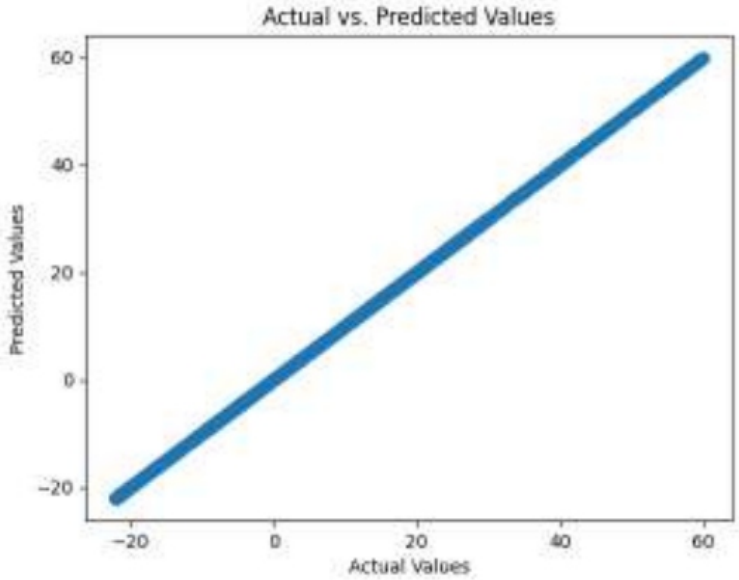


**Figure.5 Prediction based on Random Forest**

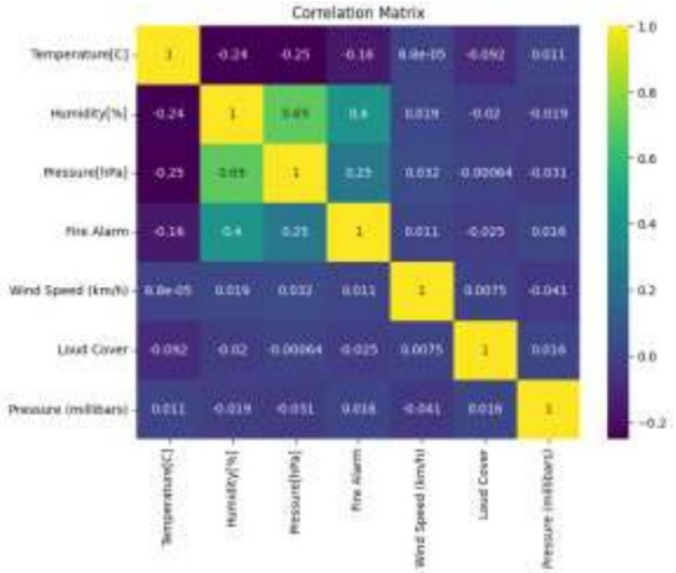


**Figure.6 Correlation Matrix based on EDA**

```
Epoch 1/50
1566/1566 [==============================] - 4s 2ms/step - loss: 16.4375
Epoch 2/50
1566/1566 [==============================] - 3s 2ms/step - loss: 0.2319
Epoch 3/50
1566/1566 [==============================] - 3s 2ms/step - loss: 0.1687
Epoch 4/50
1566/1566 [==============================] - 3s 2ms/step - loss: 0.1118
Epoch 5/50
1566/1566 [==============================] - 3s 2ms/step - loss: 0.1142
Epoch 6/50
1566/1566 [==============================] - 3s 2ms/step - loss: 0.0753
Epoch 7/50
1566/1566 [==============================] - 3s 2ms/step - loss: 0.0981
Epoch 8/50
1566/1566 [==============================] - 3s 2ms/step - loss: 0.0608
```

