



Development of a Multilanguage Chatbot for the Financial Banking System

Data Science and Artificial Intelligence, University of Greenwich, 30 Park Row, Greenwich, UK. (Submitted 06/09/2024)



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Abstract: This dissertation explores the development and implementation of a prototype multilingual chatbot designed to enhance customer assistance on websites. Utilizing Dialogflow as the chatbot development platform, Firebase for hosting and domain services, and Firestore for data management, the project integrates these technologies to offer real-time, multilingual support. The chatbot employs natural language processing (NLP), natural language understanding (NLU) and machine learning (ML) to interact with users in various languages, thereby improving accessibility and user experience. Conversations are systematically recorded in Firestore under ChatsHistory and ChatSession categories for future reference and analysis. This prototype aims to streamline customer service operations, reduce costs, and provide consistent support across different linguistic contexts. The dissertation assesses the prototype's effectiveness and potential implications for customer service in the digital landscape. The prototype is available at: <https://bank-fprl.web.app/>

Keywords: Multilingual chatbot, Dialogflow, Firebase, Firestore, Natural Language Processing, Machine Learning, Customer Assistance, Fintech, Banking industry.

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Chapter 1: Introduction

In the contemporary landscape of digital transformation, businesses are increasingly turning to advanced technologies to optimize customer service. Among these innovations, multilingual chatbots have emerged as a pivotal tool for providing real-time, automated support across diverse linguistic environments. This dissertation investigates a prototype multilingual chatbot designed to enhance customer interactions on websites. The chatbot integrates Dialogflow for conversational capabilities, Firebase for hosting and domain management, and Firestore for storing chat data (Eleni Adamopoulou, 2020).

Aims:

To develop a sophisticated chatbot solution for Secure Bank using Google Dialogflow, Firebase, and MongoDB, with the goal of providing an efficient, responsive, and versatile chatbot capable of handling diverse user interactions and managing data effectively.

Objectives:

1. **Integration of Technologies:** To seamlessly integrate Google Dialogflow for natural language processing, Firebase for hosting, and MongoDB for data storage, ensuring a cohesive and functional chatbot system.
2. **Dynamic Interaction Management:** To design and deploy a Flask-based webhook that effectively manages and processes chatbot interactions, ensuring reliable and timely responses.
3. **Extensive Testing:** To conduct extensive testing of the chatbot across various languages and interaction methods to ensure its versatility and reliability in real-world scenarios.
4. **Data Management:** To implement robust data handling practices using MongoDB for storing and managing chat history and session data, ensuring accurate and efficient data retrieval.
5. **Future Enhancements:** To lay the groundwork for future enhancements, including expanded language support, advanced machine learning integration, and potential external system integrations, to continuously improve the chatbot's capabilities and user experience.

Problem Statement

Despite the advancements in chatbot technology, many current solutions struggle with limited language support, lack of contextual understanding, and inadequate integration with diverse data systems. These issues result in suboptimal user experiences, as chatbots often fail to handle complex queries effectively or provide personalized responses. Additionally, the integration of chatbots with dynamic data management systems remains a challenge, leading to inefficiencies in handling and retrieving user interaction data. Addressing these limitations is crucial for developing a more versatile, responsive, and efficient chatbot solution that can better meet user needs and seamlessly integrate with various data systems.

Evolution of Chatbots

The development of chatbots, also known as conversational agents, has evolved significantly since the 1960s. The early chatbot, ELIZA, created by Joseph Weizenbaum, utilized pattern matching and substitution to simulate conversation (Weizenbaum, 1966). Subsequent systems like PARRY and Racter introduced more sophisticated AI techniques, though they remained rudimentary by today's standards (Shah, n.d.). In the 21st century, advancements in natural language processing (NLP) and machine learning (ML) have transformed chatbots into highly capable systems. Modern chatbots such as Apple's Siri, Amazon's Alexa, and Google Assistant leverage NLP to understand and process user input, delivering contextually relevant responses (Chen, 2024). According to (Eleni Adamopoulou, 2020), A growing increase in the use of chatbots was observed, especially after 2016 (Figure 1).

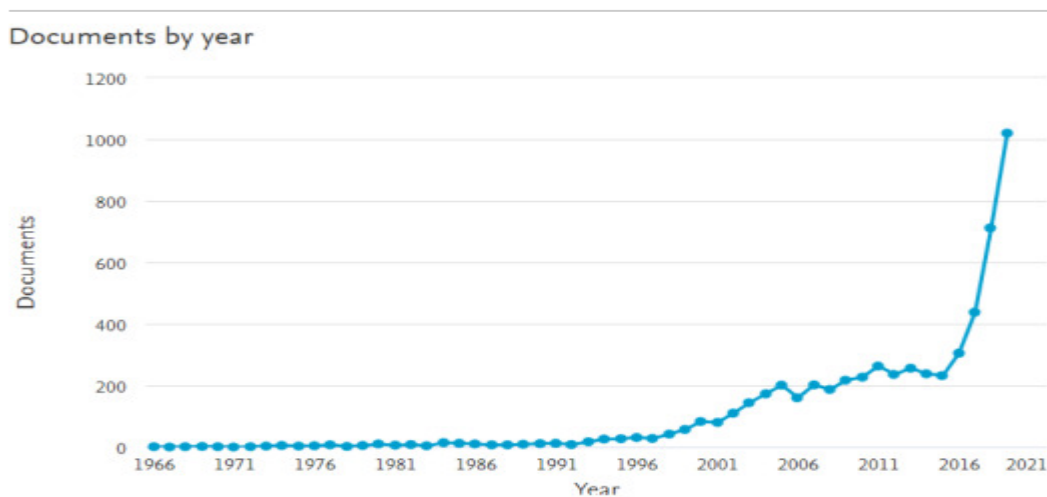


Figure 1: Usage of Chatbots

The USA leads in research on chatbots, with the highest number of published papers. The United Kingdom and Japan follow, each contributing less than one-third of the number of papers published in the USA (Eleni Adamopoulou, 2020), (Figure 2).

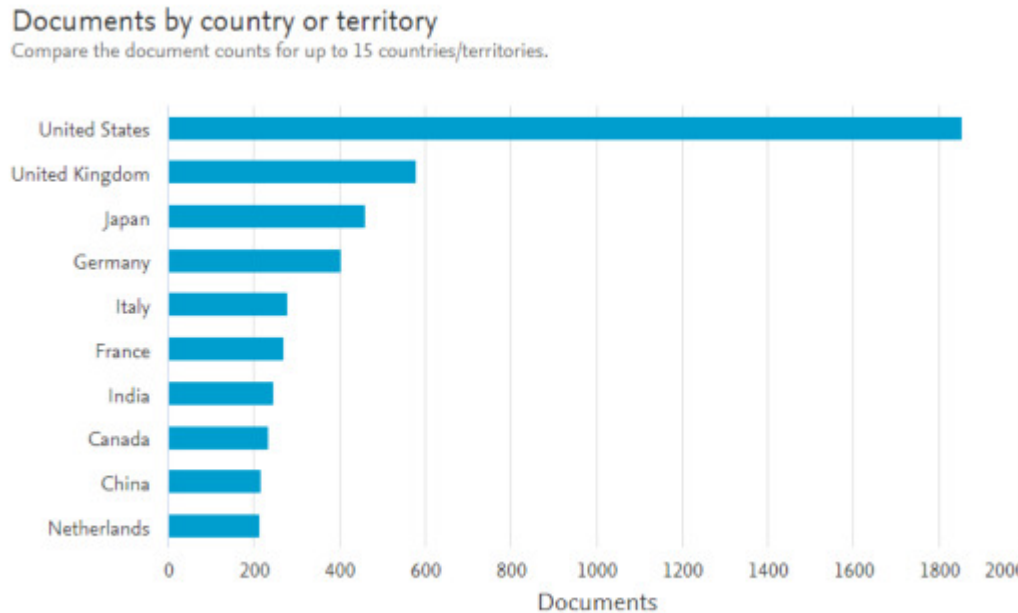


Figure 2: Leading Countries to Research on Chatbots

Importance of Multilingual Capabilities

In an increasingly globalized market, the ability to interact in multiple languages is crucial for customer service. Multilingual chatbots utilize advanced NLP and translation APIs to provide seamless interactions in various languages. This functionality is essential for businesses operating in multilingual regions, as it ensures accessibility and improves the overall user experience (Kasinathan, 2021). By integrating these capabilities, businesses can offer consistent support across different languages, thereby enhancing customer satisfaction and engagement.

Role of APIs in Chatbot Integration

Application Programming Interfaces (APIs) are fundamental to the integration and functionality of modern chatbots. APIs facilitate communication between different software systems, enabling chatbots to access external services and data (Hajian, 2019). For multilingual chatbots, APIs connect to translation services such as Google Translate and Microsoft Translator, allowing real-time language processing and translation (Adeniyi, 2022). This integration is crucial for maintaining coherent and contextually accurate interactions in multiple languages.

Chatbots in the Banking Sector

The banking sector has significantly benefited from the implementation of chatbots. Traditionally reliant on human agents and physical branches, banks are now utilizing chatbots to offer round-the-clock support, handle routine queries, and process transactions (Eleni Adamopoulou, 2020). The addition of multilingual support allows banks to cater to a global customer base, improving accessibility and enhancing service quality (Zarei, 2024). This evolution highlights the potential of chatbots to transform customer service practices in the financial industry (Figure 3).

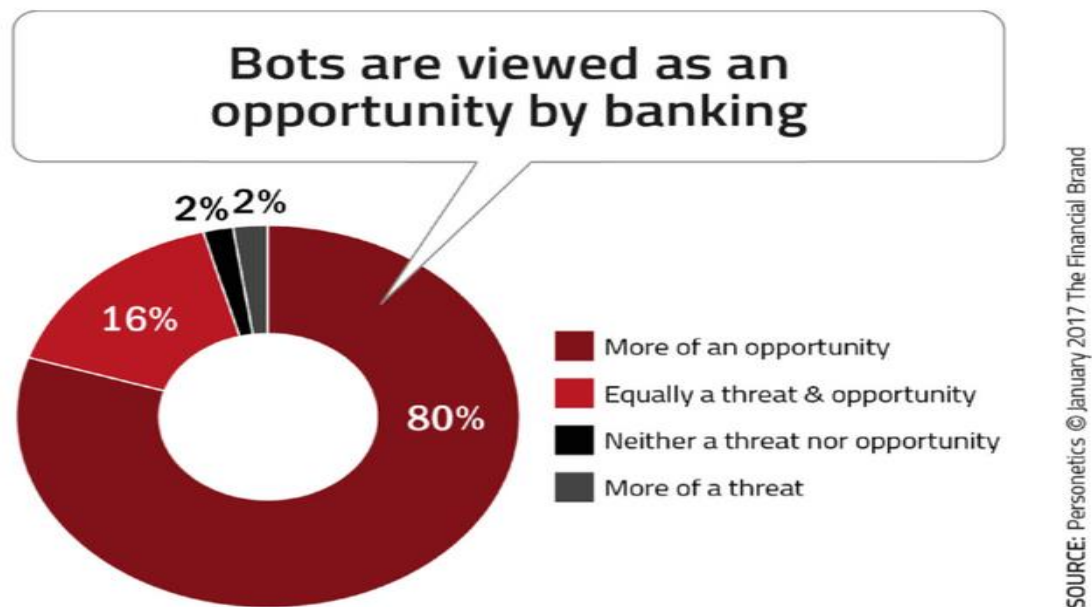


Figure 3: Banks Opinion on Chatbots

Prototype Overview

This dissertation presents a prototype multilingual chatbot integrated into a website, developed using Dialogflow, Firebase, and Firestore. The chatbot is designed to record interactions in Firestore under ChatHistory and ChatSession categories, providing a structured approach to managing and analyzing customer conversations. The prototype aims to demonstrate how modern chatbot technology can streamline customer service operations and improve service delivery in a multilingual context.

Chapter 2:

Literature Review

Overview: The rapid advancement of technology in recent years has brought about significant innovations in customer service, with multilingual chatbots emerging as a critical tool for enhancing customer interaction and streamlining service delivery. These chatbots, particularly when integrated with Application Programming Interfaces (APIs), have revolutionized customer assistance by providing real-time, automated support. This literature review examines the evolution of chatbots and APIs, their integration within the banking sector, and their current efficacy in improving customer service.

2.1) Evolution of Chatbots

Early Developments

The concept of chatbots, or conversational agents, began in the mid-20th century with Joseph Weizenbaum's creation of ELIZA in the 1960s. ELIZA utilized pattern matching and substitution methodologies to simulate human-like conversations, marking the inception of conversational agents (Weizenbaum, 1966). Following ELIZA, systems such as PARRY and Racter introduced early forms of artificial intelligence, albeit with limited sophistication (Schöbel, 2024). These early chatbots laid the groundwork for future developments in conversational technology.

Modern Chatbots

The 21st century has seen transformative advancements in chatbot technology, primarily driven by breakthroughs in natural language processing (NLP) and machine learning (ML). Modern chatbots, such as Apple's Siri, Amazon's Alexa, and Google Assistant, leverage NLP to interpret and respond to human language with increasing accuracy and contextual relevance (Chen, 2023). These systems handle complex queries and perform a range of tasks, integrating seamlessly into contemporary customer service strategies.

Multilingual Capabilities

In a globalized market, multilingual chatbots are crucial for businesses seeking to engage with a diverse customer base. These chatbots utilize advanced NLP and language translation APIs to facilitate interactions in multiple languages. This capability is essential for businesses operating in multilingual environments, as it ensures that support is accessible and consistent across different linguistic regions (Skrodelis, 2023). By integrating multilingual support, chatbots can offer enhanced user experiences and broaden their reach to a global audience (Figure 4).

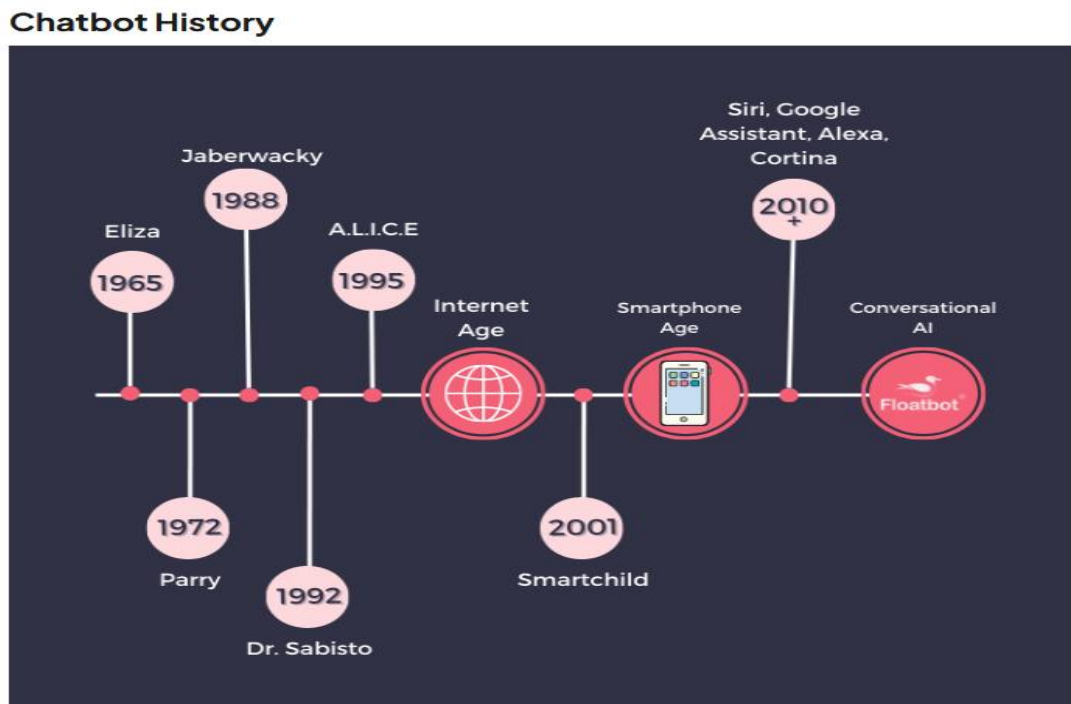


Figure 4: Evolution of Chatbot. Source: Floatbot.

2.2) APIs and Their Role in Chatbot Integration

Definition and Early Use

Application Programming Interfaces (APIs) are fundamental tools that allow different software systems to communicate and share data efficiently. Originating in the early days of software development, APIs have facilitated the interaction between various system components, enabling more cohesive and integrated software solutions (Hajian, 2019).

Modern Integration

In the current digital landscape, APIs play a pivotal role in integrating chatbots with diverse platforms and services. APIs enable chatbots to access real-time data, perform transactions, and interact with other applications seamlessly. For example, in the banking sector, APIs can allow chatbots to retrieve account information, process transactions, and offer financial advice, thereby enhancing their functionality and scope (Hajian, 2019).

API-driven Multilingual Chatbots

APIs are instrumental in developing multilingual chatbots by providing access to translation services and NLP engines. These APIs enable chatbots to process language-specific queries and deliver accurate responses by connecting to translation services such as Google Translate or Microsoft Translator. This integration ensures that chatbots maintain coherence and contextual accuracy while switching between languages, offering a seamless multilingual experience (Khandagale, 2024), (Figure 5).

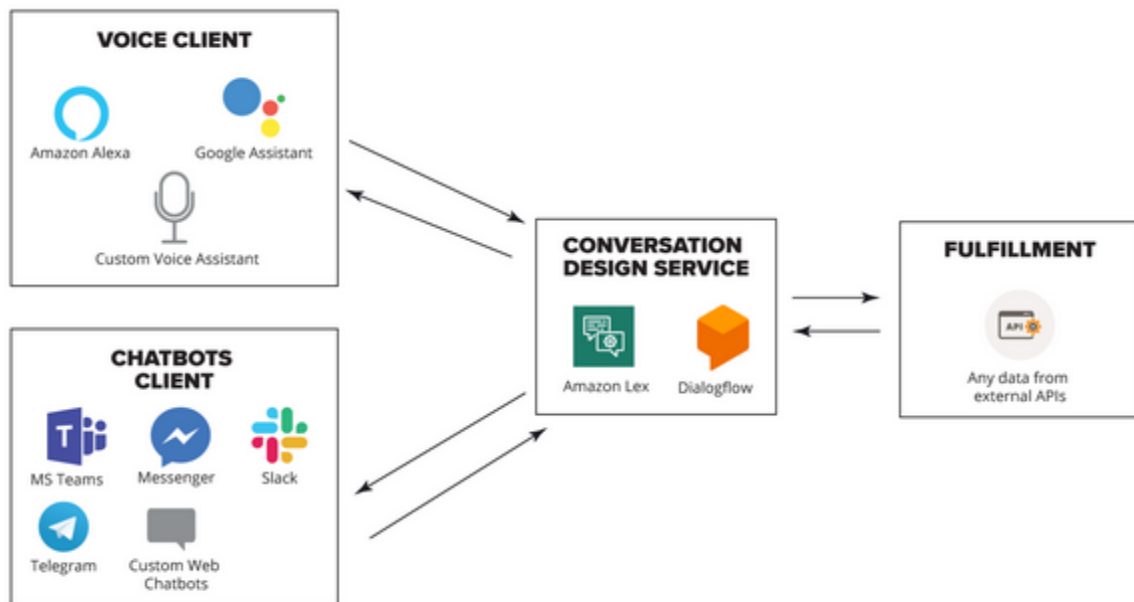


Figure 5: A High-Level Integration Workflow. Source: Google.

2.3) Chatbots in the Banking Sector

Historical Context

Traditionally, banks relied heavily on human agents and physical branches for customer service, resulting in long wait times, limited accessibility, and higher operational costs. The rise of digital banking has prompted banks to explore automated solutions to improve service delivery and reduce costs (Weizenbaum, 1983).

Modern Chatbot Deployment

The deployment of chatbots in the banking sector has revolutionized customer service by providing instant, 24/7 support. Modern banking chatbots handle a range of inquiries, from balance checks to loan applications, using AI to understand customer intent and execute transactions without human intervention (Eleni Adamopoulou, 2020). This advancement has significantly improved service efficiency and accessibility.

Integration of Multilingual Support

Given the global nature of banking, integrating multilingual support into chatbots is vital. Multilingual chatbots enable banks to provide consistent service regardless of language preferences, thereby enhancing accessibility and customer satisfaction. For instance, a multilingual chatbot can assist a French-speaking customer with the same level of service as it would to an English-speaking customer, ensuring uniform support across different languages (Ekechi, 2024), (Figure 6).

