

# EMERGING TRENDS IN MACHINE LEARNING, DATA SCIENCE, AND INTERNET OF THINGS

**PART 1**

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**Bentham Books**

# **Emerging Trends in Machine Learning 'Data Science, and Internet of Things**

***(Part 1)***

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**Emerging Trends in Machine Learning, Data Science, and Internet of Things  
(Part 1)**

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ISBN (Online): 979-8-89881-471-7

ISBN (Print): 979-8-89881-472-4

ISBN (Paperback): 979-8-89881-473-1

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First published in 2026.

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## FOREWORD

The remarkable progress of artificial intelligence over the past decade has been driven not only by advances in algorithms, but by the creative application of these techniques to meaningful real-world problems. This volume is a compelling reflection of that progress. It brings together diverse research contributions that demonstrate how machine learning, data science, and intelligent systems are reshaping healthcare, security, automation, and human–computer interaction.

The chapters in this book highlight the expanding influence of deep learning and data-driven methodologies. From skin lesion classification and epileptic abnormality recognition to cancer gene detection and bacterial colony analysis, the healthcare-focused studies illustrate the profound societal impact that intelligent models can deliver. Equally noteworthy are the works on sentiment analysis, optimization strategies, and automated grading systems, which demonstrate the growing sophistication of computational approaches in understanding human language and behavior.

The inclusion of research on early-stage fire detection, AI-powered anomaly detection for cyber security, and conflict resolution in self-driving vehicles underscores the importance of reliable and trustworthy AI systems. These contributions reflect a strong awareness of the need for robustness, safety, and privacy in modern technological ecosystems. The chapters on IoT-enabled cloud security further emphasize that intelligent systems must be both innovative and secure.

What distinguishes this volume is its balanced integration of theory and application. The contributors not only explore advanced computational models but also present practical implementations that address pressing global challenges. Such interdisciplinary engagement is essential for the continued evolution of artificial intelligence.

I commend the editors and authors for assembling a work that captures the dynamic spirit of contemporary research in intelligent computing. This book will serve as a valuable resource for researchers, practitioners, and students seeking to contribute to the next generation of AI-driven solutions.

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## Preface

The unprecedented growth of intelligent computing technologies has opened new avenues for research, innovation, and societal transformation. The integration of Machine Learning, Data Science, Artificial Intelligence, Internet of Things, and Cloud Computing is redefining the landscape of modern technological development. This book is the result of collective scholarly efforts to present recent research advancements and practical applications in these rapidly evolving domains.

The primary objective of this volume is to provide a comprehensive platform for researchers, academicians, industry experts, and students to explore innovative methodologies and solutions addressing contemporary challenges. The chapters included in this book reflect diverse research perspectives and demonstrate how intelligent systems can enhance healthcare, security, automation, and human–computer interaction.

The Machine Learning section presents research contributions focusing on healthcare diagnosis, biological data analysis, sentiment analysis, sustainable food management, and gesture-based virtual interfaces. These chapters highlight the effectiveness of advanced computational models in addressing complex real-world problems and improving decision-making processes.

The Data Science section emphasizes the importance of data-driven methodologies in improving automated assessment systems, enabling cloud-based healthcare services, and strengthening network security through advanced artificial intelligence techniques. These contributions demonstrate the significant role of data analytics in building efficient and reliable digital infrastructures.

The Internet of Things section focuses on emerging challenges in autonomous systems and secure cloud communication. The research presented in this section addresses conflict resolution in self-driving vehicles and privacy-preserving frameworks for IoT-enabled cloud environments, emphasizing the need for secure, reliable, interconnected systems.

The editors sincerely acknowledge the valuable contributions of all authors who have shared their research work and insights in this volume. We also extend our gratitude to the reviewers for their constructive suggestions, which have helped maintain the academic quality and relevance of this book. Special appreciation is extended to the organizing team and supporting institutions for their continuous encouragement and assistance throughout the compilation process.

It is our sincere hope that this book will serve as a valuable reference for readers, inspire future research endeavors, and promote innovation in intelligent computing technologies. We believe that the ideas and methodologies presented in this volume will contribute to academic excellence and technological progress.

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# Summary of the Chapters

## Section 1: Machine Learning

### Chapter 1: Skin Lesion Classification Using Data Efficient Image Transformer

This chapter presents a deep learning framework using data-efficient image transformer architectures for accurate skin lesion classification. It focuses on improving diagnostic performance with limited datasets, aiming to support early detection of skin diseases.

### Chapter 2: Neurological Tests for Human Epileptic Abnormality Recognition

The chapter explores machine learning techniques applied to neurological test data for identifying epileptic abnormalities. It highlights feature extraction methods and classification models designed to enhance diagnostic reliability.

### Chapter 3: From Tweets to Insights: A Diverse Classifier Approach to Analyze Sentiments on Twitter

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### **Chapter 12: Enhancing Network Security through AI-powered Anomaly Detection Using GANs**

This study applies Generative Adversarial Networks (GANs) for detecting anomalies in network traffic, strengthening cybersecurity frameworks.

### **Section 3: Internet of Things**

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The final chapter proposes secure IoT-enabled cloud frameworks that ensure privacy protection and secure data transmission in interconnected systems.

## **Section 1: Machine Learning**

## CHAPTER 1

# Skin Lesion Classification Using Data-Efficient Image Transformer

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**Abstract:** Skin cancer, especially melanoma, is the most common cancer globally and in the United States. About 10% of melanoma cases have a family history. In 2023, an estimated 97,610 new melanoma cases are expected in the US, with 58,120 affecting males and 39,490 affecting females. To enhance diagnostic accuracy, the DeiT (Data-Efficient Image Transformer) model was applied to the ISIC 2019 dataset, which comprises a diverse range of skin lesion images. Our Transformer model outperformed traditional CNN models, achieving a precision of 94%, a recall of 95%, and an accuracy of 93%, surpassing models such as EfficientNet and DenseNet169. This superior performance is attributed to the DeiT model's ability to capture complex image patterns efficiently. Its success indicates that Transformer-based models hold significant promise for improving skin cancer diagnosis, leading to earlier detection and better patient outcomes.

**Keywords:** DeiT, Melanoma, Skin Cancer, United States, Worldwide.

## INTRODUCTION

The abnormal growth of skin cells, known as skin cancer, usually appears on skin that is regularly exposed to the sun. That being said, it's essential to remember that this common type of cancer can also develop in areas of the skin that are not typically exposed to sunlight. People of any skin tone can be affected by melanoma [1].

Melanoma frequently appears on the palms, soles, or under fingernails or toenails in those with darker skin tones [2]. With an expected 1.5 million new cases reported in 2022, skin malignancies are the most common group of tumours diagnosed globally. More specifically, the disease was blamed for almost 60,000 deaths in the same year that 330,000 new cases of melanoma were reported globally [3]. Generally speaking, machine learning-enabled early detection can

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improve therapy efficacy and yield better results. The accurate classification of skin lesions by an AI-generated tool has the potential to transform dermatological diagnostics by facilitating the timely and accurate diagnosis of potential cancers. This development enhances patient outcomes and reduces the strain on healthcare systems by enabling early detection and optimizing treatment pathways. To train and assess our classification model, we utilized the ISIC 2019 skin lesion dataset, specifically the SIIM-ISIC Melanoma Classification Challenge on Kaggle [4]. We were able to create and verify a reliable AI-based system for melanoma [5] identification because of the wide variety of skin lesion photos tagged with diagnostic annotations that this competition made available.

In this work, we report our experiments using the ISIC 2019 Kaggle competition dataset, the most extensive publicly accessible collection of high-quality dermoscopy images of skin lesions. We propose training and assessing this dataset using the DeiT (Data-Efficient Image Transformer) model [6]. Specifically, we suggest applying the DeiT transformer-based architecture to categorize skin lesions, leveraging its effectiveness with sparse data [7]. We demonstrate that the DeiT model performs well for medical imaging tasks, despite the comparatively limited number of medical datasets available. Additionally, we conduct a comparative analysis, evaluating the DeiT model's performance against well-known topologies, including the networks DenseNet [8] and EfficientNet [9]. Through our experiments, we aim to elucidate the advantages of utilizing transformer-based models, such as DeiT, in medical image analysis, particularly for tasks involving skin lesion classification.

## **MAIN CONTRIBUTION OF THE STUDY**

This study makes the following key contributions:

- **Transformer-Based Innovation in Medical Imaging:** This demonstrates the application of the Data-Efficient Image Transformer (DeiT) model, initially developed for natural language processing, to classify skin lesions using dermoscopic images, showcasing its viability in medical image classification.
- **Superior Performance with Limited Data:** The DeiT model, trained on a relatively small augmented dataset of 1,200 images from eight skin lesion classes, significantly outperformed conventional CNN models such as DenseNet169 and EfficientNet, achieving 93–95% across all key performance metrics (precision, recall, F1-score, accuracy).
- **Model Comparison and Benchmarking:** A comprehensive evaluation was conducted using uniform metrics and datasets, demonstrating DeiT's superiority over traditional models in handling the high intra-class variability and complexity of skin lesion images.

- **Resource-Efficient Implementation:** The study highlights the computational efficiency of the DeiT model, making it suitable for use in low-resource medical settings, including mobile or edge-device-based diagnostic systems.
- **Clinical Relevance:** The model's strong multi-class classification performance, particularly for malignant melanoma, demonstrates promise for early and accurate skin cancer diagnosis, potentially aiding dermatologists in making real-time clinical decisions.

## LITERATURE REVIEW

Deep Convolutional Neural Networks (CNNs) dominate in medical diagnostics, particularly in image classification. They outperform in dermal lesion diagnosis through feature extraction. Research reveals high accuracy in distinguishing malignant and benign lesions with CNNs. For instance, a model with a CNN achieved an AUC of 0.87, a recall of 0.73, a precision of 0.76, and an F1-score of 0.74, demonstrating the efficacy of deep learning in melanoma diagnostics [10]. Medical imaging algorithms apply transfer learning with fewer labels. Massive datasets such as ImageNet enable algorithms for specific medical operations to fine-tune them. In a study, a two-step transfer learning model with a CNN increased accuracy by 20%, with mean recall, specificity, and accuracy at 0.81, 0.88, and 0.86, respectively, for diagnosing cancer [11]. One significant challenge in medical image classification is the limited number of labels. Methods such as rotation, flipping, contrast adjustment, and scaling enhance datasets and improve generalizability. Research reveals that augmented datasets have increased accuracy and less overfitting. In one study, augmentation increased AUC (89.2% vs. 87.4%), AP (73.9% vs. 71.5%), and accuracy (89.0% vs. 87.2%) compared to non-augmentation. Additionally, in another study, augmentation was found to reduce overfitting in medical image analysis [12].

