International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

# A Study on Churn Predictive Analytics at Senior Care

*Dinesh M*

**Panimalar Engineering College**

## INTRODUCTION

The landscape of elderly care services has evolved significantly in response to the burgeoning needs of an aging population. Among the myriad of care options available, senior care communities play a pivotal role in providing specialized support and assistance to older adults. However, ensuring sustained engagement and satisfaction among clients remains a critical challenge for these facilities. Churn, or client churn, poses a considerable threat to the stability and success of senior care communities, impacting both operational efficiency and the quality of care provided.

Senior care stands as a beacon in the realm of senior care services, committed to offering personalized and compassionate care to its clientele. Recognizing the imperative of understanding and mitigating client Churn, Senior care endeavours to embark on a journey of data-driven exploration and analysis. This project seeks to delve deep into the realms of client Churn patterns, leveraging the wealth of data at hand to construct predictive models capable of foreseeing client disengagement.

The overarching aim of this endeavour is to empower Senior care with the foresight and capability to proactively address client Churn, thereby fostering enduring relationships with its clientele. By unravelling the intricate interplay of factors influencing client churn, this project aspires to equip Senior care with actionable insights and strategies to optimize client retention and enhance the overall care experience.

This introduction serves as a preamble to a comprehensive exploration of client Churn patterns at Senior care , delving into the intricacies of data analysis, predictive modelling, and strategic intervention. Through the amalgamation of data science methodologies and domain expertise, this project endeavours to chart a path towards sustainable growth, operational excellence, and client- centric care provision within the realm of senior care services.

This introduction lays the groundwork for a detailed exploration of the topic within the specified three- page document. Adjustments can be made as needed to suit the specific requirements and scope of your project.

The demographic landscape of the global population is undergoing a profound transformation, characterized by a marked increase in the proportion of elderly individuals. This demographic shift, driven by factors such as declining fertility rates and increased life expectancy, has spurred a growing demand for specialized care services tailored to the needs of older adults. Among the diverse array of care options available, senior care communities have emerged as vital pillars of support, providing a holistic environment conducive to the well-being and comfort of elderly residents. Within this context, Senior care stands as a beacon of excellence, dedicated to upholding the highest standards of care provision and ensuring the dignified living of its clientele

Despite the commendable efforts of senior care communities like Athulya, the issue of client Churn looms large, posing a significant challenge to the sustainability and efficacy of care services. Client Churn, commonly referred to as churn, encompasses the phenomenon of clients discontinuing their engagement with a service provider, thereby severing the relationship. In the context of senior care facilities, churn not only undermines operational stability but also raises questions about the quality of care and overall satisfaction levels among residents.

Recognizing the critical importance of addressing client Churn, Senior care has embarked on a proactive journey to analyse and understand the underlying patterns and dynamics influencing client churn. This project represents a concerted effort to leverage data-driven methodologies and advanced analytics to unravel the intricacies of client Churn within the context of senior care services. By harnessing the power of data, Athulya aims to gain actionable insights into the factors driving client churn and develop predictive models capable of forecasting future Churn trends.

At its core, this project is driven by the overarching objective of enhancing client retention and fostering enduring relationships between Senior care and its residents. By proactively identifying at- risk clients and implementing targeted interventions, Athulya seeks to mitigate the adverse effects of churn, thereby ensuring the continuity of care and fostering a nurturing environment for its residents. Through a combination of rigorous data analysis, predictive modelling, and strategic decision- making, Athulya endeavours to redefine the paradigm of senior care services, setting new standards of excellence in client engagement and satisfaction.

This introduction sets the stage for a comprehensive exploration of client Churn patterns at Senior care , spanning multiple dimensions including data analysis, predictive modelling, and strategic intervention. Over the course of this document, we will delve into the intricacies of client churn within the context of senior care services, examining the various factors at play and elucidating strategies for mitigating its impact. Through the synergistic integration of data science methodologies and domain expertise, this project aims to empower Senior care with the tools and insights necessary to navigate the complex landscape of client Churn and uphold its commitment to providing exceptional care to elderly residents.

### *1.1.1 Client Churn Analysis*

Client Churn analysis is a strategic process undertaken by businesses to understand why Clientss discontinue their relationship with the company, often referred to as "churn." It involves examining historical data, identifying patterns and trends, and developing insights to predict and mitigate future churn. At its core, client Churn analysis aims to answer crucial questions such as: What factors contribute to Churn? Are there specific Churnsegments more prone to churn? How can businesses anticipate and prevent churn effectively? To conduct a thorough analysis, businesses typically start by collecting data from various sources, including transaction records, Churninteractions, and feedback surveys. This data is then processed and analysed to uncover insights into Churnbehaviour and churn patterns. Segmentation analysis plays a key role in client Churn analysis, allowing businesses to group Clientss based on shared characteristics such as demographics, purchase history, or engagement levels. By identifying high-risk segments, businesses can tailor retention strategies to address specific needs and preferences.Predictive modeling is another critical component of client Churn analysis. By leveraging advanced analytics techniques and machine learning algorithms, businesses can develop models to forecast future churn and proactively intervene to retain at-risk Clients

In the contemporary healthcare ecosystem, characterized by rapid technological advancements, demographic shifts, and evolving patient expectations, the imperative for data-driven decision-making has never been more pronounced. At the intersection of healthcare and analytics lies a realm of untapped potential, where the strategic application of advanced analytical techniques holds the promise of revolutionizing care delivery, optimizing resource allocation, and enhancing patient outcomes. Against this backdrop, the present study embarks on a journey to explore the intricate interplay between client Churn patterns, predictive analytics, and machine learning within the context of Senior care —a pioneering provider of senior living services committed to redefining aging with dignity, compassion, and innovation.

### *1.1.2 Evolution of Healthcare Analytics*

The genesis of healthcare analytics can be traced back to the seminal work of Florence Nightingale, whose pioneering use of statistical methods to analyze mortality rates during the Crimean War laid the foundation for evidence-based practice in nursing. Since then, the landscape of healthcare analytics has undergone a paradigm shift, fueled by advancements in data collection technologies, computational power, and analytical methodologies.