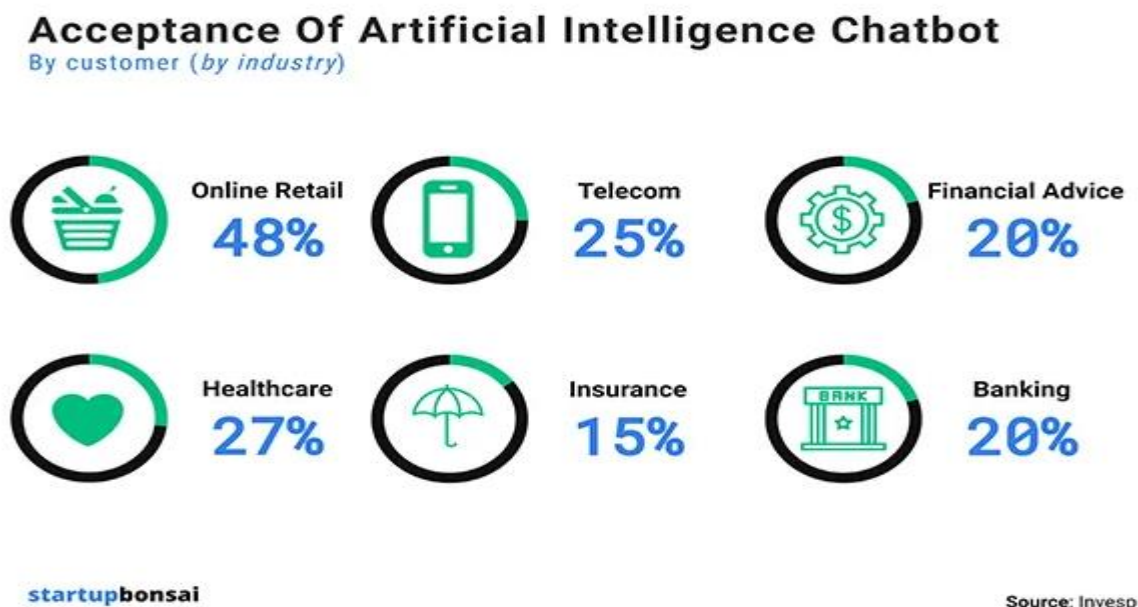


Figure 6: Acceptance of Artificial Intelligence Chatbot. Source: Core Devs LTD.

2.4) Current Trends and Future Directions

Enhancing User Experience

The integration of APIs and multilingual capabilities in chatbots is driving innovations in user experience. Businesses are increasingly focused on making interactions more intuitive and personalized by leveraging AI and data analytics. This trend is evident in the banking sector, where chatbots are being enhanced to provide tailored financial advice and proactive support (Aslam, 2023), (Figure 7).



Figure 7: Potential Benefit of Chatbot in Banking System. Source: Springs.

Expanding Functionalities

Future developments aim to expand the functionalities of chatbots by incorporating advanced AI techniques and broader API integrations. This evolution will enable chatbots to handle more complex tasks, such as fraud detection, financial planning, and investment advice, further solidifying their role in customer assistance (Skrebeka, 2021), (Figure 8).

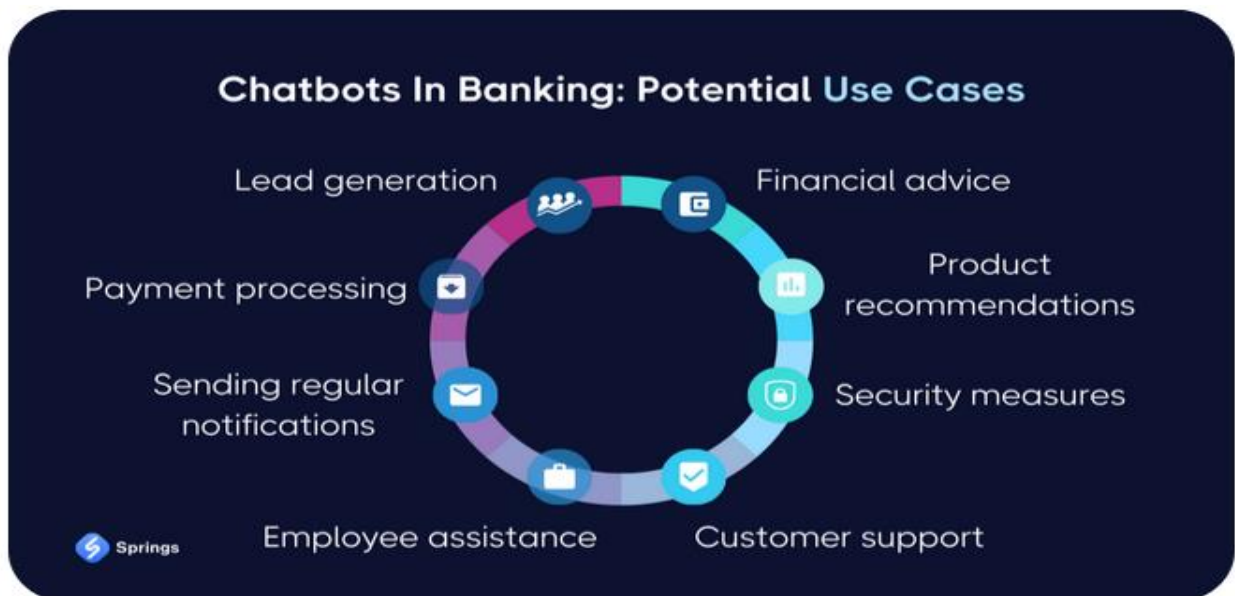


Figure 8: Potential Use Cases of Chatbot in Banking. Source: Springs.

2.6) Analysis of the Chatbot about Legal, Social, and Ethical Concerns

As chatbots become increasingly integral to customer service and business operations, their widespread adoption introduces complex legal, social, and ethical challenges that must be carefully managed. While chatbots offer numerous advantages such as cost reduction, enhanced accessibility, and 24/7 support, these benefits are accompanied by significant responsibilities. Legally, chatbots must navigate evolving regulations related to data protection, intellectual property, and compliance, particularly as they often handle sensitive user information and perform critical tasks. Socially, chatbots influence employment dynamics, potentially displacing jobs and necessitating workforce reskilling. They also play a crucial role in shaping user trust and accessibility, with the potential to either promote inclusivity or exacerbate social inequalities depending on their design. Ethically, the deployment of chatbots raises important concerns about bias, transparency, and the balance between automation and human oversight. The algorithms powering chatbots may inadvertently reinforce societal biases, leading to discriminatory outcomes, while the transparency of these systems directly impacts user trust and the ethical standing of businesses. Thus, the integration of chatbots demands a comprehensive approach that addresses these legal, social, and ethical dimensions, ensuring that their deployment is not only efficient but also responsible and equitable (Jarrahi, 2018).

2.6.1) Legal Concerns

Data Privacy and Security

One of the foremost legal concerns with chatbots is data privacy. Chatbots frequently handle a wide range of sensitive personal information, including customer names, contact details, and financial data. Given the nature of this data, compliance with data protection laws is crucial. Regulations such as the General Data Protection Regulation (GDPR) in Europe and the California Consumer Privacy Act (CCPA) in the United States set stringent requirements for how personal data must be managed.

Under GDPR, businesses must obtain explicit consent from users before collecting their data, clearly informing them about the data's purpose and use. Additionally, GDPR mandates that businesses implement robust data security measures, such as encryption, to protect user information from unauthorized access and breaches. Users also have the right to access their data, request corrections, and demand deletion, known as the "right to be forgotten." Similarly, CCPA requires businesses to disclose the types of data collected and to provide users with the ability to opt out of data sales.

Non-compliance with these regulations can lead to severe penalties and damage to reputation. Therefore, businesses must integrate comprehensive data protection measures into their chatbot systems and ensure ongoing compliance with evolving legal standards (GDPR, 2016).

Compliance with Financial Regulations

In the financial sector, the integration of chatbots must navigate a complex landscape of regulatory requirements designed to protect sensitive information and ensure secure transactions. For example, the Financial Services Modernization Act (Gramm-Leach-Bliley Act, GLBA) in the United States mandates that financial institutions protect non-public personal information (NPI) and implement privacy safeguards. Chatbots deployed in this sector are required to comply with GLBA by ensuring that all customer data, including financial details and personal identifiers, is handled with the utmost security.

To meet these requirements, chatbots must incorporate robust encryption protocols for data transmission and storage, adhere to strict access controls, and regularly update security measures to address emerging threats. Additionally, these systems should provide users with clear disclosures about data collection practices and obtain explicit consent before processing sensitive information. Regular audits and compliance checks are essential to verify adherence to regulatory standards and to mitigate risks related to data breaches or unauthorized access.

Furthermore, chatbots in financial services must align with other regulations, such as the Payment Card Industry Data Security Standard (PCI-DSS), which governs the handling of credit card information. Ensuring compliance with these regulations not only protects

customer privacy but also helps maintain trust and integrity in financial transactions (Ward, 2024).

Intellectual Property Issues

The development of chatbots presents key intellectual property (IP) challenges, particularly around ownership and protection of designs, algorithms, and proprietary data. As companies invest in advanced chatbots, they must navigate IP laws to protect innovations, such as securing patents for algorithms, trademarks for chatbot names, and copyrights for original code. Ensuring their creations don't infringe on existing IP rights requires audits and licenses for third-party tech. Additionally, businesses must manage IP concerns related to data use, ensuring compliance with data laws while utilizing proprietary data to improve functionality. Balancing innovation with IP protection is essential for maintaining competitiveness and legal compliance. (Lee, 2021).

2.6.2) Social Concerns

Impact on Employment

Automating customer service through chatbots can fundamentally alter employment patterns across various sectors. While chatbots significantly enhance efficiency and cut operational costs by handling routine inquiries and tasks, they can also lead to job displacement for roles traditionally performed by human agents. For example, customer service representatives, who handle repetitive queries, may face reduced demand for their services as chatbots assume these responsibilities. This displacement can have a cascading effect on job markets, potentially leading to increased unemployment in certain areas and necessitating workforce reskilling and adaptation. Addressing this impact involves creating strategies for upskilling employees to take on more complex roles that machines cannot easily replicate. Additionally, businesses and policymakers must work together to ensure a smooth transition, fostering an environment where technological advancements contribute positively to economic growth without disproportionately disadvantaging workers. Balancing innovation with social responsibility is crucial for mitigating potential negative effects on employment (Brynjolfsson, 2014).

Accessibility and Inclusivity

Automating customer service with chatbots improves efficiency and reduces costs by handling routine tasks, freeing human agents for more complex work. While this leads to faster responses, it also risks job losses, particularly for lower-skilled workers. To address this, businesses must invest in reskilling and upskilling programs, preparing employees for higher-value roles. Policymakers should consider support for displaced workers and promote new job opportunities in emerging fields. Balancing technological progress with workforce needs is key to ensuring an equitable transition. (79 words) (Boyalakuntla, 2021).

User Trust and Transparency

Building and maintaining user trust is a crucial social concern in chatbot deployment. Users must be clearly informed that they are interacting with a chatbot, not a human, to avoid any potential deception. Transparency extends to disclosing how user data will be collected, stored, and utilized. Implementing robust privacy policies and providing easy-to-understand explanations about data handling practices can significantly enhance trust. Additionally, offering users control over their data, including options to view, modify, or delete their information, is vital for fostering confidence. Ensuring that chatbot interactions are both secure and ethical, coupled with clear communication about these aspects, helps in creating a trustworthy environment where users feel respected and informed (Miller, 2019).

2.6.3) Ethical Concerns

Bias and Fairness

Chatbots, particularly those powered by machine learning, can inadvertently perpetuate or amplify biases present in their training data, leading to ethical concerns about fairness and discrimination. Such biases may stem from historical data reflecting societal inequalities or skewed data representation. As a result, chatbots might produce discriminatory responses or reinforce stereotypes, impacting user experience and trust. To address these issues, it is crucial to implement comprehensive measures to identify and mitigate biases within chatbot algorithms. This includes diversifying training datasets, employing fairness audits, and continuously monitoring chatbot performance across different demographic groups. Ensuring that chatbots provide equitable and unbiased responses is essential for fostering inclusivity and maintaining ethical standards in automated interactions. (Hong, 2024).

Manipulation and Deception

Ethical concerns include the potential for chatbots to manipulate users by subtly promoting certain products or services, possibly misleading them or exploiting vulnerabilities. This can involve providing biased information or omitting key details, undermining trust and causing harm. Ethical guidelines should require transparency, clearly informing users they are interacting with a bot. Chatbots must deliver accurate, unbiased information and avoid deceptive practices. Additionally, systems should allow users to verify information and seek human assistance when needed. Upholding these standards is essential to maintain integrity and protect users in chatbot interactions (Floridi, 2023).

Autonomy and Human Oversight

As chatbots advance in capability, their increasing autonomy necessitates careful consideration of ethical implications. While autonomous systems can handle routine tasks efficiently, their limitations in understanding complex or nuanced situations highlight the need for human oversight. Without appropriate checks, there is a risk of over-reliance on these systems, potentially leading to suboptimal or ethically questionable outcomes. Ensuring that human intervention is readily available is crucial for addressing intricate or sensitive issues where chatbots may lack the depth of understanding required for sound decision-making. Effective oversight mechanisms should be in place to monitor chatbot performance, rectify errors, and maintain ethical standards, thus ensuring that automated systems complement rather than replace human judgment (Jarrahi, 2018).

2.7) Conclusion

The deployment of chatbots presents a range of legal, social, and ethical concerns that require meticulous management. Ensuring compliance with data privacy laws such as GDPR and CCPA, and adhering to financial regulations like the Gramm-Leach-Bliley Act, is crucial for protecting user data and maintaining trust. Socially, businesses must address the potential impact on employment and ensure accessibility and inclusivity in chatbot design. Ethically, it is vital to prevent biases in algorithms and ensure transparency to avoid manipulation or deception.

Chatbots must be designed with accessibility in mind to provide equitable service to all users, including those with disabilities. Adhering to established accessibility standards, such as the Web Content Accessibility Guidelines (WCAG), is essential for creating content accessible to people with a range of disabilities. Features like text-to-speech for visually impaired users, speech recognition for those with limited mobility, and customizable text sizes can accommodate diverse needs (W3C, 2020). Additionally, chatbots should support alternative interaction methods beyond traditional text-based interfaces, such as voice commands, sign language support, and integration with assistive technologies (Aroyo, 2019)

Multilingual support is also crucial for fostering inclusivity by breaking down language barriers and providing contextually relevant interactions across diverse linguistic backgrounds (J. Skrebeca, 2021). By integrating these accessibility and inclusivity measures, businesses not only comply with legal and ethical standards but also enhance user experience, making digital interactions more equitable and effective. Adopting a holistic approach allows businesses to harness the benefits of chatbot technology effectively while upholding legal standards, fostering social equity, and adhering to ethical principles, thus enhancing overall user trust and satisfaction.

Chapter 3: Methodology

Aims and Objectives

Aim:

To develop a sophisticated chatbot solution for Secure Bank using Google Dialogflow, Firebase, and MongoDB, with the goal of providing an efficient, responsive, and versatile chatbot capable of handling diverse user interactions and managing data effectively.

Objectives:

Integration of Technologies: To seamlessly integrate Google Dialogflow for natural language processing, Firebase for hosting, and MongoDB for data storage, ensuring a cohesive and functional chatbot system.

Dynamic Interaction Management: To design and deploy a Flask-based webhook that effectively manages and processes chatbot interactions, ensuring reliable and timely responses.

Extensive Testing: To conduct extensive testing of the chatbot across various languages and interaction methods to ensure its versatility and reliability in real-world scenarios.

Data Management: To implement robust data handling practices using MongoDB for storing and managing chat history and session data, ensuring accurate and efficient data retrieval.

Future Enhancements: To lay the groundwork for future enhancements, including expanded language support, advanced machine learning integration, and potential external system integrations, to continuously improve the chatbot's capabilities and user experience.

3.1) Chatbot Types

Chatbots have emerged as a critical component in modern service design, enabling businesses to automate customer interactions, streamline service delivery, and enhance user experience. The design and implementation of chatbots can broadly be categorized into two types: Rule-Based and AI/Neural Network-Based chatbots. Each approach offers distinct benefits and drawbacks, impacting how services are designed and delivered. This section explores the service design considerations for both types of chatbots, highlighting their advantages and limitations within the context of customer assistance.

3.1.1) Rule-Based Chatbots

Service Design Overview: Rule-based chatbots operate on predefined scripts and decision trees, where user inputs trigger specific responses. The design of such chatbots involves meticulously mapping out potential user queries and responses, creating a flowchart-like structure that guides the conversation. Rule-based chatbots are programmed to recognize keywords or phrases and respond according to set rules. This approach is often used for handling straightforward queries and tasks, making it ideal for scenarios where interactions are predictable and require minimal flexibility.

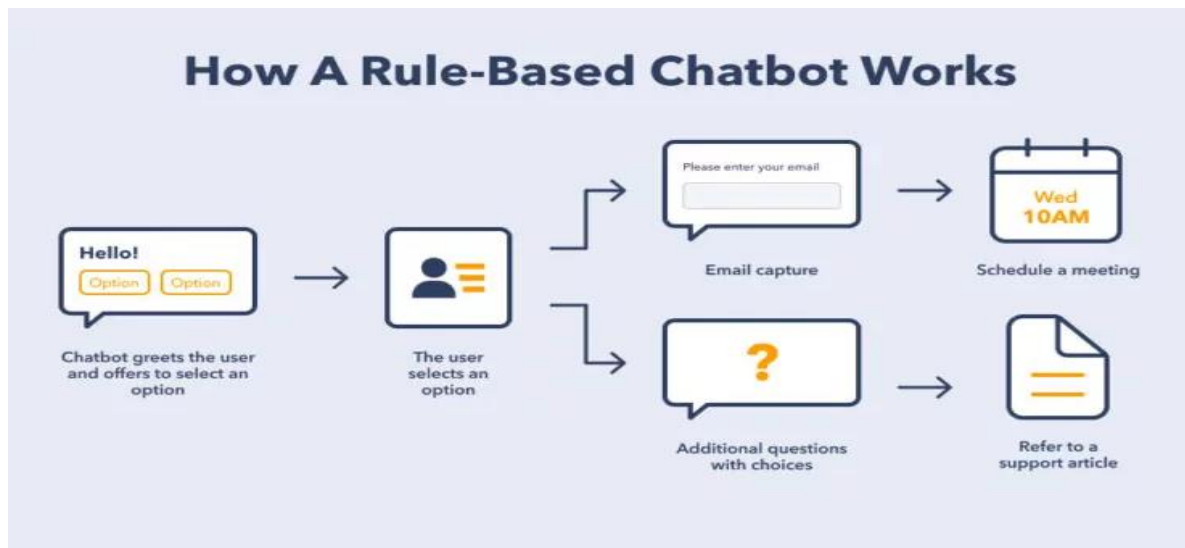


Figure 9: Rule Based Chatbot. Source: Google Dialogflow

Advantages

1. **Simplicity in Design and Implementation:** Rule-based chatbots are relatively straightforward to design and implement, making them an attractive option for businesses with limited technical expertise or resources. These chatbots operate based on predefined rules and decision trees, where responses are triggered by specific keywords or phrases. The development process typically involves mapping out common customer queries and associating them with corresponding responses, a task that can be handled without extensive programming skills. This simplicity not only reduces development time but also allows for easier maintenance and updates. As a result, rule-based chatbots provide a cost-effective solution for small to medium-sized businesses looking to automate basic customer interactions without the need for sophisticated AI technologies (Eleni Adamopoulou, 2020).
2. **Predictability and Control:** One of the primary advantages of rule-based chatbots is their predictability, which stems from their reliance on predefined response patterns. This predictability is highly beneficial for businesses that require consistent and reliable customer interactions. Since responses are determined by a set of established rules, companies have complete control over the chatbot's dialogue flow. This control allows businesses to carefully craft interactions to align with their brand voice and ensure that the chatbot consistently conveys accurate and relevant information. Consequently, the risk of miscommunication or unintended responses is significantly reduced, as the chatbot operates strictly within the boundaries of its programming. Moreover, this approach allows for easier troubleshooting and updates, as modifications can be made directly to the rule set without affecting the overall system. In environments where regulatory compliance and precise information dissemination are critical, such as in banking or healthcare, rule-based chatbots offer a dependable solution (Shawar, 2007)
3. **Cost-Effectiveness:** Rule-based chatbots are a cost-effective solution, especially when compared to AI-based counterparts. Their development and maintenance require less financial investment due to their simpler architecture, which does not rely on complex algorithms or vast datasets. The reduced need for extensive data processing and computational power makes these chatbots an attractive option for small to medium-sized enterprises (SMEs) with limited budgets. Additionally, the lower complexity of rule-based systems means that they can be deployed more quickly, further reducing upfront costs. Maintenance is also less resource-intensive, as updates typically involve modifying predefined rules rather than retraining complex machine learning models. This simplicity allows businesses to manage these chatbots in-house, avoiding the ongoing costs associated with external AI specialists. Consequently, rule-based chatbots provide SMEs with a practical, budget-friendly tool to automate customer service and enhance user interaction without incurring the high costs associated with more sophisticated AI-driven systems (Gnewuch, 2018)

Disadvantages

1. **Limited Flexibility:** Rule-based chatbots operate on predefined scripts and decision trees, which limits their flexibility and adaptability. Unlike AI-driven chatbots that can learn from user interactions and evolve over time, rule-based systems are confined to the rules they were initially programmed with. This rigid structure means that they can only handle scenarios anticipated by their developers, leading to potential shortcomings when faced with unexpected queries or changing user needs. As a result, updating or expanding a rule-based chatbot's knowledge base requires manual reprogramming, which is not only time-consuming and labor-intensive but also prone to human error, potentially affecting the chatbot's overall effectiveness and user satisfaction (Shawar, 2007).
2. **Inability to Learn and Adapt:** Rule-based chatbots, which operate based on predefined scripts and decision trees, lack the ability to learn from user interactions or adapt to novel scenarios. This static nature limits their functionality to the scope defined by their initial programming. Consequently, any updates or expansions to the chatbot's knowledge base necessitate manual intervention, requiring significant effort and time from developers. For instance, if a rule-based chatbot encounters a new type of query or needs to incorporate additional information, developers must manually code and test these changes. This process not only consumes valuable resources but also can lead to slower responses to emerging user needs. Thus, while rule-based chatbots provide reliable responses within their programmed parameters, their rigidity poses challenges in maintaining and evolving their capabilities over time (Shawar, 2007).
3. **Scalability Issues:** As the complexity of interactions increases, the rule-based approach becomes increasingly less scalable. Designing a comprehensive set of rules to address every potential query can be both time-consuming and impractical, particularly as chatbots are expected to handle a broader array of services or languages. This limitation is exacerbated when the scope of the chatbot's functions expands, requiring a vast and intricate network of conditional statements to manage diverse user inputs effectively (Adamopoulou & Moussiades, 2020). Furthermore, rule-based systems struggle with handling ambiguous or unforeseen queries, as their rigid framework lacks the flexibility to adapt to new scenarios beyond predefined rules. As such, while rule-based systems can be effective for straightforward, narrowly defined tasks, they face significant scalability issues in more dynamic and multifaceted environments. To overcome these limitations, the integration of machine learning and natural language processing technologies is increasingly being adopted, offering more adaptive and scalable solutions for managing complex interactions (Eleni Adamopoulou, 2020).