**Figure.7 Epochs running in Deep Learning**

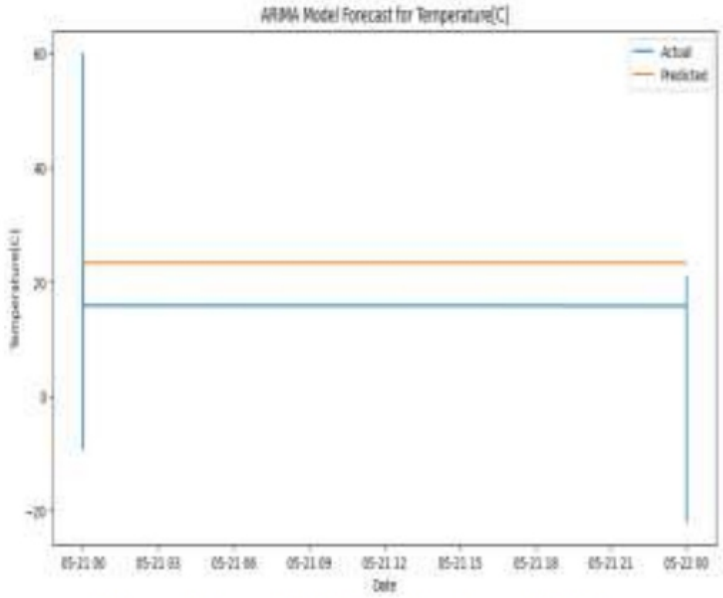


**Figure.8 Range Prediction based on ARIMA**

The study utilized machine learning techniques such as exploratory data analysis, random forest, deep learning, and ARIMA to predict and test target variables and identify crucial results. The ARIMA time-series forecasting approach showed a Mean Absolute Error of 13.83 and a Mean Squared Error of 331.90, but a low R-squared value of 0.0126 indicated it could only account for a portion of the target variable's variance. Random Forest, a robust ensemble learning technique, demonstrated excellent accuracy with an MSE and MAE of 0, an outstanding $R^2$ value, and computing efficiency, completing its analysis in just 6 seconds. Deep Learning, using neural networks, produced precise forecasts with an MSE of 0.0281 and MAE of 0.1139, capturing target variable volatility with an R2 score of 0.9999, but taking 93 seconds longer than other approaches. The exploratory data analysis showed high R2 value and low error metrics, despite not containing predictions, and took 178 seconds to complete despite a high processing cost. In conclusion, the study suggests that choosing the right machine learning method depends on research objectives and computational limitations. Random forest outperforms deep learning for high prediction accuracy, while ARIMA is not suitable for certain data sets. Exploratory research can provide initial insights, even when ARIMA fails to provide predictions. Researchers should choose the best approach for their specific requirements, considering explanatory power or prediction accuracy.

*REFERENCE*

*[1] R. Radevsky et al., "IMIA-WGP 78 (12) The effect of adverse weather on construction sites Working Group Executive Committee Sponsor."*

*[2] J. Kay and W. Vamplew, "Under the weather: Combating the climate in British sport [1]," Sport in Society, vol. 9, no. 1. pp. 94–107, Jan. 2006. doi: 10.1080/17430430500355832.*

*[3] V. R. Embar, I. Bhattacharya, V. Pandit, and R. Vaculin, "Online topic-based social influence analysis for the Wimbledon championships," in Proceedings of the ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Association for Computing Machinery, Aug. 2015, pp. 1759–1768. doi: 10.1145/2783258.2788593.*

*[4] L. R. Leon and B. G. Helwig, "Heat stroke: Role of the systemic inflammatory response," Journal of Applied Physiology, vol. 109, no. 6. pp. 1980–1988, Dec. 2010. doi: 10.1152/japplphysiol.00301.2010.*

*[5] A. Kumar and D. P. Singh, "Heat stroke-related deaths in India: An analysis of natural causes of deaths, associated with the regional heatwave," J Therm Biol, vol. 95, Jan. 2021, doi: 10.1016/j.jtherbio.2020.102792.*