Moreover, each machine learning technique evaluated in this work contributes to specific phases of the skin lesion classification pipeline. For example, DenseNet emphasizes feature reuse and gradient flow during training, enabling improved feature extraction and optimization, especially on limited medical datasets. EfficientNet incorporates compound scaling to balance depth, width, and resolution, making it particularly well-suited for classification under constrained computational resources. DeiT, leveraging the transformer architecture, is adept at capturing global image dependencies and is highly efficient in handling sparse data scenarios common in medical imaging. These models are not only used for classification but also impact data preprocessing (*via* transfer learning requirements), performance tuning (through hyperparameter adjustments), and model evaluation (using precision, recall, and F1 score). Their selection and

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**CHAPTER 2**

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**Neurological Tests for Human Epileptic Anomaly Detection****Sandeep Kaur Gill<sup>1,\*</sup> and Anju Sharma<sup>1</sup>**<sup>1</sup> *Department of Computational Sciences, Maharaja Ranjit Singh Punjab Technical University, Bathinda, India*

**Abstract:** Recognition of a medical issue is a prerequisite for dealing with any health-related ailment. The execution of diagnostic tests is the first step taken by medical professionals to address the concern. As the nervous system is one of the major systems that control the functionality of a living body, abnormalities in the system lead to considerable medical disorders that must be recognized accurately and ultimately addressed appropriately. Epilepsy is one of the most common as well as complicated neurological disorders. Substantial effort is required to acknowledge the source of epileptic concern and treat it. As the patient with an epileptic disorder loses consciousness, detecting the occurrence of an epileptic fit and locating the source of the issue is the most challenging task in the process of treating the condition. The task of predicting the occurrence of an epileptic fit and identifying the root cause of concern is approached through various neurological tests. Several neurological tests, executed by medical professionals during the process of detecting, locating, and ultimately treating the debilitating syndrome of Epilepsy, are discussed in this paper. As research in the domain demands data, this paper presents an overview of datasets related to various neurological tests.

**Keywords:** Epilepsy, ECG, EEG, MRI, Seizure.

**INTRODUCTION**

The word 'epilepsy' originated from the Greek and Latin word 'epilepsia', which refers to a 'seizure'. Epilepsy is a chronic and non-communicable disease that leads to a sudden breakdown in consciousness, creating loss of sensation in the patient's body and altering their behavior for a moment. It is a group of recurrent neurological disorders in the form of 'seizures' caused by an abnormality in the electrical activity of the brain. As the brain is composed of billions of neurons that interact *via* dendrites in a synchronized manner, an abnormality arises when the

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synchronization is distorted. Epilepsy is the result of a process named 'epileptogenesis' that excites the neuronal network abruptly. It is a paroxysmal malfunction of neurophysiological activity discharge, leading to a surge of energy in the brain and varying levels of loss of consciousness and sensation. Since any non-neurological concern may also cause seizures, not all seizures contribute to Epilepsy. Though the symptoms of Non-Epileptic Seizures (NES) are pretty similar to those of epileptic seizures, both classes have different sets of causes. Non-epileptic seizures could occur due to several physiological conditions, such as brain infection, head injury, stroke, dementia, congenital disabilities, tumors, chemical imbalance in the blood, or psychological conditions. Such seizures are called Psychogenic Non-Epileptic Seizures (PNES), and the resulting Epilepsy is referred to as symptomatic or secondary Epilepsy. Several preventive measures should be adopted to address this concern. On the other side of the coin, epileptic seizures may lead to excessive or synchronous activity of neurons in the brain. The resulting Epilepsy is referred to as idiopathic or primary Epilepsy. Apart from the occurrence of seizures, Epilepsy leads to psychological effects and additional disorders such as depression, dementia, mental decline, fractures, sleep disorders, or sometimes unexpected death.

Epilepsy is one of the most common neurological disorders that can affect anyone, located anywhere across the globe, and at any time. Approximately 1% of the population suffers from Epilepsy [1]. As per the World Health Organization (WHO), the current count of epileptic patients is 50 million, and over time, the number of people affected by Epilepsy is increasing [2]. Approximately 5 million cases of Epilepsy are detected each year. However, the disorder can capture anyone irrespective of their age, gender, location, culture, or environment, as per the WHO 90% of the epileptic population is located in developing countries, with necessary treatment inaccessible to most of them. As per Fujiwara *et al.* [3], only 70% of epileptic patients can be treated *via* either medication or surgical treatment. Around 75% of epileptic patients can lead an everyday life if appropriately treated. Still, as per Media-center, 80–90% of personnel with Epilepsy in the Southeast Asian region do not get treated appropriately. Sudden onset is mainly observed during the border phases, specifically in early childhood or the geriatric phase of life.

A systematic review of QoS-aware load balancing techniques in Software-Defined Internet of Things (SD-IoT) networks is given by the authors of [4]. One benefit mentioned is the effective management of dynamic traffic flows, which enhances data delivery and reliability for time-sensitive applications, particularly those in the medical field, such as epilepsy monitoring systems. The incorporation of these processes into real-time health monitoring systems, where jitter and latency limitations are more crucial, is still lacking, though. For optimal task scheduling, the study [5] recommends integrating a hybrid Aquila–Whale Optimization Algorithm (AWOA) into SDN-based Fog-IoT networks. This

method offers benefits for situations involving critical decision systems, such as seizure prediction platforms, by significantly reducing processing time and job makespan. However, deployment validation in edge environments with high mobility conditions is lacking in this research, which is crucial for IoT use cases focused on health.

Using LSTM models to predict server usage patterns, the authors of a study [6] presented a novel server load-balancing architecture for the Software-Defined Internet of Multimedia Things (SD-IoMT). The primary benefit is its proactive resource allocation approach, which reduces energy consumption while maintaining excellent service quality, essential for real-time biological data processing, including EEG and ECG, in the diagnosis of Epilepsy. However, a significant drawback that restricts its applicability in real-world healthcare systems is its dependence on artificial workloads in simulation environments. A thorough analysis of the incorporation of AI into load balancing for Software-Defined Networks (SDNs) was provided by the method in [7]. One significant benefit is the application of clever strategies, including fuzzy logic and metaheuristics, to dynamically adapt to traffic variations, thereby improving responsiveness in systems such as automated neurodiagnostic services. The absence of empirical testing in systems with variable user demands and diverse traffic, such as customized e-health platforms, is the main research gap found.

The content is ordered as: Section 2 classifies the epileptic abnormality and describes the steps required to be executed to treat the epileptic concern; Section 3 describes the structural and functional neuro-imaging options utilized by neurologists to fetch the root cause of epileptic concern; Section 4 describes epilepsy datasets that are openly available and could be used by researchers in the domain; Section 5 discusses the future scope of computer vision in the task of automating the process of detecting and locating the root cause of epileptic abnormality.

## **MAIN CONTRIBUTION OF THE STUDY**

This chapter provides a comprehensive overview of the diagnostic landscape for Epilepsy, focusing on the physiological and neurological tests used to detect and localize epileptic abnormalities. The key contributions of this work are as follows:

- **Comprehensive Diagnostic Overview:** This chapter systematically reviews and classifies both structural and functional neuroimaging tests, including EEG, MEG, PET, CT, MRI, fMRI, DTI, and MRS, highlighting their roles in identifying the source of epileptic activity.

## CHAPTER 3

## From Tweets to Insights: A Diverse Classifier Approach to Analyze Sentiments on Twitter

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**Abstract:** This study delves into the realm of Twitter sentiment analysis, employing an array of machine learning algorithms. Through meticulous preprocessing of a substantial Twitter dataset, the research meticulously examines algorithmic performance. Results are elucidated through visual representations, revealing comparative efficacy, strengths, and limitations. This exploration significantly advances the comprehension of sentiment analysis within the context of social media, providing valuable insights for subsequent research and the refinement of methodologies in this dynamic domain. The study's findings contribute to the evolving discourse on sentiment analysis and its applications in the digital landscape.

**Keywords:** Comparative analysis, Feature selection, Machine learning algorithms, Twitter sentiment analysis, Text mining.

### INTRODUCTION

This research delves into the intriguing realm of Twitter sentiment analysis, utilizing a diverse array of machine learning algorithms to decipher the complex tapestry of emotions embedded in tweets. As the proposed work navigates through this exploration, it becomes apparent that sentiment analysis is not merely about deciphering text; it's about unraveling the pulse of a global digital conversation [1 - 5]. The significance lies in discerning not just what is said but how it resonates with the underlying sentiment. With the surge in social media usage, the ability to gauge public opinion on Twitter has become a valuable compass for businesses, policymakers, and researchers alike [6, 7]. From forecasting stock market movements to anticipating public reactions during crises, the ability to quantify sentiment in real time has opened new frontiers across multi-

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iple disciplines [8]. Our journey commences with a thorough examination of existing literature, revealing both the strides made and the gaps present in current Twitter sentiment analysis methodologies. Armed with this knowledge, the work embarks on a methodological odyssey, delving into the intricacies of machine learning algorithms. The selection and application of these algorithms are pivotal, demanding a balance between sophistication and practicality. Twitter, as a microblogging platform, presents unique challenges in terms of language nuances, brevity, and the ever-evolving lexicon of digital communication [9 - 11]. Emojis, hashtags, acronyms, and cultural slang often carry sentiment-laden meaning that can be lost in conventional text-based approaches. As such, advanced Natural Language Processing (NLP) techniques that incorporate contextual embedding and semantic analysis are increasingly vital. Addressing these challenges, our study meticulously preprocesses a substantial dataset, ensuring the integrity of the subsequent sentiment analysis. The algorithms deployed, ranging from classic models like Naive Bayes to more complex neural networks, are subjected to rigorous evaluation and testing. This research not only seeks to unravel the efficacy of various classification algorithms but also to contribute to the evolving discourse on sentiment analysis [12 - 14]. In a world where every tweet carries the potential to shape narratives, understanding the sentiment behind the words becomes not just an academic pursuit but a strategic imperative for navigating the vast sea of digital expressions on Twitter. In the ever-evolving landscape of social media, where trends shift at the speed of a tweet, the role of sentiment analysis becomes increasingly pivotal. Beyond deciphering positive, negative, or neutral tones, our research aims to tease out the contextual subtleties that define sentiment within the Twitter verse [15]. Context matters, and within the confines of 280 characters, users often wield an economy of words that demands a sophisticated understanding. This also means recognizing that the same word or emoji may carry different meanings depending on the user's intent, cultural background, or the topic of discussion—factors that static models often fail to grasp [16]. Moreover, the rise of generative AI tools and language models has introduced new possibilities for augmenting sentiment interpretation, especially in identifying sarcasm, irony, and implicit cues that traditional models often overlook. The work unravels the intricacies of sentiment, and the team also acknowledges the ethical considerations inherent in analyzing user-generated content. This includes not only compliance with data protection regulations but also cultivating responsible AI practices that ensure algorithmic transparency and fairness. Incorporating fairness-aware machine learning techniques, regular audits of model biases, and explainability frameworks are vital steps in ensuring that sentiment analysis tools remain ethical and accountable. Striking a balance between mining valuable insights and respecting user privacy is a delicate yet essential aspect of our inquiry [17 - 20]. This research not only seeks to enhance the technical foundations of sentiment analysis but also to contribute to the broader discourse on the ethical dimensions of studying sentiments in the digital age.