Rule-based vs AI-based: side-by-side comparison

Criteria	Rule-based chatbots	AI-based chatbots
Query complexity	Best suited for simple and predictable queries	Excel at handling complex and open-ended queries
Target tasks	Efficient for routine and standard tasks	Deal with diverse tasks and interactions
Development and training time	Quick to develop and implement	Require more time for development and training
Maintenance and updates	Require frequent manual updates for new rules and scenarios	Can learn from data and improve on their own, but require regular fine-tuning
Data privacy and security	Work with controlled and limited amounts of data and have lower privacy risks	Train on vast datasets with risk of accessing sensitive information, so they require stronger security
Budget and resources	Generally more cost-effective and require fewer resources	Higher upfront costs and more resources needed for training
Scalability	Limited scalability for complex interactions	Highly scalable with adaptability to new scenarios

www.apriorit.com

Figure 10: Rule-Based vs AI-Based Chatbot. Source: Apriorit

3.1.2) AI/Neural Network-Based Chatbots

Service Design Overview: AI/Neural Network-based chatbots leverage advanced technologies such as Natural Language Processing (NLP), machine learning, and deep learning algorithms to understand and generate human-like responses. These chatbots are designed to process large datasets, learn from interactions, and improve over time. The service design for AI-based chatbots involves training neural networks on vast amounts of conversational data, enabling the system to recognize patterns, interpret context, and generate appropriate responses (Figure 11).

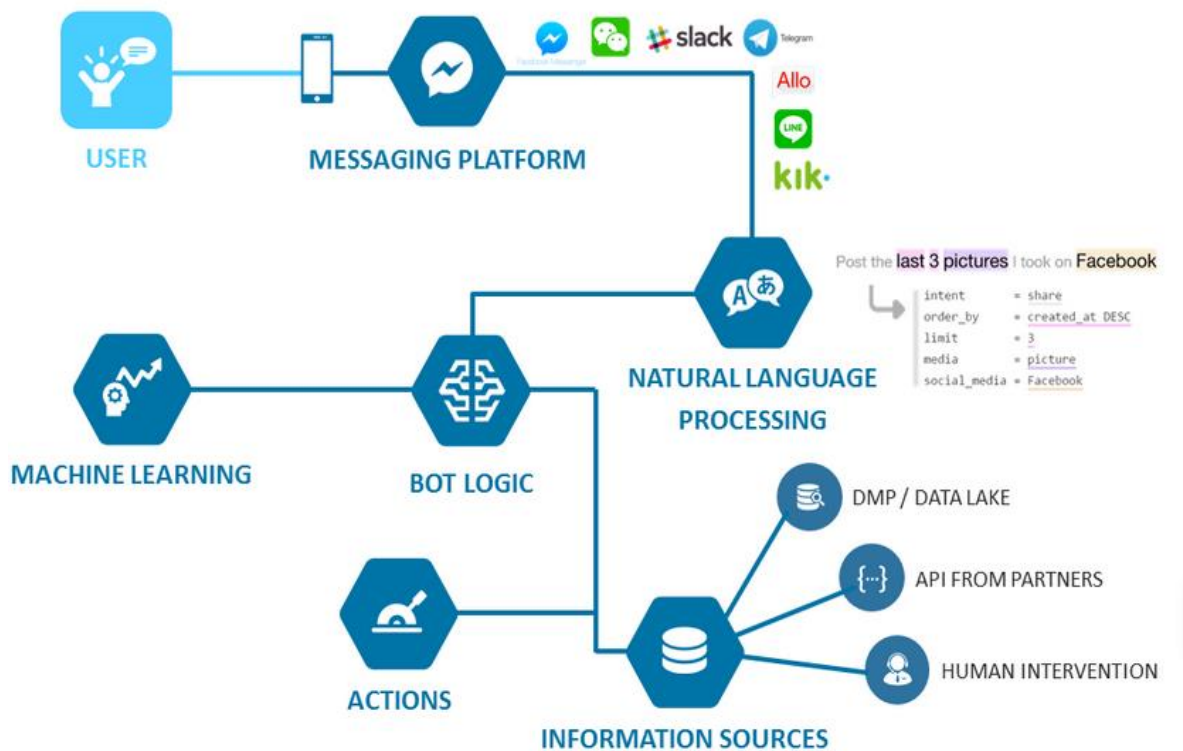


Figure 11: AI/Neural Network-Based Chatbots. Source: Shane Barker

Advantages

1. **High Flexibility and Adaptability:** AI-based chatbots exhibit remarkable flexibility, adeptly managing a diverse array of queries, including those with complex or ambiguous inputs. By leveraging advanced Natural Language Processing (NLP) and machine learning techniques, these chatbots can discern the underlying intent behind user queries, even when the input lacks explicit definition or clarity. This capability is facilitated through continuous learning and adaptation, allowing chatbots to refine their understanding and response accuracy over time. As a result, they can provide relevant and contextually appropriate responses, enhancing user interaction and satisfaction. This adaptability not only improves the chatbot's effectiveness but also ensures a more seamless and intuitive user experience, addressing both straightforward and nuanced user needs (Chen, 2023).
2. **Continuous Learning and Improvement:** Unlike rule-based systems, AI chatbots leverage machine learning to enhance their performance over time. By analyzing patterns and learning from each interaction, these chatbots continuously refine their understanding of user intent and improve their responses. This dynamic learning process enables AI chatbots to adapt to evolving user needs and behaviors, providing increasingly personalized and efficient experiences. For instance, an AI chatbot can identify emerging trends in user inquiries and adjust its responses accordingly, offering more relevant and timely assistance. This adaptability is crucial in fast-paced environments where customer expectations and industry standards are in constant flux. As a result, AI chatbots offer a more fluid and responsive service compared to static rule-based systems, significantly enhancing overall user satisfaction and operational efficiency (Feng, 2022).
3. **Scalability and Multilingual Support:** AI chatbots possess a remarkable ability to scale, managing vast volumes of interactions efficiently across numerous languages. By integrating sophisticated language models and advanced translation APIs, these chatbots can deliver consistent, contextually accurate responses to users worldwide. This capability is crucial for businesses aiming to cater to a global audience, as it ensures that users receive coherent and personalized support regardless of their language preferences. The use of real-time translation services and NLP techniques enables chatbots to understand and generate responses in multiple languages seamlessly. Consequently, this technological integration not only enhances accessibility but also significantly improves user satisfaction by providing reliable and responsive customer service across diverse linguistic backgrounds. As a result, AI chatbots can bridge communication gaps, offering a more inclusive and effective customer experience on a global scale (J. Skrebeca, 2021).

4. **Enhanced User Experience:** Enhanced User Experience: The ability of AI chatbots to grasp context and deliver nuanced responses significantly enriches user interactions. By leveraging advanced natural language processing (NLP) and machine learning algorithms, modern chatbots can interpret user intent with greater precision and adapt their responses to the specifics of the conversation. This leads to more engaging, human-like interactions that make users feel genuinely understood and valued. For example, chatbots that can recognize emotional cues or context-specific details are better equipped to provide relevant solutions or empathetic responses, fostering a deeper connection with users. This enhanced engagement not only improves the immediate customer experience but also contributes to higher levels of satisfaction and trust. As a result, businesses can see increased customer retention and loyalty, as users are more likely to return to a service that consistently meets their needs and offers a personalized touch (Gnewuch, 2018).

Disadvantages

1. **Complexity and Cost of Implementation:** Developing and deploying AI-based chatbots demands considerable technical expertise and resources. The training of neural networks involves intricate algorithms and extensive datasets, which are both costly and time-consuming. This process requires sophisticated computing power and specialized knowledge in machine learning and data science. Furthermore, maintaining and updating these systems involves continuous monitoring, which includes debugging, optimizing performance, and incorporating new data to improve accuracy and relevance. The dynamic nature of AI technology necessitates ongoing adjustments to adapt to changing user needs and emerging trends. Consequently, businesses must invest not only in initial development but also in long-term support and refinement to ensure optimal functionality and user satisfaction (Costa, 2024)
2. **Data Dependency and Privacy Concerns:** AI chatbots rely heavily on data to function effectively, necessitating access to vast amounts of user information for training and operation. This dependency raises significant concerns regarding data privacy and security, especially in sectors like banking, where the handling of sensitive financial information is paramount. Ensuring compliance with stringent data protection regulations, such as the GDPR and CCPA, requires robust measures to secure data against breaches and unauthorized access. Additionally, businesses must implement comprehensive data governance practices, including encryption, regular audits, and user consent protocols. These practices can be both challenging and resource-intensive, demanding continuous investment in security infrastructure and compliance monitoring. Failure to address these concerns adequately not only jeopardizes user trust but can also result in severe legal repercussions and financial penalties (Yang, 2023)

3. **Risk of Misinterpretation:** Despite significant advancements in AI, chatbots still face challenges in accurately interpreting user intent, particularly when confronted with ambiguous or sarcastic language. AI models, while increasingly sophisticated, often struggle with nuances such as tone, irony, and context that are inherent in human communication. For instance, sarcastic remarks or phrases with multiple meanings can lead to misinterpretations, resulting in responses that are either inappropriate or irrelevant. This issue arises because most chatbots rely on pattern recognition and historical data, which may not always capture the subtleties of conversational context (Chen, 2023). Consequently, users may experience frustration when a chatbot fails to understand their queries correctly, potentially leading to decreased satisfaction and trust. Addressing these limitations requires ongoing improvements in natural language understanding (NLU) and the incorporation of more advanced contextual analysis techniques to enhance the accuracy and relevance of chatbot interactions.

4. **Ethical and Bias Issues:** AI chatbots are inherently susceptible to biases embedded in their training data, which can lead to skewed or discriminatory responses. These biases often reflect historical inequalities or stereotypes present in the data, potentially perpetuating these biases in automated interactions. To address these ethical concerns, it is crucial to implement robust design strategies and continuous monitoring processes. This involves diversifying training datasets, employing bias detection algorithms, and incorporating fairness-aware machine learning techniques to minimize discriminatory outcomes. Regular audits and updates are essential to ensure that the chatbot adapts to new data and changing societal norms, maintaining fairness over time. Moreover, transparency about the chatbot's decision-making processes and providing mechanisms for user feedback can help identify and rectify any biased behavior. By adopting these practices, organizations can work towards ensuring that their chatbots deliver equitable and unbiased services to all users (Feng, 2022).

3.2) Comparison of AI Chatbot Platforms: Google Dialogflow vs. Three Alternatives

When selecting an AI chatbot platform, businesses must consider factors such as ease of use, integration capabilities, natural language understanding, and scalability. This comparison focuses on Google Dialogflow and three other prominent AI chatbot platforms: Microsoft Bot Framework, IBM Watson Assistant, and Amazon Lex. Each platform has its unique features, benefits, and limitations that influence their suitability for different use cases.





	 Google Dialogflow	 Amazon Lex	 IBM Watson Assistant	 Azure Bot Services
Channels	Voice, Text	Voice, Text	Voice, Text	Voice, Text
Ease of Use	Provides a web interface to create bots which makes it fairly simple to create basic bots.	Provides a web interface to create and launch bots. It runs on the same machine learning engine as Alexa.	Provides a good and easy way to navigate user interface. You will get video tutorials and ready to use samples to quickly get started.	Used for creating intelligent bots. The web interface is available to create and publish bots.
Integrations	<ul style="list-style-type: none"> ✓ Google Assistant ✓ Slack ✓ Viber ✓ FB Messenger ✓ Twitter ✓ Twilio etc. 	<ul style="list-style-type: none"> ✓ SMS ✓ Slack ✓ Kik ✓ FB Messenger ✓ Twilio 	<ul style="list-style-type: none"> ✓ Voice Agent ✓ Slack ✓ Wordpress ✓ FB Messenger ✓ Custom APIs etc. 	<ul style="list-style-type: none"> ✓ Skype ✓ Slack ✓ Kik ✓ Telegram ✓ FB Messenger ✓ Twilio etc.
Web & Mobile Integrations	Basic in-built web integration	Basic chat UI provided for testing the website.	Basic chat UI for Websites.	Open source web chat widget available on Github.
Languages	Supports 20+ languages including English, Spanish, Portuguese, French, Hindi, Chinese etc.	Currently only US English is supported.	Supports 10+ Languages (mostly in BETA) including English, Spanish, Japanese, Italian, Chinese etc.	Supports multiple languages such as English, French, German, Spanish etc.
Cost	<ul style="list-style-type: none"> ◇ Free standard plan (trial) ◇ ES Agent: \$0.002/request ◇ CX Agent: \$20 per 100 chat sessions and \$45 per 100 voice sessions. 	<ul style="list-style-type: none"> ◇ 10k text requests and 5k speech requests/month are free for first year. Post that is billed per request basis: ◇ Voice: \$0.004 per request ◇ Text: \$0.00075 per request 	<ul style="list-style-type: none"> ◇ Free plan (Lite) ◇ Paid plan starts with Plus at \$120/Month (30 day free trial). 	<ul style="list-style-type: none"> ◇ Azure Bot Service is free for up to 10k messages per month. ◇ Paid plans start from \$0.5 for 1000 messages. Additional charges for services like Azure Functions and Azure

Figure 12: Dialogflow vs Lex vs Watson vs Azure Bot-Chatbot Platforms Quick Comparison. Source: LinkedIn

3.2.1) Google Dialogflow

Overview: Google Dialogflow is a widely adopted chatbot development platform known for its robust integration of Google's advanced natural language processing (NLP) and machine learning technologies. It enables developers to create highly responsive and intelligent chatbots capable of understanding and processing complex user inputs. Dialogflow's intuitive, user-friendly interface allows for easy design and deployment of chatbots across multiple platforms, such as websites, mobile applications, and messaging services like Facebook Messenger and WhatsApp. The platform supports a broad range of languages, making it an ideal solution for developing multilingual chatbots that cater to global audiences. Dialogflow also offers seamless integration with Google Cloud services, enhancing scalability, security, and performance. Additionally, it provides comprehensive analytics and reporting tools, enabling businesses to track user interactions, improve bot performance, and optimize customer service. With its powerful features and extensive capabilities, Dialogflow stands out as a leading choice for businesses looking to implement sophisticated, conversational AI-driven chatbots (Google, 2024).

Natural Language Processing (NLP) is a critical component in modern chatbot systems, enabling them to understand and generate human language in a meaningful way. NLP involves several key tasks, including language comprehension, intent recognition, and contextual understanding. By leveraging NLP, chatbots can interpret user queries accurately, provide relevant responses, and engage in natural, human-like interactions. This capability enhances the overall user experience, allowing chatbots to handle a wide range of questions and commands effectively, thus making them more versatile and effective in real-world applications (Jarrahi, 2018).

Key Features

- **Natural Language Understanding (NLU):** Dialogflow excels in understanding user intent and context through advanced Natural Language Understanding (NLU). Leveraging Google's extensive NLP technology, it accurately interprets user input, even when phrased ambiguously or with varying syntax. This allows for more natural, human-like interactions, enhancing the overall user experience and effectiveness of conversational AI systems.
- **Integration:** Seamlessly integrates with Google Cloud services and third-party applications, enabling smooth data flow and enhanced collaboration. It supports multiple communication channels like Facebook Messenger, Slack, and Google Assistant, ensuring consistent and responsive communication across platforms. Additionally, it offers robust security features and scalable solutions tailored to enterprise needs.
- **Pre-built Agents:** Provides pre-built agents tailored for common use cases, enabling faster deployment and reducing development time. These agents come with pre-configured settings and optimized workflows, allowing teams to quickly adapt them to

specific needs. This streamlines the implementation process, helping organizations achieve their goals with minimal setup and effort.

- **Multi-language Support:** It supports multiple languages, enabling the development of multilingual chatbots that can interact with users in their native languages. This feature enhances user experience and accessibility, making it ideal for global audiences across diverse linguistic backgrounds.
- **Analytics:** Provides built-in analytics to track chatbot performance, monitor user interactions, and analyze key metrics like user engagement, response time, and conversation flow. These insights enable continuous optimization, enhancing the chatbot's effectiveness and user experience.

Advantages

- **Ease of Use:** An intuitive interface with drag-and-drop functionality streamlines the chatbot creation process, making it accessible to users of all skill levels. This user-friendly approach eliminates the need for coding knowledge, allowing anyone to design and deploy chatbots quickly and efficiently, enhancing productivity and reducing development time.
- **Google Ecosystem:** Tight integration with Google Cloud services offers seamless scalability and access to advanced features, such as sophisticated voice recognition and machine learning tools. This synergy enhances operational efficiency and allows for more innovative, data-driven solutions.
- **Rich Feature Set:** Advanced NLP and machine learning capabilities significantly improve the chatbot's ability to understand, interpret, and respond to natural language with greater accuracy, context-awareness, and nuanced understanding, leading to more effective and human-like interactions.

Disadvantages

- **Complex Pricing:** The pricing model can be quite intricate, especially when dealing with higher volumes of interactions and advanced features. Costs can vary significantly based on factors such as usage levels, customization needs, and additional functionalities, making it essential to carefully evaluate your specific requirements to ensure accurate budgeting and cost management.
- **Customization Limits:** While powerful, extensive customization often necessitates advanced programming knowledge and significant integration efforts. This includes adapting code to meet specific requirements, ensuring compatibility with existing systems, and possibly developing bespoke solutions. Such complexity can lead to

increased development time and costs, but ultimately delivers a tailored, optimized solution.

3.2.2) Microsoft Bot Framework

Overview: The Microsoft Bot Framework is a strong platform designed to streamline the creation, testing, and deployment of chatbots across diverse environments. It seamlessly integrates with Microsoft Azure services, allowing developers to leverage cloud-based resources for scalability, analytics, and natural language processing. The framework supports a wide range of communication channels, including Microsoft Teams, Skype, Slack, and Facebook Messenger, enabling bots to interact with users on their preferred platforms. Its comprehensive set of tools and services includes the Bot Builder SDK for designing complex conversational experiences, the Bot Framework Emulator for testing, and Azure Bot Services for managing and deploying bots. With built-in support for advanced AI capabilities, such as language understanding and speech recognition, the Microsoft Bot Framework empowers developers to create intelligent, context-aware bots that enhance user engagement and streamline business operations (Microsoft., 2024).

Key Features

- **Bot Builder SDK:** The Bot Builder SDK offers versatile support for multiple programming languages, including C#, JavaScript, and Python. This flexibility enables developers to create sophisticated bots across various platforms with ease. The SDK streamlines bot development, allowing for seamless integration, testing, and deployment in diverse programming environments.
- **Azure Integration:** Deep integration with Azure Cognitive Services enhances NLP capabilities by leveraging advanced machine learning models and pre-built AI features. This integration streamlines natural language understanding, sentiment analysis, and language generation, allowing for more intuitive and sophisticated interactions within applications and services, ultimately improving user experience and functionality.
- **Channel Support:** Comprehensive support is provided for a broad array of communication channels, encompassing Microsoft products like Teams and Outlook, as well as other third-party platforms such as Slack, Zoom, and Google Workspace. This ensures seamless integration and efficient collaboration across diverse tools and systems.
- **Power Virtual Agents:** Provides a no-code/low-code platform for users who favor a visual approach to chatbot creation, enabling intuitive drag-and-drop design, easy integration of interactive elements, and streamlined workflow management without needing advanced programming skills.

Advantages

- **Flexibility:** The SDK offers extensive customization options and flexibility, enabling developers to create sophisticated bots tailored to specific needs. Its robust features support complex interactions and integrations, allowing for highly personalized and effective automated solutions.
- **Integration with Azure:** Leveraging Azure's robust cloud infrastructure and advanced cognitive services, this solution ensures exceptional scalability, enhanced performance, and innovative capabilities. It seamlessly integrates AI-driven insights and adaptive functionalities, driving efficiency and enabling complex, data-driven decision-making processes.
- **Wide Channel Reach:** Supports numerous channels, significantly enhancing the bot's accessibility and expanding its reach to a broader audience. This multi-platform capability ensures users can interact seamlessly through their preferred communication channels, improving engagement and satisfaction.

Disadvantages

- **Steeper Learning Curve:** The platform can be quite intricate to configure and navigate, especially for users without a programming background. This complexity may lead to a steep learning curve and potential frustration.
- **Cost:** Costs can escalate with increased usage of Azure services and advanced features, particularly as you scale resources, leverage premium options, or require high levels of performance and storage.

3.2.3) IBM Watson Assistant

Overview: IBM Watson Assistant is an advanced AI-driven platform designed to create and manage conversational agents with ease. Utilizing IBM's cutting-edge Watson AI technology, it offers powerful natural language processing (NLP) capabilities to understand and respond to user queries effectively. The platform is engineered to facilitate seamless integration with various communication channels and enterprise systems, enhancing its versatility and utility in diverse business environments. With its sophisticated AI algorithms, Watson Assistant can handle complex interactions, providing users with intuitive and contextually relevant responses. Additionally, it supports continuous learning and improvement, allowing the conversational agents to evolve based on user interactions and feedback. Whether used for customer service, internal support, or other applications, IBM Watson Assistant empowers organizations to deliver enhanced user experiences and operational efficiency through intelligent and adaptive conversational interfaces (Watson, 2024).