### *1.1.3 The Imperative for Client Retention in Healthcare*

In the realm of senior living services, where Senior care stands as a beacon of excellence, the imperative for client retention transcends mere financial considerations to encompass broader imperatives related to care continuity, quality of life, and social connectedness. Unlike traditional healthcare settings where episodic encounters predominate, senior living facilities serve as the nexus of a holistic ecosystem wherein residents forge enduring relationships with caregivers, peers, and community stakeholders. Against this backdrop, the specter of client Churn looms large, threatening to disrupt the delicate balance of trust, familiarity, and personalized care that underpins the Athulya experience. , the imperative for client retention transcends mere financial considerations to encompass broader imperatives related to care continuity, quality of life, and social connectedness

### *1.1 Theoretical Framework: Understanding Client Churn*

At the heart of the present study lies a theoretical framework grounded in the seminal work of Churnrelationship management (CRM), wherein client Churn—or churn—emerges as a multifaceted phenomenon shaped by a myriad of individual, interpersonal, and environmental factors. Drawing upon insights from behavioral economics, social psychology, and organizational theory, the framework seeks to elucidate the underlying drivers of client Churn within the context of senior living services, encompassing dimensions such as client satisfaction, service quality, caregiver dynamics, health status, and socio-demographic characteristics. Disease Prediction and Diagnosis: ML algorithms can analyze patient data such as medical history, symptoms, and diagnostic test results to predict the likelihood of diseases or conditions. For example, ML models have been developed to aid in the early detection of diseases like cancer, diabetes, and cardiovascular disorders by identifying subtle patterns in imaging scans, genetic data, or patient records.

### *1.1.1 Personalized Treatment Planning:*

ML algorithms can help healthcare providers tailor treatment plans to individual patients based on their unique characteristics, preferences, and response to therapy. By analyzing patient data and clinical outcomes, ML models can recommend the most effective treatment options, dosage adjustments, or personalized interventions to optimize patient care and improve outcomes.

### *1.1.2 Drug Discovery and Development:*

ML techniques are increasingly being applied in pharmaceutical research and drug discovery to accelerate the identification of potential drug candidates, predict their efficacy and safety profiles, and optimize drug development processes. ML algorithms can analyze molecular structures, biological pathways, and clinical trial data to identify novel drug targets, design candidate molecules, and prioritize compounds for further testing.

### *1.1 Clinical Decision Support Systems:*

ML-powered clinical decision support systems (CDSS) assist healthcare providers in making informed decisions by synthesizing and analyzing vast amounts of patient data, medical literature, and clinical guidelines. These systems can help clinicians diagnose diseases, recommend appropriate treatments, predict patient outcomes, and identify potential adverse events or drug interactions in real-time, thereby improving the quality and efficiency of care delivery.

### *1.2 Healthcare Operations and Resource Management:*

ML algorithms can optimize healthcare operations and resource allocation by analyzing operational data, patient flow patterns, staffing levels, and supply chain logistics. For example, ML models can predict patient admission rates, optimize hospital bed utilization, schedule surgical procedures, or forecast equipment maintenance needs to enhance operational efficiency, reduce costs, and ensure timely access to care.

### *1.3 Healthcare Fraud Detection and Prevention:*

ML techniques are employed to detect and prevent healthcare fraud, waste, and abuse by analyzing claims data, billing patterns, and provider behavior. ML algorithms can identify anomalous patterns indicative of fraudulent activities, such as billing for unnecessary procedures, upcoding, or falsifying documentation, enabling payers and regulatory agencies to mitigate financial losses and safeguard the integrity of healthcare systems.

### *1.4 Remote Patient Monitoring and Telemedicine:*

ML-powered remote patient monitoring solutions leverage wearable devices, sensors, and mobile applications to continuously collect and analyze patient health data in real-time. These systems can detect deviations from baseline health parameters, predict exacerbations of chronic conditions, and alert healthcare providers to intervene proactively, enabling timely interventions, reducing hospital readmissions, and promoting patient autonomy and self-management.

### *1.5 Methodological Approach: A Holistic Lens*

Adopting a holistic lens, the methodological approach adopted in this study transcends traditional silos of inquiry to embrace a multidimensional perspective that integrates qualitative and quantitative methods, human-centered design principles, and interdisciplinary collaboration. Grounded in the principles of mixed-methods research, the study employs a sequential exploratory design wherein qualitative insights gleaned from in-depth interviews, focus groups, and ethnographic observations inform the development and refinement of quantitative measures and analytical models. By triangulating findings across multiple data sources and methodological approaches, the study seeks to enhance the validity, reliability, and generalizability of its conclusions while capturing the richness and complexity of the senior living experience.

### *1.6 Data Infrastructure: Navigating the Data Deluge*

Central to the success of any analytics endeavor is a robust data infrastructure capable of ingesting, storing, processing, and analyzing vast volumes of structured and unstructured data. In the case of Senior care , the data landscape is characterized by a diverse array of data sources spanning electronic health records (EHRs), client satisfaction surveys, caregiver notes, billing records, and operational logs. Leveraging cloud-based technologies, distributed computing frameworks, and interoperable data standards, the organization has endeavored to create an integrated data ecosystem that facilitates seamless data flow, interoperability, and scalability while safeguarding the privacy, security, and integrity of sensitive health information.

### *1.7 Unleashing the Power of Predictive Analytics*

At the core of the analytical arsenal deployed in this study lies a suite of advanced machine learning algorithms meticulously curated to tackle the complexities of client Churn prediction in senior living settings. From classic linear models such as logistic regression to cutting-edge ensemble techniques such as random forests and gradient boosting machines, the analytical toolkit encompasses a diverse array of methodologies tailored to the unique nuances of the problem domain. Leveraging open-source libraries such as scikit-learn, TensorFlow, and PyTorch, the study harnesses the power of distributed computing platforms, parallel processing architectures, and hyperparameter optimization techniques to train, validate, and fine-tune predictive models capable of discerning subtle patterns, detecting early warning signs, and forecasting future churn events with unprecedented accuracy.

