CHATBOTS IN HEALTHCARE

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What is a Chatbot?

- A chatbot is a software application. It simulates human conversation. This interaction can be via text or voice.
- Chatbots are computer programs that can understand client inquiries and respond automatically. These intelligent agents are developed using a range of technologies including Natural Language Processing (NLP), Machine Learning (ML).
- An artificial intelligence (AI) technique that generates synthetic artifacts by analyzing training examples, learning their patterns and distribution, and then creating realistic facsimiles.

1. Balamurugan A, et al. Artificial Intelligence-Based Chatbot with Voice Assistance. In2024 International Conference on Trends in Quantum Computing and Emerging Business Technologies 2024 Mar 22 (pp. 1-6). IEEE.

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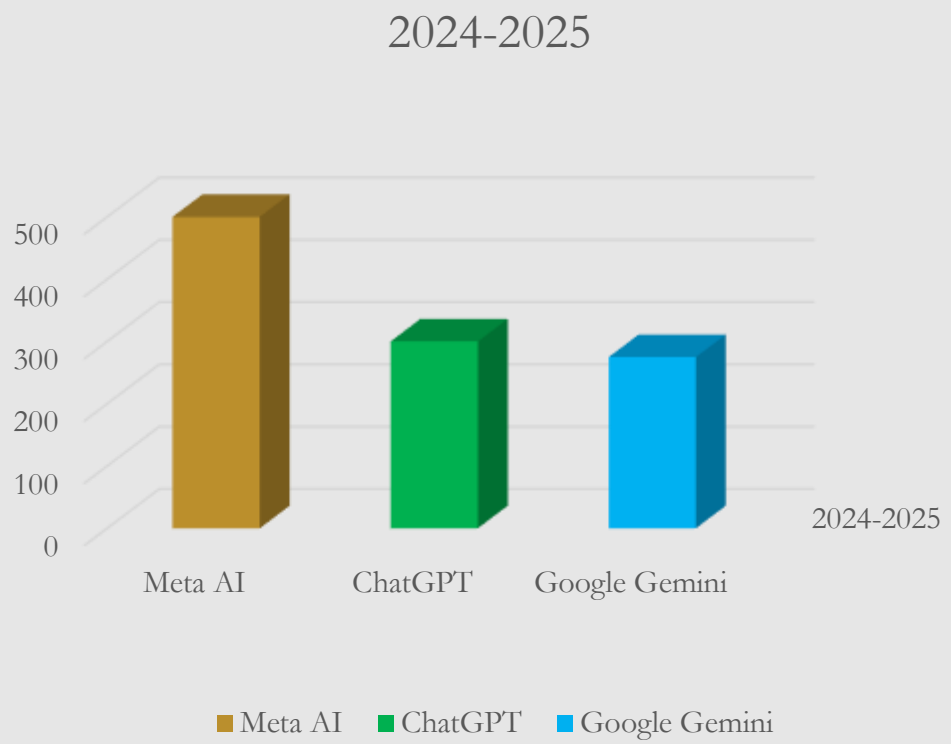
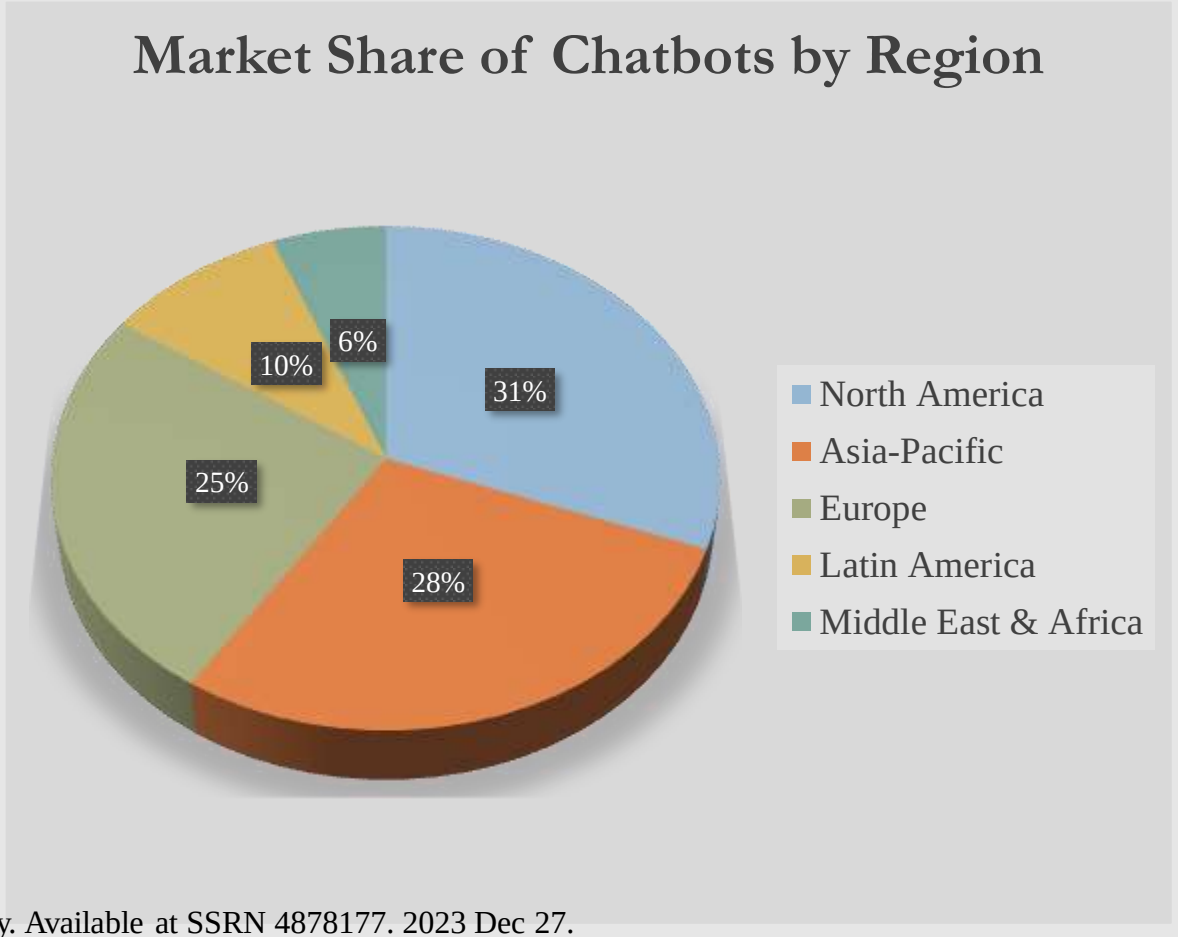
Global Chatbot Usage Statistics (2024-2025)





1. Gupta KP. Global Research Trends on Chatbot and ChatGPT in the 21 st Century. Available at SSRN 4878177. 2023 Dec 27.
2. https://explodingtopics.com/blog/chatbot-statistics.

Types of Chatbots

1. Based on Intelligence and Technology

- Rule-Based: Follow predefined rules and decision trees, Cannot learn from past interactions
  Example: basic customer service bots.

- AI-Based: Use Machine Learning and Natural Language Processing (NLP), Can understand context and improve over time
  Example: ChatGPT, Google Bard

- Hybrid: Combine rule-based logic with AI capabilities
  Example: A support bot that handles FAQs with rules, but transfers to an AI module (or human agent) for complex questions.

1. Karimova GZ, Kim Y. The Typology of Chatbots: Crafting Conversations. InDesign and Development of Emerging Chatbot Technology 2024 (pp. 51-61). IGI Global.

Types of Chatbots

Based on User Interface

Text based Chatbots

Voice Based Chatbots

Multimodal Chatbots

1. Makasi T, Nili A, Desouza KC, Tate M. A typology of chatbots in public service delivery. IEEE Software. 2021 Apr 15;39(3):58-66.

Types of Chatbots

3. Based on Platform

- ❑ Website Chatbots
- ❑ Social Media Chatbots
- ❑ Mobile App Chatbots
- ❑ Voice based Bots

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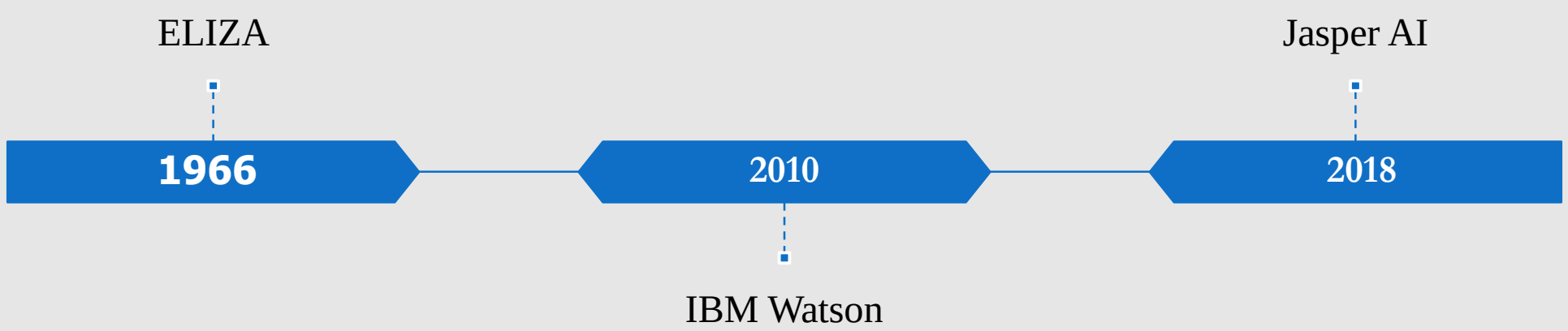
History of Chatbots

Early Attempts
Eliza and PARRY were early chatbots. They aimed to mimic human conversation.

ML Integration
ML drove chatbot progress in the 2010. IBM Watson, Alexa, and Siri emerged.

Transformer Networks
This requires training with massive data.



