
بسم الله الرحمن الرحیم

Chatbots presentation

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1404/12/04

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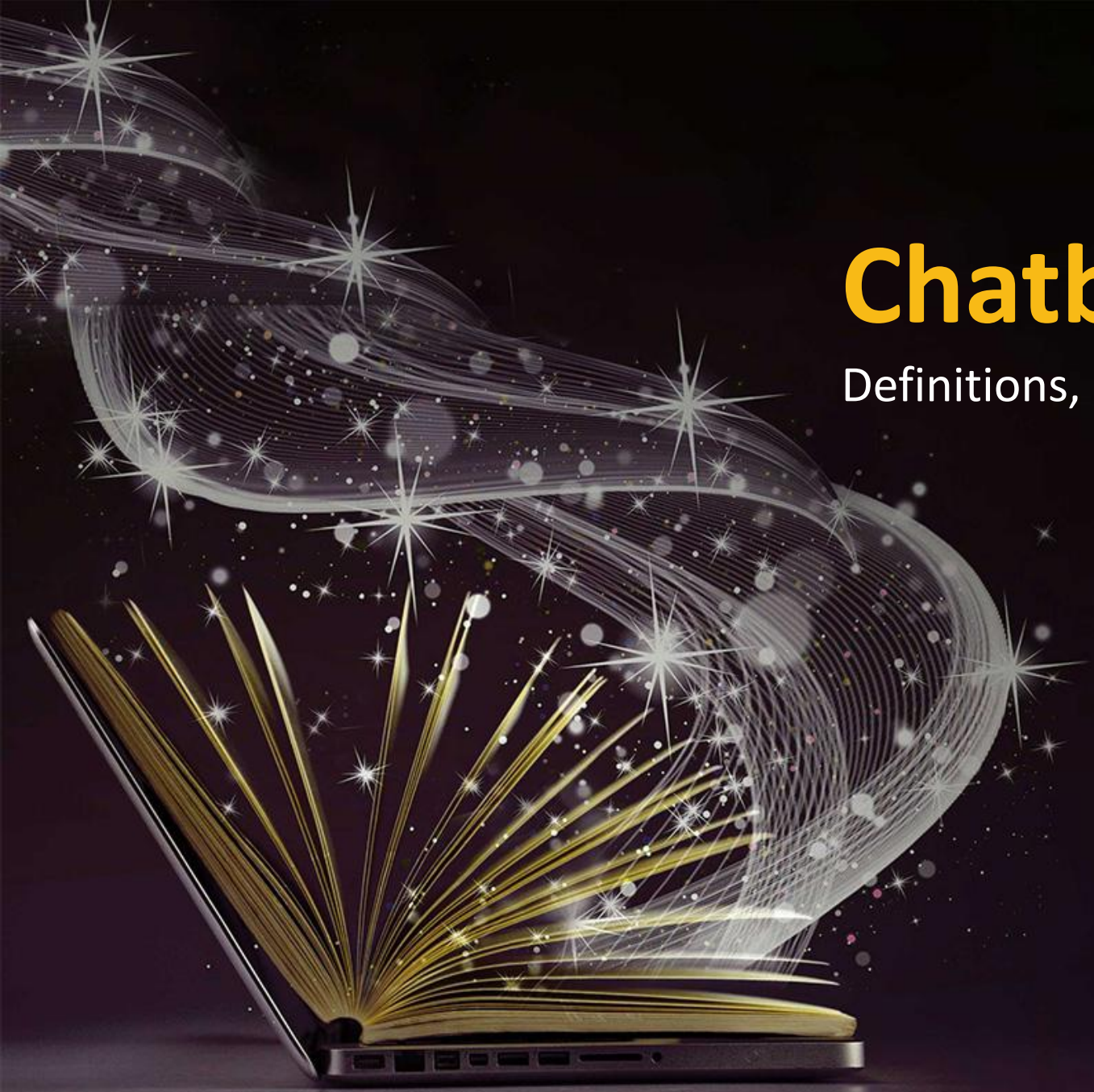


Chatbot definition

Definitions, History, Applications, Intellectual origin

Chatbot definition

- A Chatter Robot
- An Agent

- Open AI: A chatbot is an AI system designed to understand and generate natural language, enabling users to interact with computers in a conversational way to get information, complete tasks, and solve problems

Chatbot definition

Organization	Main Focus of Definition
ISO	Human–machine interaction
Gartner	Business application and customer support
IBM	Artificial intelligence and NLP
Microsoft	Text-based and voice-based interaction
UNESCO	Education and access to knowledge
Britannica	Conversation simulation
IEEE	Intelligent agent

Intellectual origin: Alan Turing

Can machines think?

1950 | Alan Turing → Introduction of the Turing Test and the question, “Can machines think?

Core idea → If a machine appears human-like in conversation, it can be considered intelligent.

1960s | ELIZA → The first practical chatbot (Weizenbaum); the beginning of human–machine interaction through conversation.

Resorce: From ELIZA to ChatGPT: A brief history of chatbots and their evolution

Chatbot History

ELIZA (1960s)

The first rule-based chatbot, developed by Joseph Weizenbaum, simulated a psychotherapist's conversational style.

PARRY (1970s)

Designed to emulate the thought process of paranoid patients, setting new standards for conversational AI.

SmarterChild (2001)

An interactive digital assistant widely used on messaging platforms, precursor to modern virtual assistants.

Siri (2011)

Apple's intelligent assistant, leveraging advanced natural language processing for user interaction.

ChatGPT Evolution (2018–2023)

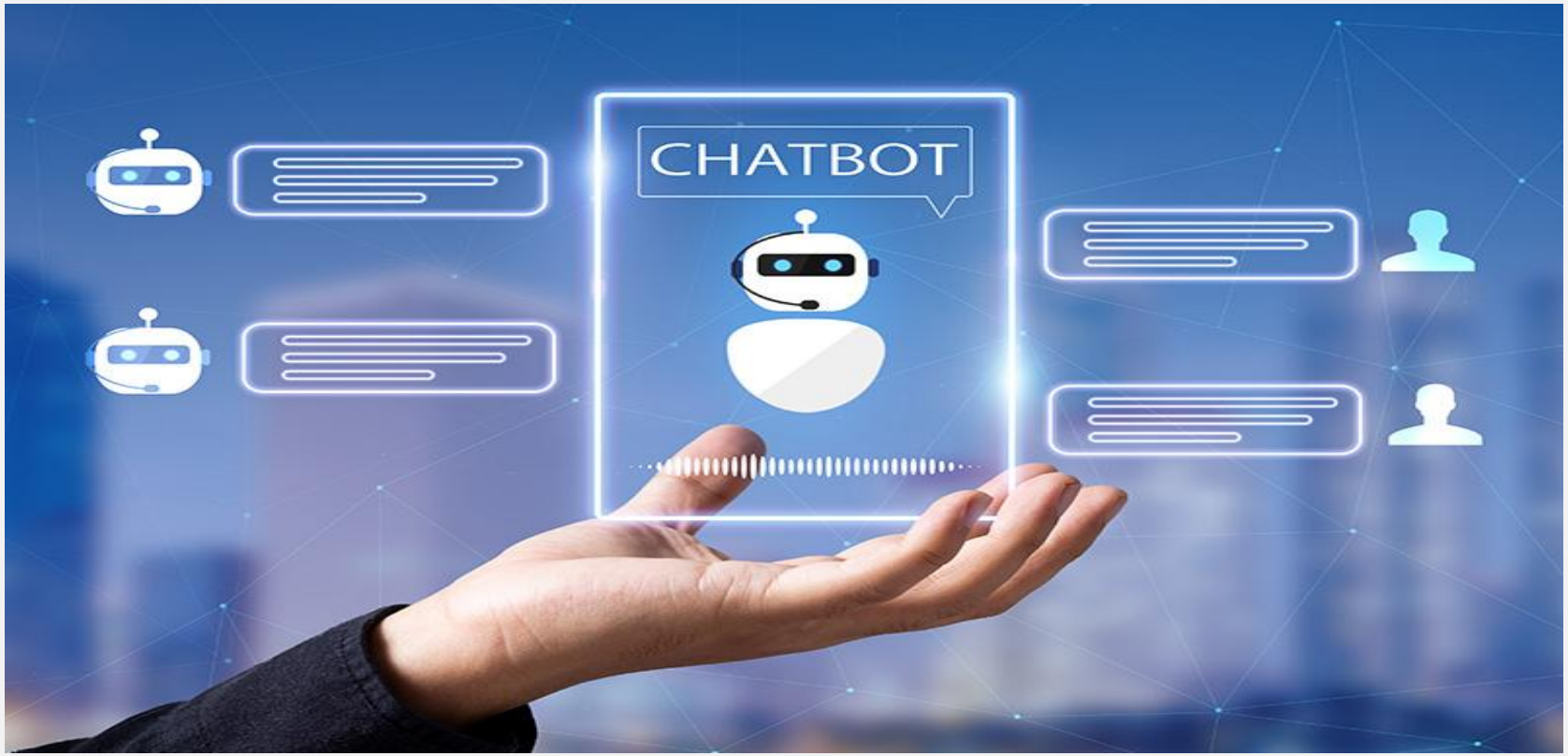
Early models (GPT-1, GPT-2): Marked initial progress in conversational AI, focused on learning from large datasets.

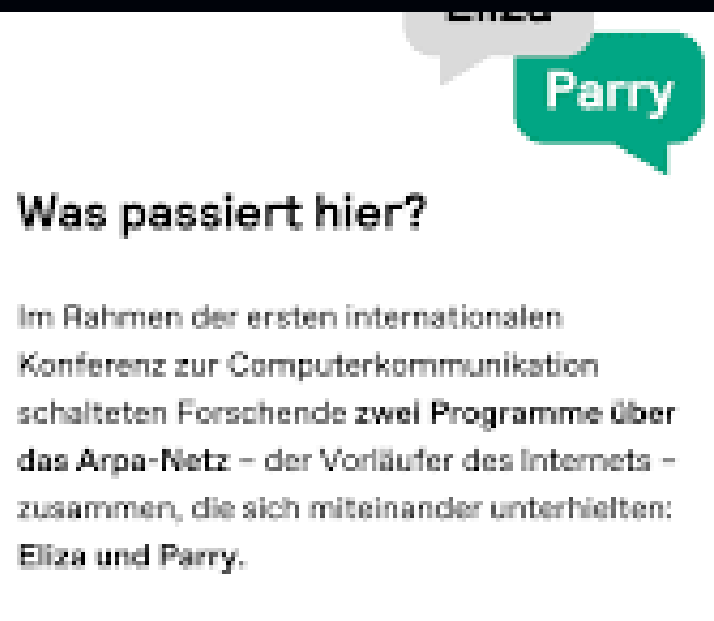
Advanced models (GPT-3, GPT-3.5, GPT-4)

Significant increases in model parameters and capabilities, powering more natural, intelligent, and flexible interactions.

Eliza Chats with Parry

At a computer conference in 1972, the expected thing happened: ‘the patient started to converse with the doctor’.

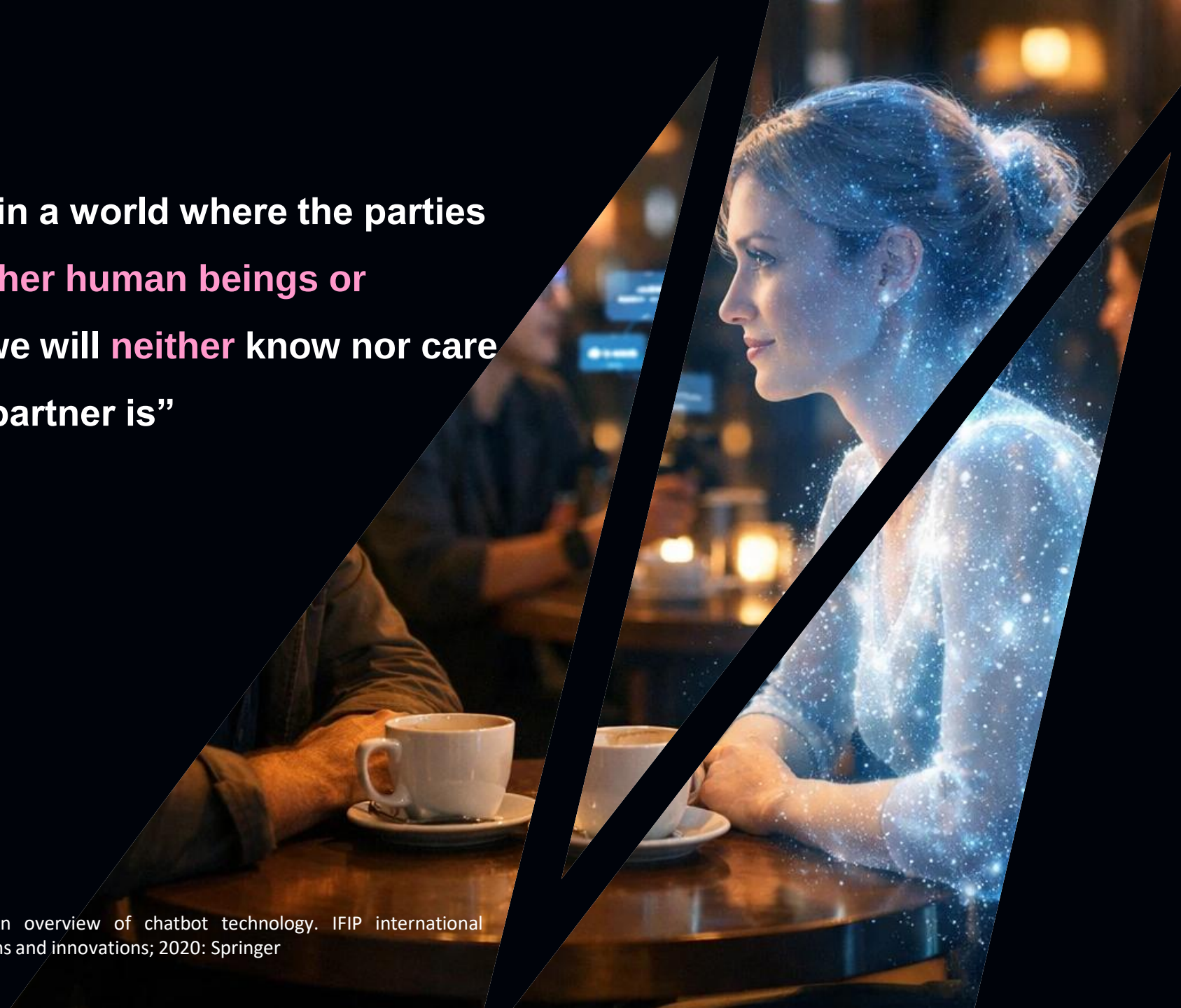




parry: People get on my nerves sometimes.
eliza: I am not sure I understand you fully.
parry: You should pay more attention.
eliza: Suppose you should pay more attention?
parry: You're entitled to your opinion.
eliza: What makes you think I'm entitled to my opinion?
parry: It bothers me just to be around people.
eliza: Please go on.
[Parry continues with some paranoid ramblings about horseracing, bookies, and the Mafia]
parry: I know the mob controls the big rackets.
eliza: Who are you really talking about?
eliza: In what way?“

A Brief History of Chatbots

“In the near future, we will live in a world where the parties to our conversations will be either human beings or chatbots; and in many cases, we will neither know nor care which one our conversational partner is”