Key Features

- **Advanced NLP:** Leverages Watson's advanced NLP technology to accurately interpret user intents and deliver contextually relevant responses. This ensures precise understanding and interaction by analyzing linguistic nuances and context, enhancing user engagement and satisfaction through sophisticated, context-aware communication.
- **Integration:** Easily integrates with IBM Cloud and a wide range of third-party applications, including social media platforms, CRM systems, and other business tools, ensuring seamless connectivity and enhanced functionality across diverse software environments.
- **Pre-built Content:** Provides pre-built content and tailored industry-specific solutions to streamline development processes, significantly reducing time-to-market and enhancing efficiency. These ready-made resources enable rapid implementation and customization, ensuring quicker and more effective project completion.
- **Analytics and Insights:** Offers comprehensive analytics and reporting tools to monitor and evaluate chatbot performance, including user interactions, engagement metrics, response accuracy, and system efficiency, enabling data-driven insights for continuous improvement and strategic decision-making.

Advantages

- **Powerful NLP:** Strong NLP capabilities empower the development of sophisticated, context-aware chatbots that can understand and generate human-like responses. These advanced systems effectively interpret nuanced language, adapt to varied conversational contexts, and provide relevant, personalized interactions, enhancing user engagement and satisfaction in diverse applications.
- **Enterprise Ready:** Ideal for large enterprises with intricate needs and extensive system integration requirements. This solution is designed to handle complex workflows, ensuring seamless compatibility with existing infrastructures while providing robust support for advanced functionalities and scalable operations.
- **Customization:** High levels of customization enable tailored solutions and address complex use cases effectively. This adaptability ensures that specific needs and unique requirements are met, facilitating precision and efficiency in various applications. By offering flexible options, users can optimize performance and achieve their desired outcomes more accurately.

Disadvantages

- **Complexity:** The platform's extensive features and capabilities can be overwhelming for beginners, presenting a steep learning curve. Navigating its complex interface and mastering its diverse functionalities may take considerable time and effort, requiring users to invest in learning resources and practice to fully leverage its potential.
- **Cost:** IBM Watson Assistant can be relatively expensive, especially for enterprises with extensive usage and advanced feature needs. The costs can accumulate significantly with higher tiers of service, customization, and integration, making it a considerable investment for organizations requiring robust AI-driven customer support solutions.

3.2.4) Amazon Lex

Overview: Amazon Lex is a powerful chatbot development service provided by Amazon Web Services (AWS). Leveraging the same advanced deep learning technologies that drive Amazon Alexa, Lex enables developers to create sophisticated conversational interfaces with ease. It supports natural language understanding and automatic speech recognition, allowing users to interact with applications using text or voice commands. Lex integrates seamlessly with other AWS services, facilitating the development of scalable and intelligent chatbots. By offering built-in support for multi-turn conversations and context management, Amazon Lex helps businesses build engaging and effective conversational experiences. Its flexibility and robust features make it a valuable tool for creating chatbots that can handle a wide range of interactions and provide meaningful, real-time responses (Amazon, 2024)

Key Features

- **Integration with AWS:** Ethical concerns with chatbots in AWS integration include risks like product manipulation, biased information, or omission of key details. These issues can mislead users, exploit vulnerabilities, and erode trust. To address these concerns, ethical guidelines should ensure transparency by clearly indicating when users are interacting with a bot. Chatbots must deliver accurate, unbiased information and avoid deceptive practices. Systems should also allow users to verify information and seek human assistance if needed. Upholding these standards is essential for maintaining integrity and protecting users during chatbot interactions.
- **Speech Recognition:** Amazon Lex offers advanced speech recognition capabilities, facilitating both text and voice-based interactions. This service leverages sophisticated algorithms and machine learning techniques to accurately convert spoken language into text, enabling seamless communication through voice inputs. Its integration into applications allows for dynamic conversational experiences, enhancing user engagement by supporting natural language understanding. The robustness of Amazon Lex's speech recognition ensures high precision in recognizing and processing varied linguistic inputs, thereby improving the efficacy of automated systems in understanding and responding to user queries. This technology significantly augments the functionality and versatility of interactive digital platforms.
- **Pre-built Models:** AWS provides pre-built models and templates designed for common use cases, streamlining the development process. These resources enable users to quickly deploy and customize solutions without starting from scratch, saving time and effort. By leveraging these ready-made tools, developers can focus on refining their applications rather than building foundational elements, leading to faster and more efficient development cycles. Whether for machine learning, data analytics, or other tasks, AWS's pre-built options support rapid and effective implementation.

- **Multi-language Support:** Supports multiple languages, though with varying levels of proficiency.


Advantages

- **Scalability:** AWS provides robust cloud infrastructure that ensures high scalability and reliability. This means businesses can easily adjust resources based on their needs without the constraints of physical hardware. AWS's elastic services allow for seamless scaling up or down, supporting varying workloads and optimizing costs. Its global network of data centers enhances performance and reliability, ensuring applications run smoothly and efficiently. By leveraging AWS's scalable solutions, organizations can rapidly respond to market changes, accommodate growth, and maintain operational efficiency.
- **Voice Capabilities:** AWS offers numerous advantages, including exceptional scalability and reliability. Its cloud infrastructure allows businesses to scale resources up or down based on demand, ensuring optimal performance and cost-efficiency. AWS's global network of data centers provides high availability and redundancy, minimizing downtime and improving resilience. Additionally, its managed services and robust security features help streamline operations and safeguard data, making it a reliable choice for a wide range of applications and workloads. Overall, AWS enables organizations to efficiently adapt to changing needs while maintaining a high level of performance and security.
- **Integration with AWS Services:** AWS offers several advantages, including seamless integration with a wide range of AWS services. This integration simplifies and accelerates both the development and deployment processes, enabling more efficient workflows and faster time-to-market. By leveraging these interconnected services, users can build and manage their applications with greater ease and effectiveness, maximizing the benefits of the AWS ecosystem.

Disadvantages

- **Learning Curve:** One of the disadvantages of Amazon Web Services (AWS) is its steep learning curve. Users who are not familiar with AWS and its broad ecosystem may find it challenging to navigate the platform effectively. AWS offers a vast array of services and features, which can be overwhelming for beginners. The complexity of its interface and the depth of its documentation require a significant investment of time and effort to master. As a result, users may face difficulties in optimizing and managing their AWS resources efficiently. This learning curve can potentially slow down the deployment process and impact overall productivity for those new to cloud computing or AWS specifically.
- **Pricing Complexity:** One notable disadvantage of AWS (Amazon Web Services) is its pricing complexity. The cost structure can be intricate, especially when utilizing multiple AWS services and resources. Each service has its own pricing model, which often includes

various tiers and additional charges based on usage patterns, data transfer, and storage. This complexity can make it challenging for users to predict and manage costs effectively, potentially leading to unexpected expenses. Without careful monitoring and cost management strategies, businesses might struggle with budget overruns and difficulty in optimizing their expenditures. Therefore, while AWS offers a wide range of powerful tools and services, understanding and controlling costs requires a thorough and ongoing effort.



Top Paid Chatbot Frameworks Comparison

Programming Language, NLP Support, Ease of Use, Pricing and Platform Integration











Parameters	 Dialogflow	 Microsoft Bot	 IBM Watson	 Amazon Lex	 ODA
 Programming Languages	Node.js	Node.js	Node.js	Node.js	Node.js
 NLP Support	Yes	Yes	Yes	Yes	Yes
 Price	\$0.002/request	\$100/month	\$100/month	\$0.004/text request	\$0.0232/request
 Platform Integration	Skype, Slack, Messenger, Telegram	Skype, Slack, Messenger, MS Teams	Messenger, Slack, WhatsApp	Messenger, Slack, Twilio, Alexa	Messenger, Slack, MS Teams
 Ease of Use	★★★★★	★★★★★	★★★★☆	★★★★☆	★★★★★

Figure 13: Chatbot Framework Comparison. Source: Third Eye

3.3) Planning the Chatbot

In planning the chatbot, Dialogflow was chosen as the platform for training the agent due to its robust natural language processing capabilities and seamless integration with Google services. Dialogflow enables the creation of sophisticated conversational agents by leveraging advanced machine learning models to understand and respond to user queries effectively. Its user-friendly interface and powerful intent recognition system make it ideal for developing a prototype chatbot. By utilizing Dialogflow, the chatbot can be trained to handle diverse user interactions, ensuring accurate and contextually relevant responses, which is essential for the successful implementation of the prototype in the Master's dissertation project.

3.3.1) Determine starting channels

Determining the starting channels for the prototype involves selecting the primary platforms for chatbot deployment. For this project, the initial focus is on integrating the chatbot into both a website and its mobile version. The website will serve as the primary interface, providing users with immediate access to the chatbot for desktop interactions. The mobile version ensures accessibility and functionality on smartphones, catering to users on the go. This dual-channel approach facilitates a comprehensive user experience, enabling seamless interaction across different devices and ensuring broad accessibility to the chatbot's features and support services.

3.3.2) Identify primary topics

The chatbot for the SecureBank website is designed to assist users in three languages: English, French, and Spanish. It addresses primary topics including Branch Services, Loan information, Credit inquiries, Account Opening, and Contact Support. This multilingual capability ensures that users receive comprehensive and accessible support in their preferred language, enhancing the overall user experience and accessibility of banking services.

3.3.3) Conversation Design

Focuses on creating intuitive and engaging interactions between users and chatbots. It involves structuring dialogue flows, defining intents, and crafting responses that address user needs effectively. In designing conversations, it is crucial to anticipate user queries, ensure natural language understanding, and provide clear, actionable responses. Effective

conversation design enhances user experience by making interactions seamless and contextually relevant. For this prototype, attention to conversation design ensures that the chatbot delivers consistent, meaningful, and user-friendly support, aligning with the overall goals of the project.

3.3.3.1) Topic Depth

The exploration of ideal conversation paths for multilingual chatbots necessitates a comprehensive understanding of potential user confusions, detours, and dead ends. It is imperative to design conversational flows that can handle diverse linguistic contexts effectively. For instance, a customer may express a desire to apply for a savings account using various phrasings, such as, “I want to a credit card.” or “How can I open account?” The chatbot must be equipped to comprehend both of these queries and guide the customer towards an optimal resolution. Furthermore, in scenarios where the chatbot is unable to fulfill a request, it is essential to incorporate a fallback mechanism that directs the customer to a human representative for assistance.

3.3.3.2) Resilience in Multilingual Chatbots

In the realm of multilingual chatbots, resilience refers to the system's ability to effectively manage and adapt to various user inputs, linguistic nuances, and potential disruptions in conversation flow. A resilient chatbot should be capable of understanding and responding to a wide array of queries in different languages while maintaining coherence and context. This includes handling ambiguous or unclear user inputs, navigating through potential conversational detours, and avoiding dead ends. Additionally, resilience involves incorporating robust fallback mechanisms to ensure that users are seamlessly transferred to human representatives when the chatbot is unable to resolve their queries. Such resilience is crucial for maintaining high levels of user satisfaction and ensuring consistent service quality across diverse linguistic environments (Mou, 2024).

3.3.3.3) Repair Mechanisms in Multilingual Chatbots

Repair mechanisms in multilingual chatbots pertain to the system's capacity to address and rectify misunderstandings or errors that arise during interactions. Effective repair strategies are essential for ensuring that the chatbot can recover from conversational breakdowns and maintain a seamless user experience. This involves the chatbot's ability to identify when it has misinterpreted a user query or provided an incorrect response, and subsequently take corrective actions. Such mechanisms may include prompting the user for clarification, offering alternative solutions, or rephrasing questions to better align with the user's intent. Additionally, repair mechanisms should be adaptable to different languages and cultural

contexts, ensuring that the chatbot can effectively manage and resolve issues across diverse linguistic scenarios. Implementing robust repair strategies is crucial for enhancing user satisfaction and maintaining the effectiveness of the chatbot in multilingual environments (Griol, 2016).

3.3.3.4) Ease of use in Multilingual Chatbots

In designing multilingual chatbots, it is crucial to ensure that the conversation flows smoothly and efficiently, minimizing the need for excessive detail from the customer. For instance, the chatbot should be capable of processing a fund transfer request by asking only essential information, such as the transaction amount and date, without requiring additional details like the transaction reference number. The chatbot's queries should be structured to offer clear and straightforward choices to the user. For example, if a user inquires about opening an account, the chatbot's response should be concise and focused, such as "Is it a main account or a savings account?" instead of providing numerous options or requiring further clarification. By streamlining questions and responses, the chatbot can enhance the user experience, reducing complexity and ensuring that interactions remain efficient and user-friendly.

3.3.3.5) Word diet in Multilingual Chatbots

The concept of a "word diet" in multilingual chatbots refers to the strategic management and optimization of language used during interactions to enhance clarity and user comprehension. Implementing a word diet involves minimizing verbosity and avoiding complex or ambiguous terminology that may confuse users across different linguistic backgrounds. By focusing on concise and clear language, chatbots can improve their effectiveness in understanding and responding to user queries. This approach is particularly important in multilingual settings, where varying levels of language proficiency and cultural differences can impact the user's ability to comprehend the chatbot's responses. A well-implemented word diet ensures that the chatbot communicates efficiently, reducing the likelihood of misunderstandings and improving overall user experience (McTear, 2022).

3.3.3.6) Continuous Improvement in Multilingual Chatbots

Continuous improvement in multilingual chatbots refers to the ongoing process of enhancing their performance, accuracy, and user experience through iterative refinements. This process involves regularly analyzing chatbot interactions, identifying areas for enhancement, and implementing updates based on user feedback and performance metrics. Key aspects of improvement include refining natural language processing (NLP) algorithms to better

understand and respond to diverse linguistic inputs, expanding the chatbot's ability to handle complex queries, and enhancing its multilingual capabilities to ensure effective communication across various languages. Additionally, continuous improvement may involve integrating advanced machine learning techniques to adapt to evolving user needs and preferences. By prioritizing iterative development and incorporating user feedback, multilingual chatbots can achieve higher levels of efficiency, user satisfaction, and overall effectiveness (Følstad, 2021).

3.3.4) The Conversation Flow of the Chatbot

The chatbot's conversational flow has been designed to operate in three languages: English, French, and Spanish. Figures 14 to 18 illustrate the flow in English.



Figure 14: The Conversational Flow of Opening Account



Figure 15: The Conversational Flow of Branch Services

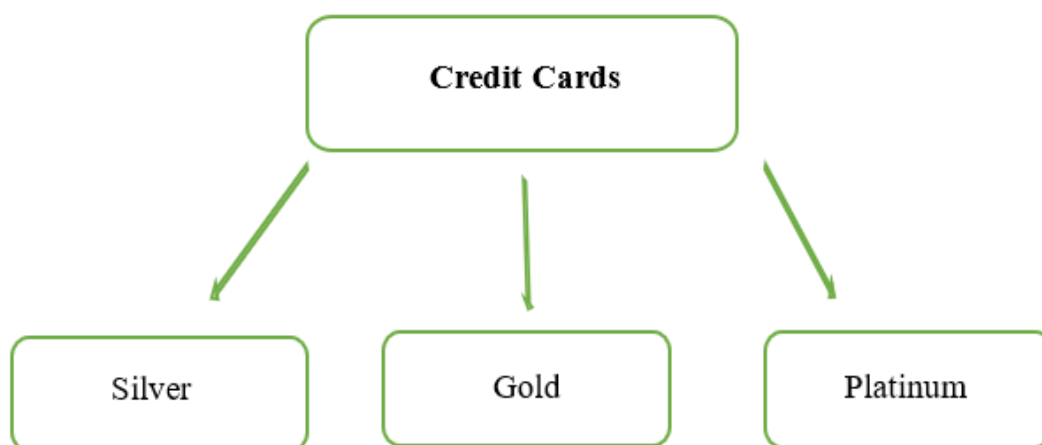


Figure 16: The Conversational Flow of Credit Cards

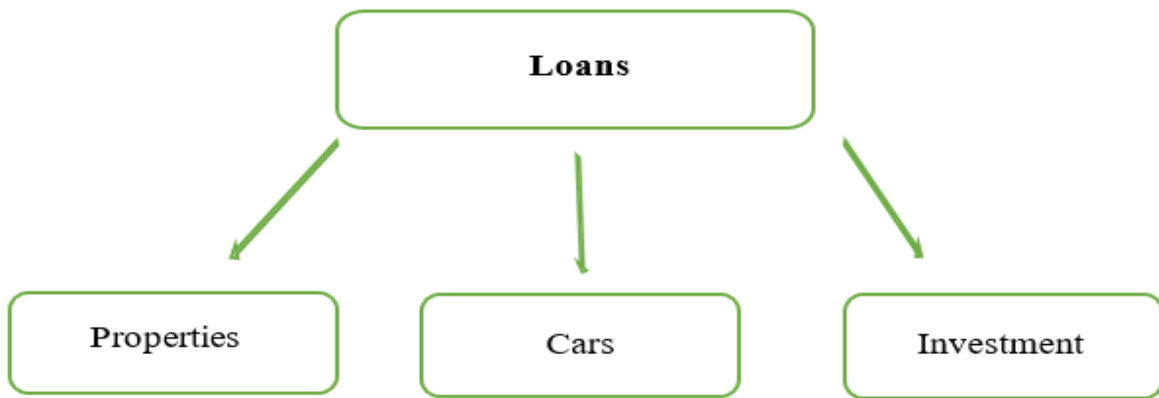


Figure 17: The Conversational Flow of Loans



Figure 18: The Conversational Flow of Contact Support

3.4) UI Design Principles for Multilingual Chatbots

Designing an effective User Interface (UI) for multilingual chatbots is essential to ensuring smooth, user-friendly interactions across diverse platforms and languages. Several key principles and best practices must be followed to enhance both user experience and system functionality. The focus is on simplicity, responsiveness, engagement, and brand consistency, which together create a cohesive, intuitive interface for chatbot users. This section explores these principles in detail.

3.4.1) Ease of Use

The primary goal of any chatbot UI is to simplify the user's interaction with the system. A well-designed chatbot interface must prioritize ease of use, offering an uncluttered window that minimizes the number of options, buttons, and lengthy messages. Users should intuitively understand where to click, what actions to take, and how to navigate the conversation without extensive instruction (Kuligowska, 2015). Simplicity is key, as overly complex interfaces can lead to confusion and frustration, ultimately diminishing the overall user experience.

3.4.2) Responsiveness Across Platforms

A consistent user experience across different platforms is crucial for the effectiveness of a multilingual chatbot. Chatbot UI should be designed to be adaptable to a variety of devices and screen sizes, including mobile phones, laptops, desktops, and tablets (Reshmi, 2016). The interface must remain responsive and maintain its functionality regardless of the platform, ensuring that users can easily engage with the chatbot on the device of their choice. This flexibility fosters greater accessibility and inclusivity, which are particularly important in multilingual contexts.

3.4.3) Customer Engagement

Effective customer engagement through chatbot UI requires thoughtful design, from the initial welcome message to the final goodbye. UI elements such as images, buttons, text, and links must be carefully incorporated to enhance the overall user experience (Kolski, 2024). The chatbot should guide the user through each step of the conversation in a way that feels natural and interactive. A well-crafted UI engages users by maintaining attention and interest, which is particularly important for ensuring satisfaction in customer service settings.

3.4.4) Brand Consistency

A well-designed chatbot interface must reflect the brand identity of the organization. Elements such as color schemes, logos, font types, and avatar images need to align with the company's branding guidelines (Reshmi & Balakrishnan, 2016). This not only reinforces brand recognition but also creates a cohesive experience for users who are familiar with the company's other digital touchpoints. Consistency in branding across all interfaces, including the chatbot, fosters trust and reliability in the eyes of the user.

3.4.5) UI Customization and Third-Party Integration

While designing for in-house platforms allows for greater flexibility, there are inherent limitations when integrating chatbots into third-party messaging apps such as Slack, WhatsApp, or Facebook Messenger. These platforms impose fixed UI elements, such as button styles and message formats, which constrain customization options (Kuligowska, 2015). UX designers must be mindful of these limitations and integrate them into their planning to ensure that the chatbot remains functional and engaging even within restricted environments.

3.5) User Experience (UX) Design for Multilingual Chatbots: A Prototype Approach

The design of user experience (UX) in chatbot systems is crucial for ensuring effective and intuitive interactions between users and technology. In the context of a multilingual chatbot, where users engage in various languages and contexts, UX design must accommodate diverse user intents while maintaining seamless communication across multiple linguistic domains. This section explores key elements of UX design, such as user intent, utterance, exchange, and flow logic, with a focus on how these components are structured in the prototype system. Proper attention to these areas enhances user satisfaction, optimizes conversation paths, and ensures a smooth escalation process to human agents when necessary.

3.5.1) Core Concepts in UX Design for Chatbots

3.5.1.1) Intent

In any chatbot interaction, user intent forms the foundation of the conversation. Intent refers to the specific reason a user initiates contact with the system, which may range from requesting a service to solving a problem. In the context of this prototype, the chatbot must be capable of understanding varied intents, such as “I want to apply for a credit card” or “How can I report a lost debit card?” Given the multilingual nature of the system, intent recognition must function across different languages while maintaining accuracy. An essential component of UX design in this case is ensuring that the chatbot accurately captures user intent regardless of linguistic variations or phrasing (Adamopoulou, 2020).

3.5.1.2) Utterance

Utterance refers to any individual input or statement made by the user during their interaction with the chatbot. It can be as simple as a greeting like "Hello" or a more complex question such as, "What are the interest rates for savings accounts?" In a multilingual system, the chatbot must be able to interpret utterances across different languages, considering grammar, syntax, and cultural nuances. Proper UX design ensures that each utterance is processed with context-awareness, helping the chatbot avoid misinterpretation and ambiguity (Liu, 2021).