### *1.8 Navigating the Ethical Terrain*

In the pursuit of data-driven insights, it is incumbent upon researchers and practitioners alike to navigate the ethical terrain with care, compassion, and conscientiousness. Recognizing the inherent vulnerability of senior populations, Senior care has embraced a culture of ethical stewardship characterized by a steadfast commitment to privacy, consent, and transparency in all facets of data collection, storage, and analysis. By adhering to established ethical guidelines such as the Health Insurance Portability and Accountability Act (HIPAA), the General Data Protection Regulation (GDPR), and the principles of beneficence, non-maleficence, and justice, the organization seeks to uphold the rights, dignity, and autonomy of its clients while leveraging the transformative potential of healthcare analytics for the great

In conclusion, the present study represents a seminal contribution to the burgeoning field of healthcare analytics, offering novel insights into the complex dynamics of client Churn within the context of senior living services. By embracing a holistic approach that integrates theoretical, methodological, and ethical dimensions, the study seeks to transcend the boundaries of traditional analytics to illuminate the path forward for Senior care and similar organizations committed to reimagining aging in the 21st century. Armed with a deeper understanding of client needs, preferences, and aspirations, and empowered by the transformative potential of predictive analytics, Senior care stands poised to chart a course towards a future defined by excellence, empathy, and innovation in senior care delivery.

### *1.9 Potential of Machine learning in Health care*

The potential of machine learning (ML) in healthcare is vast and continually expanding as advancements in technology and data analytics enable new applications and innovations. Here are some key areas where ML holds immense promise:

- **Early Disease Detection and Diagnosis**: ML algorithms can analyze vast amounts of patient data, including electronic health records (EHRs), medical imaging scans, genetic profiles, and wearable sensor data, to identify patterns indicative of early disease onset or progression. By detecting subtle anomalies or biomarkers that may not be discernible to the human eye, ML models can facilitate earlier and more accurate diagnoses of diseases such as cancer, cardiovascular disorders, neurodegenerative conditions, and infectious diseases, thereby enabling timely interventions and improving patient outcomes.
- **Personalized Treatment Planning and Precision Medicine**: ML techniques can analyze patient-specific data, including genetic variations, molecular profiles, clinical characteristics, and treatment responses, to tailor treatment plans and interventions to individual patients. By integrating multi-omics data with clinical outcomes and predictive analytics, ML models can identify optimal treatment regimens, predict drug responses, and stratify patients into subgroups based on their likelihood of benefiting from specific therapies. This approach, known as precision medicine, holds the promise of improving treatment efficacy, minimizing adverse effects, and optimizing healthcare resource allocation.
- **Drug Discovery and Development:** ML techniques are revolutionizing the drug discovery and development process by accelerating the identification of novel drug candidates, predicting their efficacy and safety profiles, and optimizing clinical trial design. ML algorithms can analyze vast repositories of biological data, including genomic, proteomic, and metabolomic data, to uncover new drug targets, design candidate molecules, and predict their pharmacological properties. Additionally, ML models can optimize preclinical experiments, identify patient subpopulations most likely to benefit from experimental therapies, and streamline the drug development pipeline, thereby reducing costs and time-to-market for new drugs.
- **Healthcare Operations and Resource Management:** ML algorithms can optimize healthcare operations and resource allocation by analyzing operational data, patient flow patterns, staffing levels, and supply chain logistics. For example, ML models can predict patient admission rates, optimize hospital bed utilization, schedule surgical procedures, or forecast equipment maintenance needs to enhance operational efficiency, reduce costs, and ensure timely access to care.
- **Remote Patient Monitoring and Telemedicine:** ML-powered remote patient monitoring solutions leverage wearable devices, sensors, and mobile applications to continuously collect and analyze patient health data in real-time. These systems can detect deviations from baseline health parameters, predict exacerbations of chronic conditions, and alert healthcare providers to intervene proactively, enabling timely interventions, reducing hospital readmissions, and promoting patient autonomy and self-management.

Overall, machine learning has the potential to revolutionize healthcare delivery by augmenting clinical decision-making, optimizing operational processes, and improving patient outcomes across the continuum of care. However, it is essential to address challenges related to data quality, privacy, regulatory compliance, and algorithmic bias to realize the full benefits of ML in healthcare while ensuring ethical and equitable access to high-quality care for all patients.

## OBJECTIVES OF THE STUDY

- ToIdentify key demographic and behavioural factors contributing to client Churn.
- To Develop predictive models to forecast the likelihood of client churn.
- To Segment the clients based on their risk of Churn to tailor retention strategies.
- To Evaluate the effectiveness of current retention efforts in reducing churn rates.
- To Implement proactive measures to mitigate client Churn and improve overall retention rates.

## REVIEW OF LITERATURE

- “Development of a Prediction Model for Churn with Life-log Data for Digital Healthcare Applications: A Retrospective Observational Study” ( 2024 – JAN )
- “ Intelligent Data Analytics using Hybrid Gradient Optimization Algorithm with Machine Learning Model for Churn Prediction “ by Fayzullaev, Nurulla , Klochko ( 2024-FEB )
- “ Telecom Churn Prediction Using Machine Learning “ by Patil, Ashwini Wankhade, Nilesh ( 2023 )
- “ Churn Prediction in Telecommunication Industry: A Comparative Analysis of Boosting Algorithms” by Abdullahi Muhammad, Umar , Aimufua, G.I.O. ( 2023)
- “Churn prediction using composite deep learning technique to avoid financial loss ” by Khattak, Asad ,Mehak, Zartashia ( 2023 ).
- “Enhancing Churn Analytics: A Comprehensive Framework for Effective Churn Prediction” by ramooz ( 2022 )
- “Churn Prediction in the Banking Sector Using Machine Learning-Based Classification Models” by Tran, Hoang, Nguyen, Van-Ho (2021)
- “A deep multimodal autoencoder-decoder framework for Churn prediction incorporating chat- GPT” by Xia, Guoe , Wang, Su ( 2020)
- “Advanced Machine Learning in Big Data for the Prediction of Churn in the Telecommunication Industry” by Chinnasamy Shanmugam, Velu (2020)
- “Analysis of Employee Churn Using Perspectives from Machine Learning” By Krishna, Shobhanam , Sidharth, Sumati ( 2020 )
- “A Churn Prediction Model Using Random Forest: Analysis of Machine Learning Techniques for Churn Prediction and Factor Identification in Telecom Sector” by Malik, Ahmad , Imran, Muhammad ( 2019)
- “Churn Prediction Analysis for development of market advancement” by Shah, Fenil, Rahevar, Mrugendrasinh ( 2018).
- “A Sequential Pattern Detection and Sentiment Analysis Combined Approach to the Churn Prediction Problem in Client Relationship Management Environments” by Hason Rudd, David