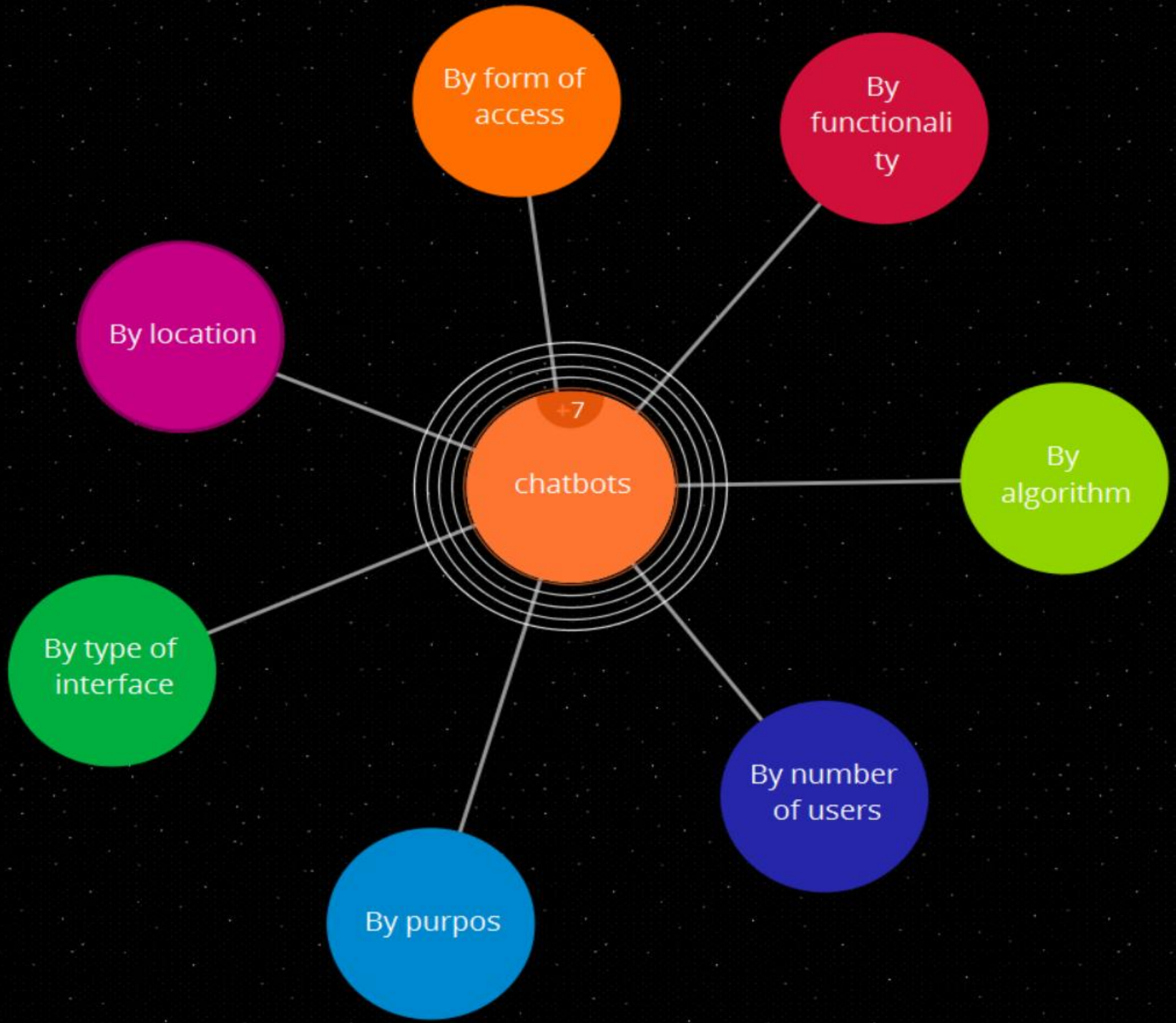
Adamopoulou E, Moussiades L, editors. An overview of chatbot technology. IFIP international conference on artificial intelligence applications and innovations; 2020: Springer

Applications of Chatbots

- **Customer Support:** Automated responses to frequently asked questions and assistance with resolving user issues
- **Education:** Learning assistants, answering students' questions, and providing personalized learning experiences
- **Healthcare:** Initial guidance for patients, medication reminders, and appointment scheduling
- **Business and Sales:** Purchase recommendations, order placement, and customer follow-up
- **Banking and Financial Services:** Checking account balances, handling transactions, and guiding users through services
- **Social Networks and Messaging Platforms:** Intelligent interaction and engagement with users

Classification of Chatbot

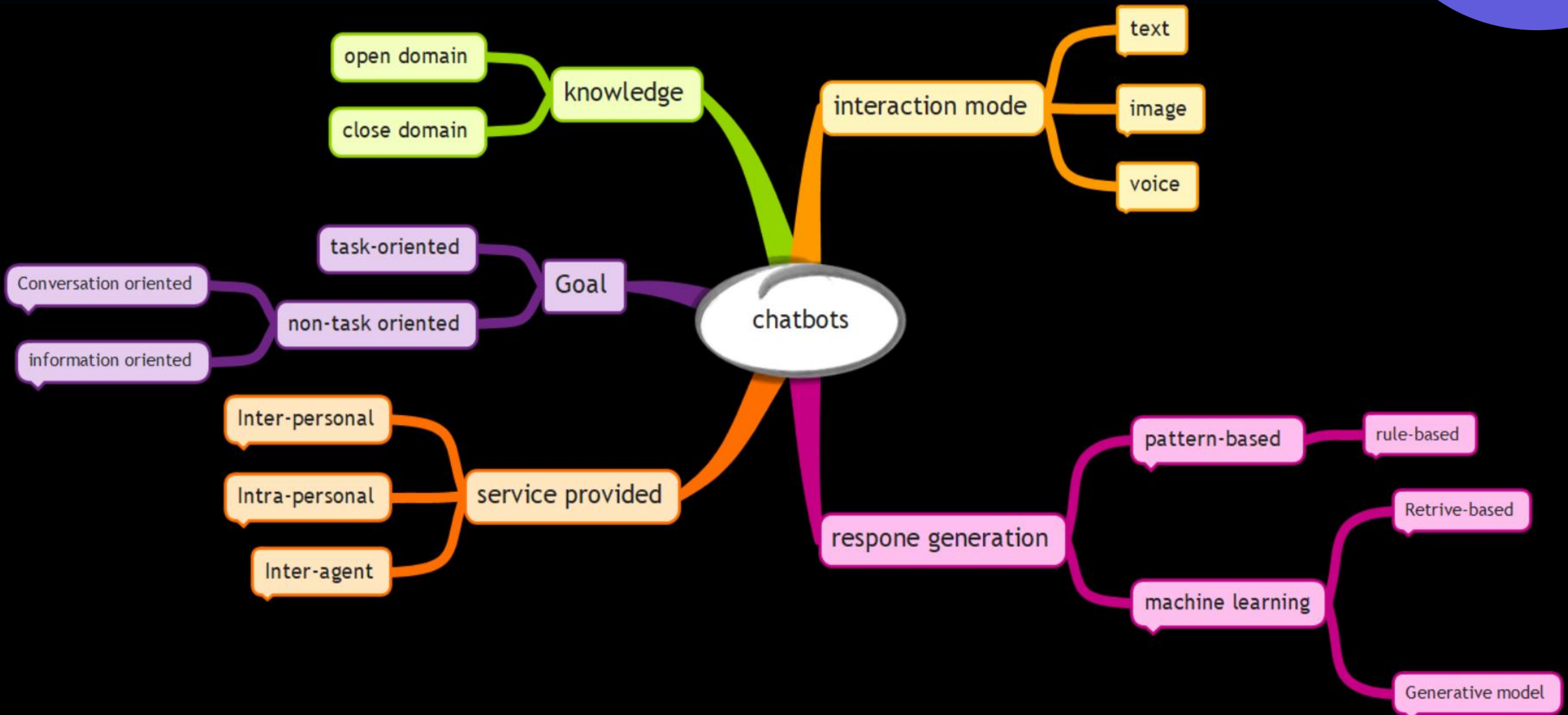
Type of chatbots



INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE «INTELLECTUAL SYSTEMS AND INFORMATION TECHNOLOGIES»:

Classification of chatbots

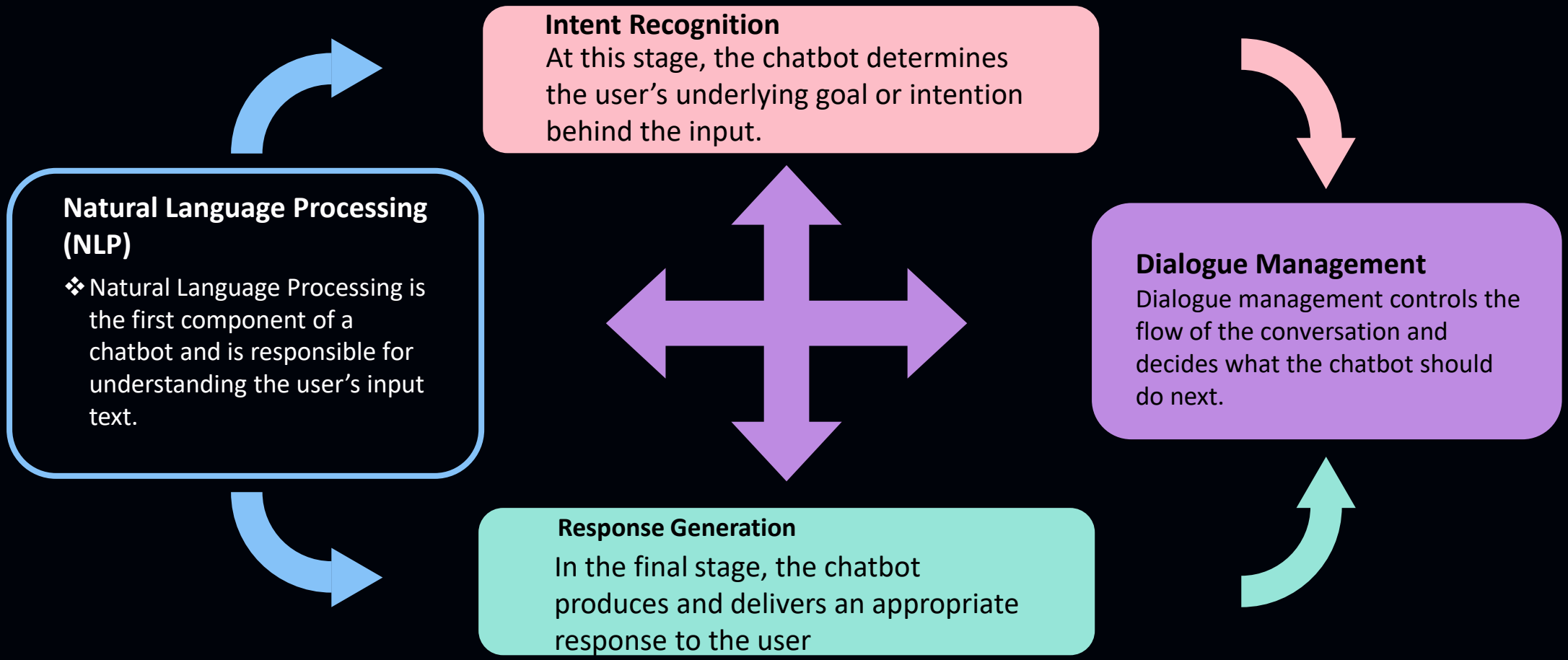
Classification of Chatbot



Concepts

Main concepts and General Architecrute

Architecture and Core Components of Chatbots



General architecture of chatbots

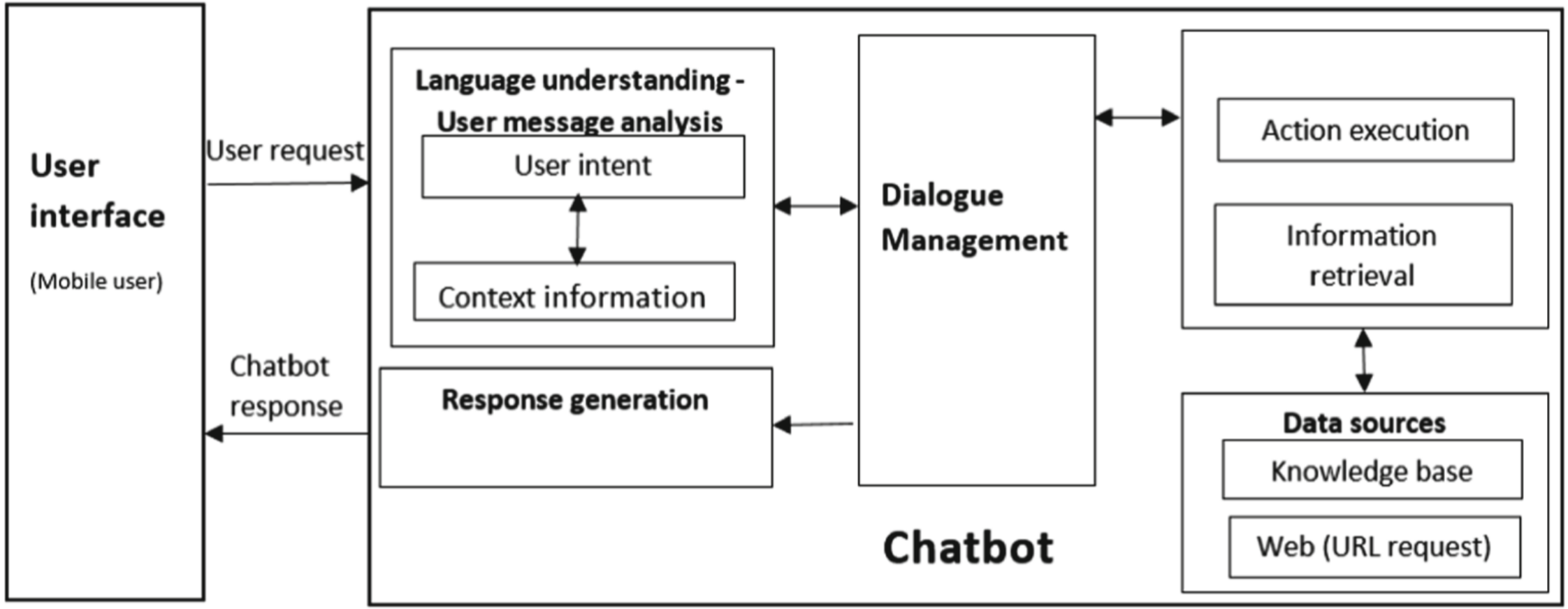
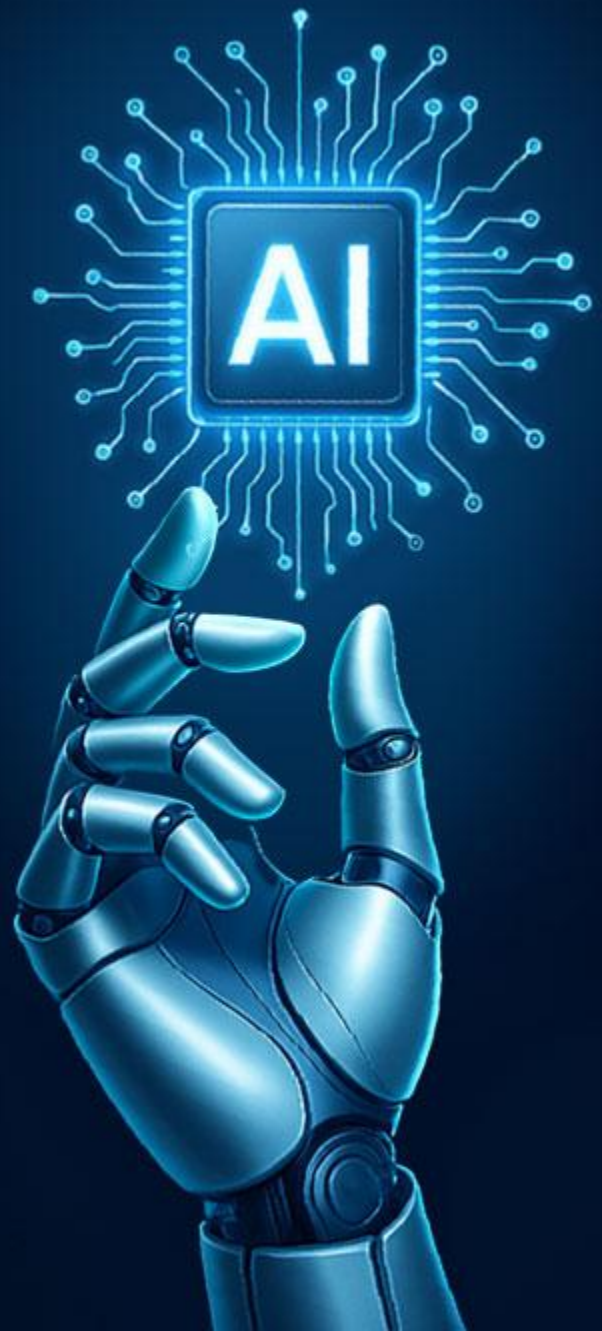


Fig. 3. General chatbot architecture

An overview of chatbot technology.