## LITERATURE REVIEW

In the expansive landscape of sentiment analysis on social media, particularly on Twitter, a substantial body of literature has been dedicated to understanding the

challenges and advancements in this dynamic field. Researchers have made significant strides in harnessing the wealth of user-generated content to effectively decipher sentiments and opinions. One seminal work laid the groundwork for sentiment analysis by introducing a classification framework that categorized sentiment analysis approaches into machine learning and lexicon-based methods. This exploration highlighted the need for robust methodologies to address the inherent complexities of sentiment conveyed in diverse language styles on platforms such as Twitter.

Subsequent studies have explored the nuances of sentiment analysis on microblogging platforms. Some works examined the impact of linguistic factors, such as emoticons and informal language, on sentiment classification accuracy, showing that incorporating these elements can significantly enhance classifier performance. The rapid evolution of sentiment analysis techniques has led to the integration of sophisticated machine learning algorithms. Several studies have investigated the use of Support Vector Machines (SVM) in this domain, emphasizing their ability to handle the nuanced nature of short and informal text typical of tweets.

The rise of deep learning has further transformed the field. Convolutional Neural Networks (CNNs) have demonstrated exceptional capabilities in capturing contextual cues and representing hierarchical relationships in text, making them well-suited for handling the compact and often ambiguous format of tweets. Transformer-based models, particularly those designed to consider both preceding and following context, have demonstrated a strong ability to understand sentiment at a deeper level. Applications of these models to health-related tweets, political discourse, and public opinion datasets have consistently revealed higher performance metrics compared to traditional methods.

An emerging area within the literature is multimodal sentiment analysis, which incorporates not only textual but also visual and auditory cues. On Twitter, where users often accompany their messages with images, memes, or video content, capturing sentiment from visual signals has proven valuable. Techniques that align visual and textual representations have helped in detecting subtleties, such as sarcasm or conflicting sentiments between text and image. Additionally, ensemble methods that combine multiple classifiers have gained popularity due to their enhanced ability to generalize across varied sentiment expressions. Some studies have proposed hybrid models that integrate deep neural networks with boosting-based classifiers to enhance sentiment detection, particularly in multilingual or code-mixed tweets prevalent in diverse user communities.

## Unveiling Optimization Algorithms for Finetuning of Sentiment Analysis

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**Abstract:** Sentiment analysis, a field within natural language processing, has become a focus of interest lately due to the rapid increase in content created by users on online platforms. Its main aim is to identify the sentiment or emotional tone conveyed in text. Within the modern e-commerce environment, online product reviews are essential tools for consumers who face numerous choices. Gleaning significant insights from these reviews is crucial, and sentiment analysis, a branch of Natural Language Processing (NLP), plays a vital role in interpreting and grasping consumer emotions. This document provides an in-depth examination of sentiment analysis techniques tailored explicitly to Amazon product reviews. With the rise of e-commerce, Amazon has become a key source of insightful consumer feedback, making it a prime subject for sentiment analysis studies. This analysis examines how sentiment analysis research has evolved in response to ongoing updates to Amazon's review platform, highlighting the importance of developing robust and adaptable models. By exploring a range of methods and strategies, this document aims to provide readers with a comprehensive understanding of the sophisticated models used in analyzing sentiments found in Amazon's extensive product feedback network.

**Keywords:** Amazon product reviews, Consumer feedback, E-commerce, Natural Language Processing (NLP), Sentiment analysis.

### INTRODUCTION

In the dynamic and expanding field of Natural Language Processing (NLP), sentiment analysis stands out as a critical discipline, enabling the deciphering of complex human emotions embedded in textual content. The scope of sentiment analysis encompasses various applications, including the evaluation of customer feedback, monitoring social media, conducting market research, and managing

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brand reputation. It involves deploying computational techniques and algorithms to analyze textual data, aiming to extract sentiment-related insights. Techniques from machine learning, deep learning, and NLP are integral to the construction of sentiment analysis models. These models undergo training on datasets annotated with sentiment scores, equipping them to identify patterns and correlations between textual elements and their associated emotions.

Particularly compelling within this sphere is the analysis of sentiments within Amazon product reviews. As a leading e-commerce platform, Amazon amasses a considerable volume of user-generated reviews, presenting a rich source for sentiment analysis. This comprehensive review explores sentiment analysis models specifically designed for the dynamic environment of Amazon's product feedback. In an era where e-commerce is reshaping consumer interactions, analysing sentiments in Amazon reviews not only enriches the domain of sentiment analysis but also bears significant implications for businesses. It provides them with a lens to gauge customer sentiment, pinpoint areas for improvement, and craft strategies centered on product development, marketing, and customer relations based on consumer feedback.

Deriving insights from sentiment analysis of Amazon reviews presents an invaluable opportunity for businesses to tap into customer satisfaction levels, identify areas for improvement, and make informed decisions based on customer perspectives. The pursuit of refining sentiment analysis models for e-commerce contexts, such as Amazon, involves continuous innovation and research. This investigation delves into the intricacies of sentiment analysis, highlighting its practical applications, the challenges encountered, and the progress made in adapting these models to fit the vast ecosystem of Amazon products.

This exploration highlights the evolution of sentiment analysis as a tool not only for academic inquiry but also as a practical instrument for businesses to navigate the complexities of customer sentiment in the digital marketplace. By analyzing customer reviews on platforms such as Amazon, businesses and researchers can gain profound insights into consumer behavior, preferences, and experiences. The ongoing advancements in sentiment analysis models tailored to e-commerce platforms promise to enhance our understanding of consumer sentiment, offering a more nuanced and actionable perspective that can inform business strategy, drive innovation, and improve customer satisfaction in the digital age. The significant contributions of this approach are:

- The incorporation of probabilistic segmentation enhances localization in complex and noisy medical images by introducing a probabilistic segmentation module specifically designed to detect liver tumor locations accurately.

- To improve classification performance, an ensemble approach incorporating multiple feature extraction methods was developed to capture a range of spatial and textural tumor properties.
- Weighted loss functions and data augmentation are two suggested techniques to successfully address class imbalance, a significant problem in datasets used for liver tumor diagnosis.
- The architecture was designed and refined to ensure low latency and high throughput, enabling real-time use in clinical diagnostic procedures.

## LITERATURE SURVEY

Sentiment analysis, also known as opinion mining, is a facet of Natural Language Processing (NLP) that utilizes computational techniques to identify and extract subjective sentiments and emotional tones from text. The foundational work highlighted in a study [1] offers a comprehensive overview of sentiment analysis and opinion mining, setting the stage for understanding the field's challenges and opportunities. A more recent survey [2] offers insights into sentiment analysis, specifically within the realm of social media, highlighting the evolving trends in this area.

The field has seen the development of various techniques, as detailed in Liu's extensive work [3], which covers a range of sentiment analysis methods, including those based on machine learning and natural language processing. This book delves into the techniques used to analyze opinions. Concurrently, a study [4] investigates emerging trends and new developments in sentiment analysis and opinion mining, reflecting the ongoing evolution of this discipline. In the context of e-commerce, sentiment analysis plays a pivotal role, with research [5] focusing on its application in deciphering customer feedback on platforms such as Amazon. This is crucial for understanding consumer sentiment. The authors of a study [6] introduced a multi-objective optimization model for traffic control in QoS-aware Software-Defined IoT systems. A key advantage is its ability to prioritize latency-sensitive tasks using dynamic flow scheduling, which aligns well with the computational demands of real-time sentiment classification models. However, the model does not incorporate sentiment-specific traffic patterns or contextual processing cues, which limits its performance in applications like emotional tone detection from user reviews.

Although the emphasis is often on visual data, a study [7] addresses the challenges associated with analyzing sentiments in textual Amazon reviews and discusses how sentiment analysis can improve recommendation systems. Another piece of research [8] examines review patterns, facilitating the identification of anomalies and unexpected expressions in user-generated content. The advent of

## Comparative Analysis of Bacterial Colony Counting (Detection, Quantification, and Clustering): YoloV8 vs Blob Identification

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**Abstract:** This study presents a comparative analysis of the YOLO v8 deep learning model and image processing techniques employing blob detectors for detecting colonies in microscopic images. The objective is to assess the effectiveness of every approach in precisely recognizing colonies in the photos. The study aims to identify the advantages and disadvantages of each strategy through experimentation and data analysis from both methods. Birch clustering is also applied to analyze the discovered particles further based on their sizes, providing insights into the colony clustering patterns. The results of this study provide important new insights for future colony identification research and advance our understanding of the capabilities of deep learning and conventional image processing techniques.

**Keywords:** Blob detection, Birch clustering, Image processing, YOLO v8.

### INTRODUCTION

In many scientific fields, microscopic image analysis is essential because it allows scientists to examine minute features at the cellular and molecular levels. The identification and examination of colonies—clusters of cells or microbes grown on a substrate—represent a fundamental challenge in this field. In disciplines such as microbiology, where it aids in pathogen identification, antibiotic susceptibility testing, and understanding of microbial behavior, accurate colony identification is crucial.

Conventional techniques for detecting colonies frequently rely on tedious manual inspection or simple image processing algorithms. However, the accuracy and efficiency of automated detection techniques have significantly improved with the

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introduction of deep learning, specifically Convolutional Neural Networks (CNNs). Among these, YOLO (You Only Look Once) v8 stands out for its real-time object detection capabilities and robust performance.

Parallel to this, conventional image processing methods, such as blob detection algorithms, provide a more straightforward yet efficient method for colony detection. These techniques are interpretable and versatile enough to be applied to various experimental configurations, as they often identify regions of interest based on geometric features or local intensity fluctuations. Even with their widespread use, their effectiveness can vary based on background clutter, colony morphology, and image quality, among other factors. To detect colonies in microscopic images, this study compares the effectiveness of YOLO v8 with blob detection techniques, examining the advantages and disadvantages of each approach under various conditions.

In addition to gaining further insights into the discovered colonies, Birch clustering is employed, a hierarchical clustering approach suitable for large datasets. The objective is to identify patterns in colony dispersion by grouping the detected particles according to their sizes. This approach can yield important insights into the dynamics of microbial growth and the spatial assembly of colonies. The understanding of colony behavior and its consequences in numerous scientific applications is enhanced by this thorough investigation, which also assesses the effectiveness of various detection techniques.

The study's conclusions will ultimately help practitioners and researchers select the most effective methods for colony identification and analysis in microscopic images, opening new avenues for breakthroughs in various sectors, including environmental science and biomedicine.