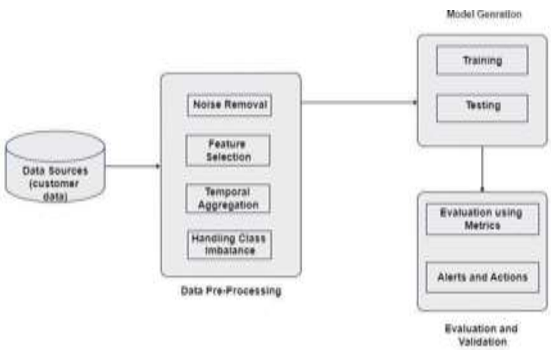
## METHODOLOGY

This study involves several distinct phases. Firstly, we will collect historical client data from our database and preprocess it to ensure quality and consistency. Next, we will divide the data into training and testing sets and train machine learning models using algorithms such as Decision Trees, SVM, Gradient Boosting, Logistic Regression, and Random Forest. Finally, we will evaluate the performance of each model using appropriate metrics and classify clients into churn or non-churn categories to derive actionable insights for improving churn prediction strategies."

## RESEARCH DESIGN

This study adopts a quantitative research design to analyse Churn prediction in senior care facilities. The quantitative approach facilitates the collection and analysis of numerical data extracted from the company database, enabling the identification of key factors influencing client Churn.

## DATA COLLECTION




The data utilized in this project is sourced from the Senior care service provider in Chennai, encompassing a diverse range of health-related attributes and demographic information. The dataset is collected with the consent of the participants and adheres to strict privacy and ethical guidelines. It includes information on medical history, lifestyle factors, physiological parameters, diagnostic tests, and medication usage, providing a comprehensive overview of the health status of senior citizens.

This architectural diagram offers a visual representation of the essential elements engaged in a churn prediction system utilizing decision trees. It demonstrates the pathway of data from its sources to the deployment of models, monitoring, and integration with business operations. This underscores the significance of ongoing feedback loops and enhancements for enhancing Clients retention.

**DATA CLEANING:**

- Clean the collected data to remove any inconsistencies, errors, or missing values that could affect the quality of the analysis.
- Handle missing data by imputing values or removing incomplete records, ensuring that the dataset is complete and suitable for analysis.
- Check for outliers or anomalies in the data and address them appropriately.

**FEATURE SELECTION:**

- Identify relevant features or variables that may influence client churn, such as age, length of stay, satisfaction levels, and engagement with services.
- Use domain knowledge, statistical techniques, and feature importance analysis to select the most informative features for churn prediction.

**DATA PREPROCESSING:**

- Preprocess the selected features to prepare them for training the machine learning models.
- Scale numerical features to a similar range to prevent bias in the model training process.
- Encode categorical variables using techniques such as one-hot encoding to represent them numerically.

**MODEL TRAINING:**

- Divide the pre-processed data into training and testing sets to evaluate the performance of the trained models.
- Train machine learning models using algorithms such as Decision Trees, SVM, Gradient Boosting, Logistic Regression, and Random Forest on the training data.
- Tune the hyperparameters of the models using techniques such as cross-validation to optimize their performance.

**MODEL USED FOR PREDICTION :**

- Decision tree
- Support vector machine
- Random forest
- Logistic Regression
- Gradient Boosting

**Decision Tree :**

**DATAANALYSIS AND INTERPRETATION**

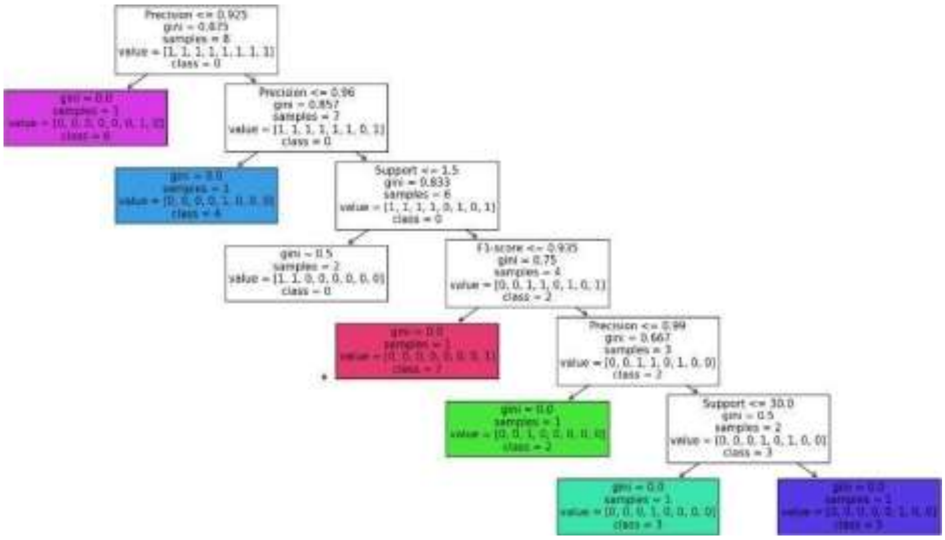
Decision Tree, a robust machine learning algorithm, is employed to predict churn rate at Senior care by analyzing various customer data points. By recursively partitioning the data into subsets based on significant features, it creates a tree-like structure. This structure offers insights into factors influencing churn, aiding strategic decision-making. Decision Trees provide interpretable coefficients and handle both binary and multi-class classification tasks, making them invaluable for understanding and predicting customer churn effectively.