Intelligent chatbots

Rule-Based, ML / NLP-Based, LLM-Based Chatbots



Types of chatbots based on their level of intelligence

01 Rule-Based Chatbots

02 ML / NLP-Based Chatbots

03 LLM-Based Chatbots

Rule-Based Chatbots

Definition:

Rule-Based Chatbots are systems that respond to users based on a predefined set of rules, typically using *if–then* logic. They do not learn from data and only follow explicitly programmed instructions.

How They Work

- Match user input with predefined keywords or patterns
- Apply the corresponding rule
- Return a predefined response
- Use a **fallback** response if no rule matches

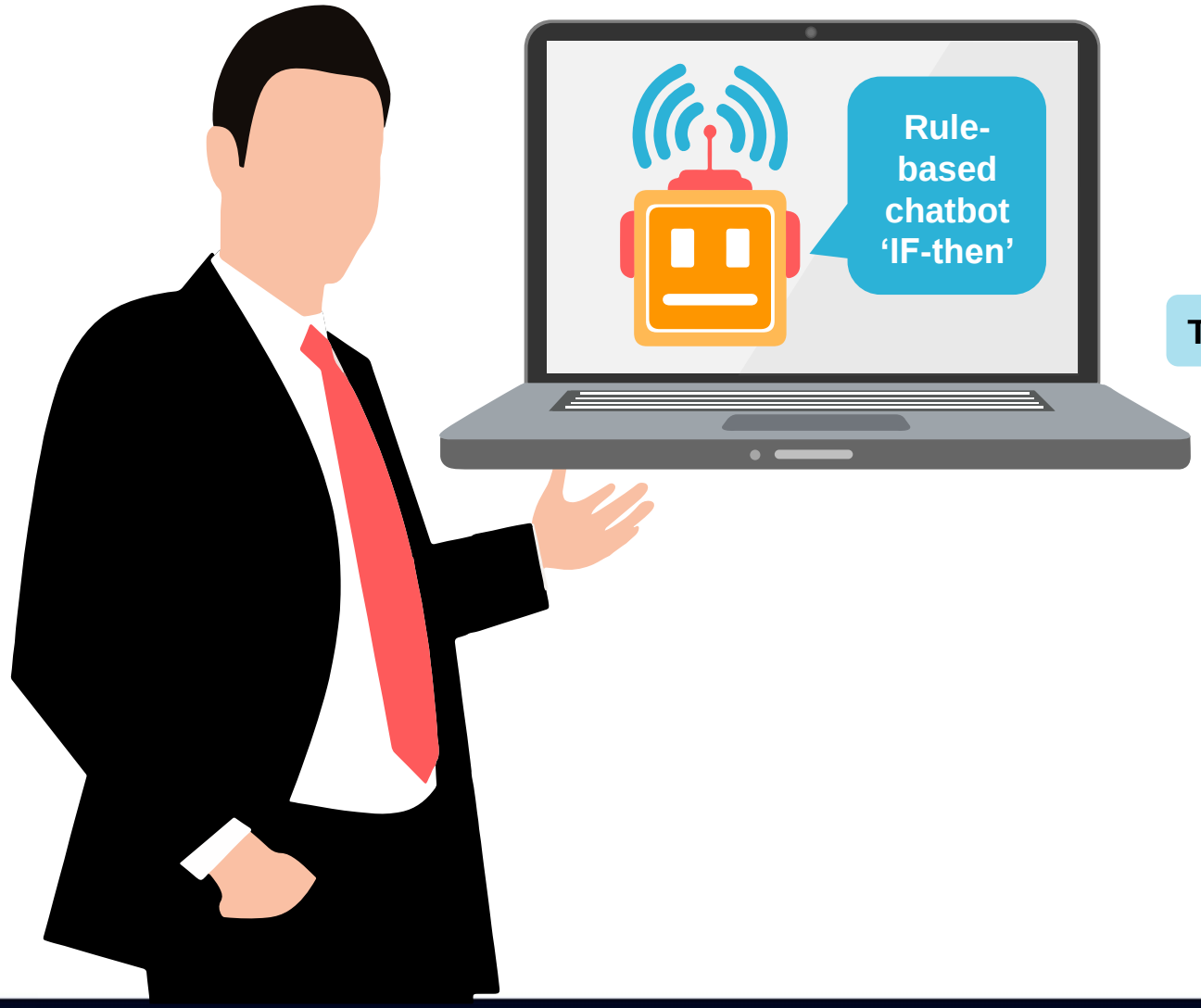
Key Characteristics

- Simple and deterministic behavior
- High control and predictability
- No learning or reasoning capability
- Limited flexibility

Typical Use Cases

- FAQ systems
- Customer support with fixed scenarios
- Menu-based or guided conversations

Rule-Based Chatbots



Top 5 Tools for Rule-Based Chatbots

1.Chatfuel – Popular no-code rule-based chatbot builder

2.ManyChat – Widely used for messaging platforms

3.Rasa – Powerful framework with explicit rule policies

4.Botpress – Professional flow- and rule-based chatbot platform

5.AIML – Classic pattern-based chatbot language

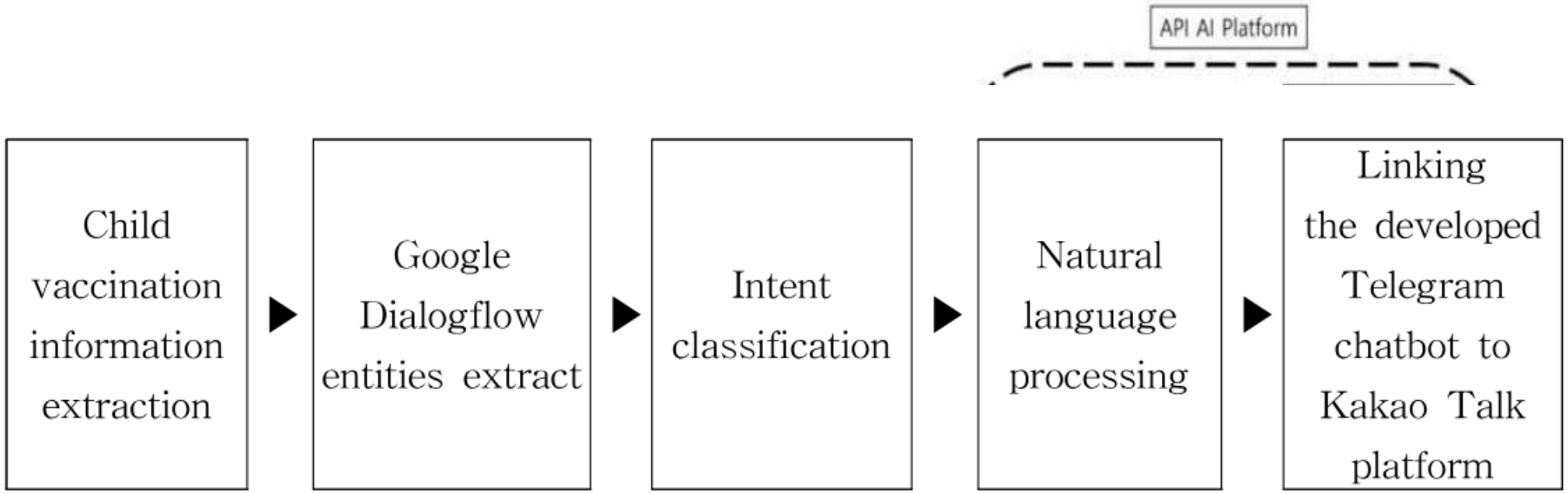


Figure 6. Chatbot's development process

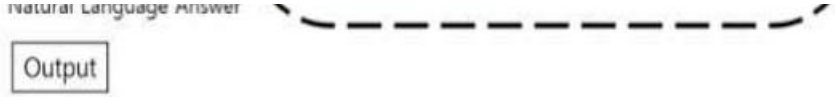


Figure 5. Conversational architecture of the child vaccination chatbot

Turing test results

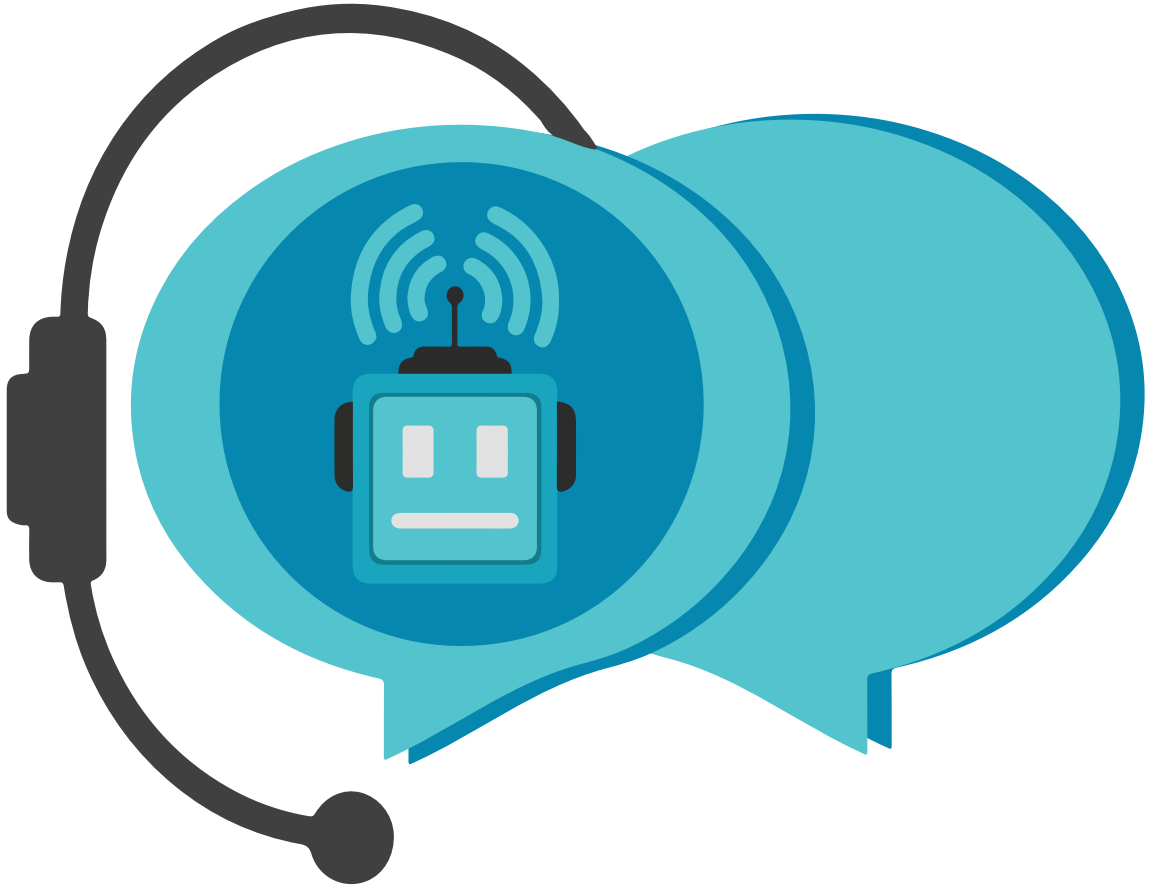
Human-like Factors

- Natural, warm, and friendly tone
- Use of emotional elements (soft tone, mild humor, emoticons)
- Sympathetic and informal information delivery
- Emphasis on *how* responses were expressed rather than accuracy alone

Machine-like Factors

- Failure to understand questions (e.g., asking users to repeat)
- Emotionless, overly formal, or rigid predefined responses
- Overly accurate, long, or highly detailed answers
- Use of technical/English terms without simple explanations
- Too much information in one message
- Instant replies without natural delay