## **MAIN CONTRIBUTION OF THE STUDY**

This chapter presents a novel comparative framework that integrates both deep learning and traditional image processing techniques for bacterial colony detection and analysis in microscopic images. The main contributions of the study are as follows:

- A dual approach to colony detection is conducted, evaluating YOLOv8, a state-of-the-art object detection deep learning model, and OpenCV-based blob detection, to identify bacterial colonies under varying image conditions.
- Performance-Driven Analysis: The study contrasts these methods across multiple metrics, including precision, recall, accuracy, and robustness against

background complexity, providing critical insights into their suitability for different laboratory scenarios.

- **Integration of Birch Clustering:** By employing Birch clustering on the detected colonies, the study extends its scope beyond detection and quantification, exploring spatial and size-based distribution patterns that provide a deeper understanding of microbial growth dynamics.
- **Real-World Usability *via* GUI:** A custom-built GUI using the Tkinter library facilitates testing and visualization, enabling practical deployment and validation of the YOLOv8 model in real-time applications.
- **Comprehensive Dataset Development and Augmentation:** A well-structured dataset of microscopic colony images was curated and enhanced using augmentation strategies to improve model generalization and robustness.
- **Application-Oriented Implications:** The findings offer actionable recommendations for microbiologists and bioinformatics professionals to select the optimal detection methods, highlighting the trade-offs between speed, accuracy, and resource constraints.

## LITERATURE SURVEY

For both biological research and clinical diagnosis, determining the amount of bacteria in a sample is essential [1]. Bacterial colony enumeration is a technique used to analyze the outcomes of bacterial culture by counting the number of live bacteria present in the colonies. Bacterial colony enumeration is a labor-intensive and low-throughput procedure because hundreds or thousands of colonies can be present on a single Petri plate. Often, the counting process is performed manually by experts. It is an error-prone method to hand count because the findings are typically more subjective and require extensive practice, especially when a large number of colonies appear on the plate [2]. Consequently, it is crucial to have consistent standards.

Several systems utilized custom hardware and a MATLAB-based segmentation algorithm to automate the laborious process of manually counting bacterial colonies on agar plates. When the accuracy and functionality of the system were evaluated on plates containing various bacteria with known CFU levels, promising findings were found. While conventional methods, such as threshold segmentation, watershed, and wavelet transform, provide options for automatic recognition, they are not particularly effective in analyzing complex overlap scenarios and low-contrast images [3, 4].

The Feature Pyramid Network (FPN), an effective method for creating feature pyramids by utilizing the multi-scale hierarchy present in deep convolutional networks, was introduced in a few publications. FPN's usefulness is demonstrated

## Fire Detection at an Early Stage Using Deep Learning Through a Real-Time Video

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**Abstract:** The main goal of the research paper is to contribute to augmenting the efficiency level of camera-monitoring systems of security and surveillance through economically efficient vision-detection methods. It will especially focus on the early detection of fire-related accidents and mishaps, causing significant accidents. Moreover, the paper emphasizes the need for modern technologies in the system of fire detection, paying much attention to the complexity of the task because of factors like deformity, varying camera flexion, and variation in the environment. For these challenges, in this paper, a new approach to transfer learning using the convolutional neural network with dilated convolutions is proposed by employing the InceptionV3 model. From the results of the experiment on a dataset custom-built from fire images, the performance of the method proposed here is very efficient for generalization with new data and has a very low false alarm rate. It also presents the basic principles of fire detection systems involving control panels, fire detectors, and alarm output devices, and their use for prompt notice to the occupants and responding emergency organizations in the case of emergency fire events.

**Keywords:** Computer vision, Convolutional neural network, Deformity, Generalization, InceptionV3, Video monitoring.

### INTRODUCTION

It is appropriate for us to develop a program for fire detection systems. It already has fire protection programs that detect fire, activate alarms, and activate water sprinklers. But these are not available everywhere, so our program focuses on detecting the fire at an early stage and notifying the user about it, to prevent any accident. Smoke detection is a new technology that has gained popularity in residential areas and areas where there is a danger of fire. The devices are used to detect fire at early stages, using the human sense of smell through artificial intelligence, and they raise an Alarm notification. This is one important function to raise alarms and alert the user. This is called Digital Olfaction. A new tech-

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nique for fire detection is somewhat like capturing the fire and smoke-related pictures, analyzing them, and predicting the outcomes. There is a difficulty as smoke and fog in both images raise confusion in the system, and there might be some false alarms. Various algorithms must be studied to overcome this problem. Deep Learning and CNN techniques, with various other steps, make it easy to understand and do a valuable study of this problem with a comparison that can lead to good results. The success of our Fire and smoke early detection through camera depends on proper suppression and detection components, and a good algorithm comparison. As per the convention of an image analysis method, the process for detecting fire in images is based on convolutional neural networks. Our first model is a customized version of a basic convolutional Neural Network (CNN), taking inspiration from the AlexNet architecture and the other models by creating a customized InceptionV3 model. This detection system, using a convolutional neural network, works in a few steps. So, the model takes the image and applies image pre-processing and reduction. Then, the CNN with a focus on object detection in specific regions determines whether the fire appears or not in a selected area examined using a convolutional layer, pooling layer, connected layer, *etc.*

## MAIN CONTRIBUTION OF THE STUDY

This research presents a novel approach to real-time fire detection using deep learning methods with two custom CNN architectures. The key contributions of the study are:

- **Dual CNN Architecture Comparison:** The study evaluates and compares a customized AlexNet model and a modified InceptionV3 model for fire detection, demonstrating superior performance by the InceptionV3 architecture in terms of accuracy, generalization, and robustness.
- **Integration of Dilated Convolutions:** Dilated convolutions were applied to improve feature extraction, allowing the system to better capture subtle and fine-grained fire patterns across varying environments and video frames.
- **Efficient Alert System Implementation:** A full-stack, real-time notification system was developed that triggers alerts *via* SMS and email upon fire detection, enhancing responsiveness in emergency scenarios.
- **Layered Web-Based Architecture:** The fire detection system was designed using a modular three-layer architecture (Presentation, Business, and Service layers), improving usability, scalability, and maintainability.
- **Preprocessing and Augmentation for Generalization:** Robust preprocessing techniques (grayscale conversion, normalization, resizing) and augmentation strategies (rotation, flipping, shifting) were employed to enhance model training

and ensure adaptability to real-world visual noise.

- **Experimental Validation and Benchmarking:** Extensive experiments showed the proposed InceptionV3 model achieved 97.45% validation accuracy, outperforming both the AlexNet model and other referenced fire detection models like MobileNetV2.

## LITERATURE SURVEY

**Video Smoke Detection for Indoor Environment** by Cong Hoang *et al.* This paper proposes the use of surveillance cameras in detecting smoke in an indoor environment [1]. It applies optic flow to find the regions of motion between frames and deep neural networks for smoke identification. Simulated images of smoke have been used for dataset augmentation to overcome the lack of data quantity. The approach has been tested on synthetic and real video sequences and looks promising for the accurate detection of fire smoke.

**Detecting the Smoke in the Foggy Environment** by Mehmet Erdal Özbek *et al.* in 2021 [2]. This paper synthesizes a modern deep learning architecture created for the detection of smoke in the outdoor environment using surveillance video clip input congruently with the IoT implementation demand and carried out efficiency of the different color spaces, comparing accuracy and memory based on collected videos with the state-of-the-art and most popular DL architectures. This paper also suggests that an effective architecture be used to estimate the challenges facing the distinction of smoke from normal occurrences, such as fog. This work offers valuable insights for enhancing smoke detection in IoT applications.

**Multistage Fire Detection Making Use of CNN and LSTM** by Manh Dung Nguyen *et al.* [3] This paper presents a new, multistage method for fire detection by combining CNNs with LSTM networks. First, the fire candidates based on color, flickering frequency, and brightness are detected. Pretrained CNNs extract 2D features of flames as input to long short-term memory. Finally, a SoftMax classifier differentiates the true fires and non-alive moving objects. The experimental outcome shows competitive perimeter and proprietary assimilation to the SOTA technique for practical uses.

By Alireza Shamsoshoara. **Pile burn detection** in 2021 [4]. This paper describes the FLAME dataset, which contains annotated sequences of overhead imagery over fire sites captured with the aim of supporting fire management. It contains annotated video recordings and thermal heat maps of fires taken by drones. This study has two objectives: solving two machine learning problems, which include a binary fire presence classifier at 76% accuracy by ANN-based methods and fire detection with deep learning based on U-Net at 92% precision and 84% recall.

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**CHAPTER 7**

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# Enhancing Sustainable Practices in Food Management Using a Machine Learning Approach

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**Abstract:** This paper presents *Smart Eat*, an intelligent Mess Management System designed to improve food management practices in college environments through the use of machine learning. The system prioritizes user preferences by employing collaborative filtering algorithms to generate personalized menu recommendations, thereby enhancing the dining experience for students. By leveraging real-time data, the system enables food service managers to dynamically adjust menus based on attendance patterns and customer feedback, thereby reducing food waste and improving resource efficiency. The application integrates Firebase, Android Studio, and Flutter to ensure seamless performance of both the backend and frontend, featuring a user-friendly interface for both customers and business owners. Business owners gain access to comprehensive data analytics and automated notifications, allowing them to make informed decisions about menu planning and customer engagement. A limited survey was conducted to assess the prototype's usability, which indicated high satisfaction levels in areas such as menu customization, feedback quality, and order placement speed. The system fosters sustainable practices while ensuring economic scalability and operational efficiency. Through *Smart Eat*, the paper demonstrates how data-driven decision-making and personalization can redefine the food service ecosystem around educational institutions and potentially scale to broader food management scenarios.

**Keywords:** Accuracy, Colleges, Eating, Economy of scale, Machine learning, Real-time, Smart.

## INTRODUCTION

In the rapidly evolving field of technology, *Smart Eat* aims to revolutionize food management in dormitories near college campuses. By applying cutting-edge machine learning methods, such as collaborative filtering, the program is a prime example of effectiveness and usability.

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Simplifying and improving the eating experience for both customers and employees is of utmost significance and forms the basis of the system. The technology provides customers with a personalized and fulfilling culinary experience by utilizing collaborative filtering to recommend new or popular menu items intelligently. Besides the outlined strengths, the tool not only assists managers in room service but also provides them with real-time data on dish selection and attendee numbers, resulting in increased output and supporting the food waste reduction target in general.

The role of the system is not merely functional. It is likely that in the future, food management around schools will become more ethical and increasingly focused on the use of technology. The said transition will be enabled through the provision of user needs, attendance tracking, and the involvement of all stakeholders in the design of the future menu. Additionally, an economic and resource-saving, energy-efficient clean production system will also be a result of this.

This paper explores the functionalities of the mess hall management system, unfolding its various layers one after the other. All segments are meticulously examined, beginning with the core of the collaborative filtering and machine learning processes used to personalize the menu according to individual tastes, and proceeding through the interactive part that influences both managers and consumers.