**Table 3.2.6 Table showing the Test score Trained in Decision tree**

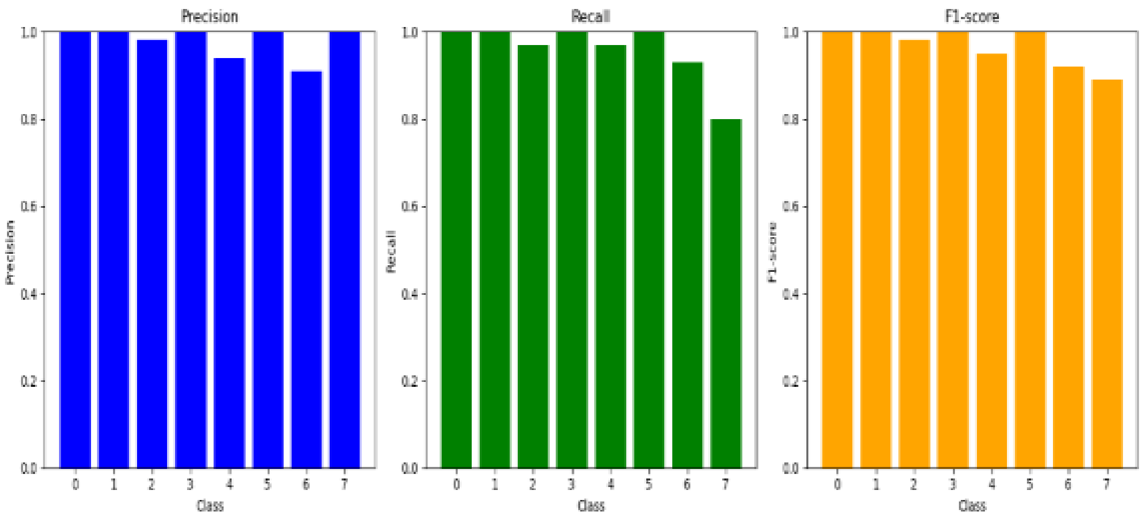
| Class | Precision | Recall | F1- score | Suppo rt |
|---|---|---|---|---|
| 0 | 1.00 | 1.00 | 1.00 | 1 |
| 1 | 1.00 | 1.00 | 1.00 | 1 |
| 2 | 0.98 | 0.97 | 0.98 | 390 |
| 3 | 1.00 | 1.00 | 1.00 | 2 |
| 4 | 0.94 | 0.97 | 0.95 | 60 |
| 5 | 1.00 | 1.00 | 1.00 | 58 |

| | | | | |
|---|---|---|---|---|
| 6 | 0.91 | 0.93 | 0.92 | 99 |
| 7 | 1.00 | 0.80 | 0.89 | 5 |
| Accuracy | | | 0.97 | 616 |
| Macro Avg | 0.87 | 0.85 | 0.96 | 616 |
| Weighted Avg | 0.97 | 0.97 | 0.97 | 616 |

### *3.2.2 CHART SHOWING THE CLASS PREDICTION TREE VISUALIZATION*



### *3.2.3 CHART SHOWING THE DECISION TREE ANALYSIS OF PRECISION , RECALL , F1-SCORE PER CLASS*




**INTERPRETATION :**

The decision tree classifier shows excellent performance across most classes, with precision values ranging from 0.91 to 1.00, indicating high accuracy in class predictions. Similarly, recall values ranging from 0.91 to 1.00 demonstrate the classifier's ability to identify most positive instances. The F1-scores, ranging from 0.91 to 1.00, confirm a balance between precision and recall, with class 1 performing the best overall and class 6 performing the lowest among the classes. Despite this, the classifier demonstrates strong performance across all classes.

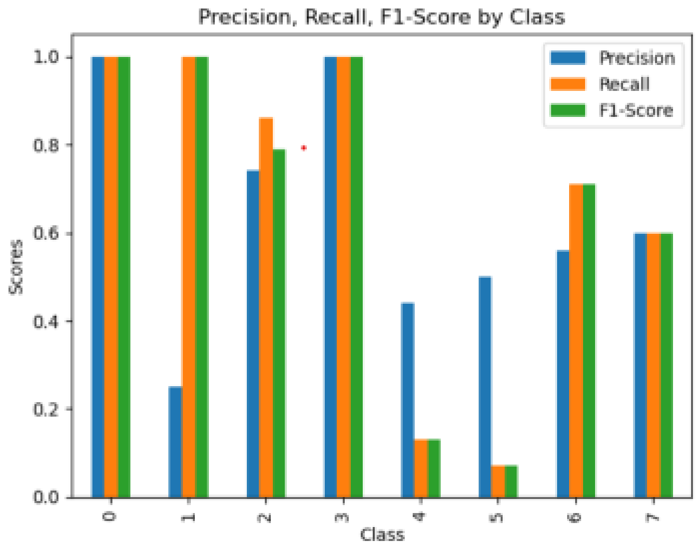
### *LOGISTIC REGRESSION :*

Logistic regression helps to predict the churn rate of Clients at Senior care by analyzing patterns in customer data. It effectively identifies key factors influencing customer churn through its interpretable coefficients, providing insights into which features are most associated with churn. The model's probabilistic outputs allow for distinguishing between Clients likely to churn and those who aren't, making it ideal for binary or multi-class classification tasks. By efficiently handling large datasets and adjusting for class imbalances, logistic regression aids in targeted interventions to reduce churn. Overall, it offers a straightforward yet powerful tool for understanding and managing customer retention.

**Table 3.2.7 Table showing the Test score Trained in logistic Regression**

| Class | precision | Recall | F1-score | Support |
|---|---|---|---|---|
| 0 | 1.00 | 1.00 | 1.00 | 1 |
| 1 | 0.25 | 1.00 | 1.00 | 1 |
| 2 | 0.74 | 0.86 | 0.79 | 390 |
| 3 | 1.00 | 1.00 | 1.00 | 2 |
| 4 | 0.44 | 0.13 | 0.13 | 60 |
| 5 | 0.5 | 0.07 | 0.07 | 58 |
| 6 | 0.56 | 0.71 | 0.71 | 99 |
| 7 | 0.6 | 0.6 | 0.60 | 5 |
| Accuracy | | | 0.69 | 616 |
| Macro Avg | 0.43 | 0.34 | 0.34 | 616 |
| weighted Avg | 0.66 | 0.69 | 0.63 | 616 |

***3.2.2 CHART SHOWING THE LOGISTIC REGRESSION PRECISION, RECA***




**INTERPRETATION:**

The Logistic Regression model applied at Senior care indicates an overall accuracy of 69%, effectively identifying patterns that predict client churn. While perfect scores in classes 0 and 3 demonstrate its capability in specific scenarios, the model struggles with classes 4 and 5, evidenced by low F1-scores, which suggest areas for improvement. The model's varied performance across different classes, with a macro average precision and recall of 0.43 and 0.34 respectively, highlights the challenge of balancing recall and precision in practice. This analysis underscores the necessity for targeted strategies to enhance prediction accuracy and ensure more consistent outcomes across all classes.