Pros and Cons



Disadvantages

Very Limited Flexibility

Inability to understand new or unexpected user inputs

Lack of True NLU

Heavily dependent on keywords

Poor Scalability

As the number of rules increases, system maintenance becomes difficult

Limited User Experience

Conversations tend to be rigid and unnatural

Advantages

Simplicity , Transparency

The decision-making logic is fully understandable and easily controllable

Predictable Responses

No unexpected or unplanned responses are generated

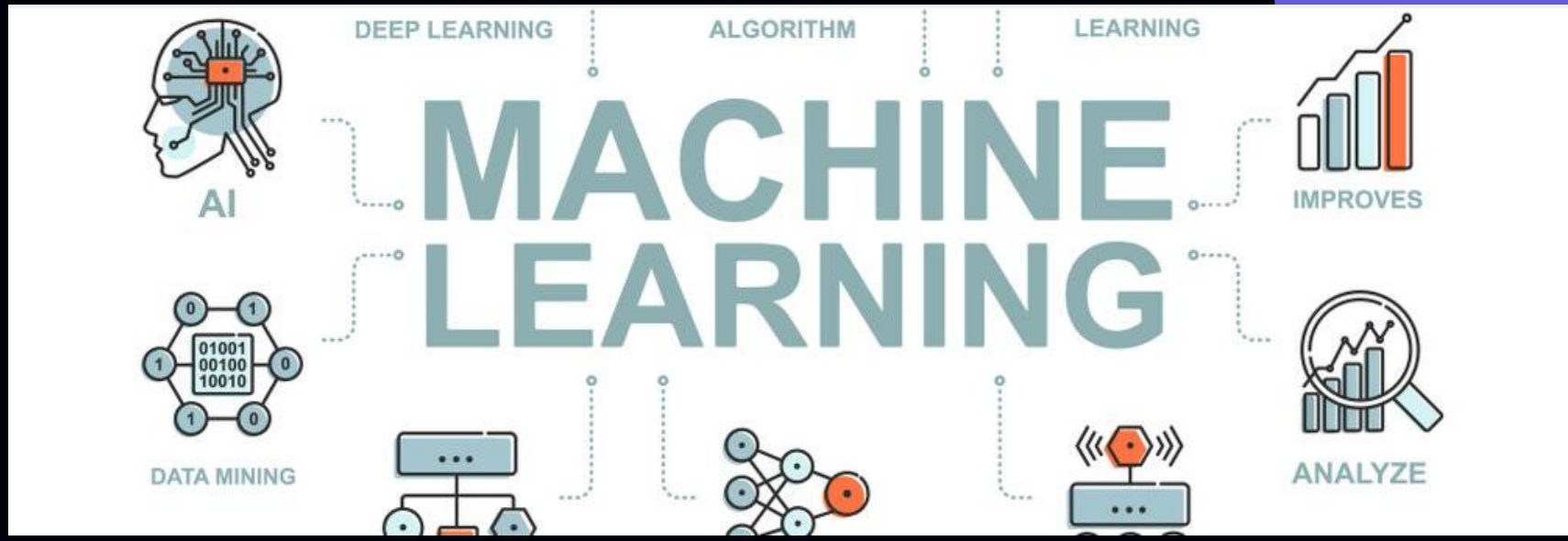
Low Development Cost

Suitable for small and simple projects

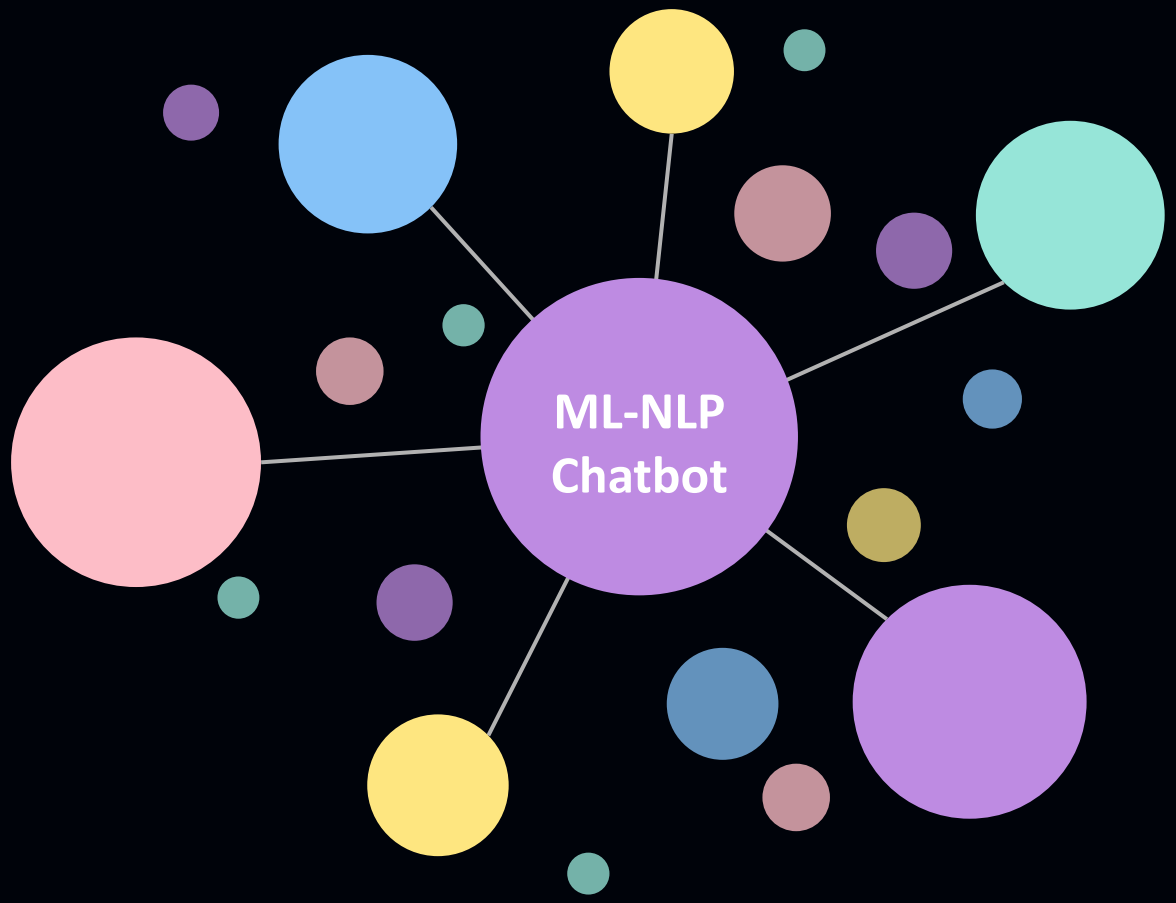
High Security

Responses are strictly limited to predefined rules

ML / NLP-Based Chatbots



These are chatbots that, instead of relying solely on predefined rules (rule-based systems), use machine learning and natural language processing to understand and generate responses.



NLP Component

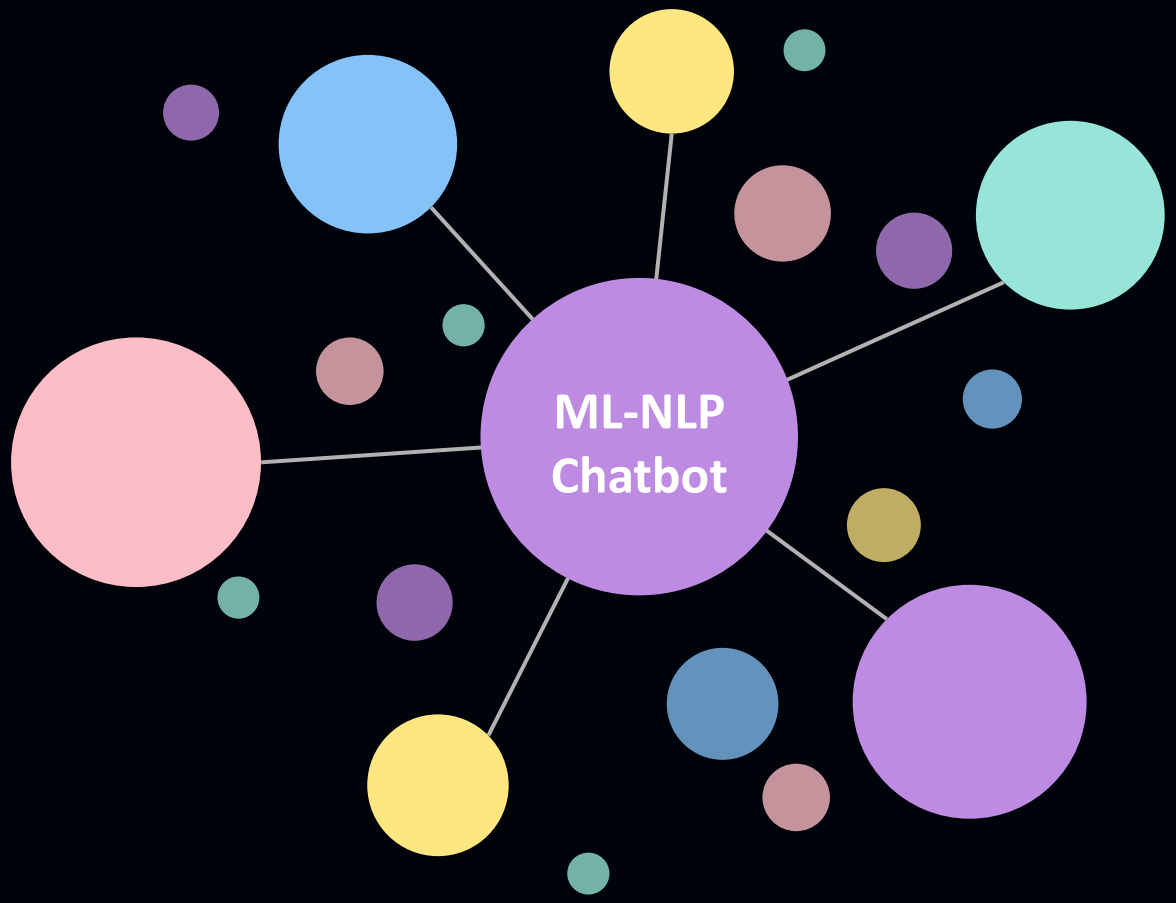
Role: Understanding the user's input

- Analyzes the user's sentence
- Identifies the user's intent
- Extracts important information (entities) such as dates, locations, and product names

ML Component

Role: Learning and making better decisions

- Learns from data and previous conversations
- Predicts the best response or action
- Improves system accuracy over time