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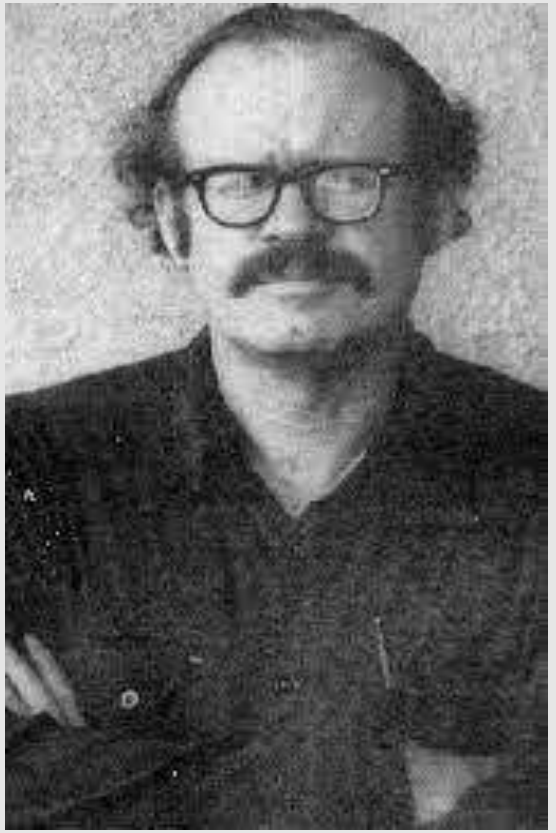
Eliza

ELIZA is one of the first chatbots in history, developed in the 1960s by Joseph Weizenbaum at the Massachusetts Institute of Technology (MIT). These chatbots were designed to simulate human conversations and use simple natural language processing (NLP) techniques.

PARRY

- PARRY was a chatbot developed in 1972 by psychiatrist and artificial intelligence researcher Kenneth Mark Colby. It was designed to simulate the speech behavior of people with paranoid schizophrenia.
- Unlike ELIZA, which only gave general, reflective responses, PARRY had a simple cognitive model that reproduced paranoid delusions and thoughts in conversation.



Comparison of ELIZA and PARRY

Feature	ELIZA	PARRY
Conversation Model	Mimics a non-directive therapist	Simulates paranoid behavior
Response Type	Reflective and general	Emotional and filled with suspicion
Actual Language Understanding	None (Pattern-based responses)	Simple cognitive model
Purpose	Human-computer interaction experiment	Studying mental disorders

IBM Watson

- It uses advanced technologies such as deep learning, structured and unstructured data processing, and cognitive computing to provide accurate answers to complex questions.

- Natural Language Processing (NLP)
- Machine Learning
- Big Data Analytics
- Cognitive Computing

Siri

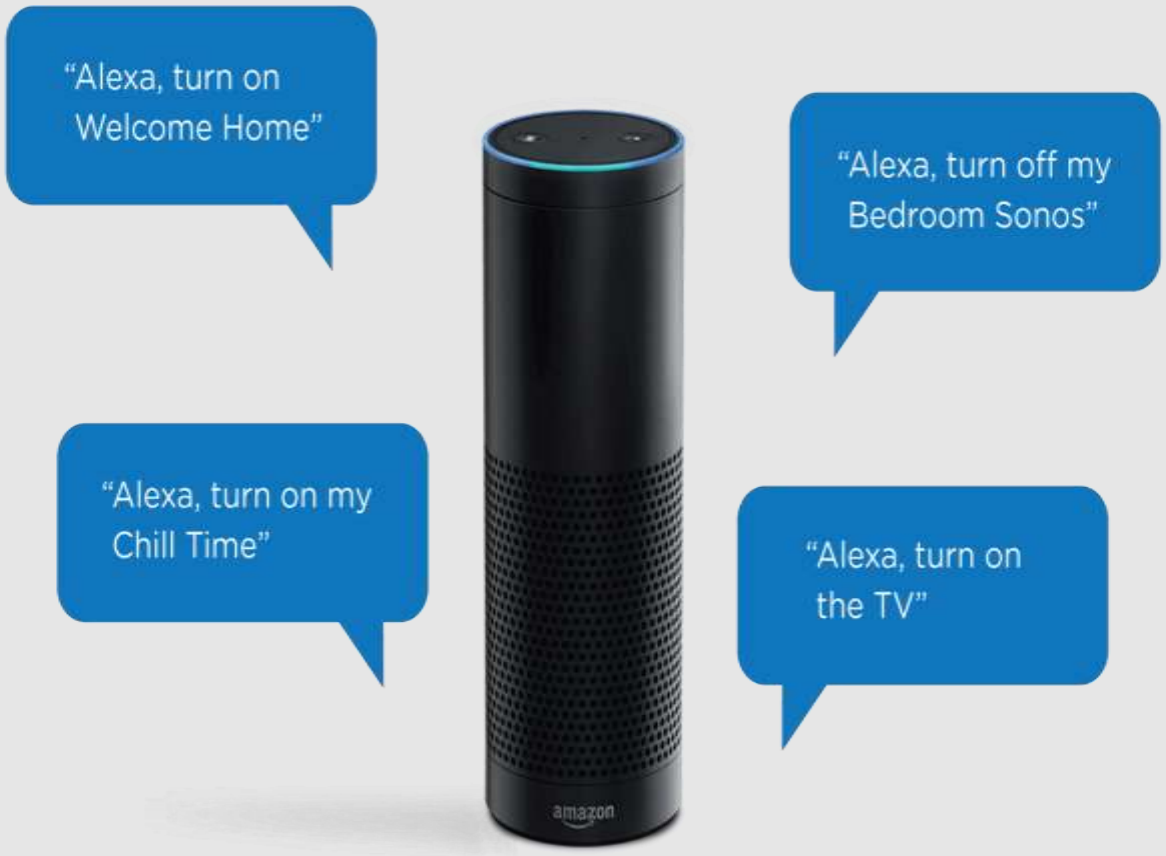
Siri is the first intelligent voice assistant to be widely used on smartphones.

It uses natural language processing (NLP), machine learning (ML), and speech recognition to allow users to interact with Apple devices through voice commands.

Alexa

- Alexa is an artificial intelligence-based voice assistant developed by Amazon.

- Using natural language processing (NLP) and machine learning (ML), the assistant can understand voice commands, provide information, control smart devices, play music, and even make online purchases.



Jasper AI

- Jasper AI (formerly known as Jarvis) is an AI-powered content creation tool that helps users produce creative, promotional, and professional texts quickly and with high quality.

- It uses natural language processing models like GPT and can generate a variety of content such as blog posts, product descriptions, promotional emails, and even fictional stories.

ChatGPT

- These models were introduced in 2018 and were subsequently developed into GPT-2, GPT-3, GPT-3.5, and GPT-4. The current version of this chatbot is one of the most advanced models available in natural language processing.
- It is designed using the Transformer architecture and deep learning and is able to simulate human conversations and provide natural and meaningful responses.

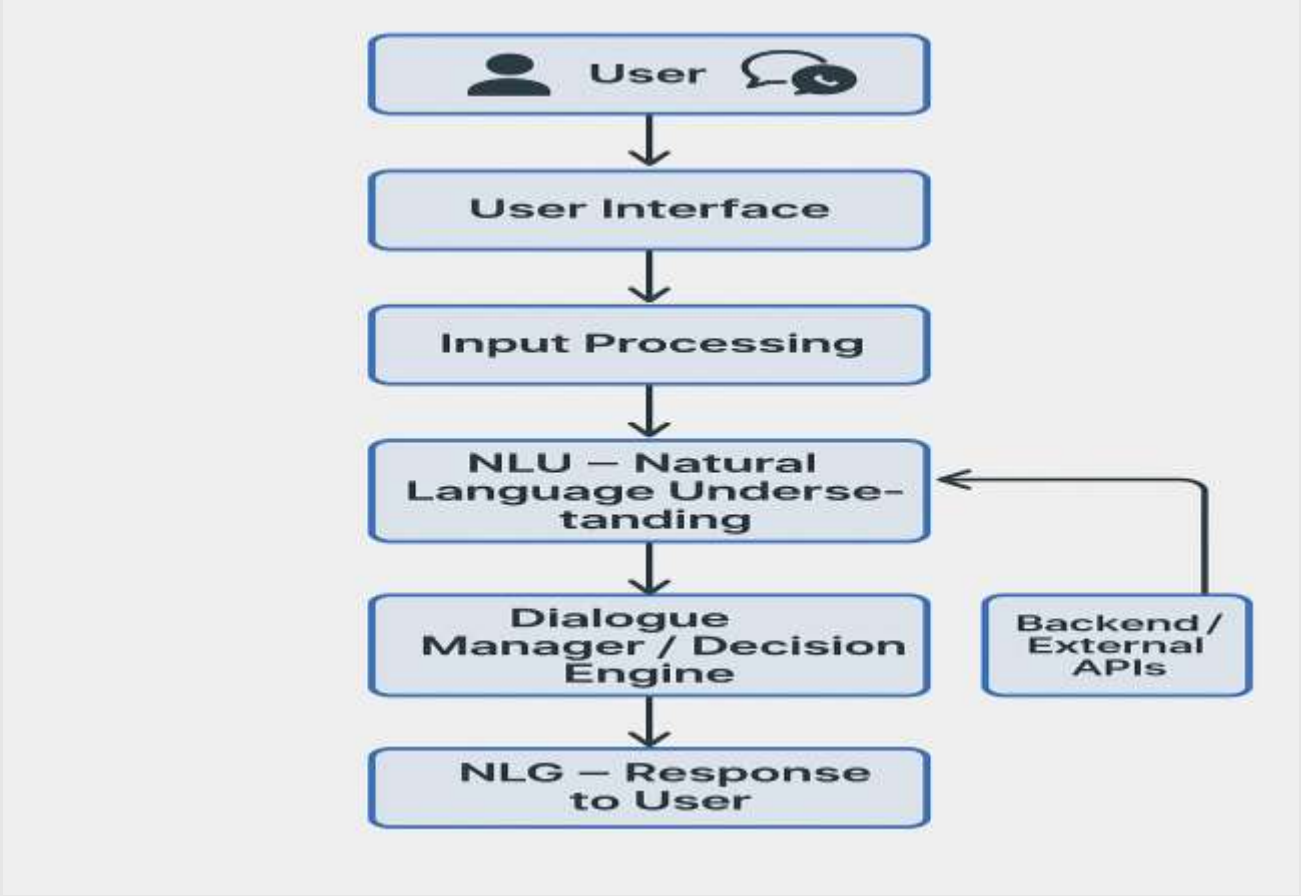
- ❑Input analysis and concept extraction
- ❑Response generation based on processed data
- ❑Sentence completion, translation, and text rewriting
- ❑Ability to understand context and context of conversation

Bard (Gemini)

- Bard, later known as Gemini, is a text generation and natural language processing AI model developed by Google AI.
- The chatbot was designed to compete with ChatGPT and uses advanced LaMDA (Language Model for Dialogue Applications) and Gemini AI models.