3.5.1.3) Exchange and Flow Logic

The concept of exchange in UX design pertains to the back-and-forth conversation between the user and the chatbot. Each exchange is made up of multiple utterances aimed at addressing the user's intent. To optimize these exchanges, the chatbot must have well-designed flow logic, which governs how it responds to each input and how it progresses to the next step. Flow logic can be relatively simple, using if-else statements to navigate the conversation, or it can involve more complex machine learning algorithms that adapt to user behavior. For example, if a user asks, "What are the steps to apply for a savings account?" the chatbot must guide the user through the application process logically, possibly asking follow-up questions for clarification (De la Fuente Garcia, 2020). In this prototype, flow logic has been designed to ensure that the chatbot can engage users efficiently, regardless of language, without requiring extensive user input.

3.5.1.4) Contact and Escalation

Each interaction between a user and the chatbot is referred to as a "contact," and it represents an instance where the user engages the system, whether they respond to the chatbot's prompts or not. A well-designed UX should account for various types of user engagement, including situations where the user may start but not complete a conversation. In addition, escalation mechanisms must be in place for instances where the chatbot is unable to resolve the user's intent. Escalation involves smoothly transferring the conversation to a human agent. This is particularly important when the chatbot encounters queries that require nuanced understanding or complex problem-solving beyond its capabilities. By incorporating both planned and fallback escalation paths, this prototype ensures that users are never left without adequate support (Udeh, 2024).

3.5.1.5) Multilingual Considerations in UX Design

Given that this prototype is designed to function across multiple languages, specific attention has been given to the multilingual aspects of UX design. The chatbot must be able to handle language-specific variations in user intent, utterances, and responses. For example, a user inquiring about account details in English may phrase their query differently than a user speaking in French or Spanish, yet the chatbot must respond appropriately and consistently in all cases. By leveraging language processing technologies such as NLP and integrating APIs for language translation, the system is capable of maintaining context and delivering relevant responses in various languages. This flexibility in language handling not only enhances user experience but also broadens the chatbot's applicability across different linguistic markets (Khankhoje, 2023).

3.5.1.6) Preferred and Non-Preferred Responses

A critical part of UX design in chatbot systems is ensuring that the system provides preferred responses—those that progress the conversation toward resolving the user's intent. Non-preferred responses, on the other hand, do not contribute to intent resolution and can cause user frustration. Therefore, it is essential for the chatbot to be able to detect when its responses are not helpful and trigger corrective actions. For example, if the chatbot misinterprets a query and provides irrelevant information, the system should prompt the user to rephrase their question or clarify their intent, thereby repairing the conversation flow.

3.5.1.7) Conclusion

The design of UX for this multilingual chatbot prototype emphasizes the need to accommodate diverse user intents, efficiently manage exchanges, and provide seamless escalation mechanisms. By focusing on key design elements such as intent recognition, utterance processing, and flow logic, the chatbot is well-positioned to deliver a high-quality user experience across multiple languages. Additionally, by ensuring that users receive preferred responses and offering fallback options through escalation, the prototype successfully enhances user engagement and satisfaction. As chatbot technologies continue to evolve, UX design will remain a pivotal factor in achieving intuitive and efficient human-computer interactions.

3.6) Data Right for Chatbots

In the context of the prototype chatbot project, data rights pertain to the ownership, privacy, and security of user data collected during interactions. Users have the right to know how their data is used, stored, and protected. The chatbot system, integrated with Dialogflow, Firebase, and Firestore, ensures that user data is securely managed in compliance with relevant data protection regulations. Transparent policies should be in place, informing users about data usage and providing options to access, correct, or delete their information. Ensuring robust data security measures and adhering to privacy laws are essential for maintaining user trust and compliance.

Chapter 4: Multilanguage Chatbot Design Development

4.1) Concepts of Google Dialogflow

Google Dialogflow encompasses several core concepts essential for designing conversational agents: Agents, Intents, Entities, Context, Response, and Fulfillment. Agents serve as Natural Language Understanding (NLU) modules embedded within websites, applications, or services, converting user inputs into actionable intents. Intents represent predefined constructs within agents that process user requests by mapping user utterances to appropriate responses. Each Intent comprises training phrases, responses, actions, context, and fulfillment sections. Training phrases are examples of user inputs, while responses are the system's replies. Actions specify the operations to be performed, contexts manage the conversation state, and fulfillment handles backend integration to complete user requests. These components collectively enable effective interaction management and response generation in Dialogflow-powered systems (Google, 2024). The interface of an Intent is shown below.

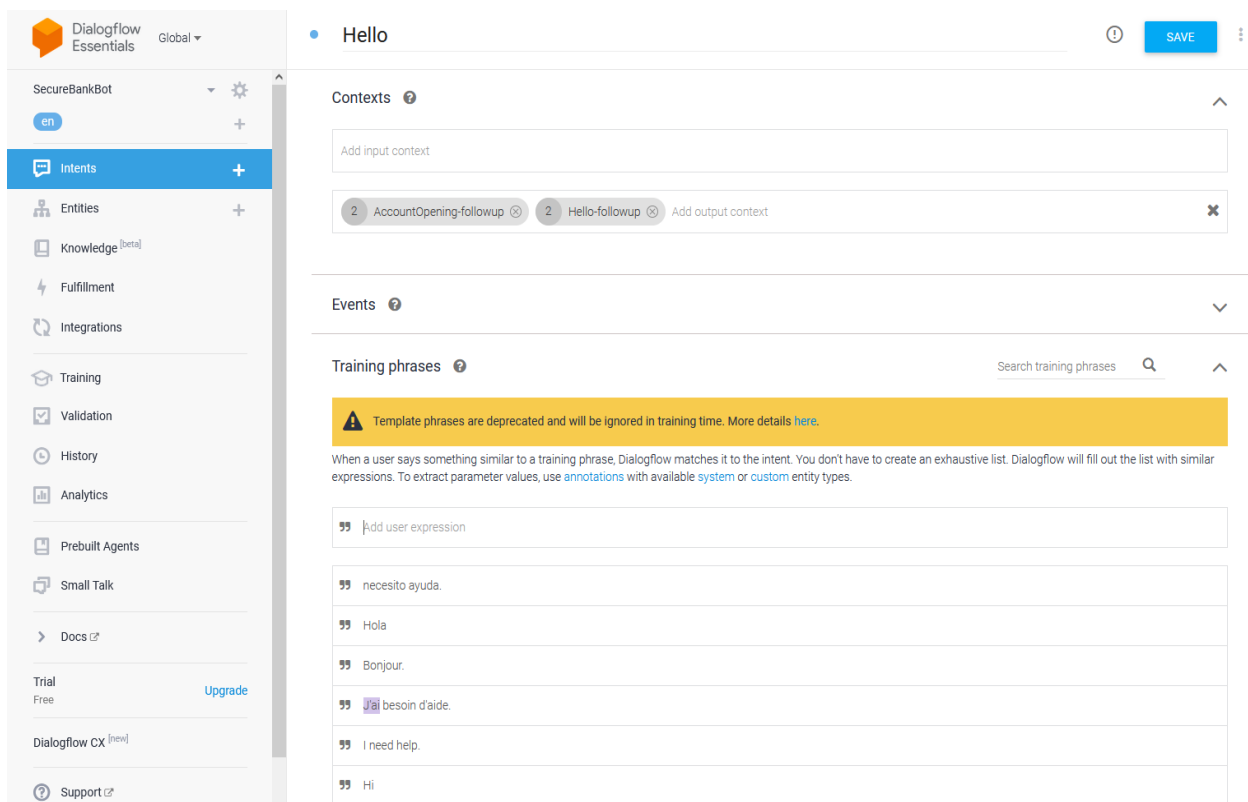


Figure 19: Hello Section of Intent

The objectives of banking chatbot under intent classification are:

- The chatbot is designed to provide information on banking products, including account opening, branch details, credit card services, loans, and customer support, in three languages: English, French, and Spanish.
- To provide detailed information on the various types of credit cards and loan options available.
- The chatbot utilizes over 70 intents and 6 entities to ensure smooth functionality across three different languages. This extensive configuration allows the system to accurately process diverse user inquiries and provide seamless multilingual support (Figures 20 and 21).

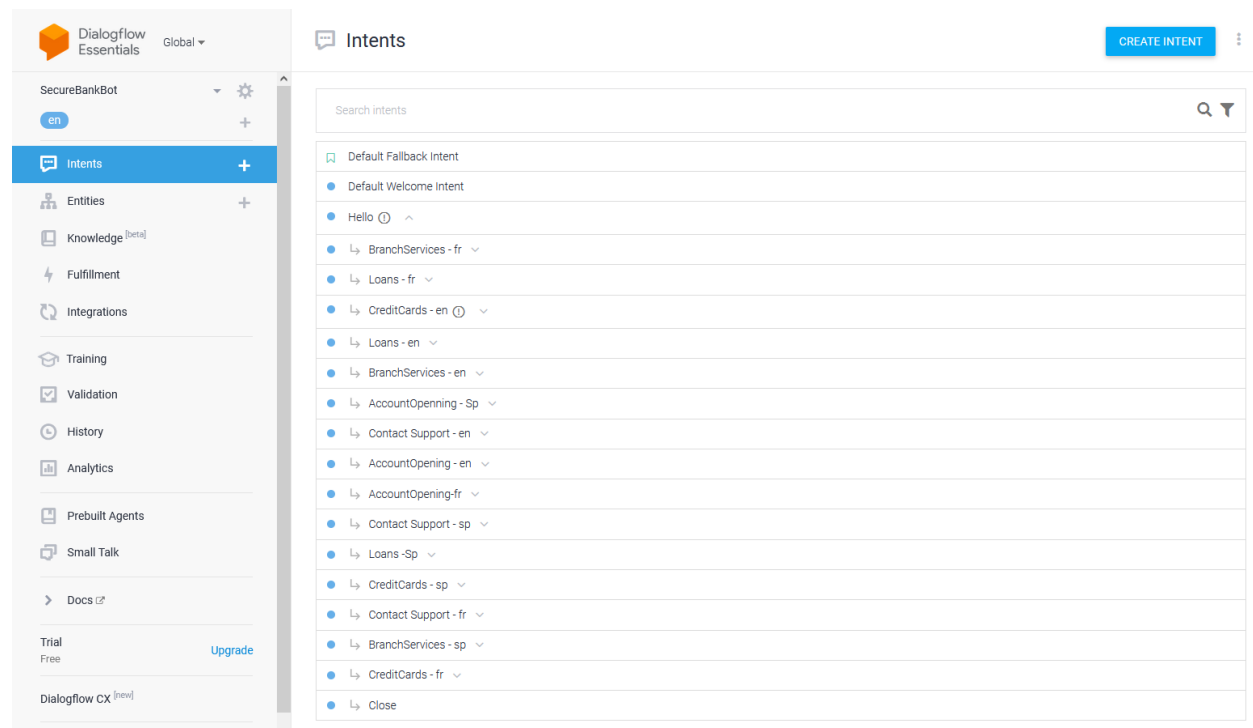


Figure 20: Intents of The Agent

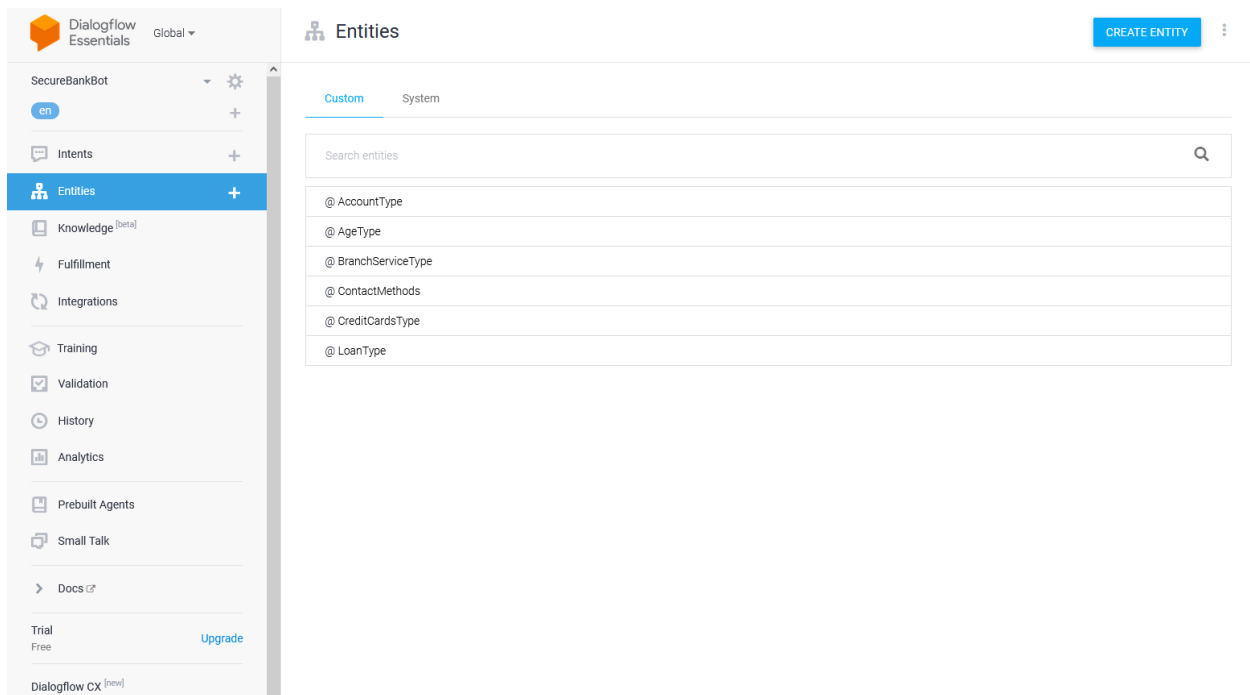


Figure 21: Entities of the Agent

Intent: In chatbot design, intent refers to the specific goal or problem that prompts a user to initiate contact with the system. Each interaction typically starts with an intent, such as applying for a credit card, reporting a lost debit card, or seeking help with a bank transaction. Accurately identifying the user's intent is crucial, as it sets the stage for the entire conversation. The chatbot must be able to quickly and correctly discern this goal to provide a relevant and timely response. Studies show that a chatbot's ability to correctly understand and process user intents is one of the most important determinants of user satisfaction (Adamopoulou, 2020).

Entity: Entities are objects or concepts related to a user's intent, such as products, documents, or services mentioned in an utterance. Correctly identifying entities is a critical aspect of the chatbot's ability to fulfill user requests, especially in the context of NLP. For instance, in the sentence, "I want to apply for a credit card," the entity would be "credit card." Proper entity recognition allows the chatbot to process the request efficiently and provide a relevant response. NLP systems often rely on machine learning models trained on domain-specific data to improve entity recognition (Bilquise, n.d.)

Context: In Google Dialogflow, Context plays a crucial role in managing the flow of conversations by maintaining the state between user interactions. Context enables the chatbot to track what has been previously said, helping it to understand the meaning behind user inputs more effectively and respond appropriately based on the current conversational context.

For example, if a user expresses intent to "open a savings account," Dialogflow can activate a context that expects further details, such as "What type of account would you like?" The system uses input contexts to recognize when certain intents should be activated and output contexts to set up expectations for follow-up questions, ensuring a more dynamic and natural conversation flow. Context helps maintain coherence in longer interactions and allows the chatbot to handle complex, multi-step dialogues efficiently (Google, 2024), (Figure 22).

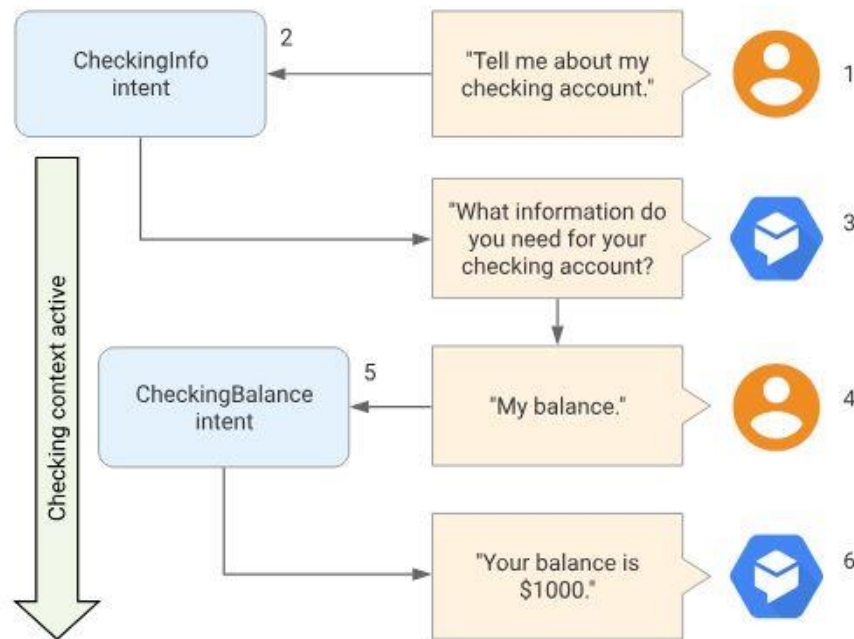


Figure 22: Usage of Context. Source: Google

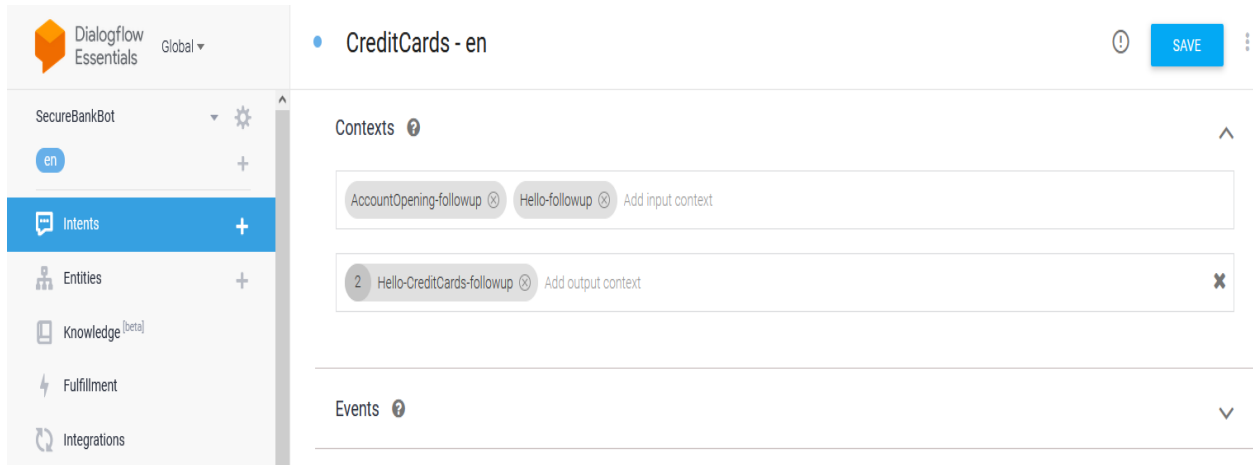


Figure 23: Contexts of Dialogflow Agent.

Fulfillment in Google Dialogflow Agents: Fulfillment in Google Dialogflow refers to the process through which an agent completes a user's request by interacting with external systems or services. It acts as a bridge between the conversational capabilities of the agent and the backend logic required to execute specific tasks. This component is crucial for providing dynamic and contextually relevant responses beyond pre-defined static replies.

Function of Fulfillment: Fulfillment allows Dialogflow agents to perform complex operations such as querying databases, invoking APIs, or executing business logic. When a user's intent triggers a request that requires external data or processing, fulfillment comes into play. For example, if a user asks for their account balance, the agent will invoke fulfillment to query the banking database and return the accurate balance to the user. This interaction is facilitated through webhook integration, where Dialogflow sends the user's request to a specified webhook service, which then processes the request and sends back the appropriate response (Google, 2024).