*[6] J. E. Dematte et al., "Annals of Internal Medicine Near-Fatal Heat Stroke during the 1995 Heat Wave in Chicago," 1998. [Online]. Available: http://www.acponline.org.*
*[7] M. N. Hassan, M. R. Islam, F. Faisal, F. H. Semantha, A. H. Siddique, and M. Hasan, "An IoT based environment monitoring system," in Proceedings of the 3rd International Conference on Intelligent Sustainable Systems, ICISS 2020, Institute of Electrical and Electronics Engineers Inc., Dec. 2020, pp. 1119–1124. doi: 10.1109/ICISS49785.2020.9316050.*
*[8] Manipal University Jaipur. School of Computing and Information Technology and Institute of Electrical and Electronics Engineers, 2019 2nd International Conference on Intelligent Communication and Computational Techniques (ICCT) : Manipal University, Jaipur, Sep. 28-29, 2019.*
*[9] A. Gautam, G. Verma, S. Qamar, and S. Shekhar, "Vehicle Pollution Monitoring, Control and Challan System Using MQ2 Sensor Based on Internet of Things," Wirel Pers Commun, vol. 116, no. 2, pp. 1071–1085, Jan. 2021, doi: 10.1007/s11277-019-06936-4.*
*[10] P. Sharma and S. Prakash, "Real Time Weather Monitoring System Using Iot," ITM Web of Conferences, vol. 40, p. 01006, 2021, doi: 10.1051/itmconf/20214001006.*
*[11] Dayananda Sagar College of Engineering, Institute of Electrical and Electronics Engineers. Bangalore Section, and Institute of Electrical and Electronics Engineers, 2nd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2020) : conference proceedings : 5-7 March, 2020.*
*[12] Y. Rahut, R. Afreen, and D. Kamini, "Smart weather monitoring and real time alert system using IoT," International Research Journal of Engineering and Technology, vol. 848, 2008, [Online]. Available: www.irjet.net*
*[13] S. Haque, Z. Eberhart, A. Bansal, and C. McMillan, "Semantic Similarity Metrics for Evaluating Source Code Summarization," in IEEE International Conference on Program Comprehension, IEEE Computer Society, 2022, pp. 36–47. doi: 10.1145/nnnnnnn.nnnnnnn.*
*[14] 2019 International Conference on Intelligent Computing and Control Systems (ICCS). IEEE.*
*[15] P. Biradar, S. Ansari, Y. Paradkar, and S. Lohiya, "Weather Prediction Using Data Mining," Internatio nal Journal of Engineering Development and Research, p. 211, 2017,*
*[Online]. Available: www.ijedr.org*
*[16] A. Joshi, B. Kamble, V. Joshi, K. Kajale, and N. Dhange, "Weather Forecasting and Climate Changing Using Data Mining Application," IJARCCE, pp. 19–21, Mar. 2015, doi: 10.17148/ijarcce.2015.4305.*
*[17] S. Poornima and M. Pushpalatha, "Prediction of rainfall using intensified LSTM based recurrent Neural Network with Weighted Linear Units," Atmosphere (Basel), vol. 10, no. 11, Nov. 2019, doi: 10.3390/atmos10110668.*
*[18] E. Salcedo Aliaga, "Automatic system for rainfall monitoring and prediction with IoT and Machine Learning."*
*[19] J. Mohan, A. Gupta, Jaypee Institute of Information Technology University, Institute of Electrical and Electronics Engineers. Uttar Pradesh Section. SP/CS Joint Chapter, and Institute of Electrical and Electronics Engineers, 2019 International Conference on Signal Processing and Communication (ICSC) : 07-09 March 2019, Jaypee Institute of Information Technology, NOIDA.*
*[20] Z. Q. Huang, Y. C. Chen, and C. Y. Wen, "Real-time weather monitoring and prediction using city buses and machine learning," Sensors (Switzerland), vol. 20, no. 18, pp. 1–21, 2020, doi: 10.3390/s20185173.*
*[21] K. Zhou, Y. Zheng, B. Li, W. Dong, and X. Zhang, "Forecasting Different Types of Convective Weather: A Deep Learning Approach," Journal of Meteorological Research, vol. 33, no. 5, pp. 797–809, Oct. 2019, doi: 10.1007/s13351-019-8162-6.*

*[22] Manipal University Jaipur. School of Computing and Information Technology and Institute of Electrical and Electronics Engineers, 2019 2nd International Conference on Intelligent Communication and Computational Techniques (ICCT) : Manipal University, Jaipur, Sep. 28-29, 2019.*
*[23] "Accuracy, Precision, Recall or F1? | by Koo Ping Shung | Towards Data Science." Accessed: Jan. 16, 2024. [Online]. Available: https://towardsdatascience.com/accuracy precision-recall-or-f1-331fb37c5cb9*
*[24] "What is F-score | Deepchecks." Accessed: Jan. 16, 2024. [Online]. Available: https://deepchecks.com/glossary/f-score/*

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