- ❑Dynamic responses and natural conversation
- ❑Access to real-time information from the Internet
- ❑Support for multiple languages, including Persian
- ❑Integration with Google services such as Google Search and Google Docs
- ❑Ability to process images, audio, and video in newer versions

Chatbot architecture



1. Huang X, CIS A. Chatbot: design, architecture, and applications. Univesity of Pennsylvania: School of Engineering and Applied Science, Pennsylvania. 2021 May 3;1.

The relationship between chatbots and artificial intelligence

Chatbot: A conversational software that can be text or voice-based and used to respond to users.

Artificial Intelligence (AI): A set of algorithms and models that allow machines to think, learn, and make decisions.

Chatbots can exist without artificial intelligence

Artificial intelligence makes chatbots smarter, giving them the ability to process natural language, learn from data, and provide dynamic responses.

How does artificial intelligence empower chatbots?

- NLP - Natural Language Processing
- ML - Machine Learning
- Generative AI

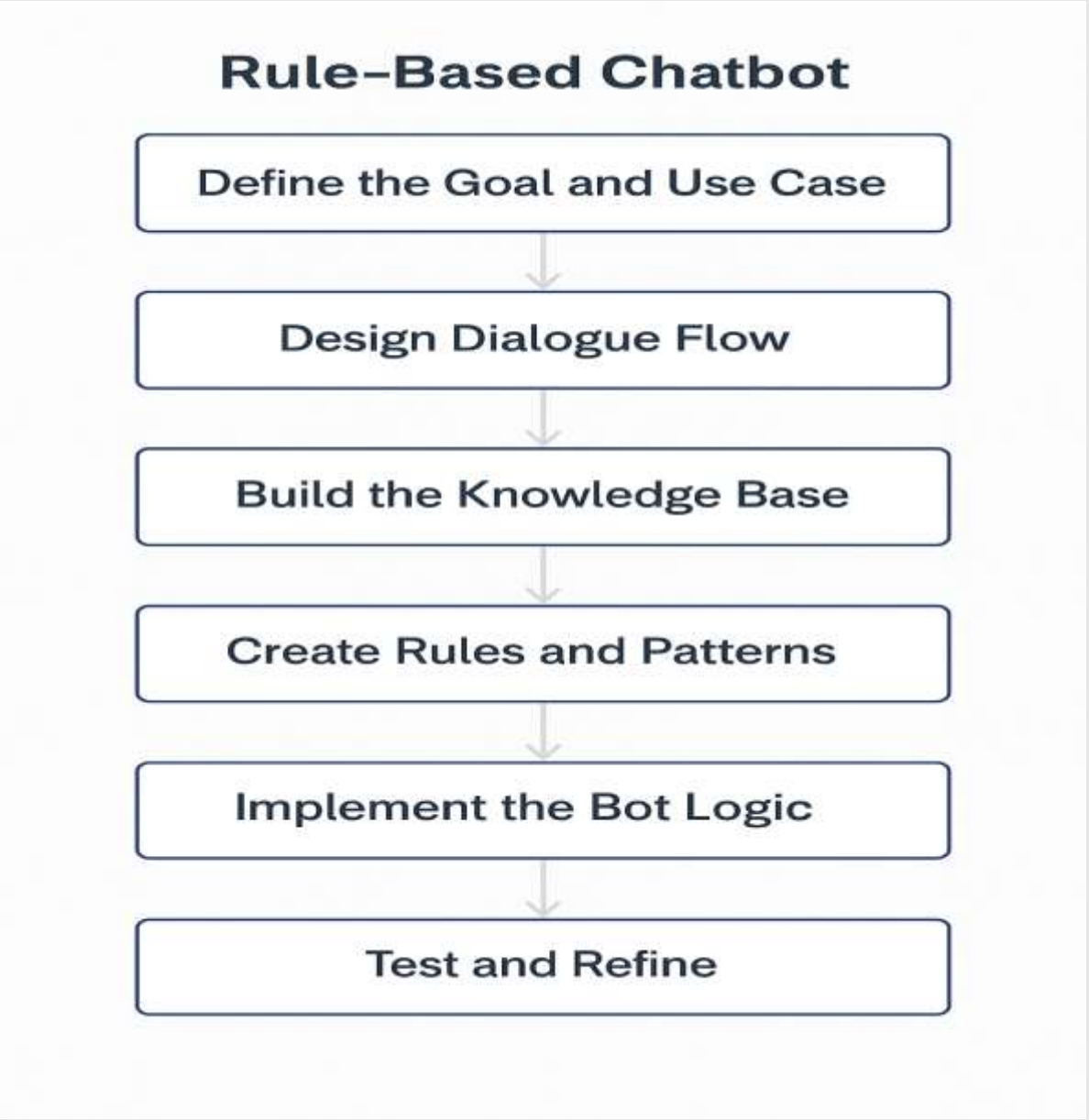
Challenges and limitations of AI-based chatbots