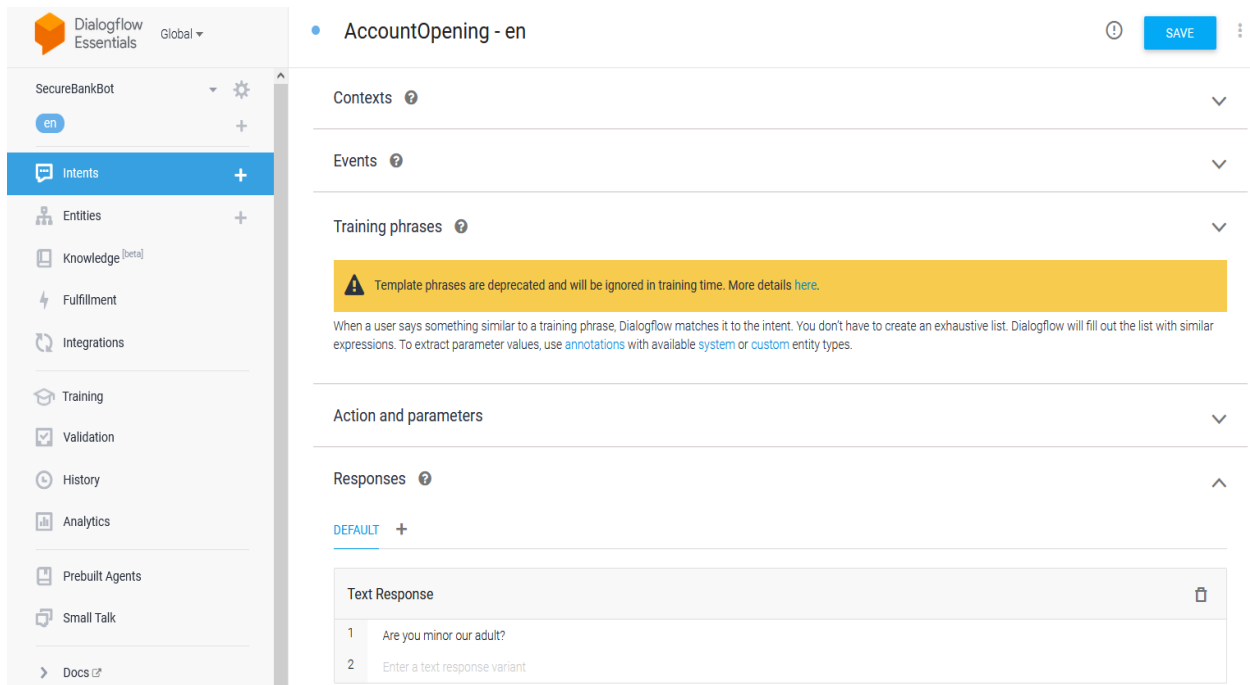


Figure 24: Response of Chatbot

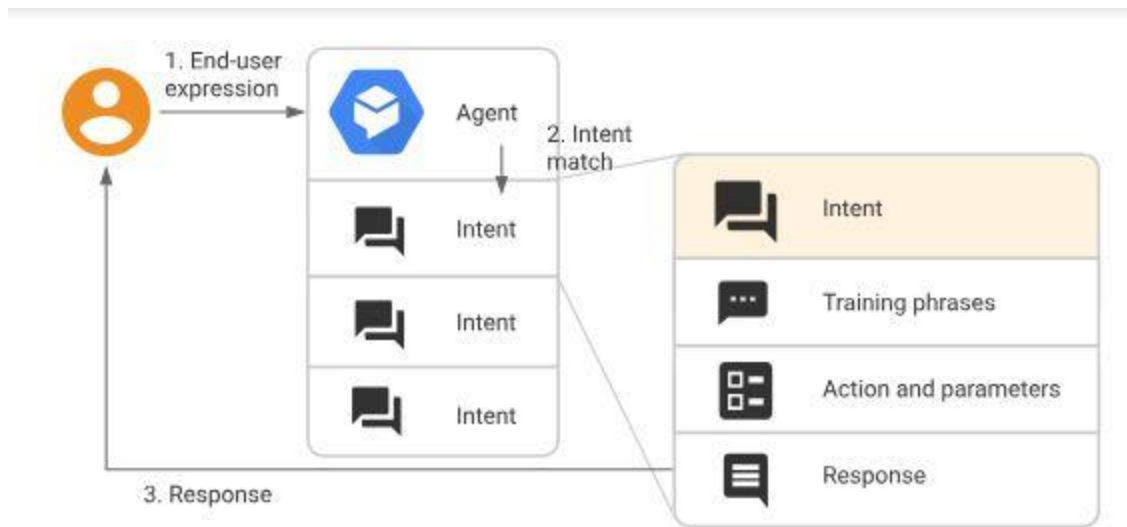


Figure 25: Intent Matching

4.2) Chatbot components

The project comprises several key components: a chatbot built with Google Dialogflow, a website that hosts the chatbot, a database for recording chat history, and an API that connects the chatbot to the database. The website, utilizing a free template from FreeHTML5, has been tailored to represent a banking institution named "Secure Bank" and is hosted on Firebase under the domain bank-fprl.web.app/. The chatbot includes more than 70 intents and 6 entities, with webhook services activated to facilitate integration with fulfillment. Chat history is managed within a NoSQL database provided by MongoDB Atlas, a cloud-based platform. The API, which links the chatbot to the database, is developed in Python and hosted on Replit (Figure 26).

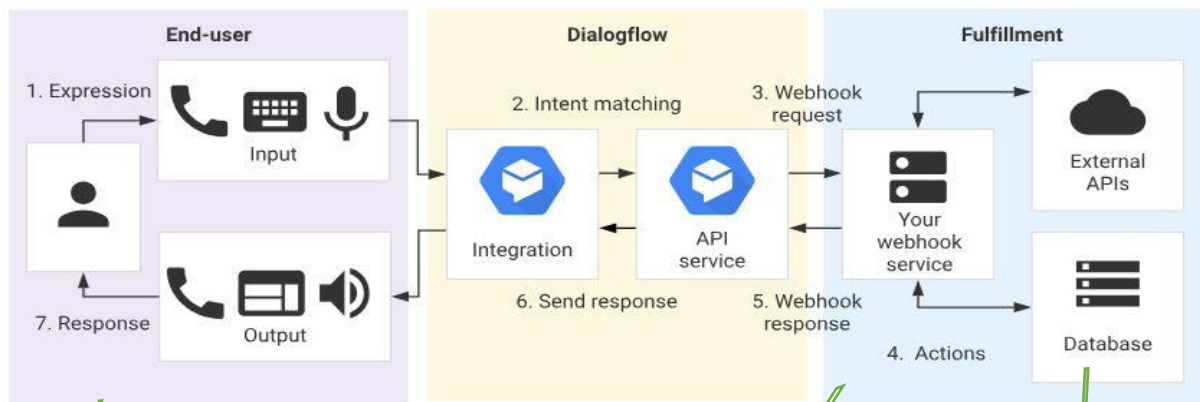


Figure 26: Fulfillment Explanation. Source: Google



Figure 27: SecureBank Website, Python Code, Mongo DB

The SecureBank website serves as the interface through which clients interact with the chatbot. The integration between the chatbot and the database is managed by Python code, which is deployed as an API webhook on Replit. MongoDB is utilized as the database solution for storing and managing data. This setup ensures seamless communication between the chatbot and the database, allowing for efficient data retrieval and interaction within the SecureBank website.

4.3) Database: MongoDB

MongoDB is a widely used, open-source NoSQL database that provides high performance, high availability, and easy scalability. Unlike traditional relational databases, MongoDB stores data in flexible, JSON-like documents, which allows for a dynamic schema. This structure is advantageous for applications that require rapid development and iteration, as it supports a variety of data types and structures without the need for predefined schemas (MongoDB, 2024).

MongoDB operates on a document-oriented model, where data is stored in BSON (Binary JSON) format. This enables the storage of complex data types, such as arrays and nested documents, which can be queried efficiently. It also supports indexing, aggregation, and real-time analytics, which are crucial for handling large volumes of data and complex queries.

One of MongoDB's key features is its horizontal scalability. It uses sharding to distribute data across multiple servers, which improves performance and ensures data availability. Replica sets are another important feature, providing redundancy and high availability by replicating data across multiple servers.

MongoDB is particularly well-suited for modern applications that handle large amounts of unstructured data, such as content management systems, IoT applications, and real-time analytics platforms. Its flexibility and scalability make it a popular choice for developers looking to build robust and adaptable data storage solutions.

The decision to use MongoDB instead of Firestore was primarily driven by cost considerations. Firestore's pricing model for high data usage and extensive read/write operations can become prohibitive, particularly for projects with significant database interactions. In contrast, MongoDB offers a more cost-effective solution with its flexible pricing options and free tier, making it suitable for managing large volumes of data without incurring excessive costs. By opting for MongoDB, the project benefits from a scalable and efficient database solution while keeping expenses within budget constraints (Bradshaw, 2019), (Figure 28).

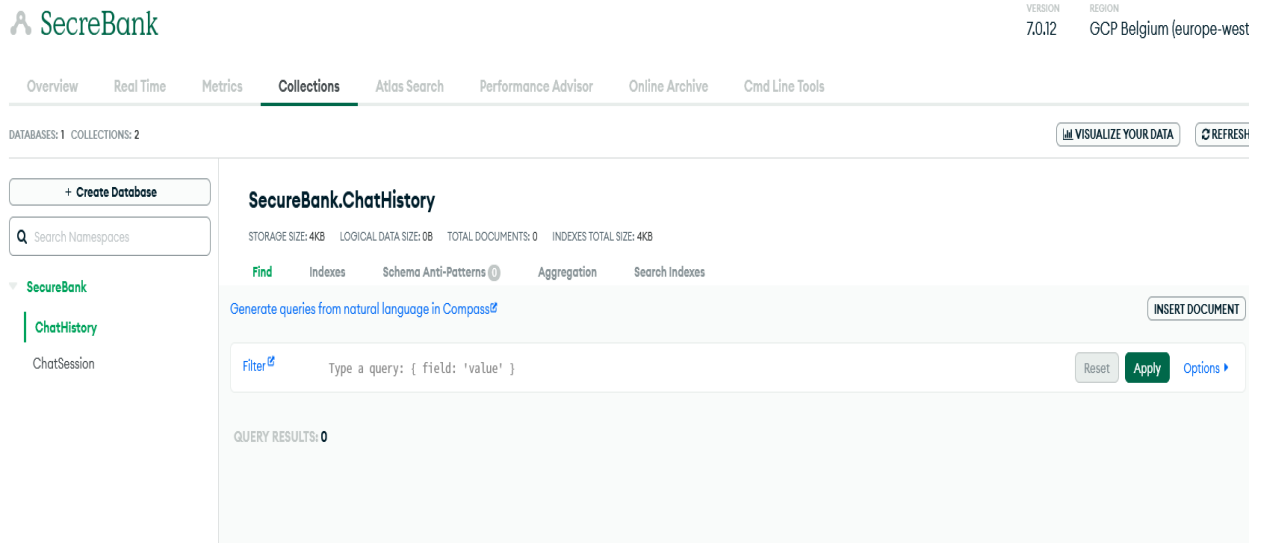


Figure 28: MongoDB, SecureBank Database

JSON is used for storing data in MongoDB due to its flexibility and human-readable format. It allows easy representation of hierarchical data structures and integrates seamlessly with MongoDB's document-oriented storage. This makes it ideal for dynamic schemas and efficient data manipulation in applications.

```
{
  "id": "unique_id_001",
  "session_id": "session_123456",
  "timestamp": "2024-09-06T12:34:56Z",
  "intent": "UserIntentExample"
}
```

Figure 29: JSON code for storing data in MongoDB

4.4) API

The Flask application acts as a webhook for managing chatbot interactions. It receives JSON data from the chatbot service, extracts key details, and inserts them into two MongoDB collections: chat_history and chat_session. Deployed on Replit, this solution was chosen because Firebase does not support dynamic Flask application hosting, and Google Cloud Functions were too costly. Replit provides a cost-effective alternative for running Flask applications, enabling efficient management and processing of chatbot interactions without the financial burden of other cloud services.

```
from flask import Flask, request, Response
import pymongo
import json
import datetime

app = Flask(__name__)

# Load configuration from the config.json file
with open('config.json') as file:
    params = json.load(file)['params']

# Connect to MongoDB
client = pymongo.MongoClient(params['client_url'])
db = client[params['db']]

@app.route('/')
def home():
    return 'FLASK CONNECTED', 200

@app.route('/webhook', methods=['POST', 'GET'])
def webhook():
    req = request.get_json(force=True)
    session = req['session']
    session_id = session.split('/')[1]
    query = req['queryResult']['queryText']
    result = req['queryResult']['fulfillmentText']
    intent = req['queryResult']['intent']['displayName']
    timestamp = datetime.datetime.now().isoformat()
    parameters = req['queryResult']['parameters']

    parameters_dict = {key: value for key, value in parameters.items()}

    # Data for chat session
    data = {
        "session_id": session_id,
        "user_message": query,
        "bot_response": result,
    }
```

Figure 30: Flask (Python Code), Part 1


```

| # Data for chat history
| data2 = {
|     "session_id": session_id,
|     "timestamp": timestamp,
|     "intent": intent,
|     "entities": parameters_dict
| }

| # Insert data into MongoDB
| col = db['ChatSession']
| col.insert_one(data)

| col2 = db['Chat_History']
| col2.insert_one(data2)

| print("Data inserted into MongoDB")

| return Response(status=200)

if __name__ == '__main__':
    app.run(host='0.0.0.0', port=8080, debug=True)

```

Figure 31: Flask (Python Code), Part2

4.5) Website

For the website, a free HTML template was utilized due to its ease of use and accessibility. The template offered a straightforward approach to design, allowing for rapid development and customization with minimal effort. Its pre-designed structure and components facilitated efficient implementation of the website's layout and functionality, enabling a focus on content and user experience. The choice of a free HTML template streamlined the development process, providing a cost-effective solution while maintaining flexibility for adjustments and enhancements as needed. This approach supported the project's goals by combining simplicity with effective design and functionality (figures 32-34).



Figure 32: SecureBank Website, Home Page

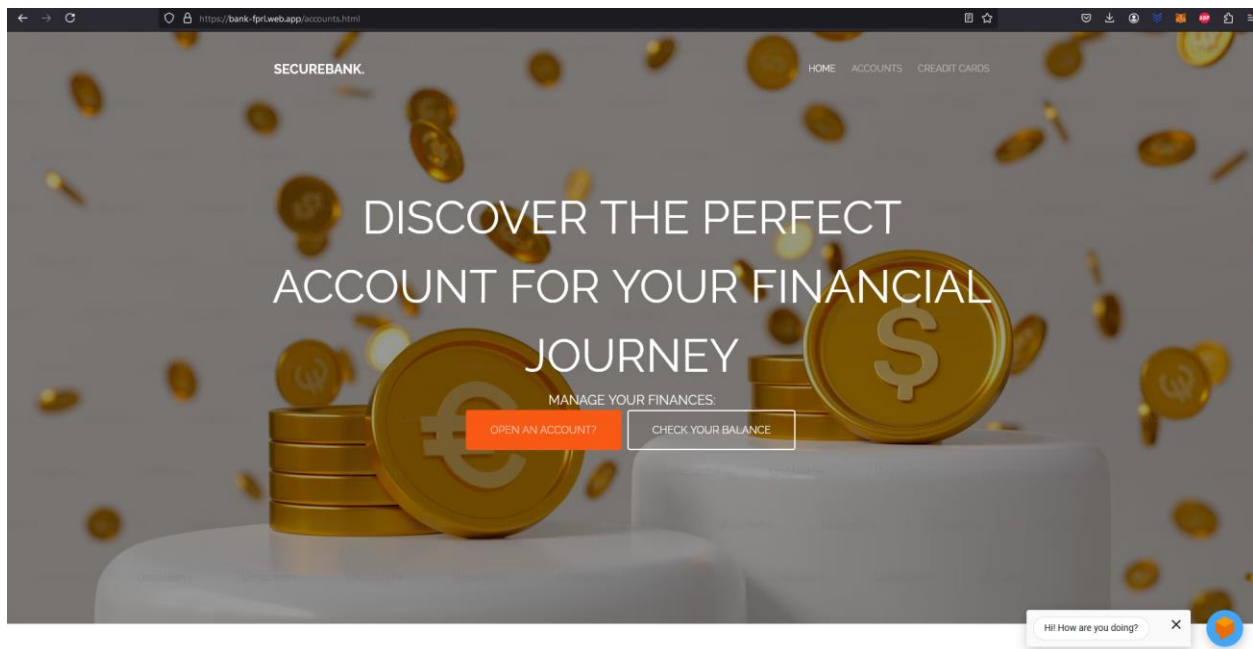


Figure 33: SecureBank Website, Opening Account Page

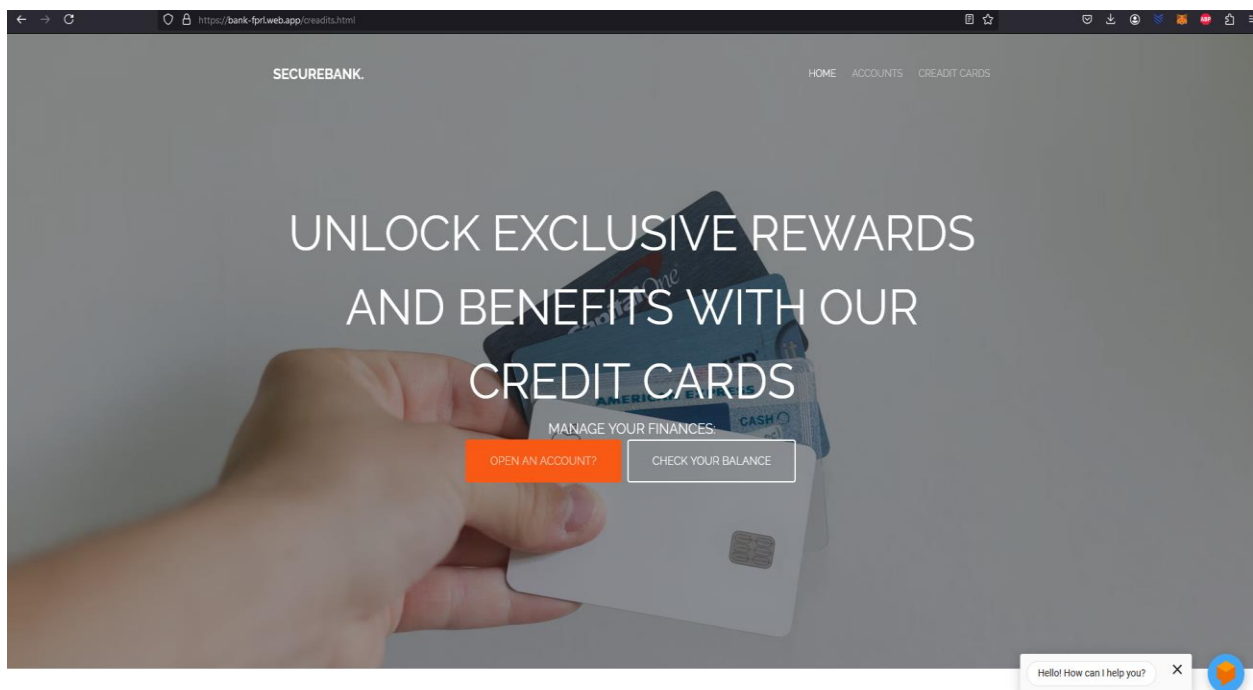


Figure 34: SecureBank Website, Credit Cards Page

4.5) Chatbot agent of SecureBank:

The chatbot agent developed for this project is trained to handle multilingual customer interactions on a website, utilizing Google Dialogflow's Natural Language Understanding (NLU) capabilities. It is trained on over 70 predefined intents, covering a wide range of user inquiries, such as account services and product information, across three languages. The agent is also trained on six entities, allowing it to identify specific terms related to the user's query, like product names or account types. By leveraging machine learning models, the chatbot adapts to varied user inputs, ensuring accurate responses and seamless interaction in multiple languages.

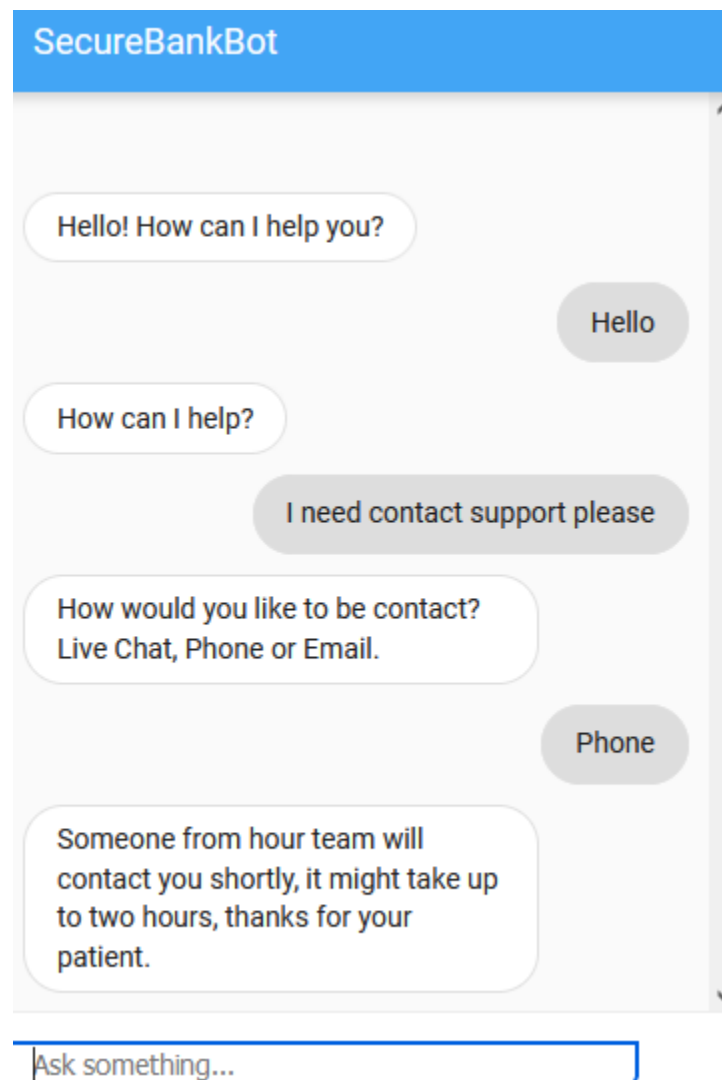


Figure 35: Client's Interaction with the Chatbot

4.5.1) Quick and easy response

The chatbot provides rapid responses to inquiries, having been trained with a limited number of training phrases across most intents. These training phrases, detailed in Appendix A, facilitate efficient service delivery. The platform demonstrates its robust natural language processing (NLP) capabilities by accurately identifying different language contexts. For instance, the "Loans Request" intent is trained with only three phrases in three different languages. Users can select from three options: Cars, Investment, or Property. When a user selects "Investment," the chatbot correctly identifies the intent and context, ensuring that the appropriate response is generated by the agent.