**SUPPORT VECTOR MACHINE:**

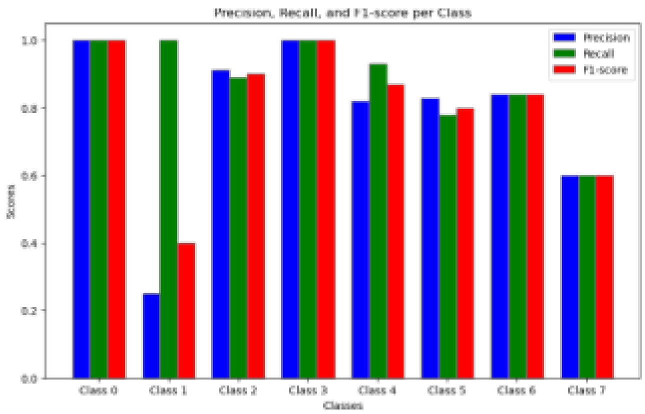
Support Vector Machine (SVM) is a robust model used to predict churn rate at Senior care by analyzing intricate patterns in customer data. SVM achieves this by establishing a hyperplane that best separates the data points of different classes, effectively identifying the key factors influencing customer churn.

The model's ability to provide interpretable coefficients offers valuable insights into which features are most closely associated with churn, aiding in strategic decision-making. SVM's probabilistic outputs enable the differentiation between clients likely to churn and those who are not, making it suitable for binary or multi-class classification tasks.

**Table 3.2.8 Table showing the Test score Trained in Support vector machine**

| Class | precision | Recall | F1-score | Support |
|---|---|---|---|---|
| 0 | 1.00 | 1.00 | 1.00 | 1 |
| 1 | 0.25 | 1.00 | 0.40 | 1 |
| 2 | 0.91 | 0.89 | 0.9 | 390 |
| 3 | 1.00 | 1.00 | 1.00 | 2 |
| 4 | 0.82 | 0.93 | 0.87 | 60 |
| 5 | 0.83 | 0.78 | 0.80 | 58 |
| 6 | 0.84 | 0.84 | 0.84 | 99 |
| 7 | 0.6 | 0.6 | 0.60 | 5 |
| Accuracy | | | 0.88 | 616 |
| Macro Avg | 0.78 | 0.88 | 0.80 | 616 |
| weighted Avg | 0.88 | 0.88 | 0.88 | 616 |

***3.2.2 CHART SHOWING THE SVM ANALYSIS OF PRECISION , RECALL , F1-SCORE PER CLASS***




**INTEREPTATION:**

The Support Vector Machine (SVM) model applied to Senior care showcases an 88% accuracy rate, indicating strong performance in identifying churn patterns among customers. Notably, while the model excels with perfect scores in classes like 0 and 3, it shows variability in classes 1 and 7 with lower precision and recall, highlighting potential areas for model tuning. The high recall in class 1 (1.00) suggests all positives are captured, but the precision at 0.25 points to a high false positive rate, affecting the F1-score adversely. The overall macro average of 0.78 and a weighted average of 0.88 reflect a decent balance across classes, emphasizing its capability in handling imbalanced data. SVM's robustness in pattern recognition and its distinct separation by hyperplanes suggest its strategic utility in proactively managing client retention and minimizing churn at Senior care .

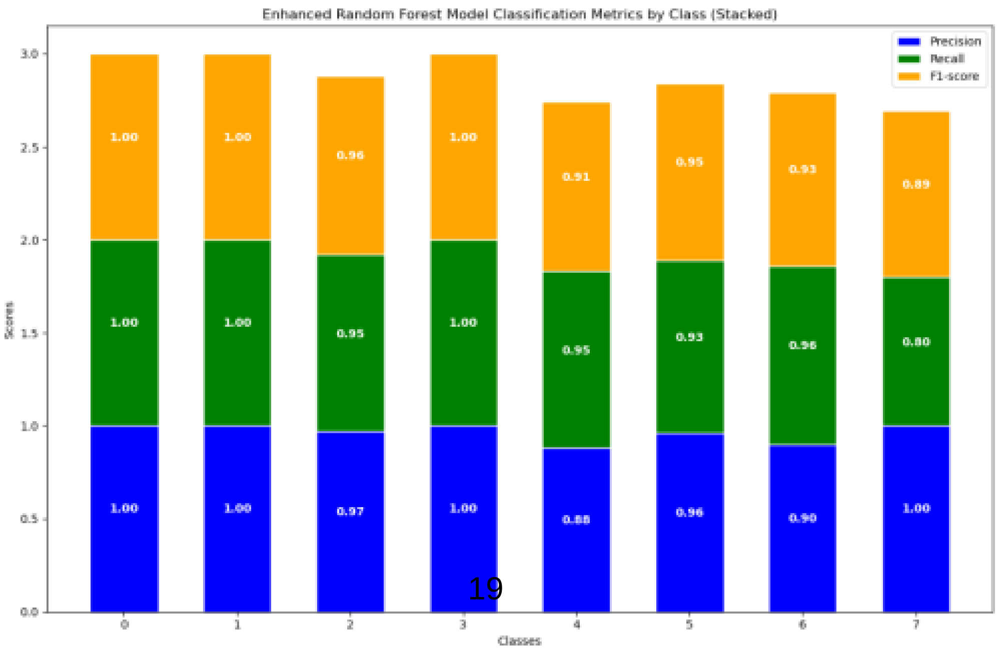
**RANDOM FOREST :**

Random Forest, a robust ensemble learning algorithm, is employed to predict the churn rate at Senior care by analyzing various customer data points. By constructing multiple decision trees and aggregating their predictions, Random Forest creates a powerful predictive model. This model offers valuable insights into the factors influencing churn, aiding strategic decision-making. Random Forest provides interpretable coefficients and excels at both binary and multi-class classification tasks,

