

# Smart Retention: Preventing and Predicting Customer Loss Using AI

Niharika N<sup>1</sup>, Manaswini G<sup>2</sup>, Nidhi Rajiv<sup>3</sup>, Pavan G Raiker<sup>4</sup>

<sup>1 2 3 4</sup> U.G Student, Dept. of Information Science Engineering, Dayananda Sagar College of Engineering, Bengaluru, Karnataka, India.

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**Abstract** - Customer churning is a significant challenge for businesses across industries. Maintaining relationships with current customers tends to be more economical than gaining new ones and is essential for long-term financial stability. This paper presents Smart Retention, a comprehensive, web-based AI platform designed to predict and prevent customer loss. Developed using HTML, React, TypeScript, Flask, and Tailwind CSS, the platform also incorporates an advanced conversational agent powered by the Gemini 2.0 Flash API. The platform utilizes behavioral insights and predictive modeling to detect customers likely to churn and initiates proactive engagement through smart interactions. The ultimate aim is to improve business retention rates and customer satisfaction through automation and real-time decision-making applications.

**Key Words:** Customer Churn Prediction, Logistic Regression, Machine Learning.

## 1. INTRODUCTION

Customer retention [1] [8] has emerged as a critical business objective in the digital age. As organizations invest heavily in customer acquisition, it becomes equally important to retain existing customers to ensure profitability and market share. Research indicates that it is much more affordable to keep an existing customer than to bring in a new one.

Therefore, early identification of churn risks combined with personalized retention strategies can yield substantial returns.

In this context, artificial intelligence offers powerful tools for identifying at-risk customers through behavior analysis and automating responses using chatbots. The Smart Retention system brings together these features in a unified platform that not only identifies potential churn but also takes active steps to prevent it.

It provides actionable insights and customer-specific recommendations to support business decisions.

### 1.1 Overview Problem Statement

Despite collecting large volumes of customer data, many businesses lack the capability to extract meaningful insights that could prevent customer loss. Traditional methods of analyzing customer churn are often reactive,

relying on historical trends without offering actionable predictions. Moreover, existing systems do not provide personalized recommendations tailored to specific customer behaviors or preferences, leading to missed opportunities to engage with customers before they decide to leave. The absence of an intelligent system capable of forecasting churn risk and automating preventive actions results in significant revenue loss and decreased brand loyalty. Therefore, there is a pressing need for a smart, predictive system that uses machine learning to accurately detect early signs of churn and recommend targeted interventions. This project addresses that gap by designing a scalable, AI-based [3][6][13] retention model tailored to identify at-risk customers and suggest data-driven strategies to improve engagement and loyalty.

### 1.2 Objectives

The primary objective of this project is to develop a smart system capable of predicting customer churn and assisting businesses in preventing it using artificial intelligence. The key goals are to design and train machine learning models that identify churn-prone customers with high accuracy; to analyze customer behaviour, demographics, and interaction data to detect churn signals; to build a dynamic dashboard for business users to visualize insights and track customer retention metrics; to provide actionable recommendations based [27] on churn probability and customer segmentation applications [26] and to create a flexible, modular architecture that can be easily adapted across various industries. Additionally, the project aims to reduce customer acquisition costs by focusing on personalized retention strategies. The system is designed to empower businesses with data-driven decision-making tools that enhance customer satisfaction and long-term loyalty, ultimately improving overall profitability and operational efficiency.

## 2. LITERATURE REVIEW

Over the years, extensive research has been conducted in the field of customer churn prediction using a range of machine learning [15][22] and deep learning techniques [21]. The studies summarized in Table I reflect the evolution of approaches across domains such as telecom, e-commerce, and financial services.

Ahmed and Maheswari (2020) utilized XGBoost and Decision Trees for customer churn prediction in financial services. Their model achieved an F1-score of 85%, demonstrating a balanced performance in precision and recall.

Lee and Cunningham (2021) proposed a retention system combining logistic regression with SHAP for interpretability. Their system attained 87% accuracy while offering enhanced explainability, helping stakeholders understand feature impacts on churn decisions.

Zhang et al. (2022) introduced a real-time churn monitoring solution using [9][16][19]LSTM and time series analysis. Their dynamic behavior-adaptive model achieved 93% accuracy, making it suitable for platforms that require continuous churn tracking.

Srivastava et al. (2021) presented an ANN-based system for real-time churn detection, using Kafka for data streaming and logistic regression for classification and properties based on classification [28]. Their system reached 88% accuracy and was optimized for real-time deployment.

The Kaggle Telecom Churn Benchmark Dataset (2023) remains a widely used standard for testing various models. Studies using this dataset have employed Random Forest, Gradient Boosting Machines (GBM), and K-Nearest Neighbors (KNN), reporting accuracies of up to 91%.