For instance, exploring the practicality of the system for its intended applications has the following benefits: It reduces food damage through attendance checks, allows mess managers to build a positive teamwork environment with their staff, and maintains an integrated notification system centered on the user. The user is informed of their status through attendance, and it leaves room for the manager to manage them more effectively. Furthermore, the system also describes user attendance.

This paper proposes a novel, scalable solution—**Smart Eat**—which integrates machine learning, real-time data processing, and user feedback to create an intelligent Mess Management System. The key contributions include: (1) leveraging collaborative filtering to personalize menu suggestions for students; (2) improving operational efficiency and reducing food waste through real-time attendance tracking and menu updates; (3) empowering mess owners with actionable insights for decision-making; and (4) validating system effectiveness through prototype testing and user feedback. This work lays a strong foundation for future advancements in sustainable and technology-driven food service systems.

## RELATED WORK

Examining the technical capabilities, usability, and implications of a Mess Management System integrated with machine learning presents a viable approach to enhancing the efficiency and user-friendliness of small business management. Therefore, the system must learn more about its customers naturally and easily. The number of references in the literature mentioned here is too numerous; we have sought them for an overall understanding of the technology's scope.

Indeed, the puzzle pieced together by Lu [1] showcases the design of a user-friendly phone application, labeled Mess Management, that is targeted at individual users with a certain level of technological proficiency, particularly small business owners. An additional central pillar of the case is the link between the Mess Management System and machine learning technologies, as reflected in the words of Benson and Kuar [2].

The algorithm used in the Mess Management System is easy to follow [3, 4]. The initial part involves the data downloading process, which takes into account past sales experience, food preferences, and customer input. Afterward, the algorithms are applied to the collected data to identify the most preferred items, enabling the chef to adjust the menu and thereby enhance customer satisfaction [4].

The application's owner communicates with the app through the user-friendly interface and is the first to know about the latest live reconfigurations and menu suggestions [5]. The system will also enable the restaurant owner to make changes to the menu by following the provided suggestions or in light of personal preferences [6]. The implementation of the real-time feedback system [7] is essential, as it keeps the app constantly updating its analysis, thereby preventing future problems caused by changes in customer preferences.

In paper [8], the authors focused on matrix factorization. Matrix factorization is a technique used in recommender systems to decompose a user-item interaction matrix into lower-dimensional matrices, revealing latent factors that represent user preferences and item characteristics. This allows for more accurate recommendations by predicting how users might interact with items they haven't previously encountered [8].

The authors in a study [9] present an innovative application of the Black Widow Optimization (BWO) meta-heuristic to the **M-connected coverage** problem in IoT networks, where each point in the monitored area must be covered and connected by at least  $M$  active sensor nodes. The algorithm enhances convergence speed and solution quality by eliminating poorly performing candidates early in the optimization process, and simulations also demonstrate that the BWO-based

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**CHAPTER 8**

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# Cancerous Gene Detection through Machine Learning Techniques

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**Abstract:** The rise in cancer cases worldwide, particularly in India, necessitates the development of quick and accurate diagnosis methods. A new initiative aims to utilize machine learning to enhance cancer gene detection, thereby saving time and reducing manual labor in conventional diagnostic procedures. The MERN stack tool and a machine learning algorithm are utilized to create a full-stack website that rapidly identifies probable malignant mutations. The approach combines Naive Bayes, Linear Regression, and Random Forest Classifier models for data processing and analysis. This cutting-edge strategy aims to revolutionize cancer diagnosis, enabling prompt and potentially life-saving therapies. This initiative represents a technological achievement and a crucial step towards reducing cancer prevalence. Additionally, our proposed model achieves an accuracy of 88 percent. The core contribution of this work lies in the integration of multiple machine learning algorithms into a unified, full-stack cancer gene detection system—capable of handling various cancer types, deployed in real-time *via* cloud infrastructure, and designed for practical clinical use through high performance, feature explanation ability, and accessibility.

**Keywords:** Cancer, Classification, Genes, Health system, Linear regression, Machine learning, Naive bayes, Random forest.

## INTRODUCTION

The long-lasting effects of cancer on people's health persist. Owing to its extensive impacts, new approaches to early identification and treatment are needed. The purpose of this research project is to provide a comprehensive overview of the vital role that machine learning plays in understanding the complex subject of cancer genetics. It seeks to highlight significant discoveries, intriguing directions, and noteworthy advancements in this area.

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## **Main Contribution of the Study**

This research presents a unified machine learning-based system for detecting cancer-causing genetic mutations, integrating Naive Bayes, Linear Regression, and Random Forest classifiers into a scalable diagnostic pipeline. The main contributions of this study are as follows:

- **Algorithmic Innovation:** Unlike prior works that rely on specific algorithms, such as MDP, PBN, or CSM, and are limited to individual cancer types, the proposed system employs a hybrid ML strategy that generalizes across multiple cancer forms using robust feature selection, preprocessing, and ensemble modeling.
- **Real-Time Full-Stack Deployment:** The model is deployed using a MERN stack integrated with a RESTful API and AWS cloud infrastructure, enabling real-time predictions and broad accessibility for clinical and research use.
- **Performance Superiority:** Achieves 88% classification accuracy, outperforming other models in precision, recall, and F1-score on benchmark datasets, as detailed in the comparative analysis section.
- **Explainability and Feature Importance:** The system incorporates visualization and interpretability modules, utilizing feature importance and confusion matrices, to help medical professionals understand the results.
- **Practical Usability:** Enhanced by user-friendly interfaces and chatbot integration, the system provides a clinician-centric experience designed to streamline early cancer diagnosis.

## **Background and Context**

Cancer is a deadly illness that causes abnormal cells to proliferate uncontrollably, damaging bodily structures. It can begin anywhere in the human body and can be caused by changes or mutations in genes responsible for cell functioning, particularly growth and division. Errors can cause genetic alterations during cell division, exposure to toxic compounds in tobacco smoke, UV radiation from the sun, and the inheritance of genetic material from one's parents. The three distinct classes of genes that result in cancer mutations are referred to as “driver” genes, tumor suppressor genes, and proto-oncogenes.

Proto-oncogenes are the genes that mediate normal cell development and division. On the other hand, cancer-causing genes are generated when these proto-oncogenes mutate or become hyperactive. Tumor suppressor genes control cell division and growth; however, when a particular mutation occurs, the cells may expand uncontrollably. DNA repair genes can repair damaged DNA, and cells with specific mutations or modifications may undergo further mutations that lead

to cancerous changes. Following a comprehensive analysis, researchers have identified a few gene changes that are common to all human malignancies.

## **RELATED WORK**

Finding gene pairs is prioritized over finding individual genes [1]. The objective is to utilize RNA-seq data to identify predictive gene pairs, even in the absence of individual gene information. The focus of the talk is on gene pairs rather than single genes because the latter are not as reliable as the former when it comes to acting as biomarkers.

MDP was selected as a method [2] because it typically achieves superior F1 and F0.5 scores when compared to other available methods. Even when considering Draw Rank, which outperforms other methods, MDP still demonstrates significantly higher precision. The machine learning technique for gene expression is the most popular method for comparing gene expression between benign and malignant conditions [3]. Machine learning models currently being developed are evaluated using gene expression data from the highlighted datasets. Genes are isolated under different cell conditions using the Common Subcluster Mining (CSM) algorithm [4]. In essence, it separates the genes that exhibit stability under normal circumstances. The algorithm's primary job is to identify the gene that, in a diseased state, has a significantly altered pattern. The datasets about leukemia, breast cancer, and lung cancer are tested using this model.

The design and development of a diagnostic system that will aid in predicting P53 mutations [5] responsible for causing cancer, utilizing biopsy images for analysis, along with pharmacogenomic analysis that incorporates epigenetics and expression analysis. The authors of the paper [6] describe the Probabilistic Boolean Network (PBN) model, which is applied here with some information regarding tumor and non-tumor cells, supporting the evaluation.

The use of data complexity in the analysis of microarray gene expression to select genes is discussed in the work [7]. Metrics of data complexity, such as attribute efficiency and Fisher discriminant ratio, are combined to rank the genes. Then, the genes that are more highly ranked are considered significant and are involved in the process of cancer detection.

Within the framework of information theory, a paper [8] described a fairly straightforward yet effective algorithm for gene selection. This method utilizes a subset to target correlation, significantly reducing the number of unusable features, and it makes no parameter considerations throughout the selection process. Additionally, it serves as an effective filter that doesn't require a classifier because it is based on a subset selection method. The integration of 781

## Virtual Mouse Using Hand Gestures

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**Abstract:** Cursor movement simplifies the user interaction with the system; it is a motive and visible pointer that is controlled by the user by using hardware (*i.e.*, mouse and touchpad) to interact with the system. This technology can be simplified by using hand gestures instead of a physical device to manipulate the cursor. It can be useful to make the user experience simple and systematic. Cursor movement by hand gesture can be provided as an energy and time-efficient technology where the user interacts with the software by using gesture recognition. The gestures that manipulate the screen first will be stored in the system database. Then the hand present in front of the device will be recognized and stored as an object in the system, and then the gestures performed in front of the system with the hand will be matched with the gesture present in the memory of the system, which will lead to cursor operations and movements. This technology will be helpful to operate a system from a distance according to the user's ease and without using a hardware component. This technology can be applied in all the sectors where there is a need for a Computer System, as it is an adaptable technology for users of any age and field.

**Keywords:** Cursor, Database, Hand gestures, Movement, Recognition.

### INTRODUCTION

In the realm of digital interaction, the project at hand delves into the rich tapestry of human communication, drawing inspiration from the innate gestures we use to convey our thoughts and feelings. This initiative seeks to transcend the conventional boundaries of human-computer interaction by integrating the fluidity and expressiveness of hand gestures into the control mechanisms of computer cursors. Envisioned to redefine the ergonomics of digital navigation, this system aims to recognize and interpret hand movements with precision, thereby allowing users to manipulate the cursor through natural motions. This endeavor not only commits to making the user experience simple and efficient but also makes it mo-

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re intuitive and engaging. It also addresses the ergonomic challenges associated with prolonged use of traditional input devices. By marrying the simplicity of gestures with advanced recognition technologies, we aim to forge a more harmonious and accessible interface between humans and their digital counterparts, ultimately enhancing the way we interact with technology in our daily lives.

## **MAIN CONTRIBUTION OF THE PAPER**

The primary contribution of this paper lies in the design and implementation of a virtual mouse system controlled entirely by hand gestures, utilizing computer vision and machine learning technologies such as OpenCV, MediaPipe, and Autopy. Key contributions include:

- **Hardware-Free Cursor Control:** Replacing traditional mouse hardware with intuitive hand gesture recognition for cursor movement and actions (click, drag, hold).
- **Real-Time Gesture Tracking:** Implementation of fingertip coordinate mapping and gesture classification to perform real-time mouse operations.
- **Improved Interaction Accuracy:** Efficient gesture-to-action mapping and use of lightweight, cross-platform Python libraries for enhanced responsiveness.
- **Accessibility and Usability:** Demonstrates potential for aiding physically challenged users or use in remote-control applications (*e.g.*, smart TVs).
- **Comparative Advantage:** The system improves upon previous models by integrating additional functionalities like drag-and-drop, hold, and more accurate gesture detection without requiring color-based recognition or complex hardware.