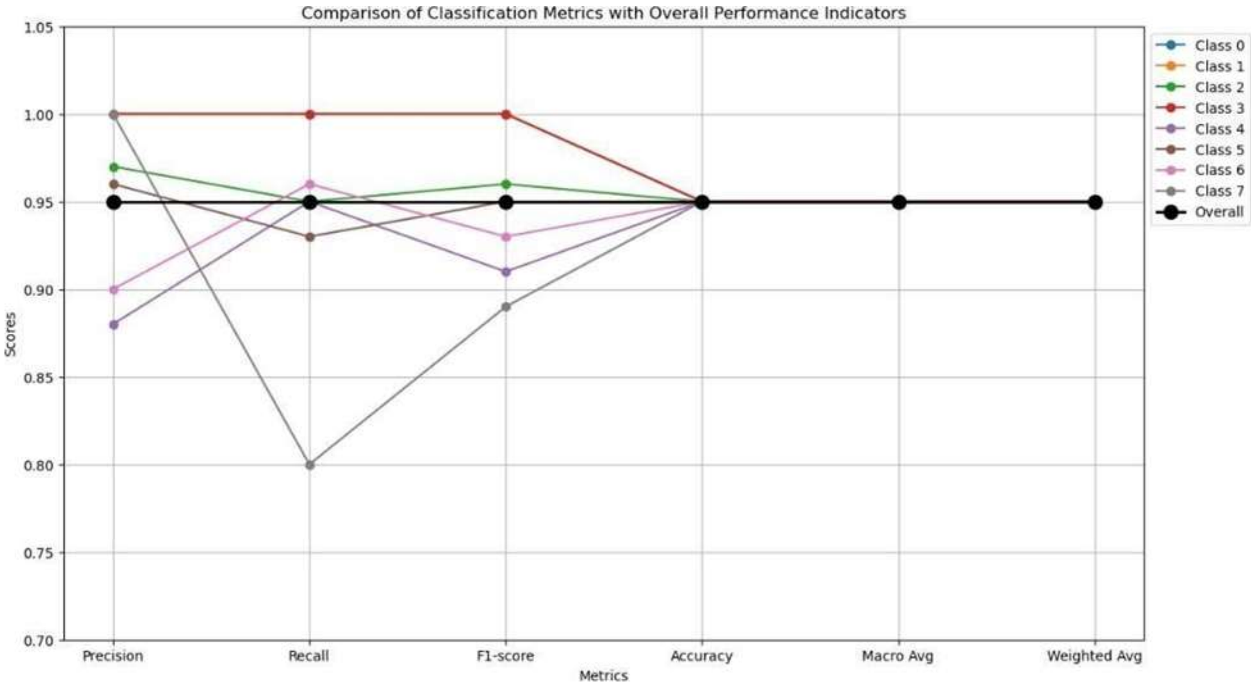
**Table 3.2.9 Table showing the Test score Trained in Random Forest**

| Class | precision | Recal | F1-score | Support |
|---|---|---|---|---|
| 0 | 1.00 | 1.00 | 1.00 | 1 |
| 1 | 1.00 | 1.00 | 1.00 | 1 |
| 2 | 0.97 | 0.95 | 0.96 | 390 |
| 3 | 1.00 | 1.00 | 1.00 | 2 |
| 4 | 0.88 | 0.95 | 0.91 | 60 |
| 5 | 0.96 | 0.93 | 0.95 | 58 |
| 6 | 0.90 | 0.96 | 0.93 | 99 |
| 7 | 1.00 | 0.80 | 0.89 | 5 |
| Accuracy | | | 0.95 | 616 |
| Macro Avg | 0.96 | 0.95 | 0.95 | 616 |
| Weighted Avg | 0.95 | 0.95 | 0.95 | 616 |

***3.2.2 THE CHART SHOWING THE ENHANCED RANDOM FOREST MODEL CLASSIFICATION METRICS BY CLASS, DISPLAYED IN A STACKED FORMAT FOR PRECISION, RECALL, AND F1-SCORE.***



***3.2.3 THE CHART SHOWING THE COMPARISON OF CLASSIFICATION METRICS WITH OVERALL PERFORMANCE INDICATORS FOR EACH CLASS IN A RANDOM FOREST MODEL ANALYSIS.***




**INTERPRETATION :**

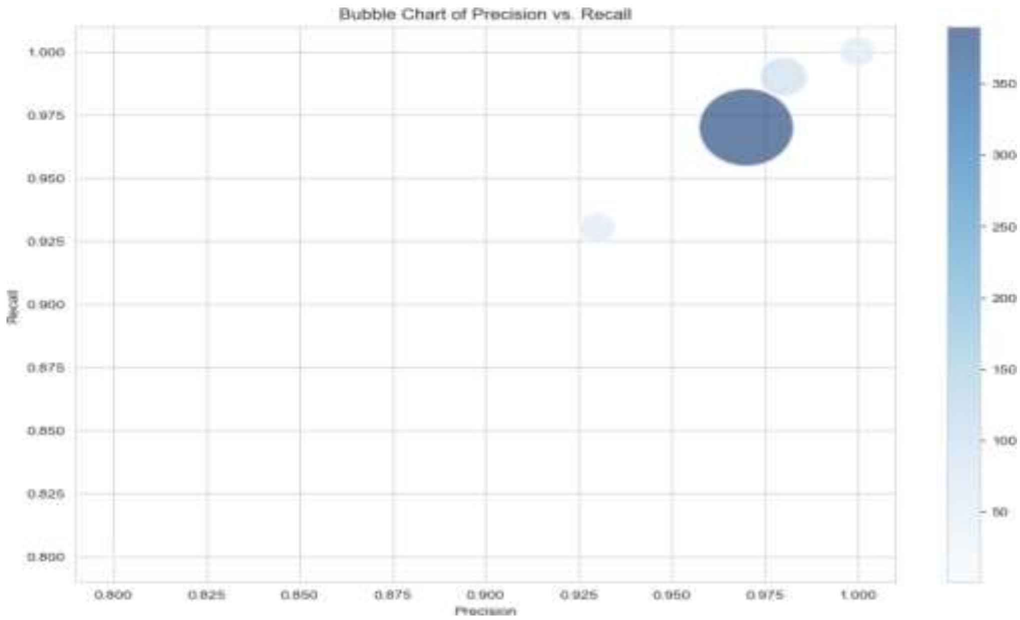
The Random Forest model employed at Senior care achieves a 95% accuracy rate, indicatingeffective churn rate predictions across classes. High precision and recall scores, particularly for Classes 0, 1, 3, and 7, denote extremely accurate predictions. Classes 2, 5, and 6 also perform well, with most metrics above 90%, though Class 4 slightly lags, suggesting room for improvement. The F1-scores near or above 90% across classes reflect the model's balanced detection capabilities. Both macro and weighted averages confirm consistent performance across varied class sizes, underscoring the model's reliability and efficiency in handling diverse data samples.