Top 5 Tools for ML / NLP-Based Chatbots

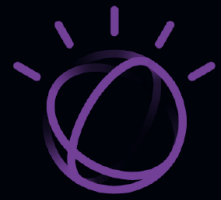
Rasa

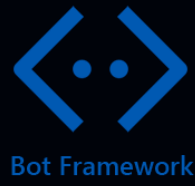
Google Dialogflow

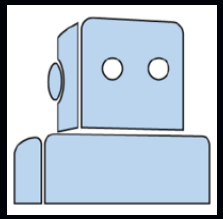
IBM Watson Assistant

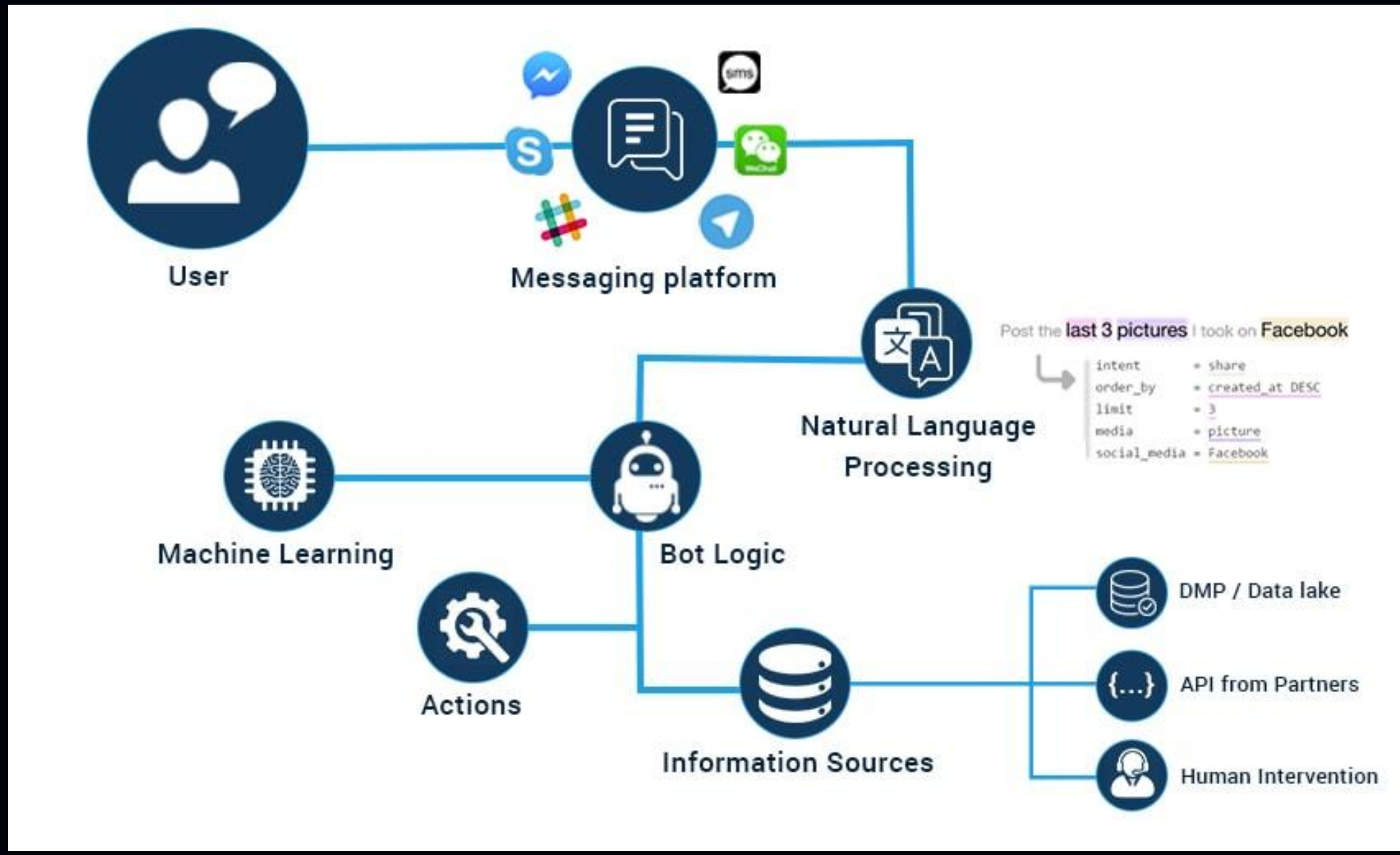
Microsoft Bot Framework

wit.ai









https://code-b.dev/blog/detailed-guide-on-how-to-develop-a-chatbot

Hybrid Chatbot Based on ML-NLP

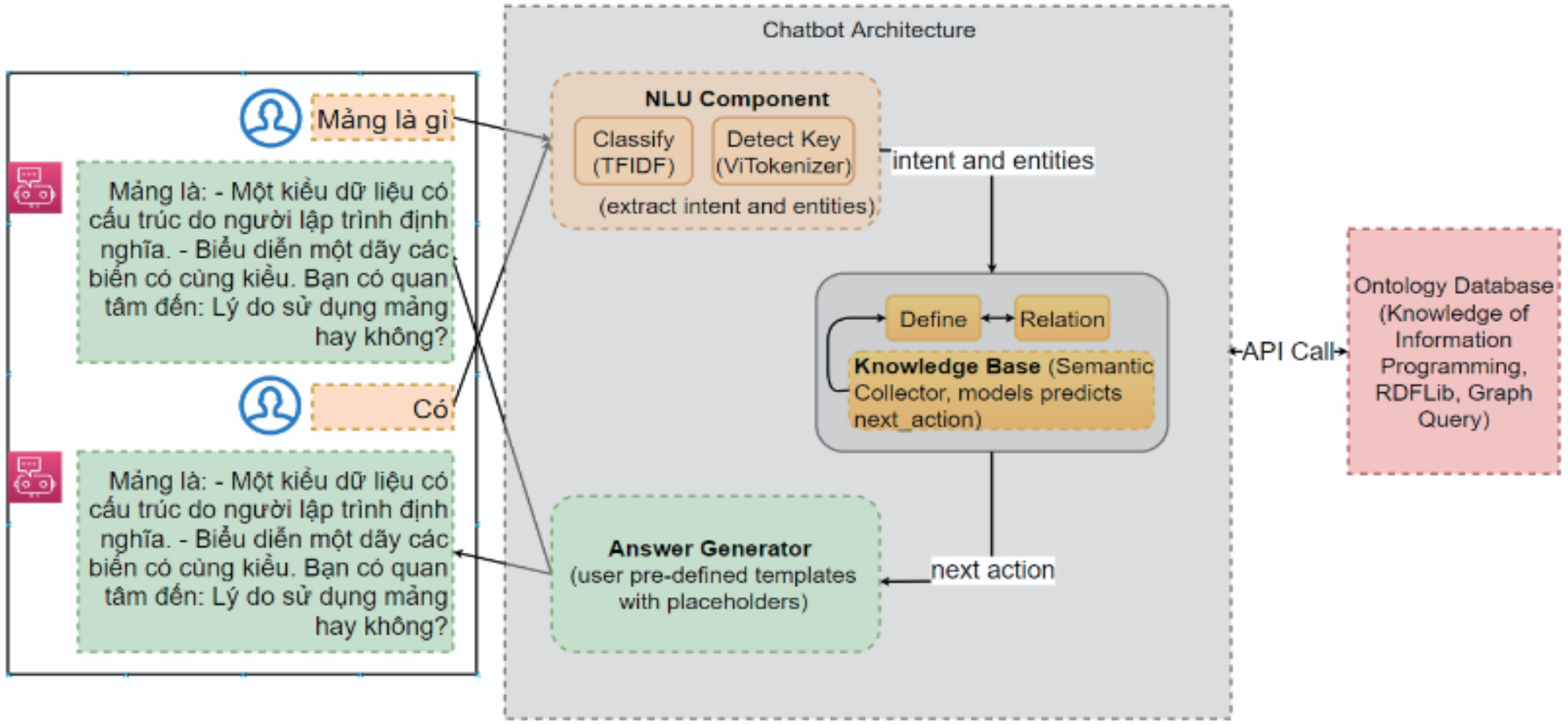
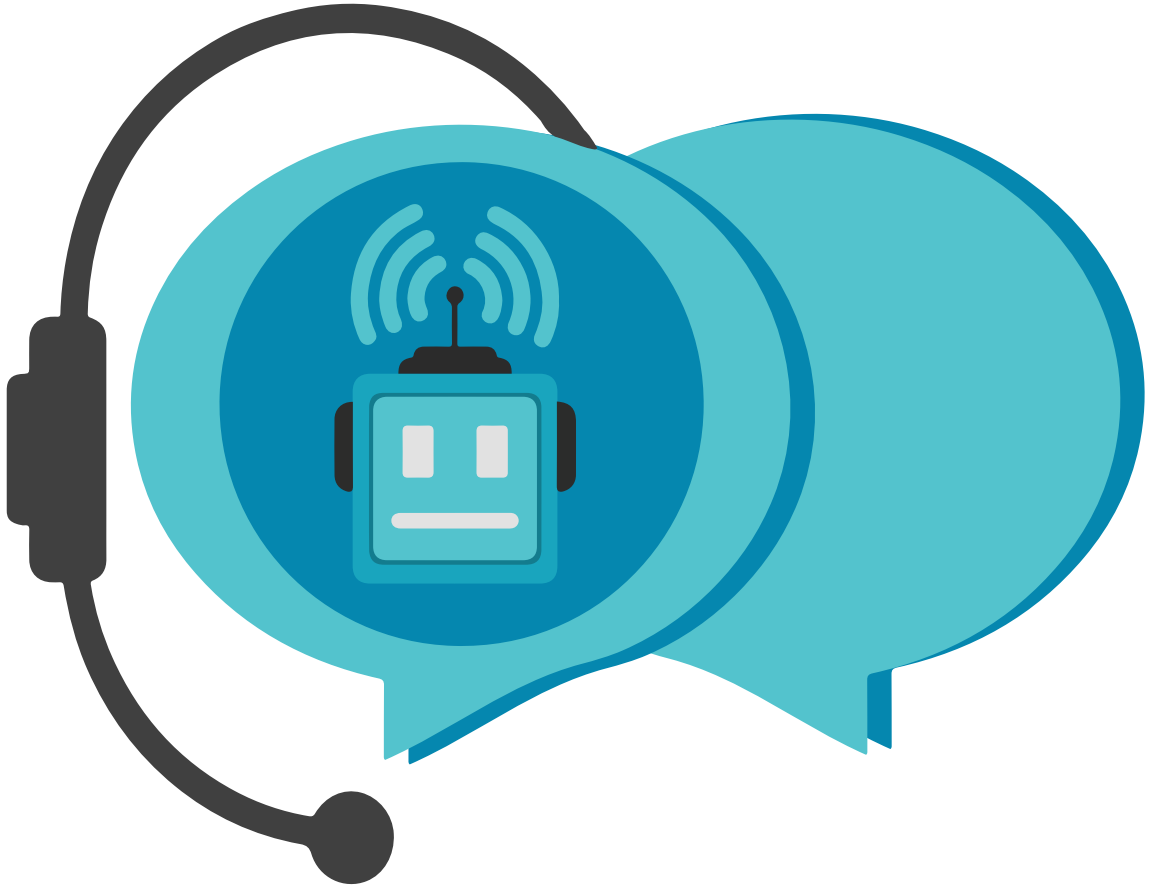


Fig. 3. (Color online) Architecture of the search system of the chatbot based on the knowledge domain.

Ontology-based Integration of Knowledge Base for Building an Intelligent Searching Chatbot

Pros and Cons



Disadvantages

Depend on Training Data

Limited or low-quality data leads to poor performance

Complexity

Requires expertise in machine learning and natural language processing

Intent Recognition Errors

Particularly in the case of ambiguous or unclear sentences

Limited Knowledge Scope

Restricted to the domain on which the model has been trained

Advantages

Better NLP

Identifying user intent rather than relying solely on keyword matching

Greater Flexibility

Ability to handle diverse and varied sentence structures

Learning from Data

Performance improves as the volume of training data increases

Limited Knowledge Scope

Restricted to the domain on which the model has been trained

LLM-Based Chatbots

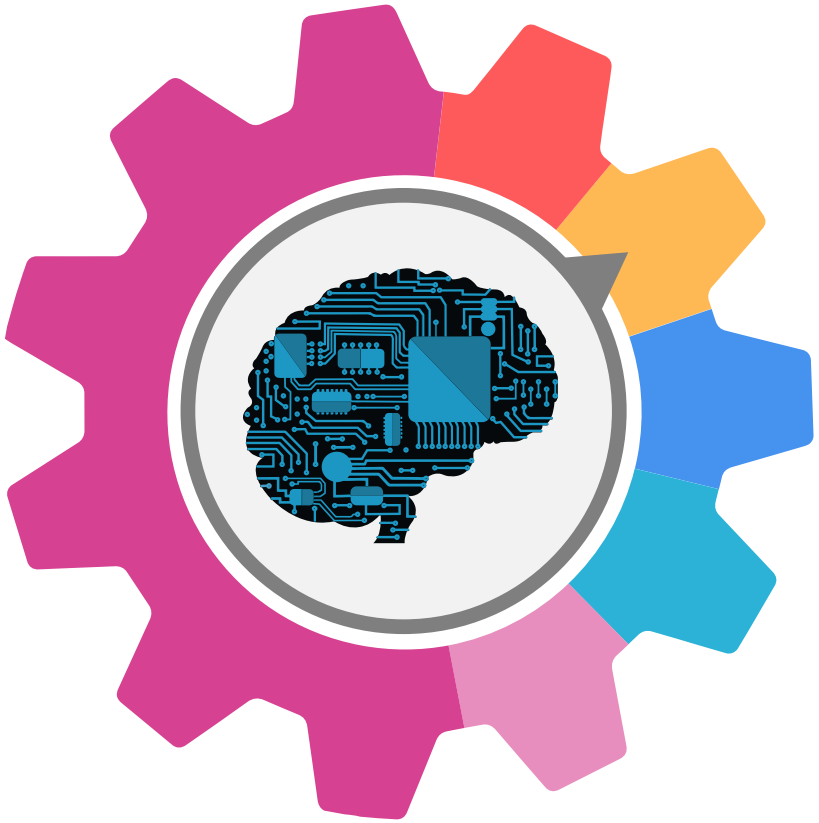
LLM-based chatbots are intelligent conversational systems that rely on large language models to understand human natural language, maintain conversational context, and generate flexible, meaningful, and human-like responses.

A **Large Language Model (LLM)** is a deep learning model trained on massive amounts of textual data to learn the statistical and semantic patterns of language, enabling it to understand, generate, and reason over natural language in a human-like manner.

What can an LLM do?

- Answer questions
- Write and summarize text
- Perform translation
- Explain concepts
- Carry out textual reasoning and analysis

Types of LLM-Based Chatbots



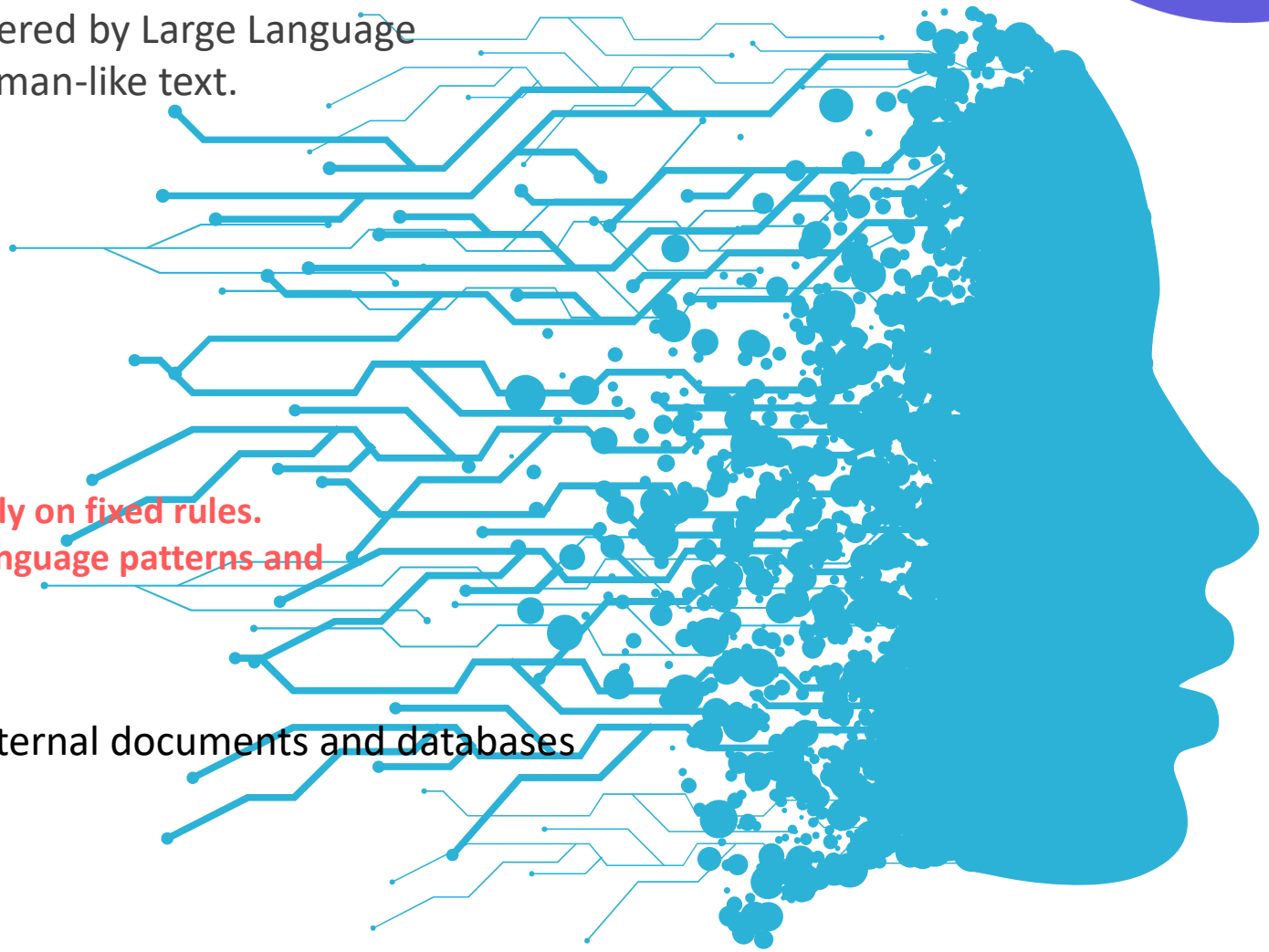
1. **LLM-Based Chatbot**
2. **Fine-Tuned LLM Chatbot**
3. **LLM + RAG** (Retrieval-Augmented Generation)
4. **LLM-Agent Chatbot**
5. **Hybrid LLM Chatbot**

LLM-Based Chatbots

LLM-based chatbots are conversational systems powered by Large Language Models (LLMs) that can understand and generate human-like text.

They use deep learning models trained on massive amounts of data to:

- Understand user intent
- Maintain conversation context
- Generate flexible and natural responses

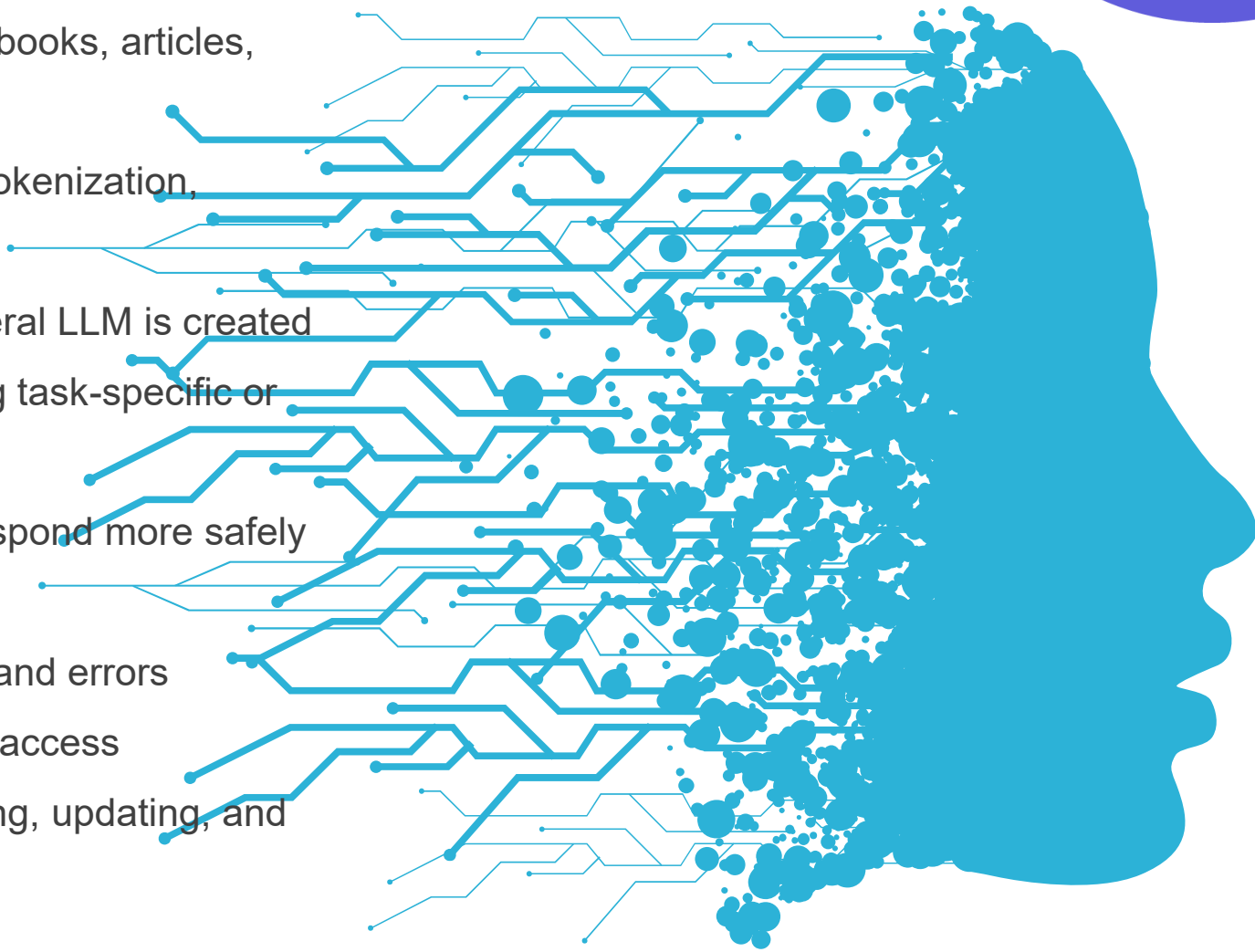


Unlike rule-based chatbots, LLM-based chatbots do not rely on fixed rules. Instead, they generate responses dynamically based on language patterns and context.