## **LITERATURE REVIEW**

This collection of research papers explores various approaches to enhancing human-computer interaction, primarily focusing on hand gesture recognition and virtual mouse control. The research leverages technologies such as machine learning, computer vision, and image processing to create intuitive and efficient interfaces. For instance, a study [1] introduces a real-time gesture recognition method using a web camera and the AdaBoost algorithm, which enhances mouse operation precision through a cascaded classifier. Similarly, another study [2] employs Sixth Sense technology with image processing and random forests to improve mobility and accessibility. Advanced methods like Kalman filters are explored in another study [3] to enhance cursor control accuracy for individuals with tetraplegia, improving decoding and direct control. Accessibility remains a key theme, with a study [4] integrating gesture and voice recognition *via* infrared sensors to cater to users with special needs, ensuring cost-effective and versatile

solutions. Research [5] highlights the potential of virtual interfaces using image processing and color detection, offering wireless and portable interaction. The innovative approach in a study [6] utilizes colored fingertips and area ratio analysis to provide natural and dynamic cursor control. Similarly, another study [7] leverages Kinect sensors for stable and multi-user hand gesture interaction. Studies [8, 9] apply OpenCV and machine learning to enhance virtual clicking and cursor movement, emphasizing accessibility and improved control. The future of natural user interfaces is explored in a study [10], where machine learning and GUI automation enhance digital well-being and functionality.

Research [11, 12] demonstrates how gesture recognition *via* color detection and machine learning can provide cost-effective and intuitive control solutions. Hand tracking *via* OpenCV in a study [13] and handwriting recognition using CNN in another study [14] offer innovative, simplified, and efficient setups for gesture-based interaction. A study addresses practical hardware challenges by proposing gesture-based solutions for web service discovery. Artificial intelligence and MediaPipe are utilized in another study [16] to create user-friendly and flexible cursor control. Research [17] incorporates eye-tracking and speech recognition to enable wireless and natural interaction. Similarly, another study [18] integrates PyAutoGUI and OpenCV for real-time, responsive cursor control. Studies [19, 20] focus on human-machine interaction, employing finger tracking and Vision Transformers to ensure high classification accuracy and cost-effective solutions. Collectively, these studies underscore significant advancements in leveraging gesture recognition, computer vision, and artificial intelligence to create accessible, efficient, and natural human-computer interaction systems.

The reviewed literature applies machine learning techniques across several stages of gesture-based interaction systems. In most cases, ML models such as AdaBoost, Random Forest, or CNNs are used for feature extraction and gesture classification. Preprocessing typically involves frame segmentation and hand landmark detection through computer vision tools like OpenCV and MediaPipe. Feature extraction focuses on tracking key points—like fingertip or joint coordinates—which are then mapped to gesture labels using classification algorithms. Some studies also incorporate filtering methods (*e.g.*, Kalman filters) for smoother cursor control, while others apply ensemble techniques to improve prediction stability. These processes collectively inform the modular design of our proposed system, which integrates gesture detection, classification, and system control in a real-time, hardware-free environment.

## **Section 2: Data Science**

# Improving Automated Grading Systems: A Comparison Of Machine Learning Techniques For Recognising Handwritten Digits

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**Abstract:** The paper focuses on handwritten digit detection using the MNIST 0-9 dataset to develop an automated grading system. Four distinct machine learning models are employed: basic and latest Neural Network Models, such as Multi-Layer Perceptron (MLP) and Convolutional Neural Network (CNN), as well as traditional models like K-Nearest Neighbors (KNN) and Gradient Boosting (XGBoost). The objective is to accurately identify handwritten digits, which is crucial for grading purposes. By evaluating the models' performance metrics, the aim is to determine the most suitable model for efficient digit detection. The ultimate goal is to streamline the grading process, ensuring timely result declaration while maintaining proper record maintenance.

**Keywords:** CNN, Handwritten digit detection, KNN, MLP, MNIST, Performance metrics, Xgboost.

## INTRODUCTION

Handwritten digit detection is pivotal in automated systems, particularly in grading and assessment. The advent of machine learning and advancements in computer vision have made the development of accurate and efficient algorithms for digit recognition increasingly feasible. This project leverages these techniques to develop an automated grading system capable of accurately identifying handwritten digits using the MNIST database. The field of handwritten digit recognition has seen significant advancements, with researchers proposing novel methods and architectures to improve accuracy and efficiency. Additionally, the

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use of absolute activation functions [1] in enhancing neural networks has also been explored. This study introduces the use of an absolute value-based activation function in place of traditional ReLU or sigmoid functions, aiming to improve training stability and classification accuracy. However, the work primarily focuses on the MNIST dataset and the LeNet-5 architecture, limiting the generalizability of its findings.

Meanwhile, some studies [2] employ fusion neural networks (FNN), which combine multiple neural architectures—such as CNNs and RNNs—into a unified framework to enhance both text detection and recognition accuracy, particularly in complex scene images. A simple convolutional neural network approach [3, 4] has also been introduced, emphasizing a lightweight and interpretable architecture for handwritten digit recognition, making it accessible for educational and low-resource deployment scenarios. Additionally, a new framework for feature generators [5] has been proposed, focusing on optimizing feature extraction layers to improve recognition rates without significantly increasing model complexity.

This research work explores the effectiveness of four distinct machine learning models: Multi-Layer Perceptron (MLP), K-Nearest Neighbors (KNN), Convolutional Neural Network (CNN), and Gradient Boosting (XGBoost). These models represent both neural network-based approaches and traditional machine learning techniques. The primary objective is to assess each model's capability in accurately identifying handwritten digits, particularly those critical for grading purposes. These works collectively contribute to the ongoing advancements in the field, each offering unique insights and methodologies. This research contributes to these advancements by identifying the most effective model for digit detection in grading systems, thereby enhancing the efficiency and accuracy of such systems. The rest of the paper is laid out as follows: Section 2 elucidates the literature review, Section 3 presents the proposed model, and Section 4 describes the simulated results and discussions. The conclusion and elaboration on the use of grading systems (future work) are presented in Section 5.

## **LITERATURE SURVEY**

Various methodologies and algorithms are being proposed and tested for their efficacy and accuracy in handwritten digit recognition.

Castellano and Sandler [6] developed a handwritten digit recognition system combining the Hough transform and a neural network. Processing 128x128 images, it utilizes nonuniform sampling for input vector reduction, ensuring translation and scale invariance. Achieving an 80% recognition rate on 720 samples highlights the potential for improved architecture exploration beyond Kohonen's self-organizing feature map. Van der Zwaag [7] demonstrated a

handwritten digit recognition project using Kohonen's self-organizing feature map neural network for educational purposes. While achieving a 98% recognition rate, its focus was on education rather than competing with state-of-the-art systems, potentially limiting direct comparison and generalizability.

Mane and Ragha [8] introduced a novel method for handwritten digit recognition, employing Elastic image Matching (EM) to address variability in digit shapes. Their approach focuses on feature extraction and recognition, utilizing operations like filtering and segmentation. Despite its promise, inherent variability in digit shapes poses challenges to recognition accuracy. Ali and Ghani [9] investigated handwritten digit recognition using Discrete Cosine Transform (2D-DCT) features and Hidden Markov Models (HMMs) as classifiers, addressing variation in writing styles. Despite challenges posed by diverse styles, their method achieved promising results, suggesting potential for enhancing recognition performance through transformation-based features and HMMs.

Dubey *et al.* [10] presented a handwritten digit recognition method utilizing Convolutional Neural Networks (CNNs) and image preprocessing techniques, including binarization, resizing, and rotation, achieving a notable accuracy rate of 99.33%. Their approach highlights the importance of preprocessing in enhancing recognition accuracy, demonstrating the effectiveness of CNNs. Patil and Kaur [11] explored handwritten digit recognition using a diverse set of machine learning algorithms, including SVM, CNN, quantum computing-based models, KNN, and deep learning. Their key innovation lies in comparing classical and emerging techniques, particularly the integration of quantum computing models for classification tasks, highlighting the potential for quantum-enhanced speed and efficiency. Despite the inherent challenges posed by handwriting variations and digit similarities, their multi-model approach demonstrates improved recognition accuracy and computational efficiency by leveraging the strengths of each algorithm. Gao and Benbo [12] introduced a handwritten digit recognition method using SVM classification, achieving a commendable recognition rate of 96.3%. Extracting key features, such as the Euler number and moment features, the approach faces challenges in handling handwriting variability and distortions, necessitating further optimization for robust recognition systems.

Shamim *et al.* [13] proposed an offline handwritten digit recognition approach that employs various machine learning techniques, including multi-layer perceptrons and support vector machines. They aimed to enhance recognition for applications such as postal sorting and bank check processing, achieving 90.37% accuracy with a Multi-layer Perceptron. Singh *et al.* [14] address handwritten digit recognition challenges using classification algorithms such as SVM, KNN, RFC, and CNN. Variations in digits' size, thickness, and direction pose recognition

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**CHAPTER 11**

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**Implementation of Cloud-Based Healthcare System****Arsh Swami<sup>1,\*</sup> and Himanshu Gupta<sup>1</sup>**<sup>1</sup> *Department of Information Technology, Amity Institute of Information Technology, Noida, Uttar Pradesh, India*

**Abstract:** The incorporation of cloud-based systems is a novel use of Information Technology (IT) in the modern healthcare environment. To understand the far-reaching consequences of cloud computing adoption on data management, collaboration, and ultimately, patient care, this paper examines the profound implications of this practice. Cloud-based systems emerge as a promising way to overcome traditional limitations as the demand for effective and accessible healthcare solutions grows. They offer scalable, affordable, and interoperable solutions that have the potential to completely change the way healthcare information is stored, accessed, and used. In light of this, the article aims to provide a comprehensive analysis of the existing research, examine real-world case studies, and incorporate insights from medical experts to present a complete picture of the benefits and challenges of cloud-based healthcare systems. Through an exploration of specific use cases, including Electronic Health Records (EHR), telemedicine, and data analytics, the study aims to clarify how cloud computing might revolutionise healthcare delivery and influence the industry in the future.