Misunderstanding of the text

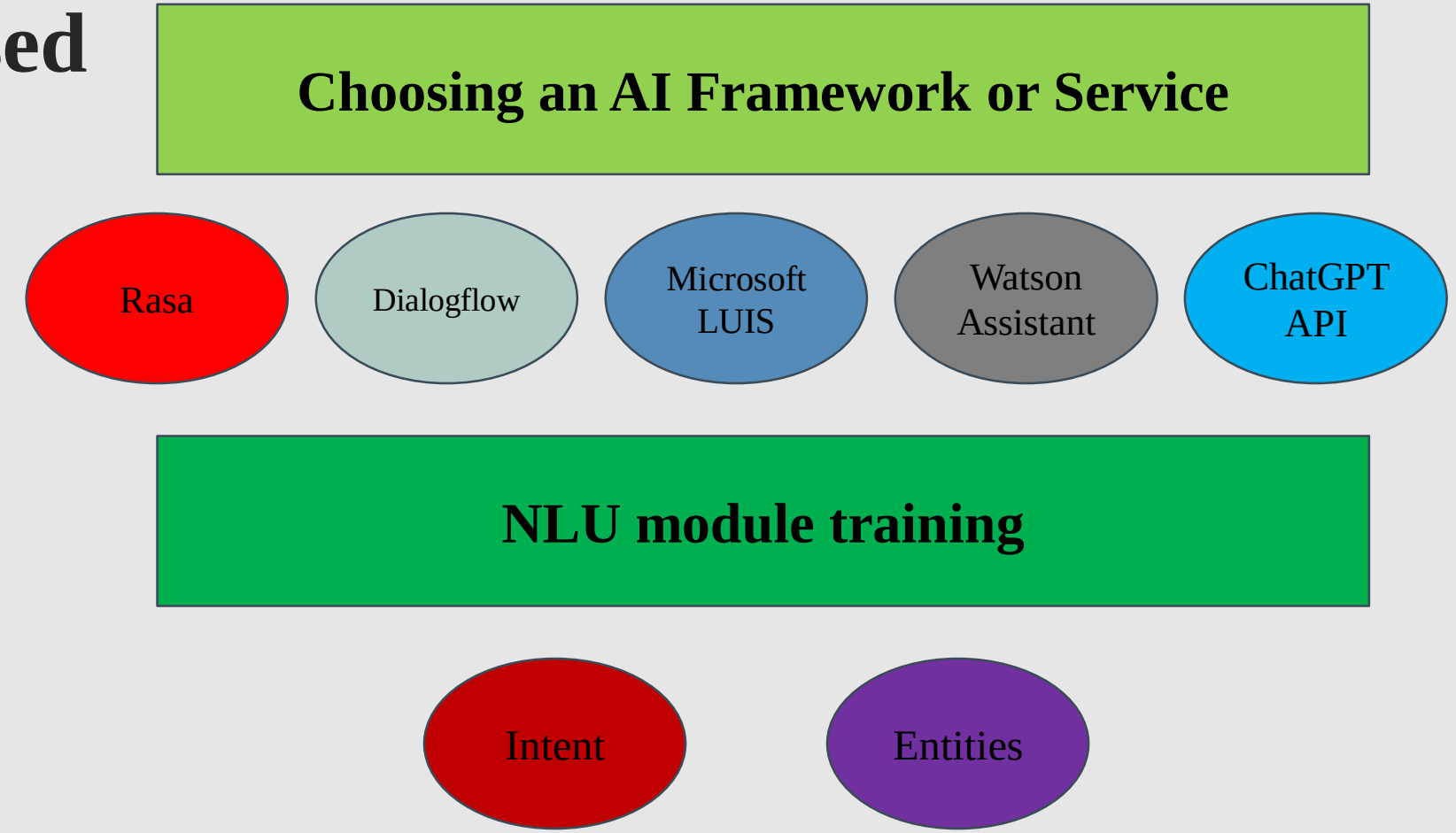
Failure to recognize complex emotions

Need for a lot of data for learning

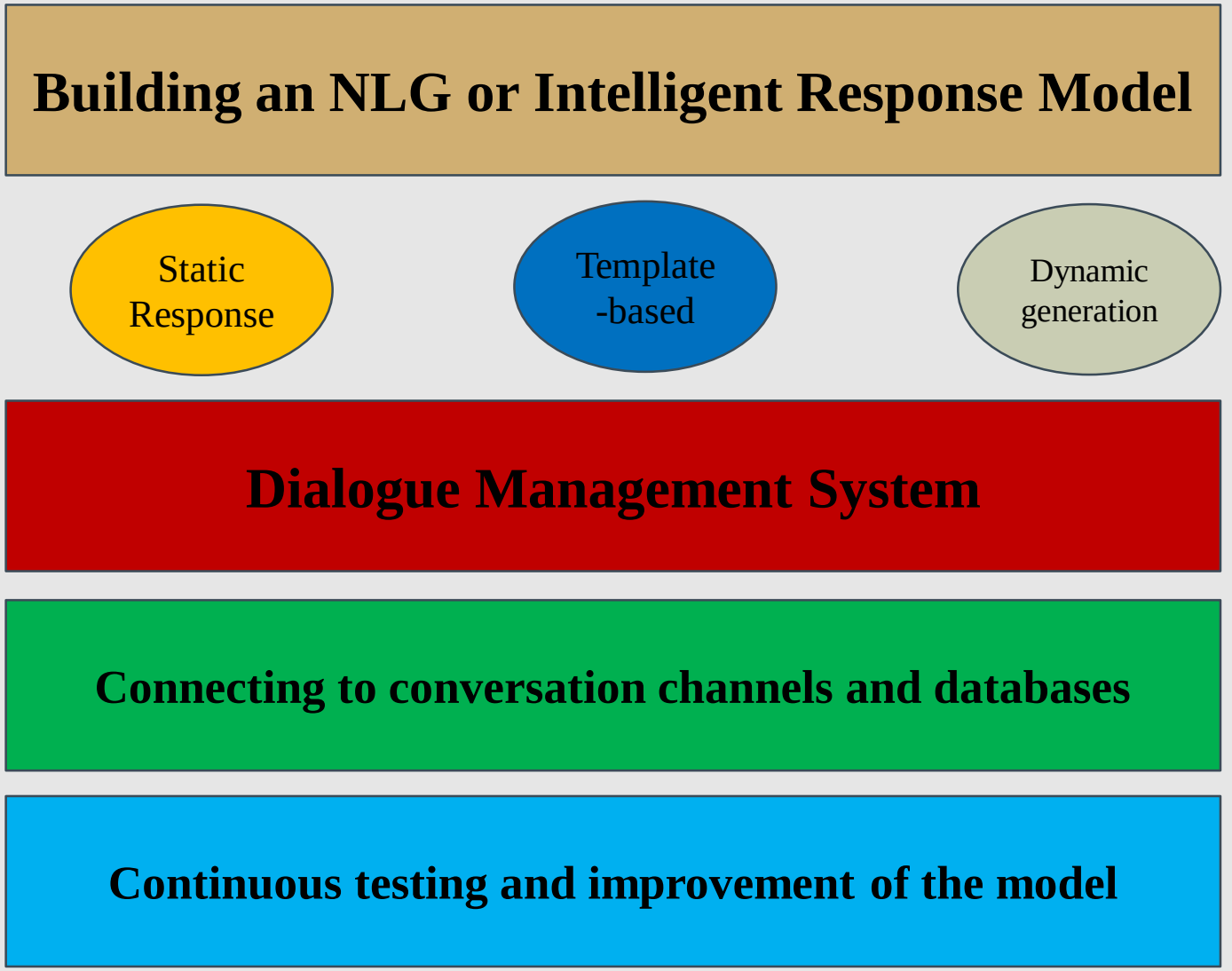
Build a Rule-based Chatbot



Build an AI-based Chatbot



Build an AI-based Chatbot

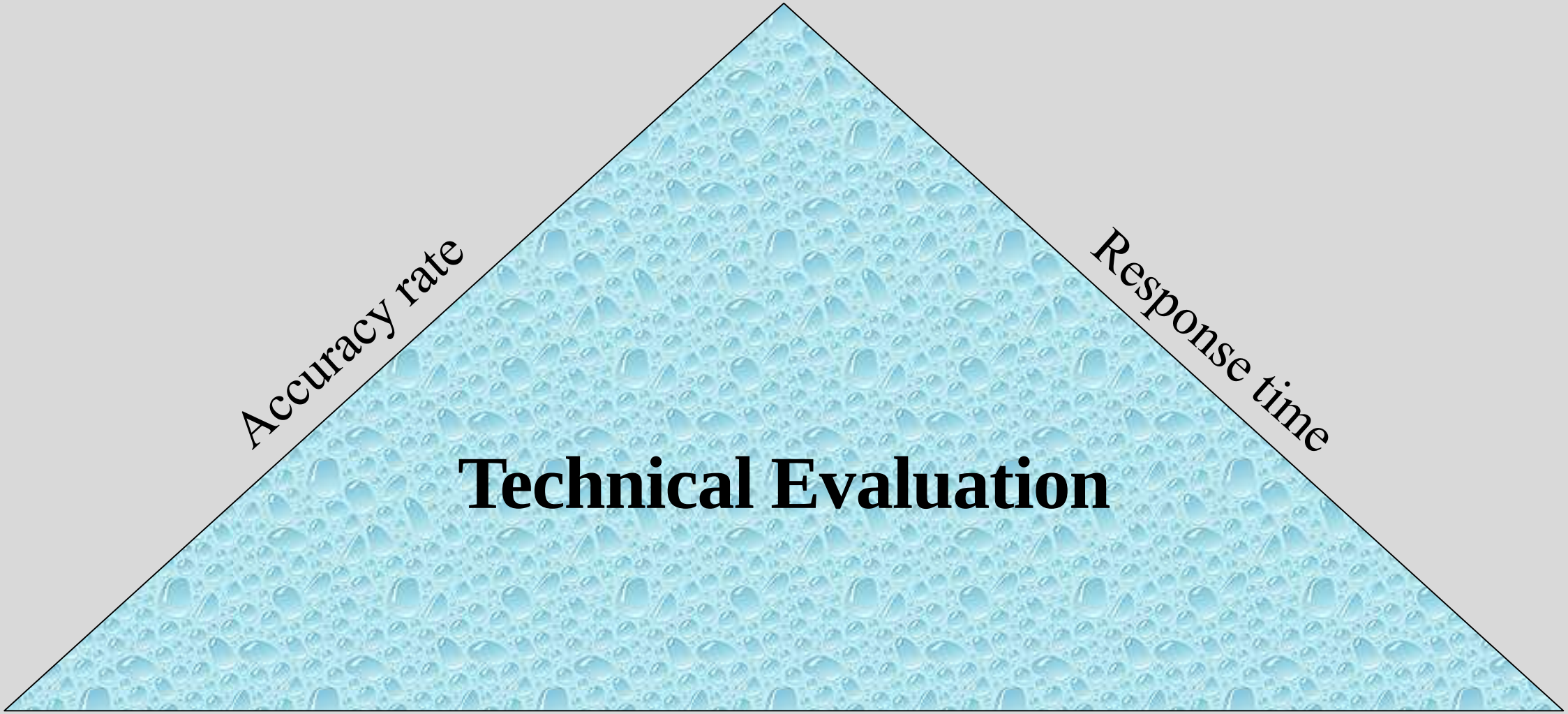


Chatbot Evaluation Methods

Technical Evaluation

System Usability Scale (SUS)

User Experience Questionnaire (UEQ)


Accuracy rate
Response time
Technical Evaluation
Stability & error handling

System Usability Scale (SUS)

What is SUS?

The System Usability Scale (SUS) is a 10-item questionnaire designed to assess the usability of a system, including chatbots.
It provides a single usability score based on user feedback.

Key Aspects Measured by SUS:

Effectiveness: Can users achieve their goals with the chatbot?
Efficiency: How quickly and easily can users complete tasks?
Satisfaction: How pleasant is the chatbot interaction?

User Experience Questionnaire (UEQ)

What is UEQ?

The User Experience Questionnaire (UEQ) is a structured assessment tool for measuring user experience beyond usability, including attractiveness, perspicuity (clarity), efficiency, dependability, stimulation, and novelty.

Key Dimensions of UEQ for Chatbots:

Attractiveness: Is the chatbot visually and functionally appealing?
Perspicuity (Clarity): Is the chatbot easy to understand?
Efficiency: Does the chatbot respond quickly and effectively?
Dependability: Can users rely on the chatbot's responses?
Stimulation: Does the chatbot engage users?
Novelty: Is the chatbot innovative and exciting?

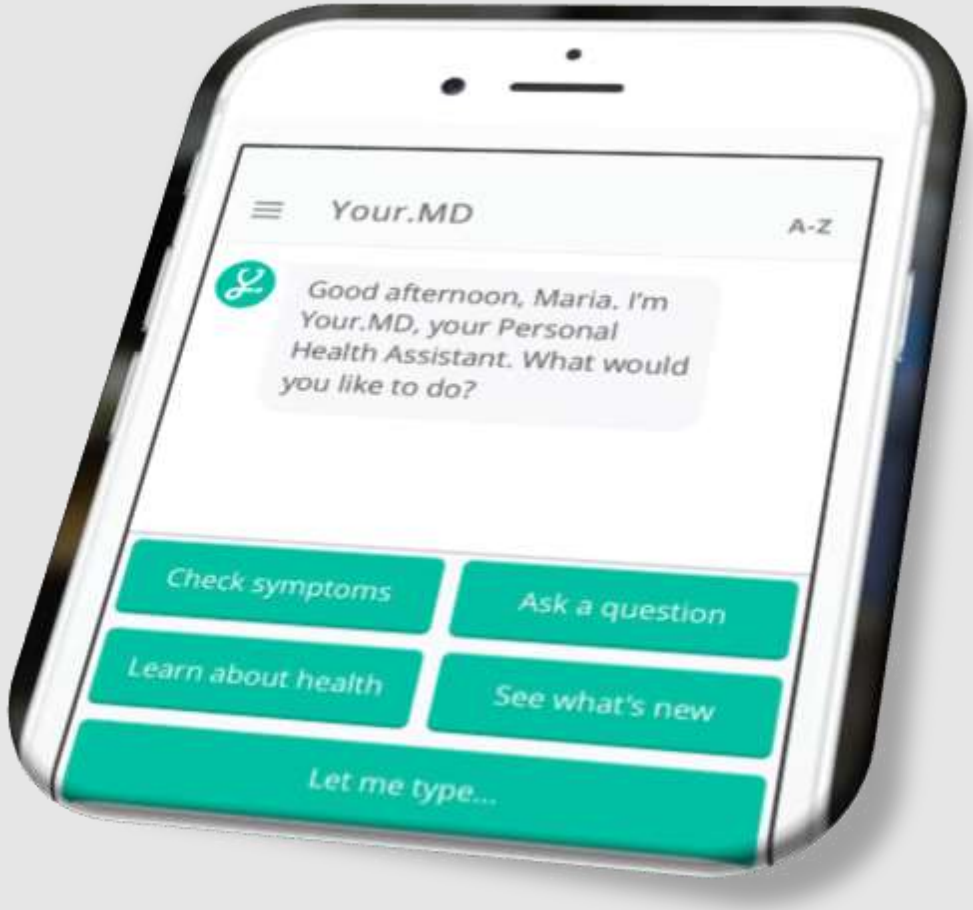
Applications of Chatbots in Healthcare and Medicine

- **1. Virtual Health Assistants**

❖Provide general health advice and answer medical queries.