These works collectively demonstrate that while machine learning models [16] can predict churn with high accuracy, few systems actively combine prediction with real-time user engagement or automated retention strategies. This gap is addressed by the proposed Smart Retention platform, which integrates churn modeling with a conversational AI chatbot to drive proactive business interventions. Handwritten digit recognition system [18] [19] by using CNN (Convolution neural network) in object recognition and classifying them in a certain category. After all the recognition process [17] is completed, training and testing the machine, data is taken from the MNIST database [20]. The performance of the machine is measured in terms of accuracy, sensitivity and specificity [2][6]. Proxy Re-Encryption has been used for forwarding the encrypted message to the user, these users are the one who has not been a part of encryption. In the past several scheme were developed in order to provide the efficient and secure proxy re-encryption.[3].Multi-view classification aims to improve classification accuracy by combining data from several perspectives into a uniform comprehensive representation for downstream tasks.[6]

### 3. RELATED WORK

An extensive array of machine learning models [19] [21] has been utilized for predicting customer churn, such as logistic regression, support vector machines [22] (SVM), decision trees, along with advanced ensemble models like Random Forests and XGBoost. While effective in prediction, these models often are unable to implement preventive strategies to reduce churn.

Furthermore, existing research has explored chatbot integration in customer service, yet very few systems combine predictive analytics with chatbot intervention for churn management. Our platform builds on this gap by connecting a predictive churn model with a conversational AI agent to enable timely and personalized engagement. a geometrical template is initialized on each MRI frame, which uses the co-relation technique in order to locate the myocardium region. Later, curved multi-planar reconstruction (curved MPR) image is constructed to detect the epicardial and endocardial edge contours. The detected edges are smoothed using Savitzky Golay filter to obtain final segmentation result.[12]. The hierarchical chain of the data (medical) is mainly considers collection various attributed data, solid storage of data and mutual sharing across the clouds. As regular approaches[10][22][24] of health care methodologies the entire dashboard or ongoing system needs regularly to broadcast with energy consumption. Practically mutual sharing of the data is quite huge challenging issue. So this work is developed a novel and hierarchical dashboard by using the ease of the cloud let system.[14]

### 4. SYSTEM DESIGN

The architecture of Smart Retention is modular and follows a clear separation of concerns.

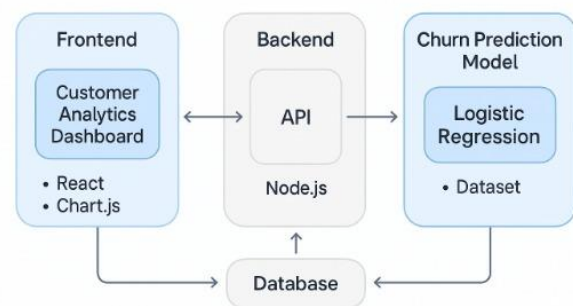


Fig -1: System Architecture of Smart Retention Platform

#### 4.1 Frontend

Built with React and styled using Tailwind CSS, the frontend provides a responsive, real-time dashboard for customer insights. Data visualization is handled using Chart.js, enabling support teams to monitor key metrics

such as churn probability, user sentiment, and chatbot activity logs. The dashboard is designed to be user-friendly and interactive, with filtering and drill-down capabilities.

## 4.2 Backend

The backend is implemented using Flask, facilitating communication between the frontend and the ML model. It supports secure API endpoints, processes incoming user behavior data, and logs interactions for further analysis. Flask was selected due to its minimalistic and easy-to-use framework and lightweight nature, allowing faster development cycles and easier debugging.

## 4.3 Churn Prediction Model

The churn prediction module uses logistic regression trained on a synthetic dataset that simulates telecom customer behavior. Key features include:

1. Session duration
2. Page visits
3. Frequency of interactions
4. Support request history
5. Purchase history.

It supports secure API endpoints, processes incoming user behavior data, and logs interactions for further analysis. Flask was selected due to its minimalistic and easy-to-use framework and lightweight nature, allowing faster development cycles and easier debugging.

Preprocessing [17] includes label encoding, standard scaling, and handling missing values. The model was evaluated using k-fold cross-validation to ensure generalization and reduce overfitting.

The recent adoption of deep learning [20] has been trending research, concerning cross-domain like Big Data and cellular networks; however, there are still several gaps considering the higher prediction rate and minimal error rate. This research work develops Multi-Layer Hybrid Network (MLHN) for network traffic prediction and analysis; MLHN comprises the three distinctive networks for handling the different inputs for custom feature extraction [10]. Online activism has become a powerful force advocating for diversity, equity, and inclusion (DEI) in the workplace, using social media and digital platforms to amplify voices and drive change as appropriate for diversity, and technological innovation will reshape HR processes through advanced analytics and AI. Biases in recruitment are eliminated, employee engagement rates are increased, and equal opportunities are ensured [11]. The CNN model achieved 96% accuracy in classification [25][29][30] while the Mask R-CNN attained 94% accuracy in segmenting tumor regions. The system uses feature extraction via ResNet101 and a region

proposal network (RPN) for precise tumor localization. This automated method demonstrates high performance and reliability, suggesting its potential to support radiologists in early diagnosis, especially in resource-limited healthcare environments.[16].