**GRADIENT BOOSTING :**

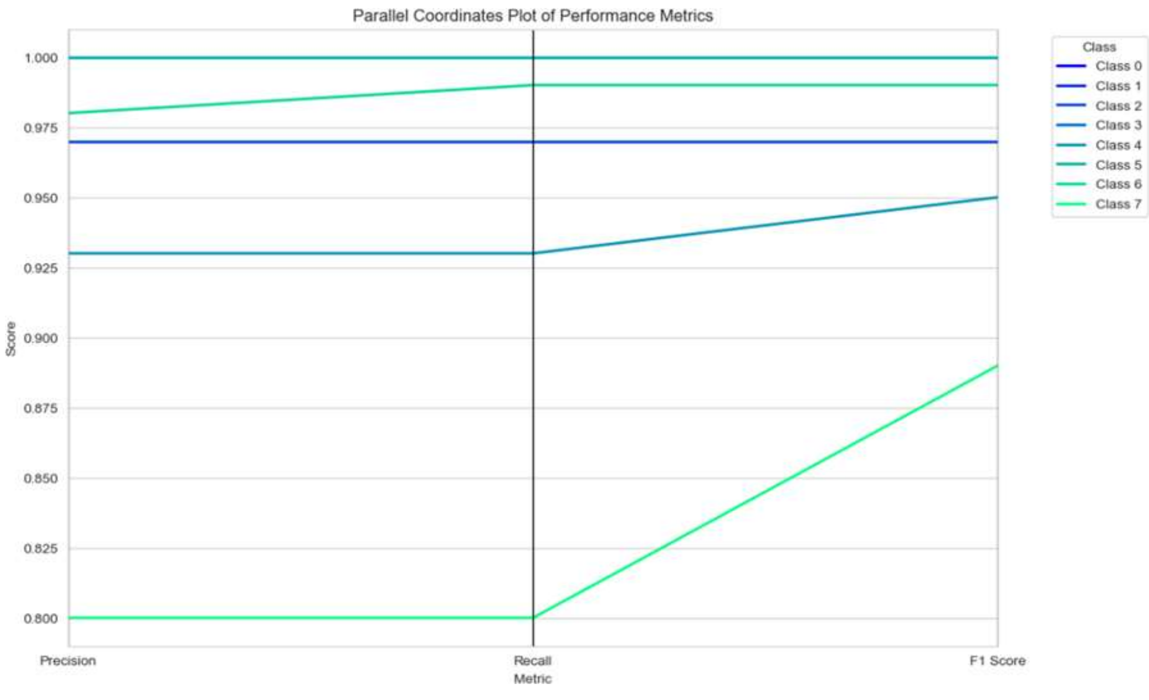
**Table 3.2.10 Table showing the Test score Trained in Gradient Boosting**

| Class | Precision | Recall | F1 score | spport |
|---|---|---|---|---|
| 0 | 1.00 | 1 | 1 | 1 |
| 1 | 1.00 | 1 | 1 | 1 |
| 2 | 0.98 | 0.97 | 0.98 | 390 |
| 3 | 1.00 | 1 | 1 | 2 |
| 4 | 0.97 | 0.93 | 0.95 | 60 |
| 5 | 1.00 | 1 | 1 | 58 |
| 6 | 0.99 | 0.99 | 0.95 | 99 |
| 7 | 0.8 | 0.8 | 0.89 | 5 |
| Accuracy | | | 0.97 | 616 |
| Macro avg | 0.98 | 0.96 | 0.97 | 616 |
| Weighted avg | 0.97 | 0.97 | 0.97 | 616 |

***3.2.8 THE CHART SHOWING THE BUBBLE REPRESENTATION OF OVERALL PERFORMANCE OF CLASS***




***3.2.9 THE CHART SHOWING THE BUBBLE REPRESENTATION OF OVERALL PERFORMANCE OF CLASS***




**INTERPRETATION :**

The model exhibits exceptional accuracy and reliability across most classes, achieving perfect precision and recall for several classes, indicative of its ability to accurately predict and correctly identify all instances without false positives or misses. The overall accuracy of 0.97 and consistent F1 scores near 1.00 highlight its efficacy in classification tasks across diverse data inputs. However, the performance in Class 7, with lower precision and recall, points to potential areas for improvement. The macro and weighted averages at 0.97 confirm the model's balanced performance, effectively managing class imbalance and maintaining high standards of predictive accuracy.

## CONCLUSION

The churn predictive analytics study at Senior care utilized machine learning models like Decision Trees, Logistic Regression, SVM, Random Forest, and Gradient Boosting to analyze customer behaviors and identify churn factors. Decision Trees excelled in precision and recall, proving effective for multi-class classifications due to their interpretability and operational applicability. Logistic Regression showed high accuracy in certain classes but was variable, highlighting areas for refinement. The ensemble nature of the Random Forest model enhanced its reliability by reducing variance and preventing overfitting. The analysis pinpointed significant performance variations across different classes, revealing the need for a balance between sensitivity and precision in predictive models. Recommendations to reduce churn included personalized care plans, a continuous feedback loop for model improvement, investment in advanced analytics, and techniques to correct data imbalances. These strategies aim to boost churn prediction accuracy, customer satisfaction, and retention. Overall, the study illustrates the transformative potential of machine learning in healthcare service delivery and customer management. By advancing analytics and refining models, Senior care can improve operational strategies, reduce churn, and promote a more engaging customer experience, setting astandard for similar analytics in service industries.