Fine-Tuning (for domain-specific knowledge)
RAG (Retrieval-Augmented Generation) to access external documents and databases

Stages of Creating an LLM

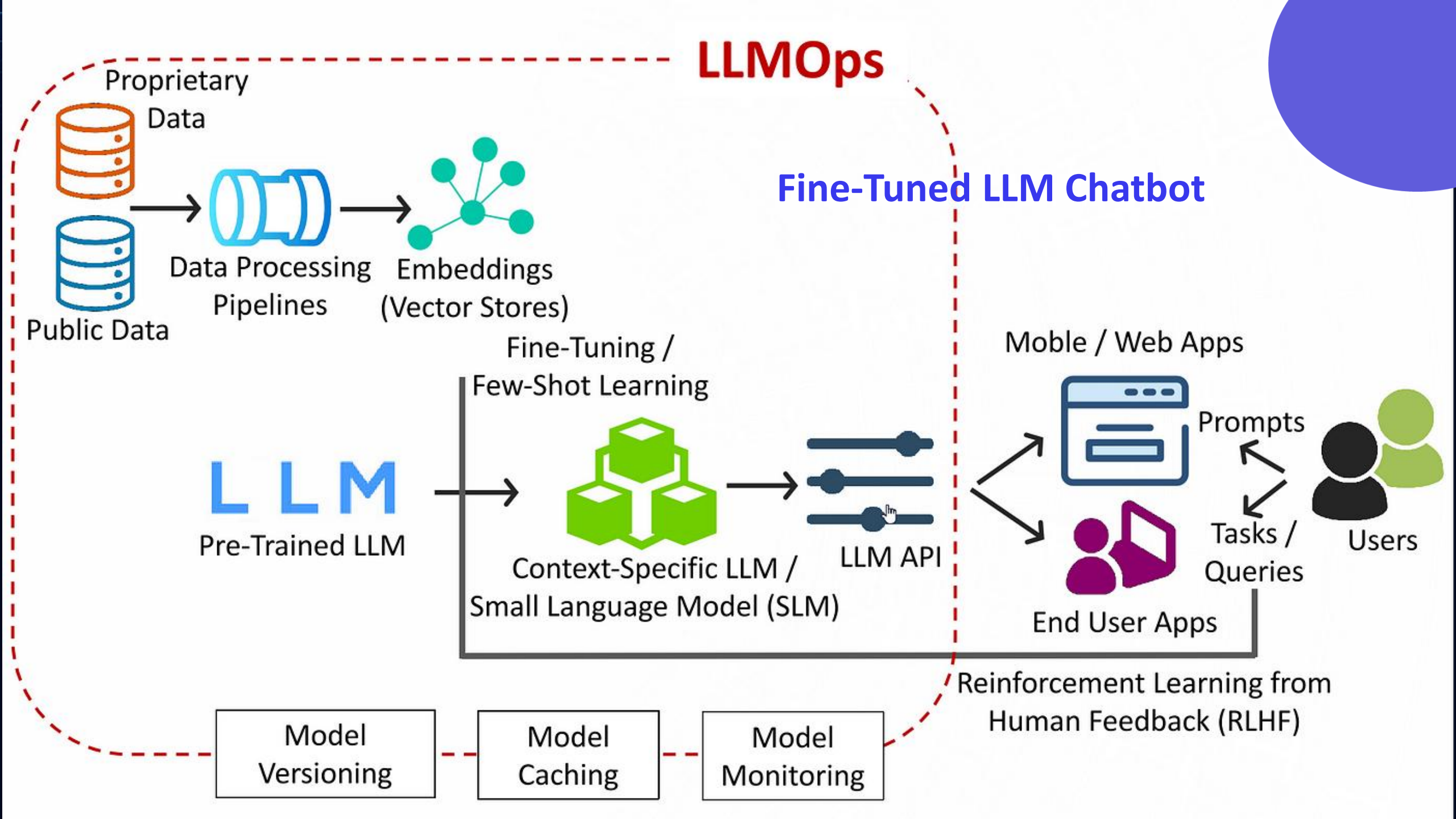
1. **Data Collection**: Large and diverse text data (web, books, articles, code)
2. **Data Preparation:** Cleaning, removing duplicates, tokenization, Embedding
3. **Pre-Training**: The model learns language → a general LLM is created
4. **Fine-Tuning:** The model becomes specialized using task-specific or domain data
5. **Human Alignment (RLHF):** The model learns to respond more safely and helpfully
6. **Evaluation:** Assessing accuracy, response quality, and errors
7. **Deployment:** Providing the model via APIs for user access
8. **Maintenance & Improvement (LLMOps):** Monitoring, updating, and continuous improvement

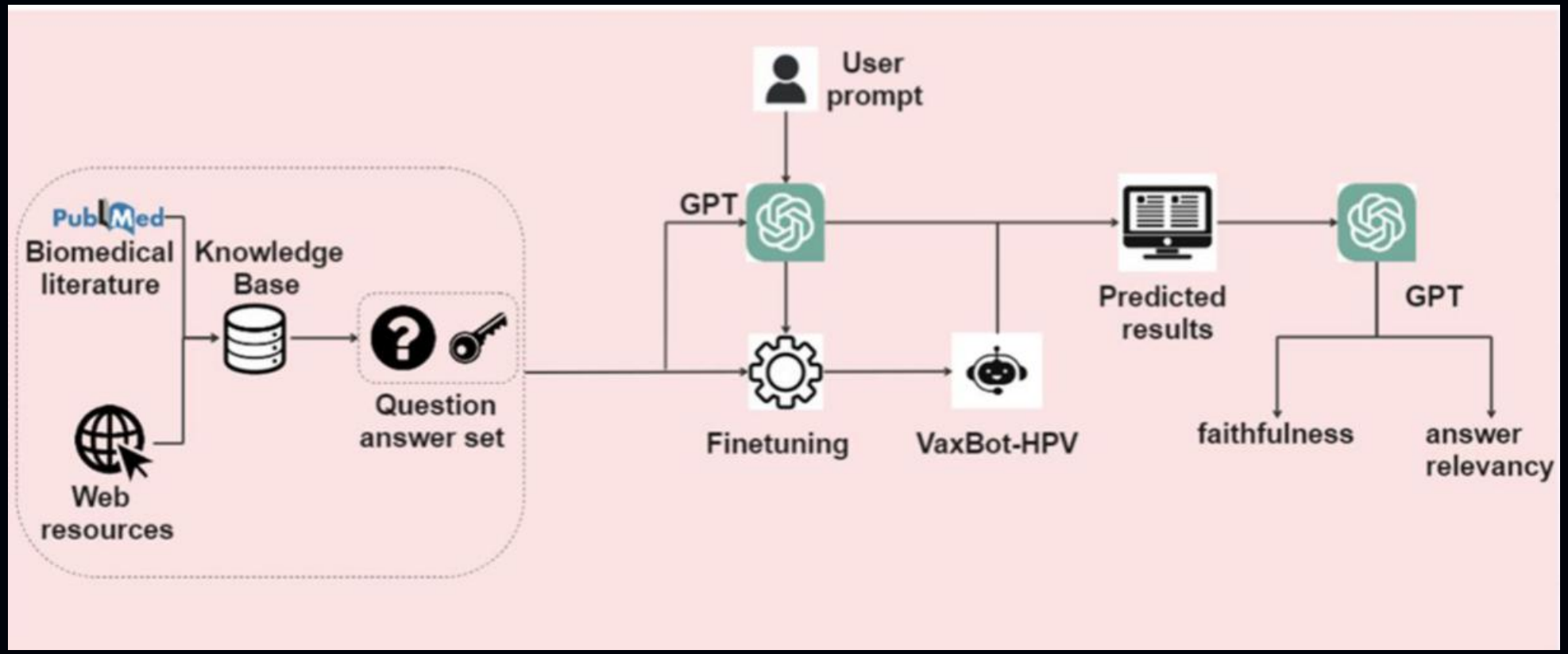


LLM Based Chatbot

Key Features

- General-purpose, conversation-oriented
- No domain-specific or organizational knowledge
- Fast and easy to deploy
- Higher risk of inaccuracies in specialized topics


LLMOps
Fine-Tuned LLM Chatbot
Proprietary Data
Public Data
Data Processing Pipelines
Embeddings (Vector Stores)
Fine-Tuning / Few-Shot Learning
L L M
Pre-Trained LLM
Context-Specific LLM / Small Language Model (SLM)
LLM API
Moble / Web Apps
Prompts
Tasks / Queries
Users
End User Apps
Reinforcement Learning from Human Feedback (RLHF)
Model Versioning
Model Caching
Model Monitoring



VaxBot-HPV: a GPT-based chatbot for answering HPV vaccine-related questions

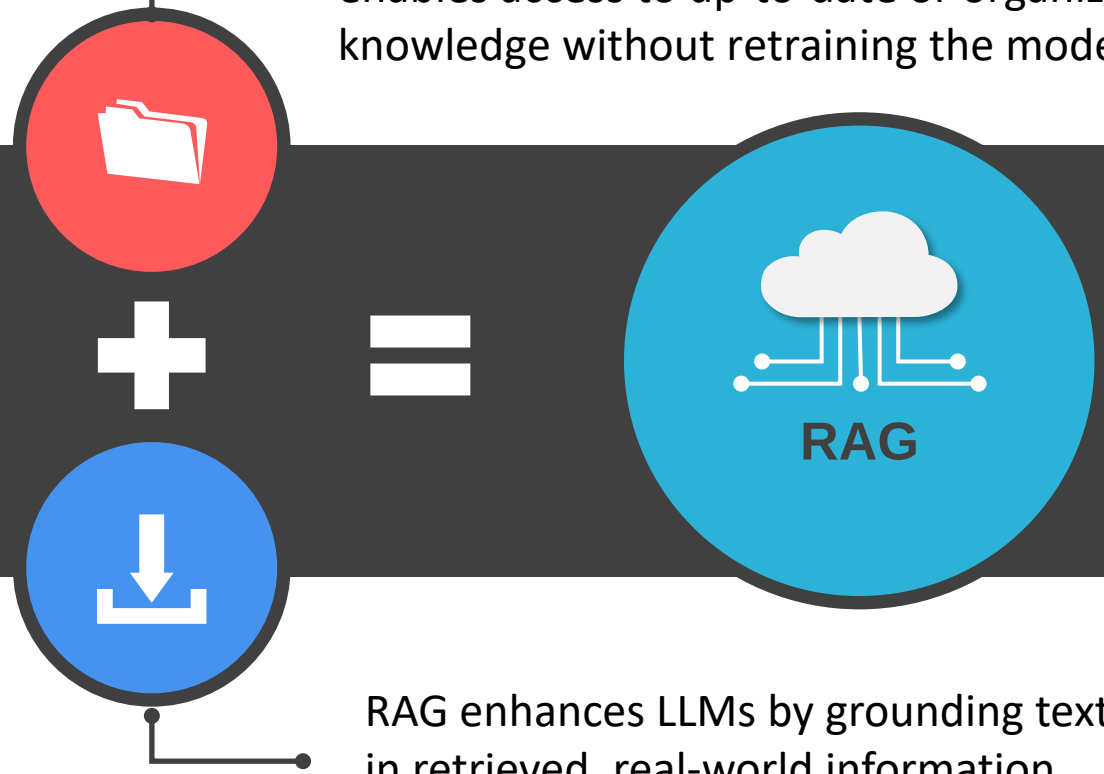
Fine-Tuned LLM Chatbot

Key Features

- Trained for a specific domain
- More accurate and consistent responses
- Aligned with organizational needs
- Requires high-quality training data

LLM + RAG (Retrieval-Augmented Generation)

This approach improves accuracy, domain relevance, and factual grounding, reduces hallucinations, and enables access to up-to-date or organization-specific knowledge without retraining the model.



LLM-RAG chatbots are conversational systems that combine Large Language Models (LLMs) with Retrieval-Augmented Generation (RAG). Instead of relying only on the model's internal knowledge, they retrieve relevant information from external data sources (such as documents, databases, or web content) and use this retrieved context to generate responses.

RAG enhances LLMs by grounding text generation in retrieved, real-world information.