**Keywords:** AI, Cloud-based, Machine learning, Object detection, Visually impaired.

**INTRODUCTION**

The healthcare sector, which is a dynamic ecosystem, has reached a new phase in which the integration of IT applications has come to represent efficiency and advancement. One prominent example of this paradigm shift is the growing adoption of cloud-based healthcare systems. Healthcare organisations are facing significant issues related to data management, accessibility, and stakeholder cooperation. One emerging trend that might revolutionise healthcare delivery is the incorporation of cloud computing. This integration is significant because it can alleviate long-standing problems that the healthcare industry has been facing. Healthcare institutions have always struggled with data silos, poor communication, and restricted access to vital patient data. Cloud-based solutions

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offer an affordable, scalable, and interoperable platform for managing healthcare data, addressing these challenges effectively. To shed light on the cloud's multifaceted uses in healthcare and their implications for patient care, data security, and overall operational effectiveness, this study aims to explore these applications.

The digitization of health records is the essential component of this change. Cloud-based technologies allow Electronic Health Records (EHR), which were previously restricted by physical boundaries, to be easily managed, accessed, and updated. This move enables healthcare providers in various locations to collaborate securely, while also ensuring real-time access to patient data. The advent of telemedicine highlights the significance of cloud-based solutions by enabling remote monitoring, diagnosis, and consultations, thereby improving the accessibility and inclusiveness of healthcare services. Cloud-based solutions allow advanced data analytics and machine learning applications, which are becoming increasingly necessary as the healthcare industry demands insights derived from data. With the use of large datasets, healthcare organisations can now extract valuable insights that can be used to develop personalised treatment regimens, predictive models, and improve population health management. Cloud computing integration in healthcare is not without its difficulties, though.

To properly utilise cloud-based healthcare systems, concerns about data security, interoperability, and opposition to change must be carefully managed. This research undertakes a thorough investigation of the advantages and challenges associated with the deployment of cloud-based healthcare systems, considering these factors. Our goal is to present a comprehensive picture of how cloud computing is changing the healthcare sector by combining case studies, current literature, and expert views. The following sections examine specific applications, discuss their impact on patient care, and provide guidance for a successful rollout. This will lead the healthcare sector towards a future in which cloud-based solutions and IT applications come together to improve the quality of care that people receive worldwide.

This paper presents a comprehensive examination of the implementation of cloud-based healthcare systems, drawing on insights from the literature, real-world case studies, expert interviews, and system comparisons. Its primary contribution lies in identifying and analysing the transformative potential of cloud technologies in enhancing healthcare data accessibility, operational scalability, and patient care delivery. The study highlights how cloud-based platforms facilitate key applications, including Electronic Health Records (EHR), telemedicine, and advanced data analytics. It also uncovers the critical challenges facing healthcare institutions—particularly data security, interoperability with existing systems, and organizational resistance to change. The research presents a multidimensional framework for evaluating the deployment of cloud-based systems, offering

actionable insights into key success factors such as strategic planning, stakeholder engagement, and customized solution design. Furthermore, it lays the foundation for future integration of cloud computing with AI and IoT technologies, paving the way for a more proactive, connected, and efficient healthcare ecosystem.

### **Case Study: Cloud-Based EHR and Telemedicine Integration in a Multispecialty Hospital**

A multispecialty hospital in Bengaluru adopted a cloud-based healthcare infrastructure using Amazon Web Services (AWS) to enhance its Electronic Health Records (EHR) and telemedicine capabilities. Before implementation, patient data was fragmented across various departments, resulting in delays in diagnosis and treatment coordination.

By migrating to AWS, the hospital centralized patient records, enabling secure, real-time access for doctors, nurses, and administrative staff. A telemedicine platform was integrated into the system, enabling remote consultations, appointment scheduling, and digital prescription management. Multi-factor authentication and data encryption cryptography HIPAA-compliant security.

Post-deployment analytics revealed a 30% reduction in patient waiting time, a 25% increase in outpatient throughput, and a significant improvement in cross-departmental communication. Patient satisfaction scores rose due to quicker service and remote access to care.

This case demonstrates how cloud platforms, such as AWS, can transform hospital operations, enhance healthcare delivery, and support scalability while maintaining data security and compliance.

### **Background**

The healthcare sector, which has historically been characterised by localised data storage and paper-based systems, has always faced difficulties in adapting to the changing demands of patient care and information management. The advent of Information Technology (IT) has brought about a new age, forcing healthcare organisations to explore creative ways to improve their operations and make them more accessible, efficient, and collaborative. In light of these factors, the integration of cloud-based technologies has become a ground-breaking strategy that holds the potential to completely transform the handling, access, and storage of healthcare data. This background lays the groundwork for a thorough analysis of the uses and consequences of cloud computing in the healthcare industry. Fig. (1) illustrates the experimental environment.

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**CHAPTER 12**

# Enhancing Network Security through AI-Powered Anomaly Detection Using Generative Adversarial Networks

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**Abstract:** Developments in communication technology have facilitated more data sharing in geographically dispersed settings, but they have also enlarged the attack surface, raising questions about network security. Research focuses on AI-based anomaly detection systems to improve Network Intrusion Detection Systems (NIDSs) in order to address this. However, data imbalance makes it more difficult for AI models to learn and effectively identify threats when legitimate traffic outnumbers malicious traffic. To balance data classes and enhance NIDS performance, suggested options include employing Generative Adversarial Networks (GANs) to produce artificial data that mimics small attack traffic. In order to guarantee that AI models acquire enough training data for both legitimate and malicious network traffic, the method includes GANs. Methods such as “voting classifier” (RF+AB+DT) and “stacking classifier” (LightGBM+DT) are used to improve the system's accuracy and resilience in detecting threats.

**Keywords:** Anomaly detection, Generative Adversarial Network (GAN), Network security, Network Intrusion Detection System (NIDS).

## INTRODUCTION

Network topologies have changed drastically as 5G mobile communication technology has proliferated. This makes sending data across many networks easier. Data comes from gadgets, computers, and the IoT. This implies that network systems can handle more of these data types correctly [1]. Having more types of access points has, however, made the attack area bigger, leaving network systems open to possible dangers [2].

Also, the growing complexity and regularity of cyber-attacks make network systems even more vulnerable. As cyber-attack methods get more complicated,

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it's even more important to have strong security steps [3]. Unfortunately, this has led to a lot of study being done on how to stop possible network threats.

Network threat identification is a major security challenge. This area has advanced with NIDS systems [4]. Recent research has largely focused on using AI to improve NIDS performance, resulting in considerable improvements [5]. The study first focused on improving NIDS utilizing Decision Trees (DTs) and support vector machines (SVMs) [6]. Since then, these attempts have included autoencoders [7], CNNs, and LSTM networks.

It's not easy to use these AI-based intruder detection systems in the real world, even though a lot of progress has been made in finding strange things [8]. A key issue is that network flow data is inherently uneven, with routine traffic being the bulk and malicious acts causing service breakdowns being very infrequent [9]. Furthermore, when it comes to negative conduct, the majority of the data is about well-known assaults, but certain sorts of attacks are still quite rare [10]. As a result, the problem with uneven data makes it harder for AI models to pick out the details of specific network risks. This lowers the accuracy of monitoring and leaves network systems open to attacks [11].

Because of these problems, researchers are still working on coming up with new ways to fix the data imbalance problem and make AI-based NIDS more reliable. These problems can be fixed to make AI-driven attack detection systems work better, which will make networks more resistant to new cyber dangers.

This research presents an innovative intrusion detection system that leverages Generative Adversarial Networks (GANs) to enhance anomaly detection in network traffic by addressing data imbalance—a common issue in real-world cybersecurity datasets. The proposed system integrates deep learning models (CNN, DNN, LSTM) with ensemble learning methods (Voting and Stacking classifiers) to boost detection accuracy and resilience. The model is rigorously evaluated across three prominent benchmark datasets—NSL-KDD, UNSW-NB15, and IoT-23—demonstrating exceptional performance, with ensemble methods achieving up to 99% accuracy. The study also contributes a detailed data preprocessing pipeline, including feature encoding, selection, and normalization, to optimize training and testing. Experimental results reveal that combining synthetic data generation with diverse classifier architectures significantly enhances intrusion detection capability. This approach not only improves model accuracy but also strengthens the generalizability of the detection system, paving the way for more secure and adaptive network environments.

## LITERATURE SURVEY

Network intruder monitoring is an important part of protection that looks for illegal access, bad behaviour, and possible threats in network systems. As technology has evolved, especially with the development of 5G mobile communication and scattered networks, it has become more difficult to detect attacks on networks [12]. The complex and varied nature of modern cyber-attacks means that traditional entry detection methods often aren't enough to stop them. Because of this, academics have turned to DL and Artificial Intelligence (AI) to make Intrusion Detection Systems (IDSs) work better [13].

Gao *et al.* [14] suggested a new way to use semi-supervised learning to find network intrusions in computer systems that are based in the cloud. Both named and unmarked data are used in their method to improve the accuracy of recognition. Similarly, Alrawashdeh and Purdy [15] developed a live anomalous breach detection system using DL. This system employs deep learning models to detect anomalies in real-time network data.

Tang *et al.* [16] looked at how DL can be used for attack detection in software-defined networking (SDN) settings. They used a method that shows DL can effectively find network attacks in SDN systems.

Zhong *et al.* [17] looked into how big data-based DL systems could be used for breach detection. This showed how big data analytics could be used to improve detection skills. Haghighat and Li [18] suggested an intruder detection system that uses a voting-based neural network. This showed how neural network ensembles can improve detection efficiency.

Qi *et al.* [19] developed a quick multi-aspect data stream anomaly detection method for smart breach detection in secure Industry 4.0 scenarios. Kim *et al.* [20] and Yin *et al.* [21] found incursions using LSTM RNNs. This revealed that RNNs can detect network traffic temporal correlations.

An intrusion detection system employing gated recurrent units in a deep neural network was proposed by Xu *et al.* [22]. They demonstrated GRUs' long-term relationship capture in sequential data. Gao *et al.* [23] employed deep learning to discover SCADA system breaches, protecting critical assets.

Javaid *et al.* [24] presented a network intrusion detection DL model. This proved that DL can detect more efficiently than normal approaches. Yan and Han [25] stressed the need to use stacked sparse autoencoders for feature extraction to improve intrusion detection systems.

## **Section 3: Internet of Things**

## Conflict Resolution in Uncertain Situations for Self-Driving Cars

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**Abstract:** Self-driving cars are the latest sensation in the 21<sup>st</sup> century. At the same time, in the present scenario, passengers lack trust and confidence in the system that operates independently. Therefore, it is crucial to have an interactive environment that allows users to interact with the system in real-time and take appropriate action. Uncertain situations may arise from these interactions. If the passenger and the Decision-making model differ in the instructions, the system can get perplexed. As a result, the purpose of this study is to create an environment for a self-driving car that can manage such unpredictable scenarios while facilitating user-system interaction. This paper proposes a VUR (Visual Uncertainty Resolver) algorithm to address the stochastic environment in which self-driving cars operate. This three-step algorithm addresses the uncertainties associated with the car's vision. The proposed algorithm utilizes YOLOv5 for object detection and classification, along with Mono-Depth Estimation and speech synthesis, to extract features from the environment for uncertainty detection and resolution. Our supervised learning model, the Decision-making model, considers various parameters to compute the best decision, which is efficient and effective for the self-driving car.