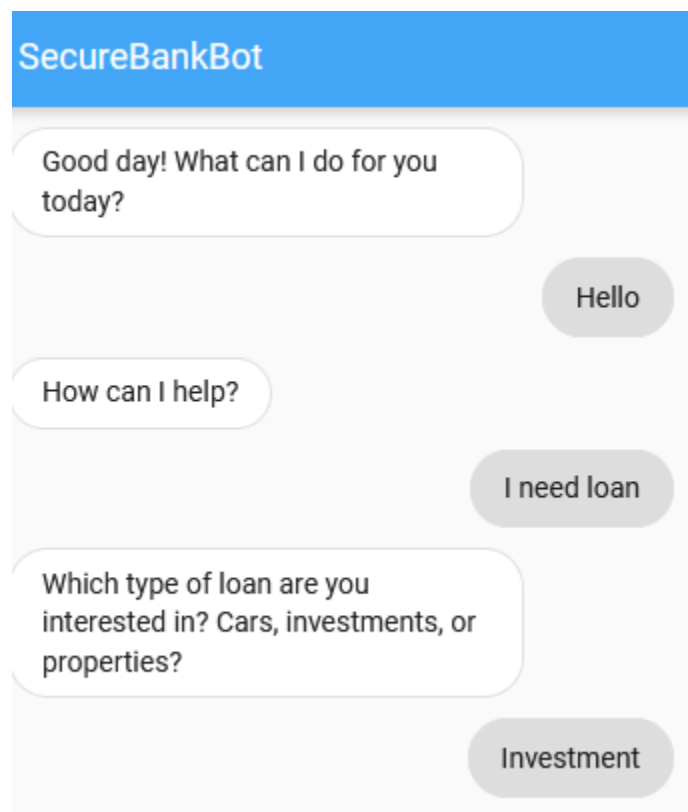
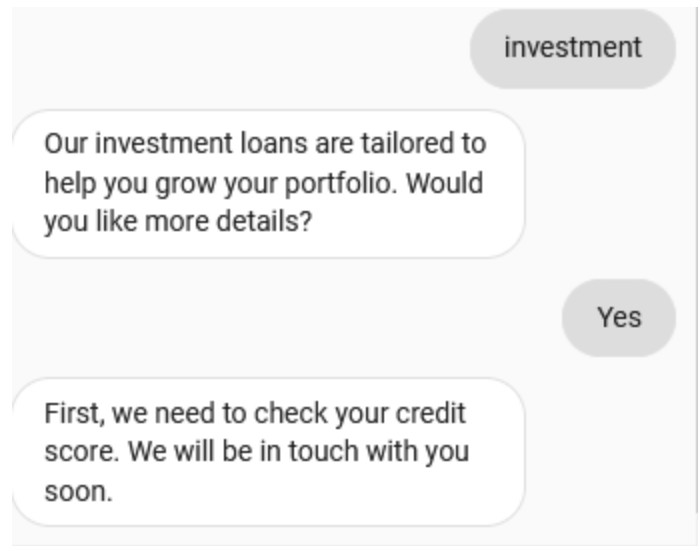


Figure 36: Client Interaction with the Chatbot for Requesting Loan (Part 1)



Ask something...

Figure 37: Client Interaction with the Chatbot for Requesting Loan (Part 2)

4.5.2) Detecting Different Languages by the Chatbot

In the prototype project, the chatbot's ability to detect and respond to different languages is essential for providing a seamless multilingual user experience. Using Google Dialogflow's Natural Language Processing (NLP) capabilities, the system can automatically recognize the language of the user's input and adjust its responses accordingly. For instance, if a user engages the chatbot in French by asking, " Je veux un prêt," the chatbot identifies French as the input language. It then processes the query using language-specific intents and entities, delivering an appropriate response in French. This ensures the chatbot can serve users in multiple languages, enhancing accessibility and user satisfaction across linguistic boundaries (figure 27).



Figure 38: The Chatbot Detecting French Language

4.5.3) Responding to Client Inquiries in Two Languages (English and Spanish)

Effectively addressing client inquiries in both English and Spanish requires a well-structured multilingual communication system. This approach involves leveraging natural language processing (NLP) technologies capable of understanding and responding in both languages with equal accuracy. By incorporating language-specific intents and context management, systems like Google Dialogflow can seamlessly switch between English and Spanish based on user preferences. Furthermore, ensuring consistent translation of responses and maintaining contextual relevance across languages are essential for delivering a coherent user experience. Such systems enhance accessibility, allowing businesses to serve a diverse clientele while maintaining the quality of interaction across linguistic boundaries (Chen, 2023) (Figures 28-31).

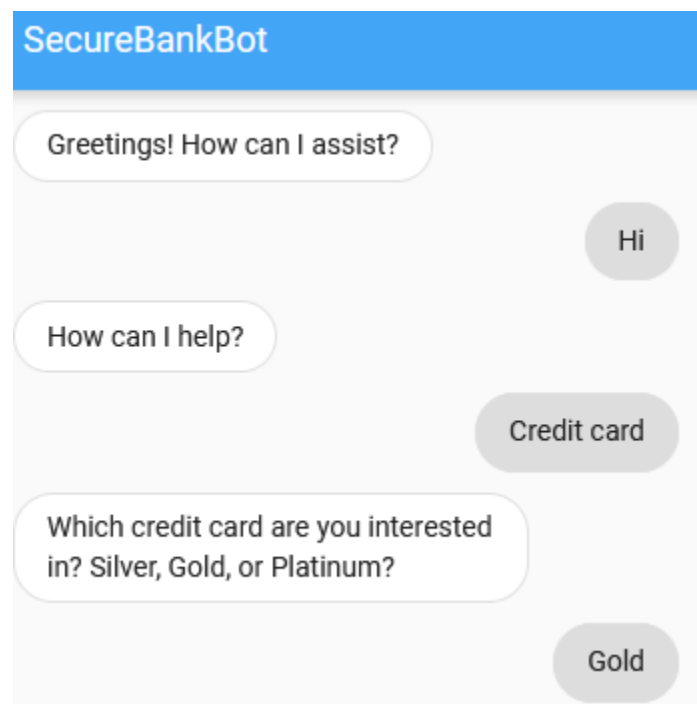


Figure 39: Client Inquiries for Gold Credit Card in English (Part 1)

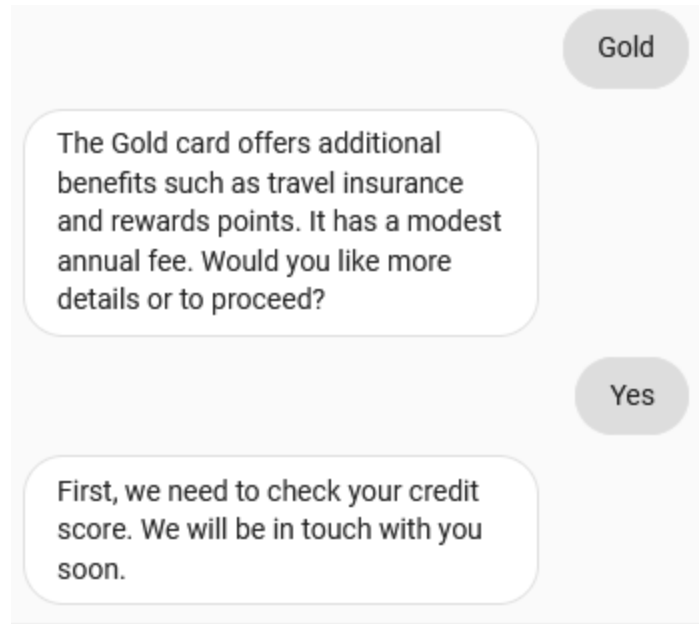


Figure 40: Client Inquiries for Gold Credit Card in English (Part 2)

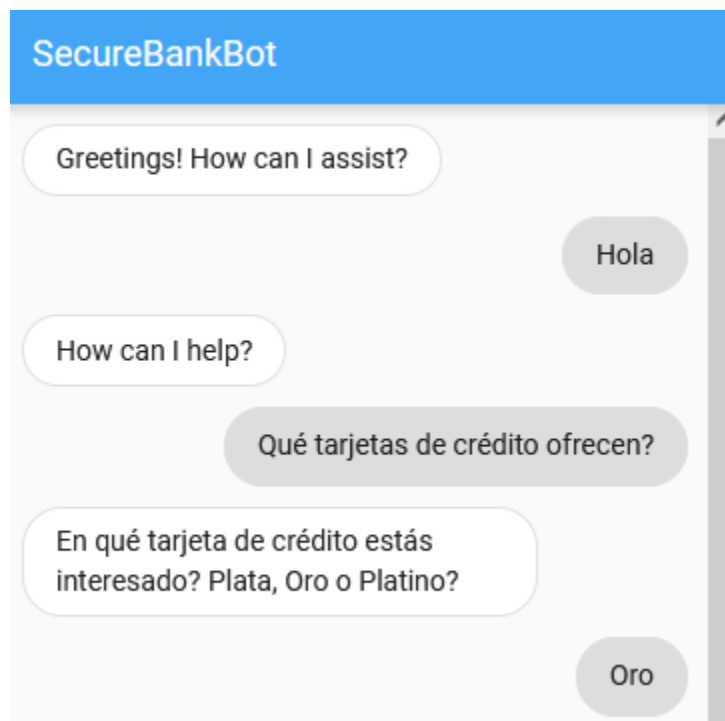


Figure 41: Client Inquiries for Gold Credit Card in English (Part 1)

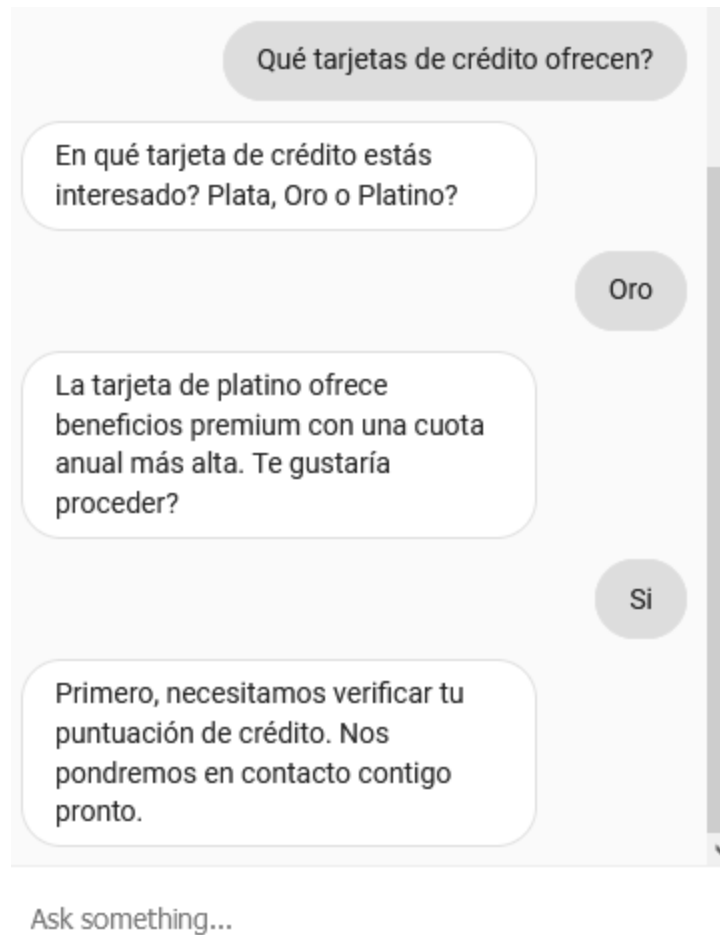


Figure 42: Client Inquiries for Gold Credit Card in English (Part 2)

4.5.4) The Fall-Back Intent

In instances where customers submit inquiries beyond the scope of the SecureBank capabilities or enter meaningless input by mistake, the chatbot system is programmed to handle these situations by redirecting the conversation to a human representative. Such scenarios are managed through the fallback intent within the chatbot platform, which is designed to capture unrecognized or ambiguous inputs. (Figure 32) demonstrates examples of these occurrences, showcasing how the system appropriately escalates unresolved queries to human agents for further assistance. This ensures that customer needs are addressed even when the chatbot cannot provide an immediate solution

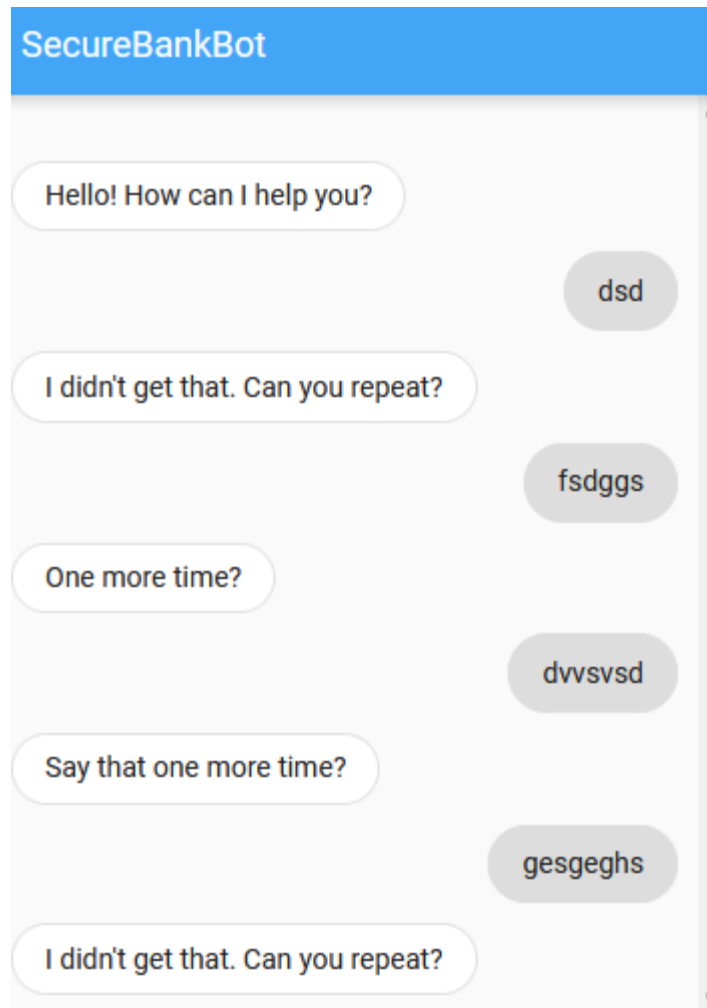


Figure 43: The Fall-Back Intent

4.5.5) Data collection by Dialigflow

Conversations between the client and the chatbot are stored in the Chatbot History of Dialogflow. This stored data serves as a valuable resource for improving the chatbot's performance. By analyzing these interactions, the agent can learn from user behavior, identify patterns, and refine its natural language understanding (NLU) capabilities. The Chatbot History captures both successful and unsuccessful exchanges, allowing developers to fine-tune Intents, adjust Entities, and enhance Response accuracy. Additionally, this historical data enables continuous training of the agent, optimizing it to handle more complex queries over time and improving user satisfaction. The process of learning from real-world interactions ensures that the chatbot evolves, becoming more effective in addressing user needs and providing accurate, contextually relevant responses

(Google, 2024). This iterative learning process is essential for maintaining a responsive and adaptive conversational agent (Figure 33).

Conversation	Date	
5 interactions Duration: 7 min		< > 🗑️
<div>USER</div> WELCOME	Event	Sep 6, 1:06 AM
<div>AGENT</div> Greetings! How can I assist?		Sep 6, 1:06 AM ⋮
<div>USER</div> Bonjour		Sep 6, 1:13 AM
<div>AGENT</div> How can I help?		Sep 6, 1:13 AM ⋮
<div>USER</div> Je veux un prêt.		Sep 6, 1:13 AM
<div>AGENT</div> Quel type de prêt vous intéresse ? Voitures, investissements ou propriétés?		Sep 6, 1:13 AM ⋮
<div>USER</div> propriétés		Sep 6, 1:13 AM
<div>AGENT</div> Nos prêts immobiliers comprennent diverses options de prêt hypothécaire adaptées à vos besoins. Souhaitez-vous plus de détails?		Sep 6, 1:13 AM ⋮
<div>USER</div> Oui		Sep 6, 1:13 AM
<div>AGENT</div> Tout d'abord, nous devons vérifier votre score de crédit. Nous vous contacterons bientôt.		Sep 6, 1:13 AM ⋮

Figure 44: Chatbot History of Dialogflow

4.6) Integration of SecureBank Bot Using Google Dialogflow

The SecureBank Bot is a text-based chatbot designed to facilitate customer interactions. Google Dialogflow offers several integration options, including the Web Demo and Dialogflow Messenger. After evaluating both, the Dialogflow Messenger was selected for its enhanced user experience compared to the Web Demo. Dialogflow provides two primary integration methods: API integration and Webhook integration. For the SecureBank Bot, the webhook integration method was implemented. This approach allows seamless interaction between the bot and external systems, enabling dynamic responses based on real-time data. The use of webhook integration enhances the bot's functionality by allowing it to execute complex tasks, ensuring a more interactive and personalized user experience (Figure 45).

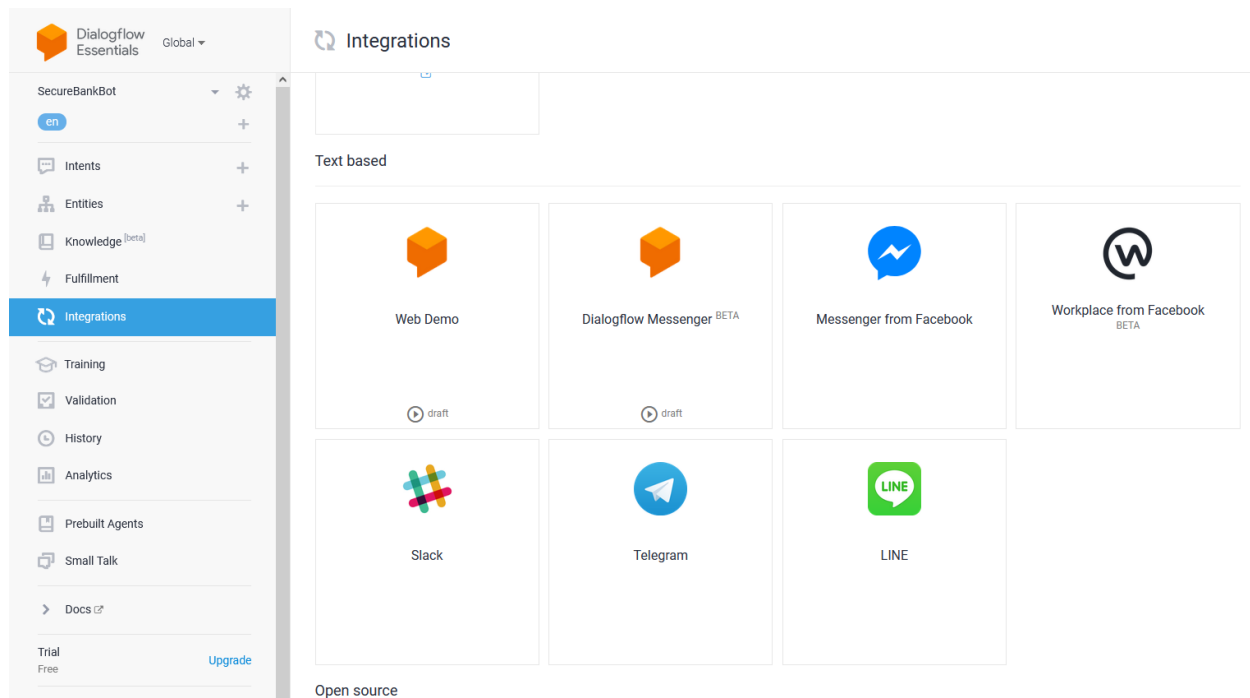


Figure 45: Integration selections in Dialogflow console. Source: Google

4.7) Firebase Hosting: A Comprehensive Overview and Rationale for Selection

Firebase Hosting, a component of Google's Firebase platform, is a powerful web hosting service designed to deploy and manage modern web applications. It offers a robust and scalable solution for hosting static and dynamic content with a focus on speed, security, and ease of use. In the context of the SecureBank Bot project, Firebase Hosting was chosen for its array of features that align well with the project's requirements.

4.7.1) Features of Firebase Hosting

Firebase Hosting provides a suite of features that contribute to its effectiveness as a hosting platform. Firstly, it offers fast and secure hosting through the use of a global content delivery network (CDN). This network ensures that content is delivered quickly to users by caching it at various locations around the world, thereby reducing latency and improving load times (Google Firebase, 2023). Additionally, Firebase Hosting includes automatic SSL certification, which encrypts data transmitted between the user and the server, enhancing security and protecting sensitive information from potential breaches.

Another significant feature of Firebase Hosting is its seamless integration with other Firebase services and Google Cloud products. This integration simplifies the deployment process and allows for easy management of both the frontend and backend components of web applications. For instance, Firebase Authentication and Firestore can be effortlessly integrated with Firebase Hosting to create a cohesive environment where user data and application logic are managed effectively (Firebase, 2023), (Figure 37).

4.7.2) Rationale for Choosing Firebase Hosting

The decision to select Firebase Hosting for the SecureBank Bot project was influenced by several key factors.