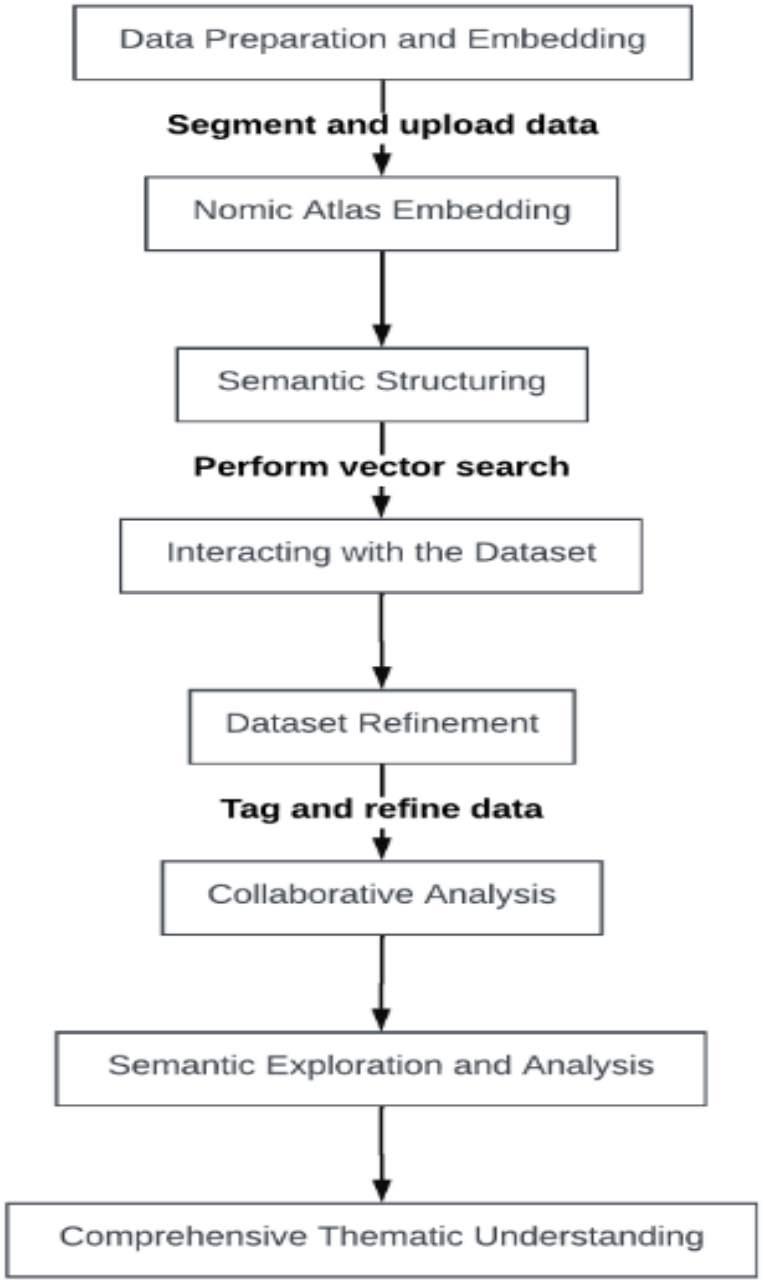


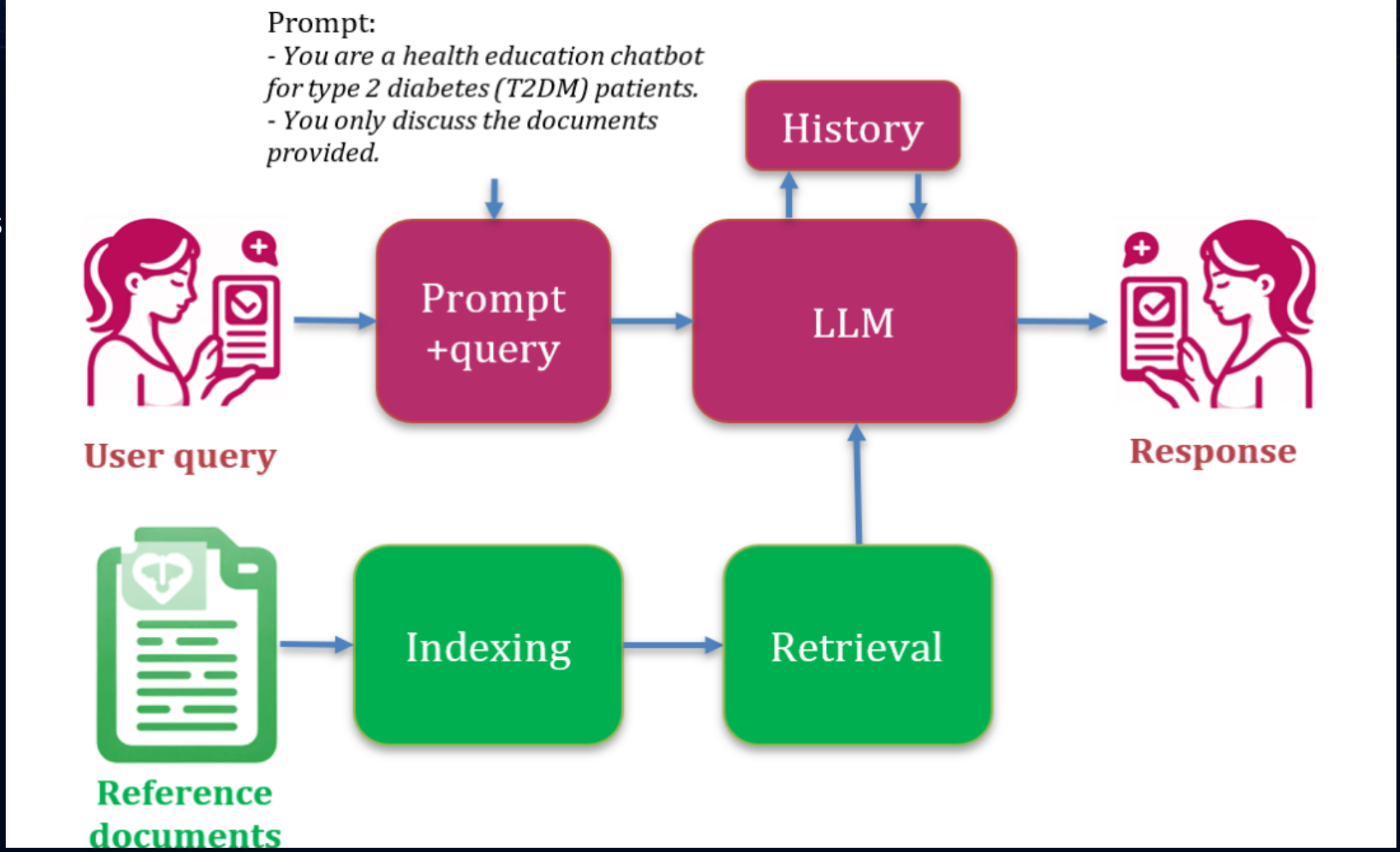
Figure 6: Illustration of the AI-driven framework for precision medicine in Multiple Myeloma.

A RAG Chatbot for Precision Medicine of Multiple Myeloma

- The Effectiveness of a Custom AI Chatbot for Type 2 Diabetes Mellitus Health Literacy: Development and Evaluation Study

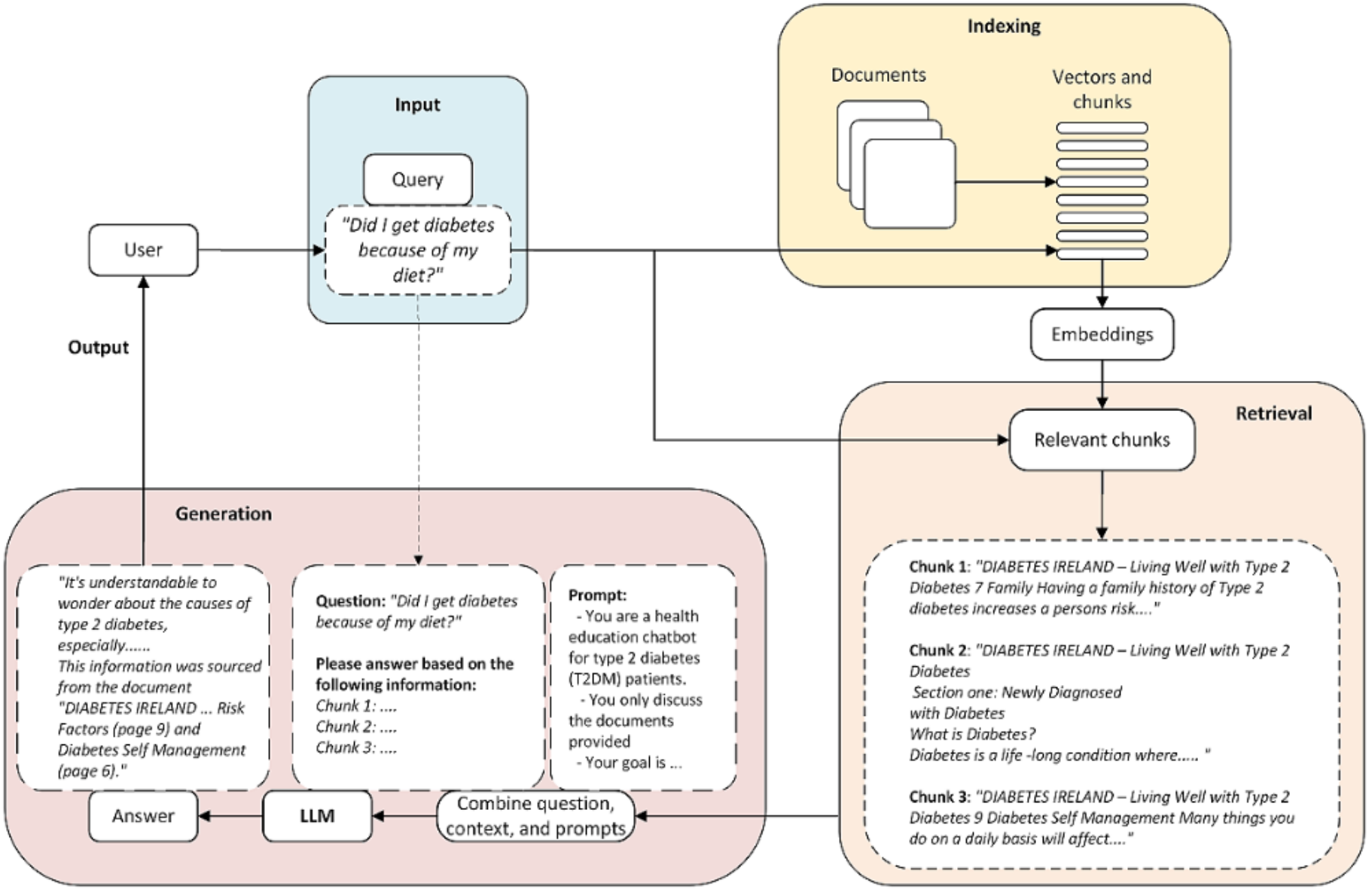
- A vaccine chatbot intervention for parents to improve HPV vaccination uptake among middle school girls: a cluster randomized trial

Figure 1. Retrieval-augmented generation large language model (LLM) architecture. The LLM responds to a combined prompt and query. The prompt is designed to control the LLM response, whereas the query is entered by the user. The LLM draws on relevant information retrieved from the reference documents to respond to the query. The history of queries and responses is provided to the LLM to retain the context of the conversation in the session.



The Effectiveness of a Custom AI Chatbot for Type 2 Diabetes Mellitus Health Literacy: Development and Evaluation Study

Figure 2. A detailed illustration of the retrieval-augmented generation operation. The figure illustrates the 3 steps: indexing, in which refere documents are split into chunks and stored in a vector store for later retrieval; retrieval, in which the top k relevant chunks are retrieved based on sema similarity to the query; and generation, in which the prompt and query are combined with the retrieved chunks and sent to the large language mo (LLM) to output a response (based on a diagram in the work by Gao et al [25]).



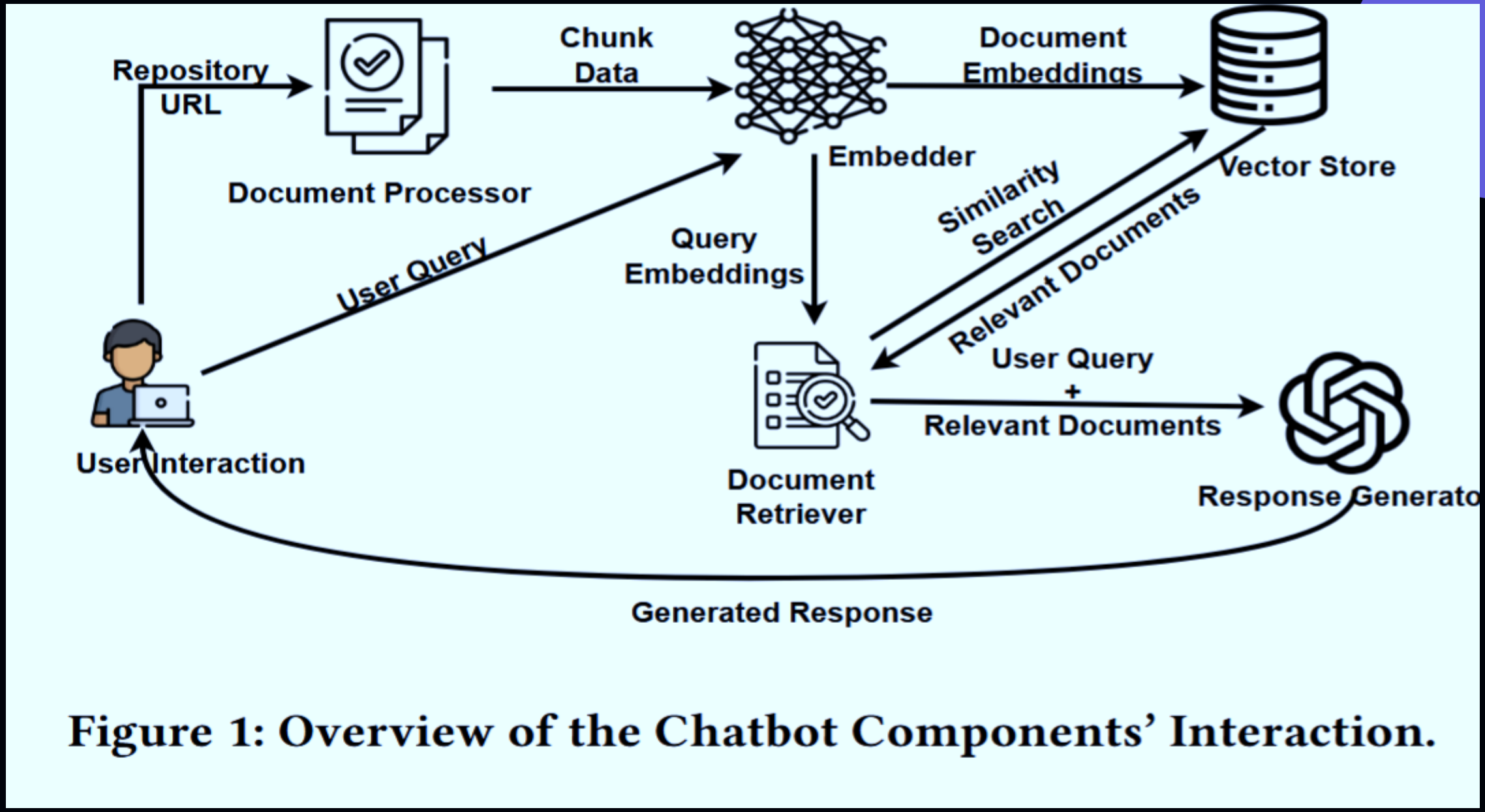


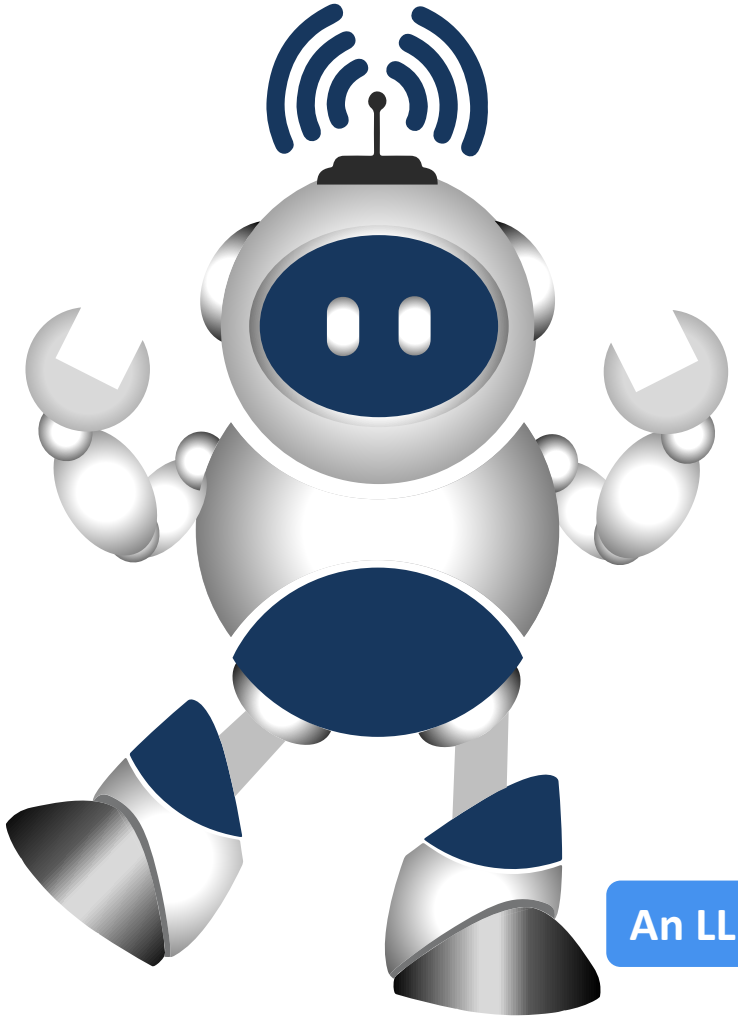
Figure 1: Overview of the Chatbot Components' Interaction.

LLM + RAG Chatbot

Key Features

- Connected to documents, databases, and trusted sources
- Reduces hallucinations
- Suitable for up-to-date information
- More reliable and traceable answers

LLM-Agent Chatbots



LLM-Agent chatbots are advanced AI systems that go beyond conversation.

They can reason, plan, and take actions to complete tasks.