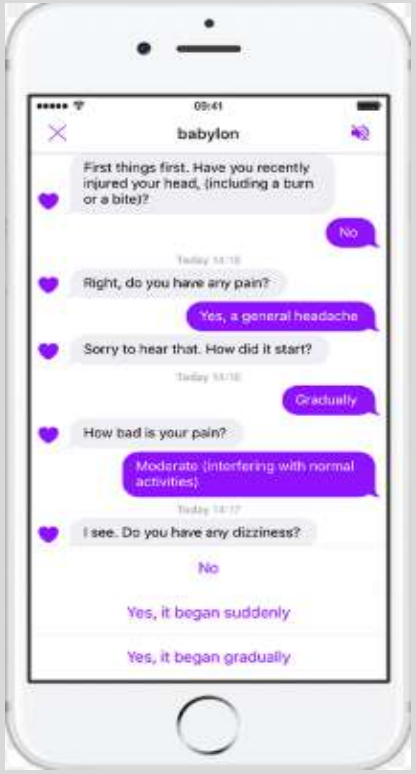
❖Offer reminders for medication and appointment scheduling.

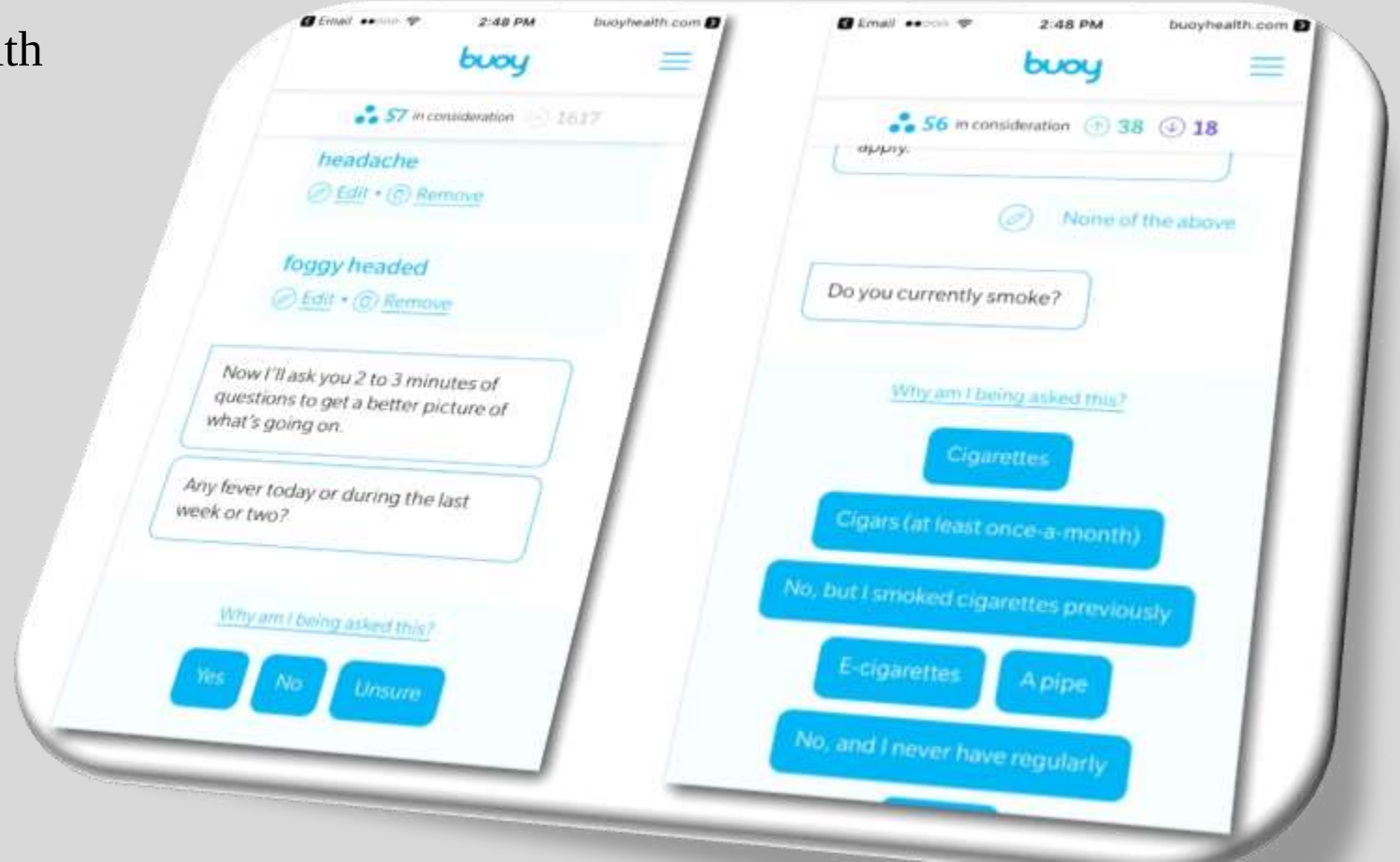
❖Examples: Ada Health, Your.MD



2. Symptom Checkers & Pre-Diagnosis

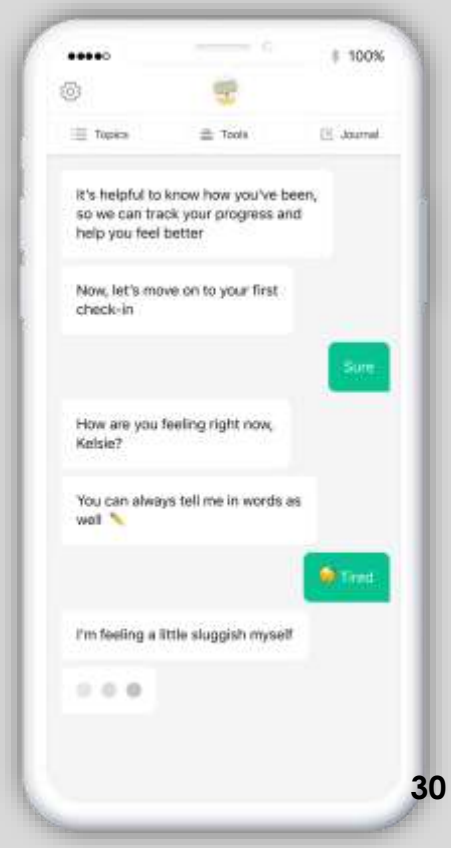
- Analyze symptoms based on user input and suggest possible conditions.
- Help users decide whether to seek professional medical advice.
- Examples: Buoy Health, Babylon Health





3. Mental Health Support & Therapy Bots

- Provide psychological support through AI-driven conversations.
- Assist users with anxiety, depression, and stress management.
- Examples: Woebot, Wysa

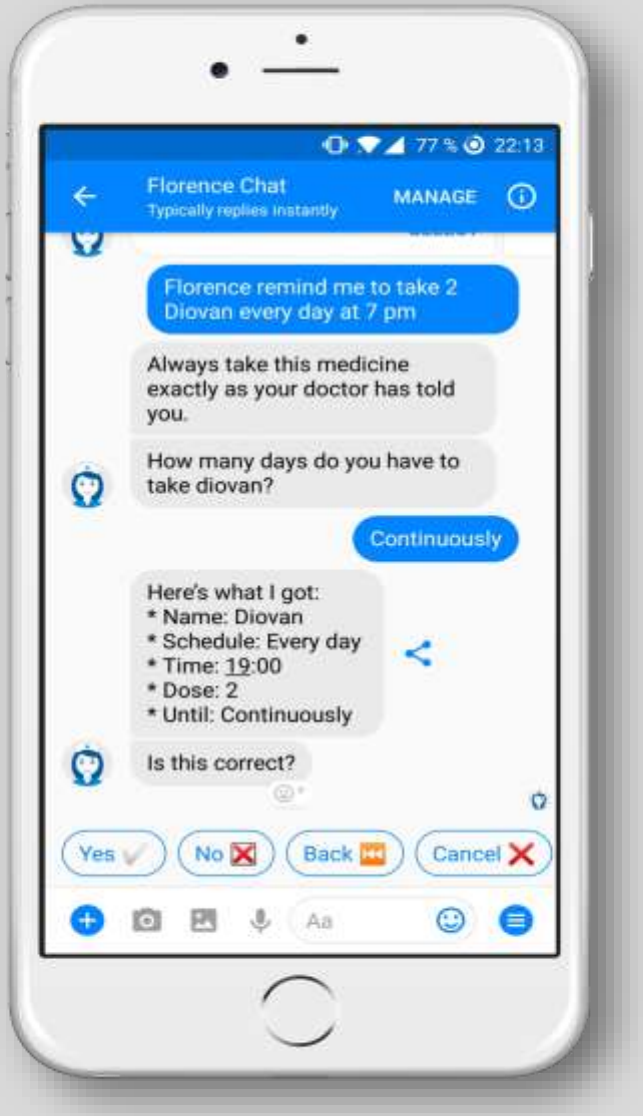


4. Chronic Disease Management

- Monitor patients with chronic illnesses like diabetes, hypertension, and asthma.
- Offer lifestyle recommendations and track health metrics.
- Examples: Healthily, MySugre

5. Patient Engagement & Post-Treatment Care

- Assist in post-surgical care and recovery monitoring.
- Provide follow-up instructions and track patient progress.
- Example: Florence



6. Administrative Support in Healthcare Facilities

- Automate appointment scheduling and hospital check-in processes.
- Reduce wait times by directing patients efficiently.
- Example: Chatbots integrated with hospital management systems

7. Medical Training & Education

- Provide interactive learning for medical students and professionals.
- Simulate patient interactions for diagnosis and treatment practice.
- One of the most prominent uses of AI-based chatbots in medicine is to help doctors make clinical decisions.
- Example: Chatbots used in medical schools for case-based learning or IBM Watson(DSS)

8. Public Health Awareness & COVID-19 Support

- Deliver real-time information about disease outbreaks and vaccination schedules.
- Provide reliable data to prevent misinformation.
- Example: WHO Health Alert Chatbot

Comparison of Chatbot Advantages and Disadvantages

Advantages	Disadvantages
24/7 availability and fast response time	Limitations in understanding natural language and providing incorrect responses
Reduced customer support costs	Inability to handle complex decision-making
High scalability	Requires continuous training and updates
Improved user experience and customer interaction	Security and privacy concerns
Ability to analyze user data and enhance services	Artificial and unnatural user experience
Wide applications across various industries	High initial development costs for advanced AI chatbots

The Future of Chatbots in Healthcare

Highly Intelligent Chatbots with Advanced Diagnostics

More Natural and Personalized Interactions

Full Integration with Electronic Health Records (EHRs)

Expanded Role in Rehabilitation and Mental Health

Stronger Security and Privacy Measures

Self-Learning and Adaptive Chatbots

Selected articles in the field

available at www.sciencedirect.com
journal homepage: www.eu-openscience.europeanurology.com

European Association of Urology

Prostate Cancer

Effectiveness of the Medical Chatbot PROSCA to Inform Patients About Prostate Cancer: Results of a Randomized Controlled Trial

Kilian Baumgärtner [a], *Michael Byczkowski* [b], *Tamara Schmid* [b], *Marc Muschko* [b], *Philipp Woessner* [b], *Axel Gerlach* [b], *David Bonekamp* [c], *Heinz-Peter Schlemmer* [c], *Markus Hohenfellner* [d], *Magdalena Görtz* [d,e,*]

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Article info

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Large language model
Natural language processing
Prostate cancer
Randomized controlled trial

Abstract

Background and objective: Artificial intelligence (AI)-powered conversational agents are increasingly finding application in health care, as these can provide patient education at any time. However, their effectiveness in medical settings remains largely unexplored. This study aimed to assess the impact of the chatbot "PROState cancer Conversational Agent" (PROSCA), which was trained to provide validated support from diagnostic tests to treatment options for men facing prostate cancer (PC) diagnosis.