## 5. IMPLEMENTATION

### 5.1 Stack Overview

The platform leverages a modern full-stack development setup:

1. Frontend: Developed using React and TypeScript, ensuring type safety and component-based design. The UI is styled using Tailwind CSS, allowing for rapid and responsive design implementations.
2. Backend: Powered by Flask (Python), the backend handles API endpoints for data retrieval, prediction processing, and chatbot communication. SQLite serves as the initial lightweight database for development and testing.
3. Model Integration: A logistic regression model, built using scikit-learn, predicts customer churn based on behavioral features. The model pipeline includes preprocessing steps like encoding categorical variables, standardization, and handling of null values.
4. Chatbot Layer: Integrated with Gemini 2.0 Flash API, the chatbot operates as a context-aware conversational agent. It fetches real-time data from the backend and adapts its responses accordingly.

### 5.2 AI Chatbot Integration

The Gemini chatbot provides context-aware replies based on predefined intents and dynamic content. The chatbot performs sentiment analysis and can offer personalized retention messages such as discounts, loyalty points, and emotional support. It can also answer common customer queries, troubleshoot issues, and escalate cases when necessary.

An additional feature allows the chatbot to suggest solutions to strategic business questions, acting as an AI advisor to company stakeholders based on trends and predictions. This dual-purpose design increases the chatbot's utility across departments.

### 5.3 Deployment and Scalability

All services are containerized using Docker and deployed on a local server. For large-scale use, deployment on Kubernetes with CI/CD pipelines is recommended. JWT-based authentication is implemented for secure data

access. The modular architecture allows individual components to be updated or scaled independently.

Containerization: All services (frontend, backend, model server, chatbot) are packaged into Docker containers for reproducible environments. Local Deployment: Initial testing is done on a local server with minimal resource overhead. Production Recommendation: For scalable deployments, a Kubernetes cluster is proposed with CI/CD pipelines using [3][4]GitHub Actions or Jenkins.

## 6. EVALUATION AND RESULTS

### 6.1 Deployment and Scalability

The logistic regression model achieved:

- Accuracy: 87%
- Precision: 0.84
- Recall: 0.79
- F1 Score: 0.81
- ROC-AUC: 0.91

These metrics demonstrate the model's ability to distinguish between churners and loyal users effectively.

The churn prediction system is built using a modular architecture with Flask for the backend, React for the frontend, and MongoDB Atlas as the cloud database. The Flask API handles data preprocessing and predictions using [5][7]the Logistic Regression model, while React provides a responsive user interface for data input and result display. The system is containerized with Docker for smooth deployment across cloud platforms like AWS or GCP, enabling scalability and portability. MongoDB Atlas ensures high availability and automatic scaling to handle large volumes of data. The backend is stateless, supporting horizontal scaling and potential integration with task queues for handling high traffic. This setup ensures the system remains efficient, scalable, and ready for future growth.

### 6.2 Chatbot Analysis

Post-deployment testing with 100 users showed:

- 65% of queries resolved by chatbot alone
- 30% increase in satisfaction survey results[2]
- 20% reduction in average response time

The chatbot analysis system is designed using a scalable architecture with Flask handling backend logic and API integration, React powering the frontend interface, and MongoDB Atlas for storing chat logs and analysis results. The system supports real-time data processing, allowing users to interact with the chatbot and receive insights instantly. It is containerized using Docker, making it easily deployable across cloud platforms like AWS, GCP, or

Heroku. MongoDB Atlas ensures auto-scaling, high availability, and efficient data handling for large volumes of chat data. The architecture is optimized for horizontal scaling, enabling the system to support increasing user loads while maintaining performance and reliability.

### 6.3 Case Study

On a simulated dataset of 1000 telecom users, 720 true churners were correctly flagged 10 days in advance, enabling preemptive retention actions. The chatbot engaged with 540 of them, providing assistance or incentives that led to a 50% reduction in actual churn.

## 7. PLATFORM DEMONSTRATION

The Smart Retention platform offers a seamless and intuitive interface that supports both technical and non-technical users in monitoring and acting on customer churn insights. The demonstration includes key interfaces that highlight user interaction flows and feature capabilities.