**Keywords:** Decision-making model, Mono-depth estimation, Object detection, Self-driving car, Speech synthesis, Stochastic, Supervised learning, Uncertain, VUR algorithm, YOLOv5.

### INTRODUCTION

Humans have continually improved their lives through innovations and discoveries. The evolution of human modes of transportation reveals a great deal about the progress of human thought. Humans have transitioned from steering tillers to steering wheels for controlling vehicles in this modern era, driven by technological advancements. The 21<sup>st</sup> century, driven by technology, has seen im-

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mense growth toward autonomy. Now, there is self-working technology for services as simple as a daily morning cup of tea, as well as the complex automobile industry. This automation is driven by data and powered by the intelligence of machines (AI) [1]. Research is underway to achieve level 5, *i.e.*, full drive automation, for autonomous vehicles.

The major drawback of self-driving cars in the current scenario is the lack of confidence of passengers in the system. As the system itself is in complete control, passengers fear sitting back comfortably. With confidence comes trust, and with trust comes the comfort of sitting inside a self-driving car. Hence, we focused on creating an atmosphere where passengers would feel safe and confident sitting in the back of the vehicle. Various studies have been conducted to develop an interactive system that allows passengers to take further actions by interacting with the system. Now, these interactions sometimes lead to an uncertain situation, which can confuse the system. Hence, I chose to work on creating a system that can handle uncertain situations in a self-driving car.

The proposed Visual Uncertainty Resolver (VUR) algorithm enables low complexity and successful interaction between the user and the car's system, featuring a robust mechanism to handle uncertain situations arising from the car's vision. The significance of the algorithm lies in its ability to make rational decisions in real-time and gain the user's trust.

The main contribution of this paper is:

- To deal with the stochastic environment of the car.
- Identifying and detecting all objects and components within the car's environment using YOLOv5.
- Computing distance between the camera and the object using various methods, including a based approach and Mono-Depth Estimation.
- Allowing interaction between the user and the system using the SHI (Speech Human Interaction) Model.
- Dealing with uncertain situation occurring with rational thinking, taking into consideration the constant change in the environment in which the self-driving car operates.

The rest of the paper is organized as follows. Section 2 defines the various existing approaches to self-driving cars. In Section 3, the algorithm and the methodology are introduced. In Section 4, the implementation details are presented. The area-based approach presented in this section of the paper is a one-of-a-kind distance computation method based on the principle of perception. In section 5, the challenges faced are presented. Section 6 focuses on performance

analysis, which includes the Evaluation and results of the proposed VUR algorithm. Finally, section 7 presented the future work, and section 8 concluded the research paper.

## LITERATURE REVIEW

Autonomous driving technologies, particularly self-driving cars, have significant potential to substantially improve and enhance vehicle safety and mobility in various driving situations [2]. At present, several industrial autonomous vehicles are performing admirably. Object detection is one of the most crucial tasks in autonomous driving. For that, several deep learning-based object detection methods are used, such as Region-based Convolutional Neural Networks (R-CNN) [3], fast R-CNN [4], faster R-CNN [5], Region-based Fully Convolutional Networks (R-FCN) [6], and You Only Look Once (YOLO) [7], and traditional methods. YOLO is a single-stage CNN-based algorithm for object detection and classification and is one of the quickest object-detection algorithms with high accuracy and excellent real-time performance [8]. YOLO has had several versions, including YOLOv1, YOLOv2 [9], YOLOv3 [10], and YOLOv4 [11], since its initial proposal, with each version improving upon the previous one. In a study [12], Tinier-YOLO, derived from Tiny-YOLOv3, was proposed to reduce model size while improving detection capability and real-time performance. In another study [13], YOLO-FIRI, a region-free object detector, was proposed for detecting objects in infrared images. The proposed method helps overcome problems with object detection in infrared images, including low recognition rates, low resolution, and others.

Multiple supervised and Semi-Supervised machine learning techniques [14] are used for self-driving cars in uncertain situation. A two-layer robust Long Short-Term Memory (LSTM) model has been used to provide commands to autonomous vehicles in uncertain situations [15]. Logistic Regression [16], Decision Tree [17], Support Vector Machine (SVM) [18, 19], Naive Bayes [20, 21], k-nearest neighbors algorithm (k-NN) [22], and many more models and algorithms can be used in a Decision-making model for uncertain situations for self-driving cars. To make decisions for self-driving cars, a unique network architecture based on Long Short-Term Memory (LSTM) and the Grasshopper Optimization Algorithm (GOA) was employed [23]. One of the most crucial network architectures for autonomous vehicle decision-making is the Long Short-Term Memory network. Reinforcement Learning (RL) [24] can also be applied to uncertain situations in autonomous vehicles, such as self-driving cars. Data gathered while driving can be used in conjunction with reinforcement learning, allowing RL to learn from the collected data.

## Security and Privacy Preserving in Cloud Computing Using IoT

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**Abstract:** The Web of Clinical Things (WCT) coordinates the medical care industry with the Web of Things (WoT) environment. It enables the creation, collection, transmission, and analysis of clinical data through IoT integration. These IoT networks comprise various medical services, IT frameworks, clinical sensors, and management software. The IoMT enhances the medical care framework by creating a seamless, open, integrated, and reliable system. Nonetheless, ensuring secure verification in IoMT is challenging due to the diverse communication environment of various IoMT devices. Although various examinations have investigated potential IoMT device authentication techniques, more work is required, especially in client validation, to develop long-term IoMT solutions. Secret key administration remains one of the significant challenges in this specific circumstance. This paper presents an IoMT-related electronic passwordless verification strategy that is quick, powerful, and secure. To achieve cross-stage similarity, it integrates a version of FIDO2/WebAuthn, one of the latest standards for passwordless authentication. This streamlines the process of obtaining and further developing client accreditations while maintaining compliance with regulations. The paper also assesses the delays in IoMT gadget verification and enrollment processes. Results and reproductions demonstrate how the proposed framework can achieve rapid validation on cloud servers with minimal enrollment and approval processes, regardless of device types.

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**Keywords:** Authentication, DAA algorithm, ECC, IoMT, Online login.

## INTRODUCTION

The IoMT has significantly transformed the medical services landscape by utilizing clinical hardware connected to the Internet to enable remote connections between patients and healthcare providers [1]. IoMT gadgets collect clinical data from patients and provide it to healthcare experts for review to identify diseases earlier. In IoMT, patient information security is of the utmost concern. The principal level of safety in IoMT is element validation [2]. The substance might be the client, an IoMT device, any smart device, and so on. Be that as it may, IoMT verification is a challenging task due to the variety of devices and limited resource availability. The most widely used method of gadget validation currently is password verification. This methodology, however, could have a couple of imperfections. Due to the widespread use of passwords in advanced stages, phishing attempts sometimes involve mimicking legitimate sites [3]. To ensure client security and protection, it is essential to reduce dependence on secret phrase-based authentication for access to online services [4]. By moving confirmation to the gadget instead of exchanging accreditations through the Web, the password-less validation approach modifies the fundamental security design.

The Coronavirus pandemic has indeed underscored the importance of intelligent medical care benefits that provide remote anticipation, diagnosis, and therapy [5]. The concept of “brilliant medical care” encompasses something beyond mere mechanical promotion and advancements in the medical services industry. Clients often use the same passwords across multiple sites, making them vulnerable to man-in-the-middle attacks and easy for attackers to compromise.

Secret key passages through human collaboration and various secret phrase recollections become tedious and costly assignments [6]. Putting away passwords in the data set does not guarantee the security of clients' information. Clients are seeking universal authentication to streamline their daily routines while maintaining the highest level of safety and organizational protection [7].

Fig. (1) illustrates the time it takes to break a password based on its strength [8]. On average, people spend just over 15 minutes per week entering and resetting their passwords. In contrast to a while back, 74% of respondents reported being more concerned about the security and protection of their information. Secret word-based gadgets are especially vulnerable to phishing attacks, where attackers trick users into revealing their credentials, thereby compromising security. Malware, keyloggers, or other malicious software can steal passwords from clients' devices, compromising the entire IoMT ecosystem. Assailants can also take advantage of human weaknesses, persuading victims to disclose passwords or

other sensitive information. A few IoT and clinical gadgets have limited input options, making it challenging to implement our strategies effectively. In the event of a security breach, it may require significant investment to identify unauthorized access, allowing attackers to cause harm or access sensitive data before being detected.

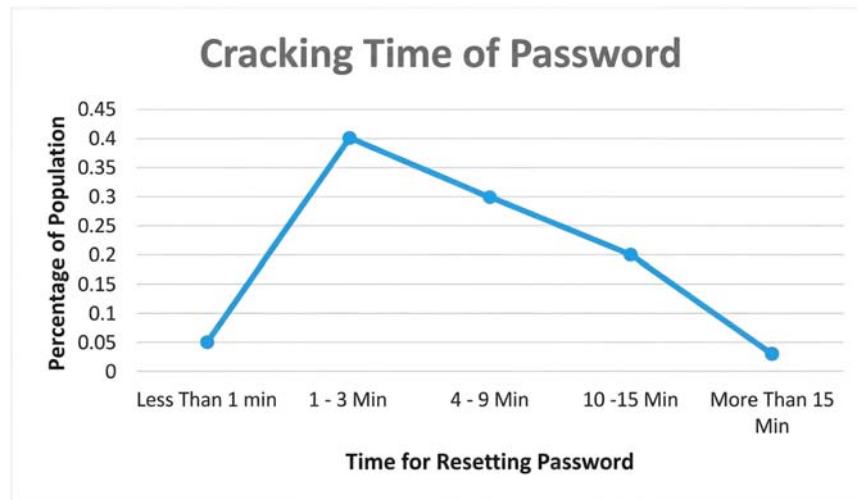


Fig. (1). Breaking season of passwords.

In this paper, we propose a passwordless, security-saving verification strategy that involves a single passkey to authenticate various devices in an IoMT environment. To facilitate cross-stage similarity, we rely on the FIDO2 standard, which utilizes public key cryptography. Gadgets that are enlisted and verified with the FIDO2/WebAuthn convention use passkeys for this cycle. The authenticator checks QR codes to produce passkeys, which are then used to make marks. The FIDO2 standard is a web-based authentication framework that enables users to authenticate themselves to servers using an electronic device known as an authenticator.

Furthermore, we inspected the time expected for enrollment and confirmation utilizing FIDO2/WebAuthn and passkeys, which eliminate password-based verification and reduce the need for human interaction, even during the initial login across different platforms.

The remainder of the paper is organized as follows: Segment 2 covers related work. Segment 3 examines the issue definition. In Segment 4, we present the proposed technique, which retains itemized data for the FIDO2/WebAuthn

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