Methods: The chatbot PROSCA, developed by urologists at Heidelberg University Hospital and SAP SE, was evaluated through a randomized controlled trial (RCT). Patients were assigned to either the chatbot group, receiving additional access to PROSCA alongside standard information by urologists, or the control group (1:1), receiving standard information. A total of 112 men were included, of whom 103 gave feedback at study completion.

Key findings and limitations: Over time, patients' information needs decreased significantly more in the chatbot group than in the control group ($p = 0.035$). In the chatbot group, 43/54 men (79.6%) used PROSCA, and all of them found it easy to use. Of the men, 71.4% agreed that the chatbot improved their informedness about PC and 90.7% would like to use PROSCA again. Limitations are study sample size, single-center design, and specific clinical application.

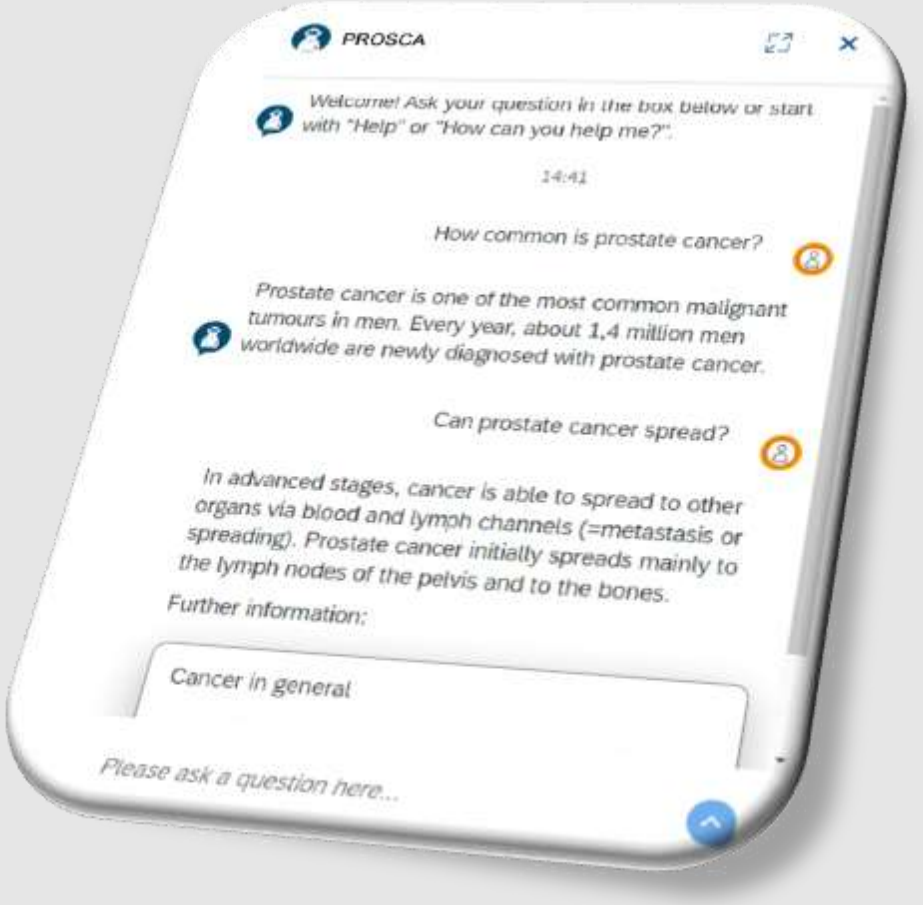
Conclusions and clinical implications: With the introduction of the PROSCA chatbot, we created and evaluated an innovative, evidence-based AI health information tool as an additional source of information for PC. Our RCT results showed significant benefits of the chatbot in reducing patients' information needs and enhancing their understanding of PC. This easy-to-use AI tool provides accurate, timely, and accessible support, demonstrating its value in the PC diagnosis process. Future steps

Study details

- Study Type: Randomized Controlled Trial (RCT)
- Year & Country:2024, Germany
- Study Objective: To evaluate the effectiveness of the medical chatbot PROSCA in reducing information needs among patients with suspected prostate cancer.
- Sample Size:112 male participants (103 completed the study)
- Target Population: Men referred to the urology outpatient clinic at Heidelberg University Hospital due to suspected prostate cancer.
- Data Collection Tool: Standardized questionnaires assessing:
  - Information needs
  - User satisfaction
  - Ease of use

Results

- The reduction in information needs was greater in the chatbot group than in the control group (p = 0.035).
- 79.6% of participants in the chatbot group used PROSCA.
- 100% of chatbot users found it simple and user-friendly.
- 71.4% felt that the chatbot provided them with more information about prostate cancer.
- 90.7% were willing to use PROSCA again.



Original Paper

A Smartphone-Based Health Care Chatbot to Promote Self-Management of Chronic Pain (SELMA): Pilot Randomized Controlled Trial

Sandra Hauser-Ulrich[1], MSc; Hansjörg Künzli[1], lic phil; Danielle Meier-Peterhans[2], MSc; Tobias Kowatsch[3,4], PhD

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Abstract

Background: Ongoing pain is one of the most common diseases and has major physical, psychological, social, and economic impacts. A mobile health intervention utilizing a fully automated text-based health care chatbot (TBHC) may offer an innovative way not only to deliver coping strategies and psychoeducation for pain management but also to build a working alliance between a participant and the TBHC.

Objective: The objectives of this study are twofold: (1) to describe the design and implementation to promote the chatbot painSELfMAnagement (SELMA), a 2-month smartphone-based cognitive behavior therapy (CBT) TBHC intervention for pain self-management in patients with ongoing or cyclic pain, and (2) to present findings from a pilot randomized controlled trial, in which effectiveness, influence of intention to change behavior, pain duration, working alliance, acceptance, and adherence were evaluated.

Methods: Participants were recruited online and in collaboration with pain experts, and were randomized to interact with SELMA for 8 weeks either every day or every other day concerning CBT-based pain management (n=59), or weekly concerning content not related to pain management (n=43). Pain-related impairment (primary outcome), general well-being, pain intensity, and the bond scale of working alliance were measured at baseline and postintervention. Intention to change behavior and pain duration were measured at baseline only, and acceptance postintervention was assessed via self-reporting instruments. Adherence was assessed via usage data.

Study details

- Study Type: Pilot Randomized Controlled Trial (RCT)
- Year & Country:2020, Switzerland
- Study Objective: To evaluate the feasibility and effectiveness of the smartphone-based chatbot SELMA in promoting self-management of chronic pain through cognitive behavioral therapy (CBT) techniques.
- Sample Size:102 participants (88 women, 14 men)
- Target Population: Adults experiencing ongoing or cyclic chronic pain, recruited online and via pain specialists.
- Data Collection Tools: Standardized questionnaires assessing:
  - Pain-related impairment
  - Pain intensity
  - General well-being
  - Working alliance with the chatbot
  - User acceptance and adherence