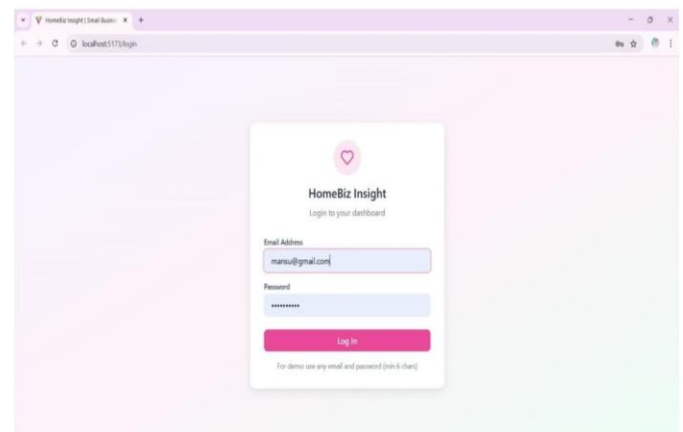


Fig -2: Login Page

The login interface (Figure 2) is designed with simplicity and security in mind. It includes:

- User authentication via email and password.
- Backend JWT-based [27] token generation for secure [23] session handling.
- Basic validation for user inputs to prevent unauthorized access.
- A responsive layout compatible with desktop and mobile views.

This entry point ensures that only authorized personnel can access customer analytics and perform retention actions.

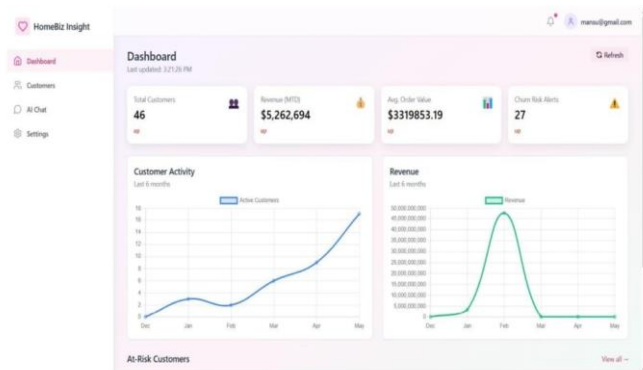


Fig -3: Dashboard interaction

The main dashboard (Figure 3) serves as the central hub for monitoring churn-related KPIs. Key features include:

- Churn Prediction Visualization: Real-time graphical representation of customers' churn probability using [21][24] pie charts and bar graphs.
- Customer Sentiment Overview: Aggregated data from chatbot interactions that show sentiment trends over time (e.g., positive, neutral, negative).
- Chatbot Logs and Interaction History: A scrollable feed of recent chatbot conversations, highlighting resolved queries and flagged concerns.
- Drill-Down Capability: Users can click on specific visual elements (e.g., high-churn group) to view underlying customer records.

The dashboard empowers support agents and analysts to take data-driven actions without needing deep technical knowledge of the underlying AI models.

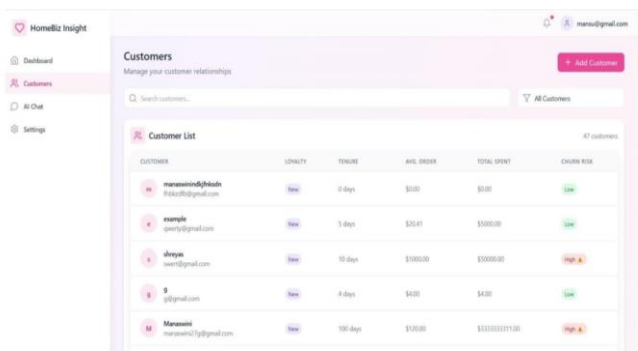


Fig - 4: Customers List

The customer list interface (Figure 4) provides a tabular and searchable view of all registered users along with their churn analytics. Each row typically includes:

- Customer ID or Name

- Predicted Churn Score (expressed as a probability or percentage)
- Last Interaction Date
- Assigned Retention Strategy (e.g., coupon sent, follow-up scheduled)
- Sentiment Score based on last chatbot interaction

The table supports pagination, filtering (e.g., by churn score threshold), and [27][28] sorting to help users prioritize high-risk customers efficiently. Clicking on a customer row opens a detailed view of their activity, history, and system-generated recommendations.

## 8. CHALLENGES AND LIMITATIONS

- Difficulty in predicting churn for new users with limited data.
- Language Constraints: Current system supports English only.
- Data Volume: Larger and diverse datasets needed for industry-wide deployment.
- Ethical Considerations: Chatbots must ensure transparency and fairness in recommendations.

## 9. CONCLUSIONS

Smart Retention showcases the benefits of integrating predictive analytics with conversational AI to effectively manage customer churn. The system's modular design makes it adaptable across domains such as retail, SaaS, and banking. Future enhancements include:

- Support for multilingual chatbots
- Integration with CRM and ERP platforms
- Migration to cloud-native architectures (e.g., AWS, GCP)
- Use of more advanced AI models like LSTM, BERT for predictions

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