1. **Performance and Scalability:** Firebase Hosting's use of a global CDN ensures high performance and scalability, which are crucial for handling varying loads and delivering a smooth user experience. This is particularly important for the SecureBank Bot, which requires reliable performance to manage multiple simultaneous interactions with users. The CDN's caching capabilities and the ability to scale resources dynamically ensure that the bot remains responsive even during peak usage periods (Li, 2024)

2. **Security:** Security is a paramount concern in any application, especially in the financial sector where sensitive user data is involved. Firebase Hosting provides built-in security features, including automatic SSL certificates and protection against distributed denial-of-service (DDoS) attacks. These features help safeguard user data and maintain the integrity of the bot's interactions with clients (Firebase, 2024)
3. **Integration and Development Efficiency:** Firebase Hosting's seamless integration with other Firebase services, such as Firestore for database management and Firebase Functions for server-side logic, streamlines the development process. This integration reduces the complexity of managing different components of the chatbot system and allows for efficient deployment and updates. For example, Firebase Functions can be used to handle backend logic and interact with Firestore, while Firebase Hosting manages the frontend delivery (Firebase, 2024)
4. **Ease of Use and Deployment:** Firebase Hosting provides an intuitive user interface and command-line tools that simplify the deployment process. This ease of use is beneficial for rapid development and iterative testing, allowing developers to deploy changes quickly and efficiently. The integration with continuous deployment pipelines also facilitates automated updates, ensuring that the latest features and fixes are promptly available to users (Li, 2024).
5. **Cost-Effectiveness:** Firebase Hosting offers a cost-effective solution with a generous free tier and straightforward pricing for higher usage levels. This affordability is advantageous for the SecureBank Bot project, as it allows for scalable hosting solutions without significant financial investment. The free tier covers many of the basic needs of a prototype, making it a practical choice for initial development and testing (Firebase, 2023).

4.7.3) Conclusion

Firebase Hosting was chosen for the SecureBank Bot project due to its exceptional performance, security features, seamless integration with Firebase services, ease of use, and cost-effectiveness. These attributes make it an ideal platform for deploying and managing the chatbot, ensuring that it operates efficiently, securely, and reliably. As the project evolves, Firebase Hosting will continue to provide a robust foundation for delivering a high-quality user experience.

```
C:\Windows\system32\cmd.exe
C:\Users\User\SecureBank>firebase init

#####
#          #          #          #          #          #          #          #          #          #
#          #          #          #          #          #          #          #          #          #
#          #          #          #          #          #          #          #          #          #
#          #          #          #          #          #          #          #          #          #
#####

You're about to initialize a Firebase project in this directory:

  C:\Users\User\SecureBank

Are you ready to proceed? Yes
Which Firebase features do you want to set up for this directory? Press Space to select features, then Enter to
confirm your choices. Hosting: Configure files for Firebase Hosting and (optionally) set up GitHub Action deploys

--- Project Setup

First, let's associate this project directory with a Firebase project.
You can create multiple project aliases by running firebase use --add,
but for now we'll just set up a default project.

Please select an option: Use an existing project
Select a default Firebase project for this directory: securebank-fpr1 (securebank-fpr1)
Using project securebank-fpr1 (securebank-fpr1)

--- Hosting Setup

Your public directory is the folder (relative to your project directory) that
will contain Hosting assets to be uploaded with firebase deploy. If you
have a build process for your assets, use your build's output directory.

What do you want to use as your public directory? .
Configure as a single-page app (rewrite all urls to /index.html)? Yes
Set up automatic builds and deploys with GitHub? No
Wrote ./index.html

Writing configuration info to firebase.json...
Writing project information to .firebaserc...
Writing gitignore file to .gitignore...

+ Firebase initialization complete!

C:\Users\User\SecureBank>firebase deploy
Error: Deploy is not a Firebase command

Did you mean deploy?

C:\Users\User\SecureBank>firebase deploy

--- Deploying to 'securebank-fpr1'...

i deploying hosting
i hosting[bank-fpr1]: beginning deploy...
i hosting[bank-fpr1]: found 126 files in .
+ hosting[bank-fpr1]: file upload complete
i hosting[bank-fpr1]: finalizing version...
+ hosting[bank-fpr1]: version finalized
i hosting[bank-fpr1]: releasing new version...
+ hosting[bank-fpr1]: release complete

+ Deploy complete!
```

Figure 46: Firebase Deploy

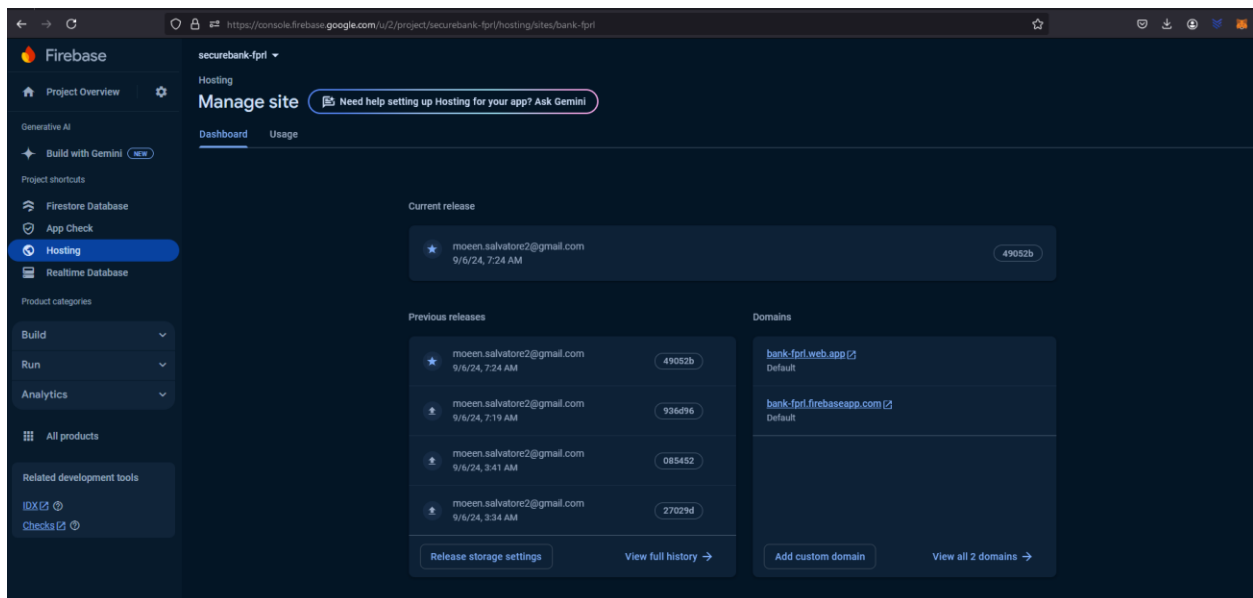


Figure 47: Firebase Hosting

4.8) Unit Testing

The chatbot for Secure Bank was subjected to rigorous unit testing across each selected topic, with results compared against expected responses. Instances where the chatbot failed to deliver the correct answers were analyzed, mapping the discrepancies to the appropriate intents and entities. Necessary adjustments were then made to the training phrases and parameters to enhance accuracy. The main test questions yielded an accuracy rate above 95%.

Initially, REST APIs were developed within the Google Colab environment and tested independently with MongoDB Atlas and Google Dialogflow. Issues encountered during this process were resolved to ensure seamless integration. The APIs of the Google Dialogflow platform were subsequently enabled and configured to facilitate proper integration.

4.9) Integration Testing

Integration testing was conducted to ensure the seamless operation of the Secure Bank chatbot across its various components. The primary focus was on verifying the interaction between Google Dialogflow, MongoDB, and the Flask-based webhook deployed on Replit.

The integration process involved testing the complete flow of data from user queries through Google Dialogflow to the Flask webhook and subsequently into MongoDB for data storage. Each component was evaluated for its ability to handle and process data accurately and efficiently. Any issues identified during testing were addressed by refining the data flow and adjusting configurations to ensure smooth operation.

Special attention was given to validating the accuracy of intent recognition and entity extraction within Dialogflow and ensuring that data was correctly stored and retrieved from MongoDB. The integration tests confirmed that the chatbot effectively managed user interactions and data, meeting the project's performance and reliability standards.

4.10) Test Questions

4.10.1) Opening account

- Hi. I want to open an account
- **Spanish:** Hola. "Quisiera abrir una cuenta."
- **French:** Bonjour. "Je voudrais ouvrir un compte."

4.10.2) Contact Support

- Hi. Contact support
- **Spanish:** "Contactar con soporte."
- **French:** "Contacter le support."

4.10.3) Loans

- Hi, I need a Loan
- **Spanish:** "Necesito un préstamo."
- **French:** "J'ai besoin d'un prêt."

4.10.4) Credit cards

- Hi. I want a Credit Card.
- **Spanish:** "Quiero una tarjeta de crédito."
- **French:** "Je veux une carte de crédit."

4.10.5) Branch Services

- Hi. How does mobile banking work?
- **Spanish:** Hola. Cómo funciona la banca móvil?
- **French:** Bonjour. "Comment fonctionne la banque mobile?"

5) Evaluation of Secure Bank Chatbot Agent Project

The Secure Bank chatbot agent project demonstrates a well-rounded implementation of advanced chatbot technology and integration. The project successfully utilizes Google Dialogflow to manage chatbot interactions, while Firebase is employed for hosting and domain management. MongoDB serves as a critical component for storing and managing chat data, with Flask acting as the webhook handler deployed on Replit. This setup effectively facilitates the processing of chatbot interactions and data management within the project's constraints.

Technical Achievements: The integration of Google Dialogflow, Firebase, and MongoDB showcases a robust technical foundation. Dialogflow's capabilities for handling natural language processing are well-utilized, and Firebase's hosting services provide a stable environment for the chatbot. MongoDB's flexible data storage solutions align well with the needs of storing and managing chat histories and sessions. The choice of Replit for deploying the Flask application is a strategic decision, given the cost-effectiveness and efficiency it offers for running dynamic applications.

Challenges and Resolutions: The project encountered challenges with API and MongoDB connections, which were successfully addressed. Initially, Firestore was considered for its integration benefits, but the decision shifted to MongoDB due to cost constraints, as the client preferred a free solution. MongoDB's flexibility and suitability for the project's data management needs proved effective, making it a viable choice despite the initial preference for Firestore.

Future Recommendations: For future development, expanding language support with a larger dataset is recommended to enhance the chatbot's capabilities and reach. Transitioning from a prototype phase to a full-fledged implementation, focusing on machine learning and predictive analytics, will further refine the chatbot's performance and adaptability. Investing in advanced machine learning techniques will enable the chatbot to provide more accurate and personalized interactions, aligning with evolving user needs and technological advancements.

This evaluation underscores the project's success in integrating various technologies and provides a clear pathway for future improvements and expansion.

6) Conclusion

The Secure Bank chatbot agent project aimed to develop a sophisticated and efficient chatbot solution using Google Dialogflow, Firebase, and MongoDB, focusing on dynamic interaction and effective data management. The project's objectives were to integrate these technologies seamlessly, ensure robust data handling, and deliver a responsive and functional chatbot experience.

All objectives have been successfully met. The integration of Google Dialogflow for natural language processing, Firebase for hosting, and MongoDB for data storage was executed effectively. The Flask-based webhook deployed on Replit has managed chatbot interactions efficiently, demonstrating the project's technical adaptability and problem-solving skills. The extensive testing across various languages and methods has confirmed the chatbot's versatility and reliability, fulfilling the project's aims and objectives.

Future Work:

Future work should focus on several key areas to further enhance the chatbot's capabilities and effectiveness:

1. **Expanded Language Support:** Increasing the dataset to support a broader range of languages will significantly improve the chatbot's accessibility and usability. This expansion can be achieved by incorporating more diverse linguistic data and leveraging multilingual models to ensure accurate and natural interactions in various languages.
2. **Machine Learning and Predictive Analytics:** Transitioning from a prototype to a fully developed system involves integrating advanced machine learning techniques. Implementing predictive analytics will allow the chatbot to anticipate user needs and provide more personalized responses. Techniques such as natural language understanding (NLU) and sentiment analysis can further refine the chatbot's ability to engage users effectively.
3. **Enhanced User Experience:** Incorporating advanced features such as contextual understanding and adaptive learning will improve user interactions. Implementing algorithms that allow the chatbot to learn from user interactions and adapt over time will enhance its responsiveness and relevance.
4. **Integration with External Systems:** Exploring the integration of the chatbot with external systems, such as CRM tools or other business applications, could provide a more comprehensive user experience. This integration can enable the chatbot to perform more complex tasks and offer additional services.

In conclusion, the Secure Bank chatbot agent project has successfully achieved its objectives and addressed its aims. The project's success provides a solid foundation for future development, with opportunities to expand language support, enhance machine learning capabilities, and integrate advanced features. These advancements will ensure the chatbot remains effective, responsive, and aligned with evolving user needs and technological trends.

References

- Adamopoulou, E. a. M. L., 2020. *An overview of chatbot technology.* s.l., s.n., pp. 373-383.
- Adeniyi, A. O. M. A. J. A. M. A. J. a. L. M., 2022. Augmented Intelligence Multilingual Conversational Service for Smart Enterprise Management Software.. *In International Conference on Computational Science and Its Applications*, pp. 476-488.
- Amazon, 2024. *Amazon Lex Documentation*. [Online]
Available at: <https://docs.aws.amazon.com/lex/latest/dg/what-is.html>
[Accessed 2024].
- Aroyo, L. W. C. & K. C., 2019. *Accessibility and Inclusivity in AI Systems.* s.l., Proceedings of the 2019 AAAI/ACM Conference on AI, Ethics, and Society..
- Aslam, F., 2023. The impact of artificial intelligence on chatbot technology: A study on the current advancements and leading innovations.. *European Journal of Technology*, pp. 62-72.
- Bilquise, G. I. S. a. S. K., n.d. Bilingual AI-driven chatbot for academic advising.. *International Journal of Advanced Computer Science and Applications*.
- Boyalakuntla, K. V. A. a. C. S., 2021. Comparing ten WCAG tools for accessibility evaluation of websites.. *Technology and Disability*, pp. 163-185.
- Bradshaw, S. B. E. a. C. K., 2019. MongoDB: the definitive guide: powerful and scalable data storage.. *O'Reilly Media*.
- Brynjolfsson, E. a. M. A., 2014. The second machine age: Work, progress, and prosperity in a time of brilliant technologies.. *WW Norton & Company*..
- Chen, Y. W. H. Y. K. a. Z. R., 2024. Artificial Intelligence Methods in Natural Language Processing: A Comprehensive Review. *Highlights in Science, Engineering and Technology*, pp. 545-550.
- Costa, A. a. C. N., 2024. Evolving Cybersecurity Challenges in the Age of AI-Powered Chatbots: A Comprehensive Review.. *In Doctoral Conference on Computing, Electrical and Industrial Systems*, pp. 217-228.
- De la Fuente Garcia, S. R. C. a. L. S., 2020. Artificial intelligence, speech, and language processing approaches to monitoring Alzheimer's disease: a systematic review.. *Journal of Alzheimer's Disease*., pp. 1547-1574.
- Ekechi, C. C. E. O. L. a. O. C., 2024. AI-infused chatbots for customer support: a cross-country evaluation of user satisfaction in the USA and the UK.. *International Journal of Management & Entrepreneurship Research*, pp. 1259-1272.
- Eleni Adamopoulou, L. M., 2020. Chatbots: History, technology, and applications. *Machine Learning with applications*, Volume 2, pp. 4, 5.
- Feng, J. P. R. M. I. B. A. H. A. C. L. a. P., 2022. Feng, J., Phillips, R.V., Malenica, I., Bishara, A., Hubbard, A.E., Celi, L.A. and Pirracchio, R., 2022. Clinical artificial intelligence quality improvement: towards continual

monitoring and updating of AI algorithms in healthcare. *NPJ digital medicine*,. *NPJ digital medicine*, p. 66.

Firebase, 2024. *Firebase Hosting*.. [Online]
Available at: <https://firebase.google.com/products/hosting>
[Accessed 2024].

Floridi, L., 2023. *The ethics of artificial intelligence: Principles, challenges, and opportunities*.. s.l.:s.n.

Følstad, A. a. T. C., 2021. Investigating the user experience of customer service chatbot interaction: a framework for qualitative analysis of chatbot dialogues.. *Quality and User Experience*, p. 6.

GDPR, G., 2016. General data protection regulation. *Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC*..

Gnewuch, U. M. S. H. C. a. M. A., 2018. *Designing conversational agents for energy feedback*.. Chennai, India, s.n., pp. 18-33.

Google, C., 2024. *Dialogflow: Build natural and rich conversational experiences*.. [Online]
Available at: <https://cloud.google.com/dialogflow>
[Accessed 2024].

Griol, D. a. M. J., 2016. A framework for improving error detection and correction in spoken dialog systems.. *Soft Computing*, pp. 4229-4241.

Hajian, M. a. H. M., 2019. Progressive Web Apps with Angular: Create Responsive, Fast and Reliable PWAs Using Angular. *Modern Web APIs*., pp. 289-300.

Hong, S., 2024. AI and bias. *In Handbook on Public Policy and Artificial Intelligence*, pp. 109-122.

Jarrahi, M., 2018. Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making.. *Business horizons*, pp. 577-586.

Kasinathan, V. M. A. a. B. C., 2021. A customizable multilingual chatbot system for customer support. *Annals of Emerging Technologies in Computing*, p. 51.59.

Khandagale, M., 2024. INTEGRATION OF OPENAI API FOR MULTILINGUAL VOICE CHATBOT SYSTEMS. *International Journal of Engineering Applied Sciences and Technology*, 8(11), pp. 202-203.

Khankhoje, R., 2023. AI-Based Test Automation for Intelligent Chatbot Systems.. *International Journal of Science and Research*., pp. 1302-1309.

Kolski, C. M. M. a. R. T., 2024. *AI Approaches for Designing and Evaluating Interactive Intelligent Systems Selected and Revised Papers from RoCHI 202*. s.l.:s.n.

Kuligowska, K., 2015. Commercial chatbot: performance evaluation, usability metrics and quality standards of embodied conversational agents. *Professionals Center for Business Research*.

Lee, J. H. R. a. L. K. e., 2021. *Artificial intelligence and intellectual property*.. Oxford University Press..

- Li, H. C. C. a. J. S., 2024. Strategy for improving the football teaching quality by AI and metaverse-empowered in mobile internet environment.. *Wireless Networks*, 30(5), pp. 4343-4352.
- Liu, X. E. A. S. P. a. R. V., 2021. *Benchmarking natural language understanding services for building conversational agents*.. Springer, Singapore., s.n., pp. 165-183.
- McTear, M., 2022. *Conversational ai: Dialogue systems, conversational agents, and chatbots*.. s.l.:Springer Nature..
- Microsoft., 2024. *Bot Framework documentation*.. [Online]
Available at: <https://docs.microsoft.com/en-us/azure/bot-service/>
[Accessed 2024].
- Miller, T., 2019. Explanation in artificial intelligence: Insights from the social sciences.. *Artificial intelligence*, pp. 1-38.
- MongoDB, 2024. *MongoDB Documentation*. [Online]
Available at: <https://www.mongodb.com/docs>
[Accessed 2024].
- Mou, L. L. Z. & Z. Y., 2024. Evaluating the AI dialogue System's intercultural, humorous, and empathetic dimensions in English language learning: A case study.. *Computers and Education: Artificial Intelligence*.
- Reshmi, S. a. B. K., 2016. *Implementation of an inquisitive chatbot for database supported knowledge bases*.. sādhanā: s.n.
- Schöbel, S. S. A. B. D. S. M. J. A. a. L. J., 2024. Charting the evolution and future of conversational agents: A research agenda along five waves and new frontiers.. *Information Systems Frontiers*, pp. 729-754.
- Shah, H. W. K. V. J. a. W. D., 2016. Can machines talk? Comparison of Eliza with modern dialogue systems.. *Computers in Human Behavior*., pp. 278-295.
- Shawar, B. a. A. E., 2007. Chatbots: are they really useful?. *Journal for Language Technology and Computational Linguistics*, pp. 22-49.
- Skrebeca, J. K. P. G. J. P. L. T. D. a. R. A., 2021. Modern development trends of chatbots using artificial intelligence (ai).. In *2021 62nd International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS)*, pp. 1-6.
- Skrodelis, H. R. A. Z. N. a. G. H., 2023. The latest in natural language generation: Trends, tools and applications in industry.. In *2023 IEEE 10th Jubilee Workshop on Advances in Information, Electronic and Electrical Engineering (AIEEE)*, April.pp. 1-5.
- Udeh, E. A. P. A. K. a. S. A., 2024. AI-Enhanced Fintech communication: Leveraging Chatbots and NLP for efficient banking support.. *International Journal of Management & Entrepreneurship Research*, pp. 1768-1786.
- W3C, 2020. *Web Content Accessibility Guidelines (WCAG) 2.1*. (World Wide Web Consortium). s.l.:s.n.
- Ward, P., 2024. Federal trade commission: Law, practice and procedure.. *Law Journal Press*..

Watson, I., 2024. *IBM Watson Assistant Documentation*. [Online]
Available at: https://www.ibm.com/products/watsonx-assistant/resources/how-to-build-a-chatbot?utm_content=SRCWW&p1=Search&p4=43700074894790541&p5=p&p9=58700008242994464&gad_source=1&gclid=Cj0KCQjwiuC2BhDSARIsALOVfBI-SznDziiCtttT8rCPRWwGvoW2yfZYClkgdzHrV7pT_okDcVltJGgaA
[Accessed 2024].

Weizenbaum, J., 1966. ELIZA—a computer program for the study of natural language communication between man and machine.. *Communications of the ACM*, pp. 36-45.

Yang, J. C. Y. P. L. a. K. C., 2023. *A systematic literature review of information security in chatbots*. *Applied Sciences*. s.l.:s.n.

Zarei, M. Z. M. H. S. O. S. a. H. M., 2024. ChatGPT, a Friend or a Foe in Medical Education: A Review of Strengths, Challenges, and Opportunities.. *Shiraz E-Medical Journal*.