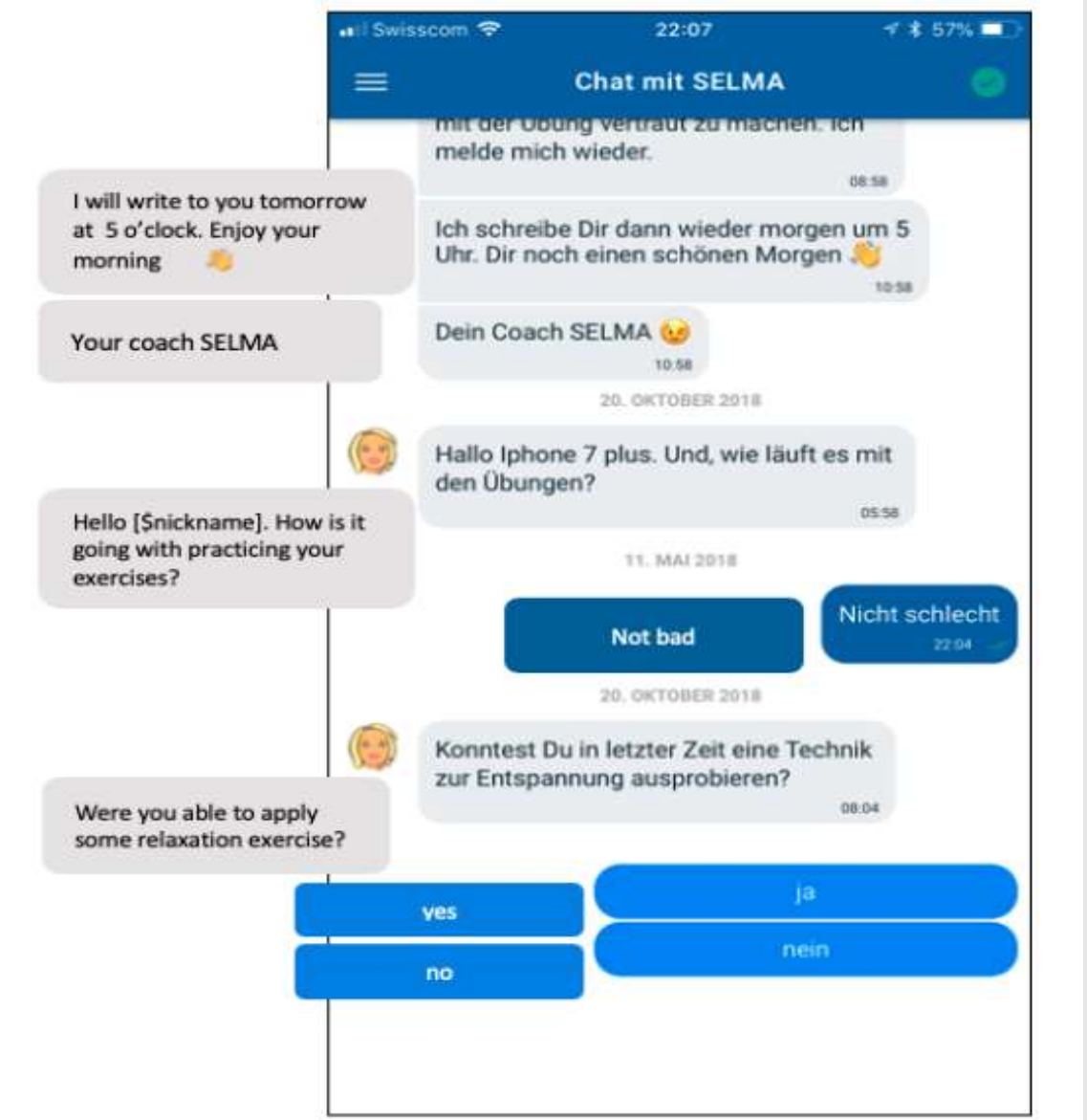
Results

- No significant difference in pain-related impairment between groups (P = .68)

- High satisfaction:
  - Usefulness: 5.47/7
  - Ease of use: 6.34/7
  - Enjoyment: 5.5/7

- Adhérence rate: 71% (approx. 200 conversations per participant)

- Users appreciated empathetic design but wanted more flexibility (e.g., free-text input)



A systematic review of AI-based chatbot usages in healthcare services

Journal of Health Organization and Management

K. Mohamed Jasim and A. Malathi
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Seema Bhardwaj
Symbiosis Institute of Business Management, Nagpur, Symbiosis International (Deemed University), Pune, India and Middlesex University, Dubai, United Arab Emirates, and
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Received 28 January 2024
Revised 2 December 2024
Accepted 17 December 2024

Abstract

Purpose – This systematic literature review aims to provide a comprehensive and structured synthesis of the existing knowledge about chatbots in healthcare from both a theoretical and methodological perspective.

Design/methodology/approach – To this end, a systematic literature review was conducted with 89 articles selected through a SPAR-4-SLR systematic procedure. The document for this systematic review was collected from Scopus database. The VoSviewer software facilitates the analysis of keyword co-occurrence to form the fundamental structure of the subject field.

Findings – In addition, this study proposes a future research agenda revolving around three main themes such as (1) telemedicine, (2) mental health and (3) medical information.

Originality/value – This study underscores the significance, implications and predictors of chatbot usage in healthcare services. It is concluded that adopting the proposed future direction and further research on chatbots in healthcare will help to refine chatbot systems to better meet the needs of patients.

Keywords Chatbots, Healthcare, Telemedicine, Mental health, Systematic literature review

Paper type Literature review

Study details

- Study Type: Systematic Review
- Year & Country: 2025, India, UAE, Malaysia and Macau
- Study Objective: To provide a comprehensive and structured synthesis of existing knowledge about AI-based chatbot usages in healthcare services. The review emphasizes theoretical and methodological perspectives.
- Sample Size: Not applicable(systematic review based on 89 selected articles)
- Data Collection Sources: Scopus

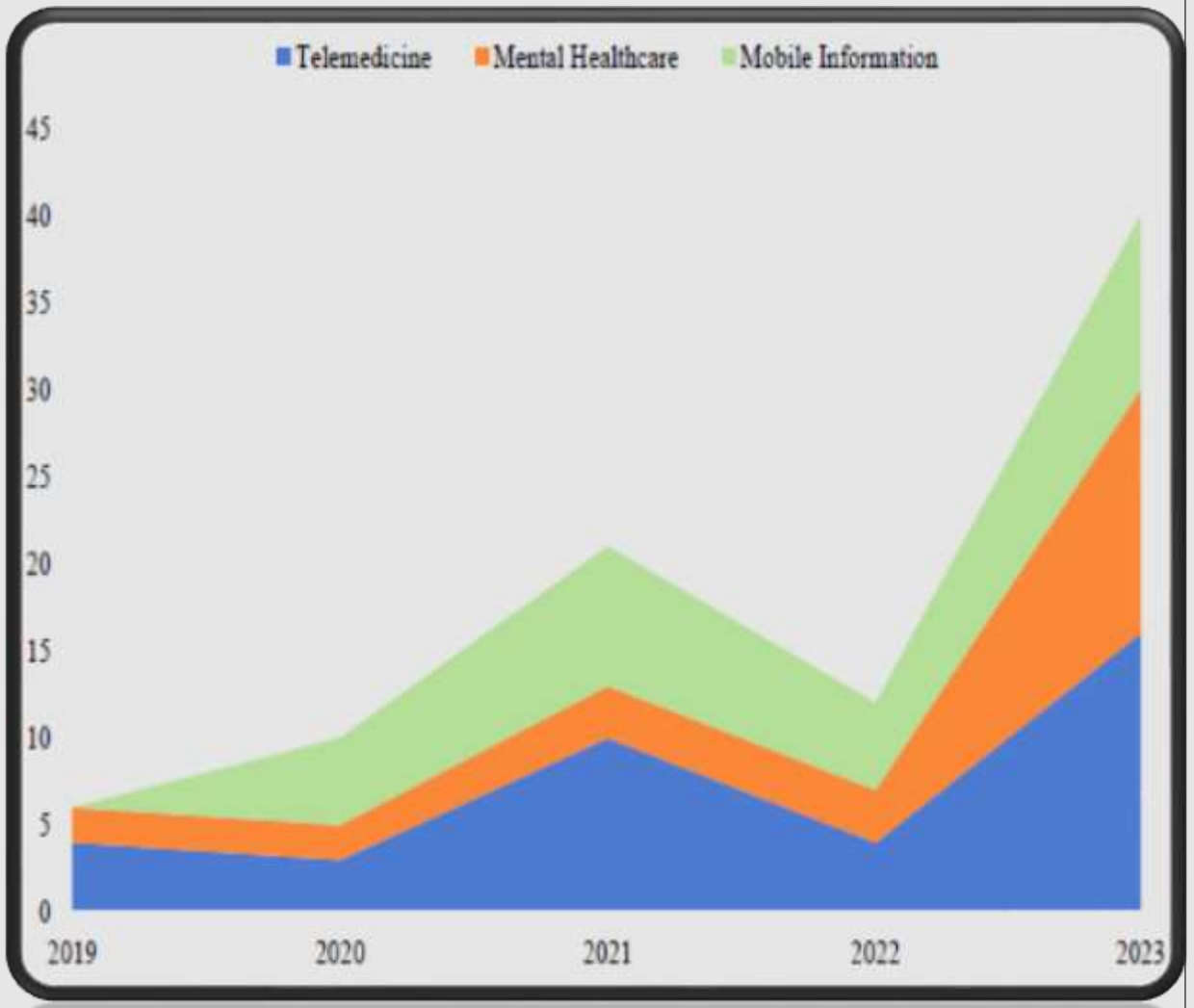
Results

- The study findings showed that artificial chatbots were used in three main areas:

- Telemedicine
- Mental Health
- Mobile(Medical) Information

- AI-based chatbots in healthcare have great potential to:

- Improve patient engagement
- Reduce healthcare provider workload
- Increase access to medical information



sensors

MDPI

Article

Assisting Personalized Healthcare of Elderly People: Developing a Rule-Based Virtual Caregiver System Using Mobile Chatbot †

Chisaki Miura [1], Sinan Chen [1,*], Sachio Saiki [2], Masahide Nakamura [1,3] and Kiyoshi Yasuda [4]

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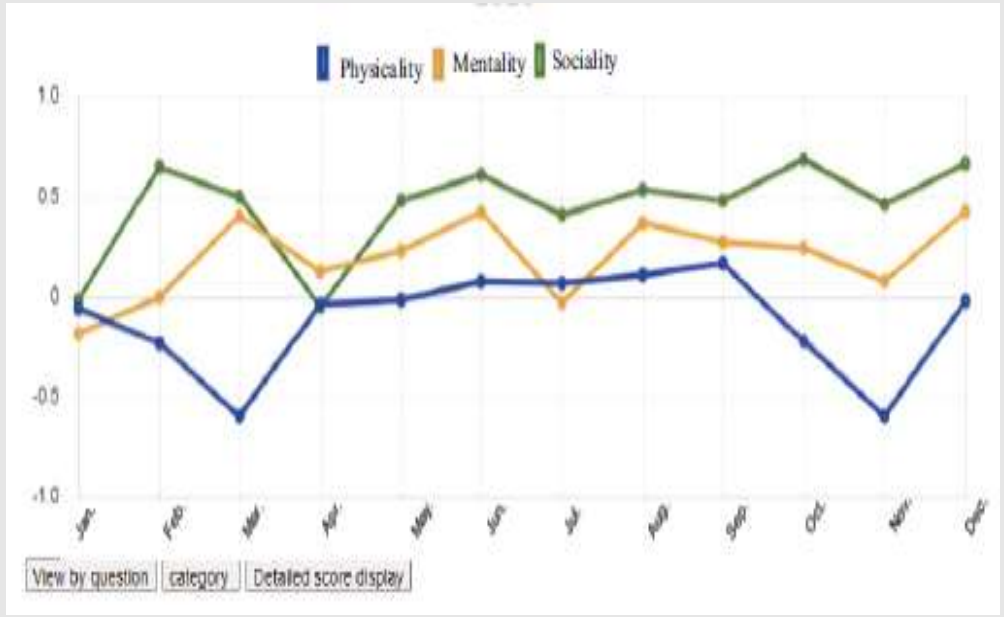
† This paper is an extended version of the conference papers: Chisaki, M.; Sachio, S.; Masahide, N.; Kiyoshi, Y. Implementing and Evaluating feedback feature of Mind Monitoring Service for Elderly People at Home. In Proceedings of the iiWAS 2020, Online, 30 November–2 December 2020.

Abstract: To assist personalized healthcare of elderly people, our interest is to develop a virtual caregiver system that retrieves the expression of mental and physical health states through human–computer interaction in the form of dialogue. The purpose of this paper is to implement and evaluate a virtual caregiver system using mobile chatbot. Unlike the conventional health monitoring approach, our key idea is to integrate a rule-based virtual caregiver system (called "Mind Monitoring" service) with the physical, mental, and social questionnaires into the mobile chat application. The elderly person receives one question from the mobile chatbot per day, and answers it by pushing the optional button or using a speech recognition technique. Furthermore, a novel method is implemented to quantify the answers, generate visual graphs, and send the corresponding summaries or advice to the specific elder. In the experimental evaluation, we applied it to eight elderly subjects and 19 younger subjects within 14 months. As main results, its effects were significantly improved by the proposed

Citation: Miura, C.; Chen, S.; Saiki, S.; Nakamura, M.; Yasuda, K. Assisting Personalized Healthcare of Elderly People: Developing a Rule-Based Virtual Caregiver System Using Mobile Chatbot. *Sensors* **2022**, *22*,

Study details

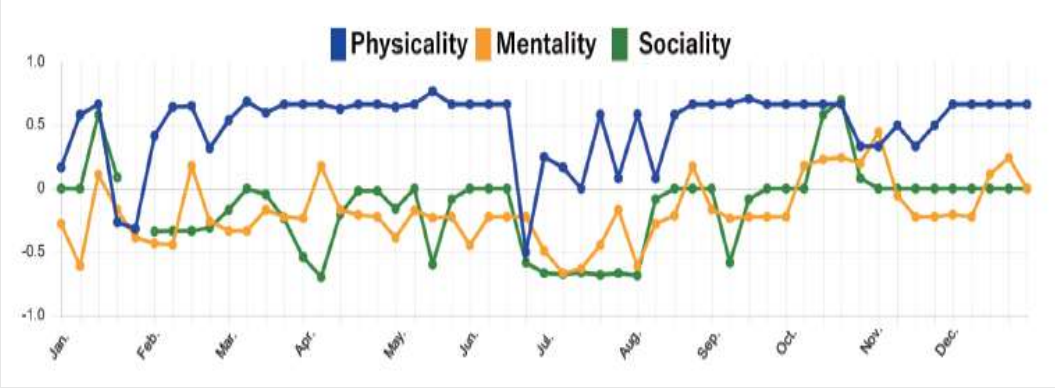
- Study Type: Intervention Study
- Year & Country: 2022, Japan
- Study Objective: develop and assess a rule-based virtual caregiver system through a mobile chatbot that supports the personalized healthcare of elderly individuals by monitoring their physical and mental condition via daily conversational interactions.
- Sample Size: 27 participants (8 elderly adults and 19 younger adults for comparison)
- Target Population: Elderly individuals aged 50–80s, and younger individuals aged 20–40s
- Data Collection Tools:
  - Mobile chatbot (LINE app) delivering daily questions
  - Quantitative scoring system to analyze responses
  - Visual feedback (charts and summaries)

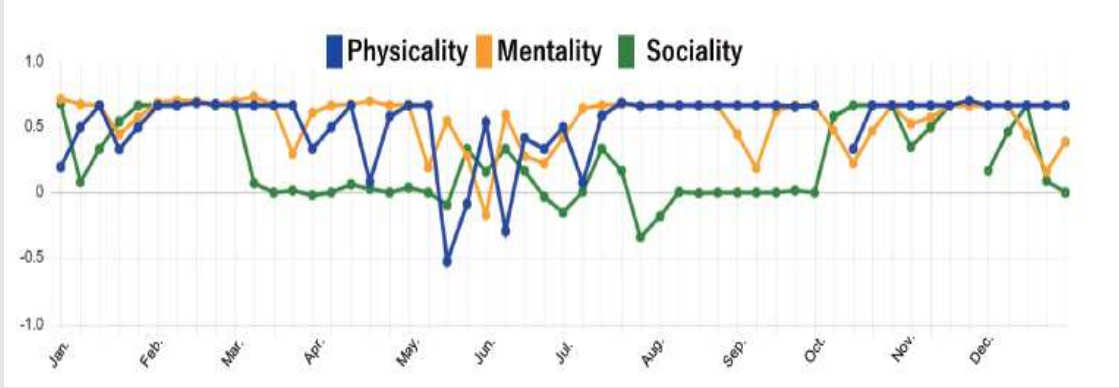

Physicality
Mentality
Sociality
1.0
0.5
0
-0.5
-1.0
Jan.
Feb.
Mar.
Apr.
May.
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
View by question
category
Detailed score display


Mei-chan
Mei-chan
Ms. Chisaki, Have you slept well for the past week?
Yes, I've slept well.
No, I haven't slept well.
Aa


Have you slept well in the past week? -> Yes, I've slept well.
I'm relieved to hear that! If you have any concerns about sleep, please let me know.
Additional question
Input text messages
I'm trying to get at least six hours of sleep. I don't have any concerns about sleep right now.
OK
Aa

Results





It was tested on 27 people (8 elderly) for 14 months.

A response rate of over 80% and high acceptance by the elderly were reported.

User feedback indicated that the system was effective for daily monitoring and increasing health awareness.

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Chatbot for Healthcare System Using Artificial Intelligence

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Abstract- **Healthcare is very important to lead a good life. However, it is very difficult to obtain the consultation with the doctor for every health problem. The idea is to create a medical chatbot using Artificial Intelligence that can diagnose the disease and provide basic details about the disease before consulting a doctor. This will help to reduce healthcare costs and improve accessibility to medical knowledge through medical chatbot. The chatbots are computer programs that use natural language to interact with users. The chatbot stores the data in the database to identify the sentence keywords and to make a query decision and answer the question. Ranking and sentence similarity calculation is performed using n-gram, TF-IDF and cosine similarity. The score will be obtained for each sentence from the given input sentence and more similar sentences will be obtained for the query given. The third party, the expert program, handles the question presented to the bot that is not understood or is not present in the database.**

Keywords:-Chatbot, Healthcare, Artificial Intelligence, Virtual Assistance, TFID, N-gram

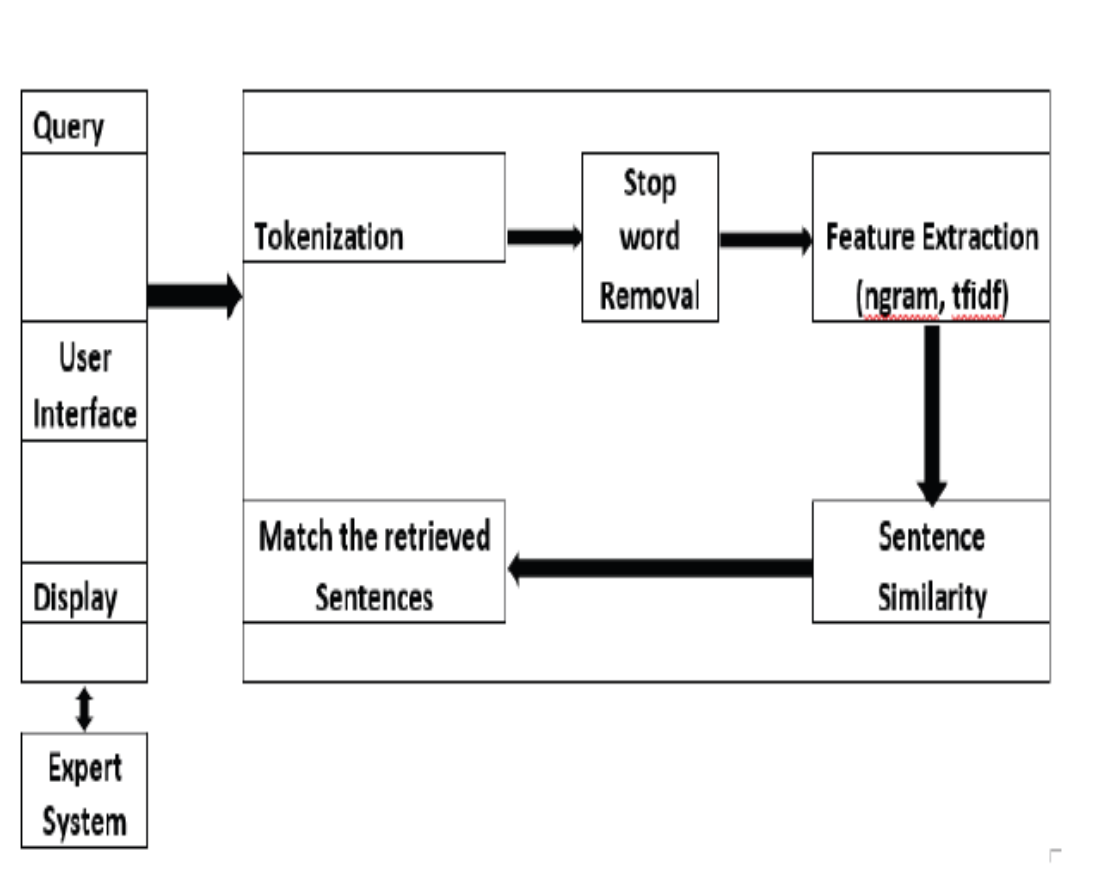
keywords are extracted from the given input sentence and the sentence similarity is found. The keyword ranking and sentence similarity are found using the N-gram, TF-IDF, and cosine similarity. The interfaces are standalone built using the JAVA programming language.

II. LITERATURE REVIEW

Here the studies are based on to recognize emotions classification using AI methods. The studies train emotions classification models from a lot of labelled data based on recurrent neural network (RNN), deep learning, and convolutional neural network. Linguistic interaction is most important in counselling using Natural Language Processing (NLP) and Natural-language generation (NLG) to understand dialogues of users. Here the multi-modal approach is used of emotion-recognition. They have collected corpuses to learn semantic information of words and represent as vector using the word vector, synonym knowledge of lexical are collected. [1]

Study details

- Study Type: Developmental
- Year & Country: 2020, India
- Study Objective: To design and implement an AI-based chatbot for healthcare that can provide medical information, answer health-related queries, and guide users toward suitable treatments.




THE
END