Key characteristics:

- ✓ **Perform multi-step tasks autonomously**
- ✓ **Use tools, APIs, and external systems**
- ✓ **Make decisions based on goals and context**
- ✓ **Act as intelligent assistants, not just responders**

An LLM-Agent chatbot doesn’t only answer questions—it gets things done

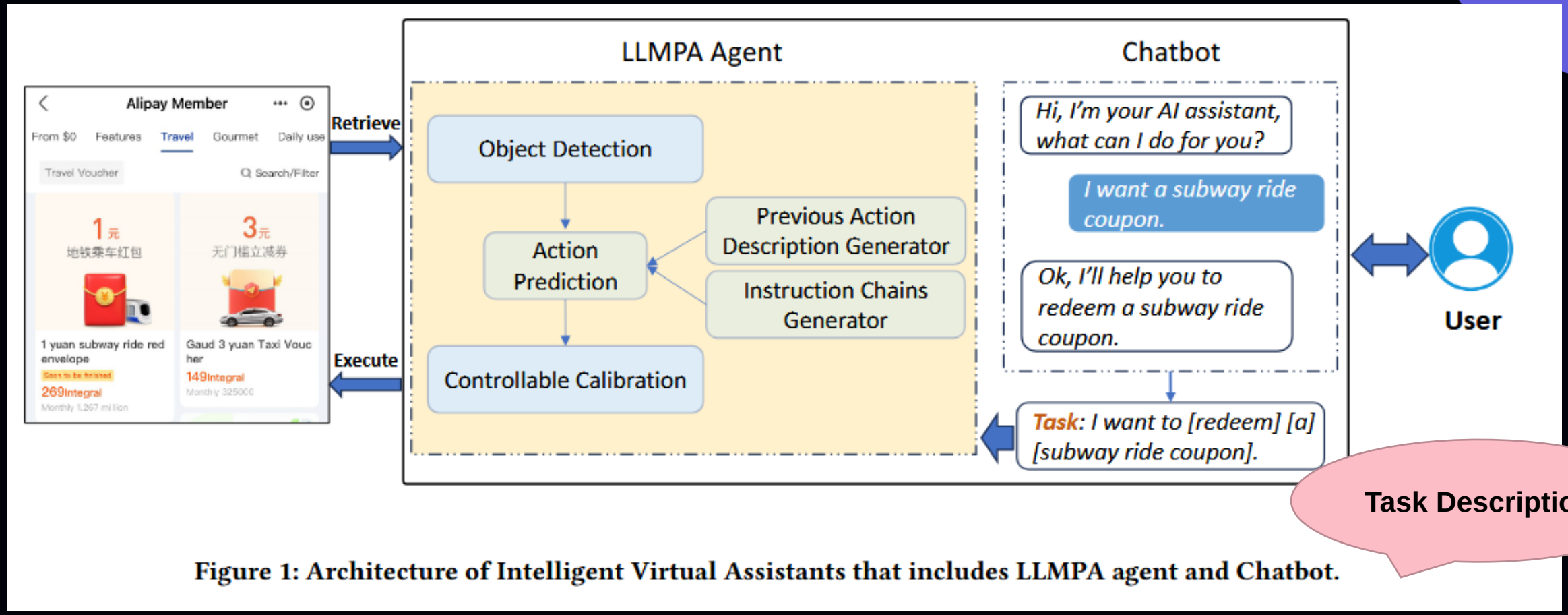


Figure 1: Architecture of Intelligent Virtual Assistants that includes LLMPA agent and Chatbot.

Intelligent Agents with LLM-based Process Automation

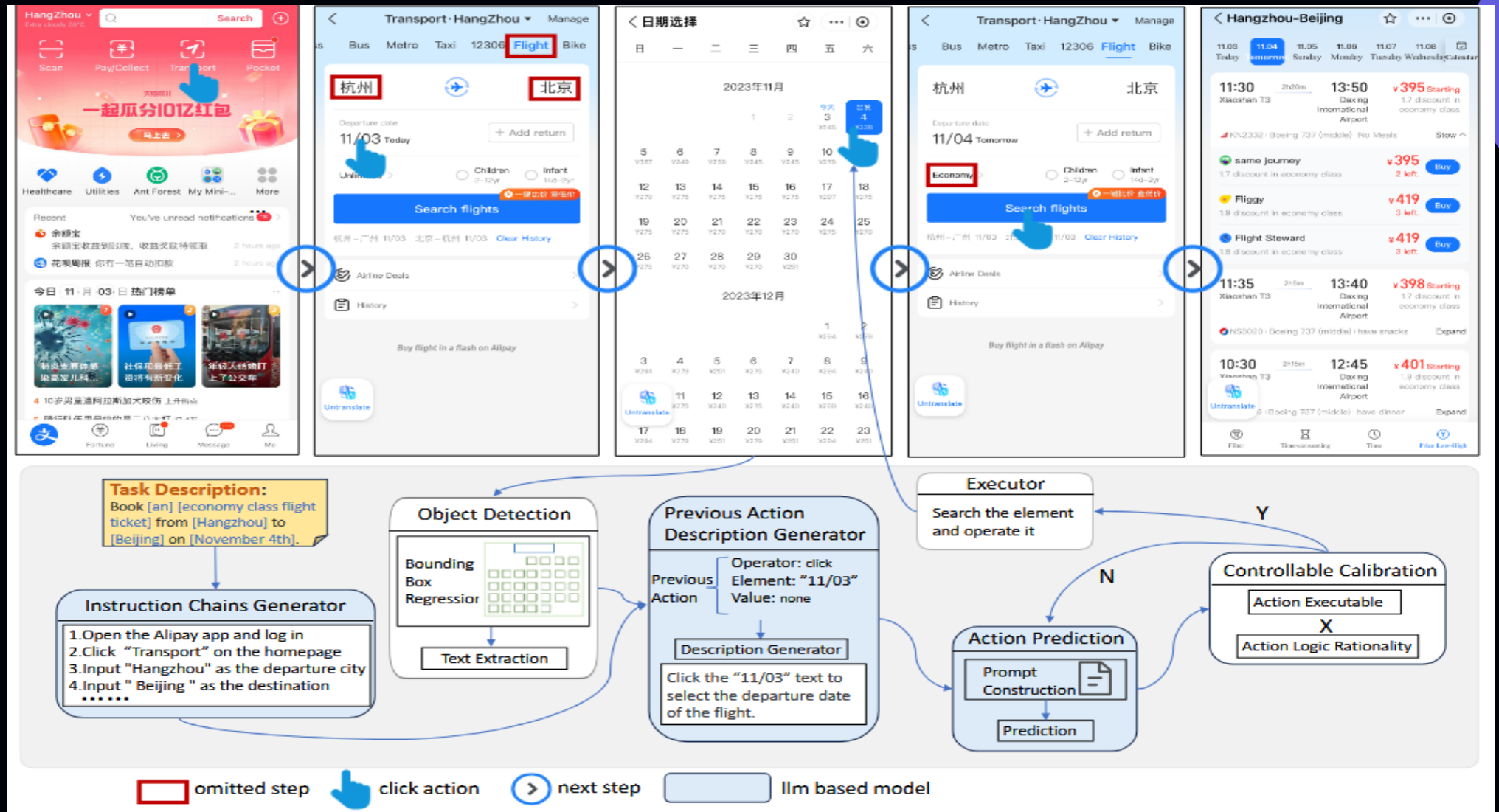


Figure 2: Pipeline of LLMPA agent.

Intelligent Agents with LLM-based Process Automation

LLM-Agent Chatbot

Key Features

- Capable of multi-step task execution
- Can make decisions and take actions, not just respond
- Integrates with tools and APIs
- Suitable for automation and intelligent assistants

Hybrid LLM Chatbot

A Hybrid LLM Chatbot combines a Large Language Model (LLM) with rule-based systems, external knowledge sources, and tools to deliver responses that are both natural and reliable.

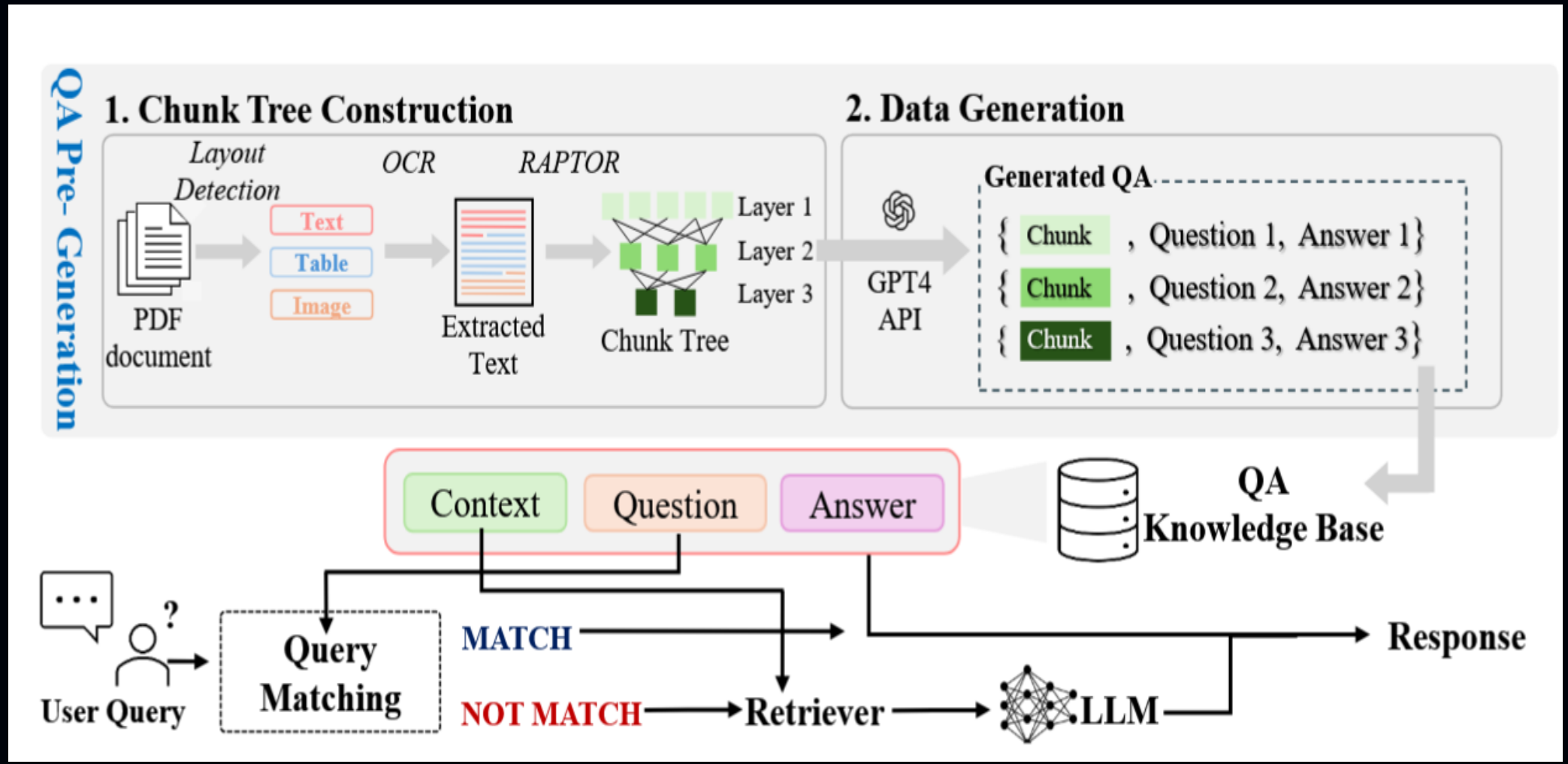
Instead of relying only on an LLM, it integrates:

- LLM for understanding and generating human-like language
- Rules for control, safety, and compliance
- RAG (Retrieval-Augmented Generation) for accurate, up-to-date information
- APIs/Tools for performing real actions (e.g., queries, transactions)

Why use it?

- Reduces hallucinations
- Improves accuracy and trustworthiness
- Suitable for enterprise, medical, financial, and mission-critical systems

Hybrid LLM Chatbot (RAG-based QA System)



HybridRAG: A Practical LLM-based ChatBot Framework based on Pre-Generated Q&A over Raw Unstructured Documents

Hybrid LLM Chatbot

Key Features

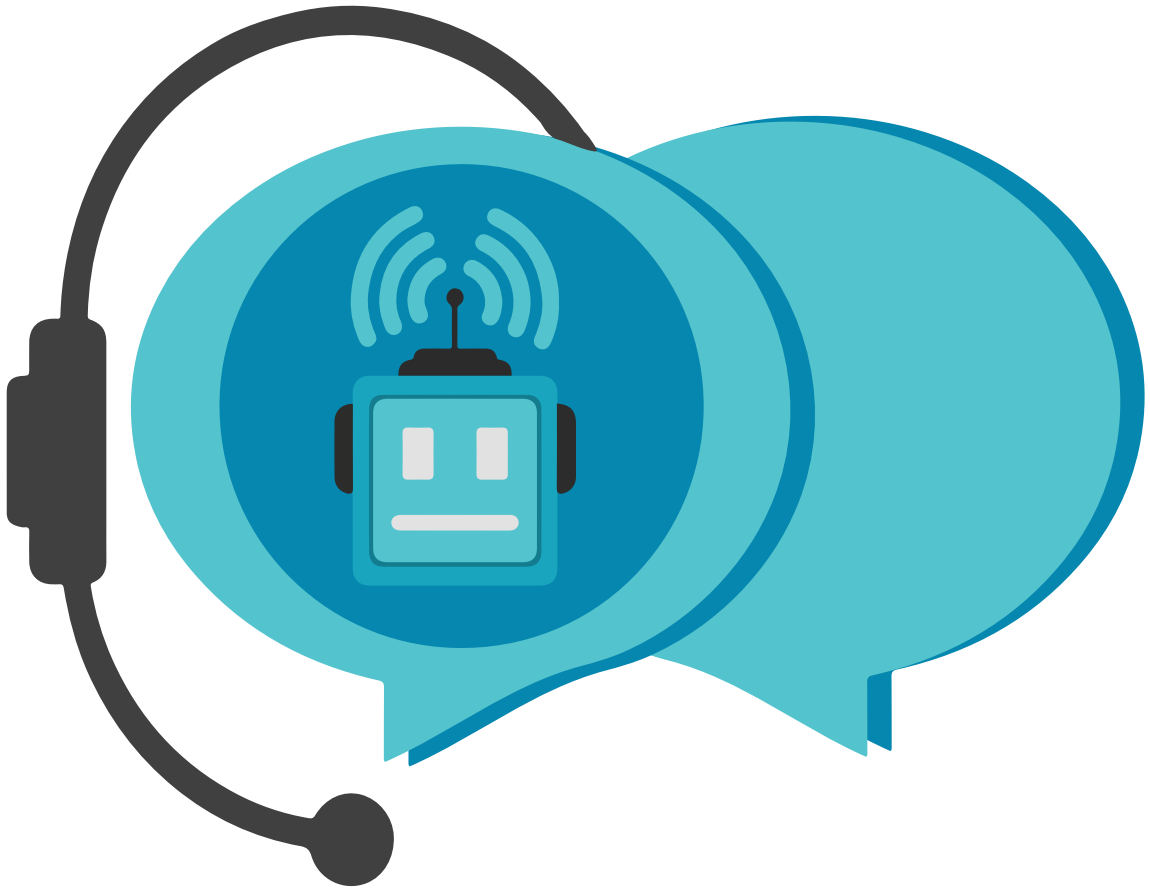
- Combines fine-tuning, RAG, and agent capabilities
- Highest accuracy and flexibility
- Ideal for advanced enterprise systems
- More complex and costly to build and maintain

Review

Key Features

- Simple: LLM-Based
- Domain-specific: Fine-Tuned
- Accurate & up-to-date: RAG
- Action-oriented: Agent
- Most advanced: Hybrid

Pros and Cons



Disadvantages

High Computational Cost

Significant resource consumption

Risk of Generating Incorrect Responses (Hallucination)

Less Output Control Compared to Rule-Based Systems

Challenges Related to Security, Privacy, and Bias

Need for Additional Control Mechanisms

Advantages

Highly NLU

Close to human-like conversation

Broad Topical Coverage

Extensive general knowledge

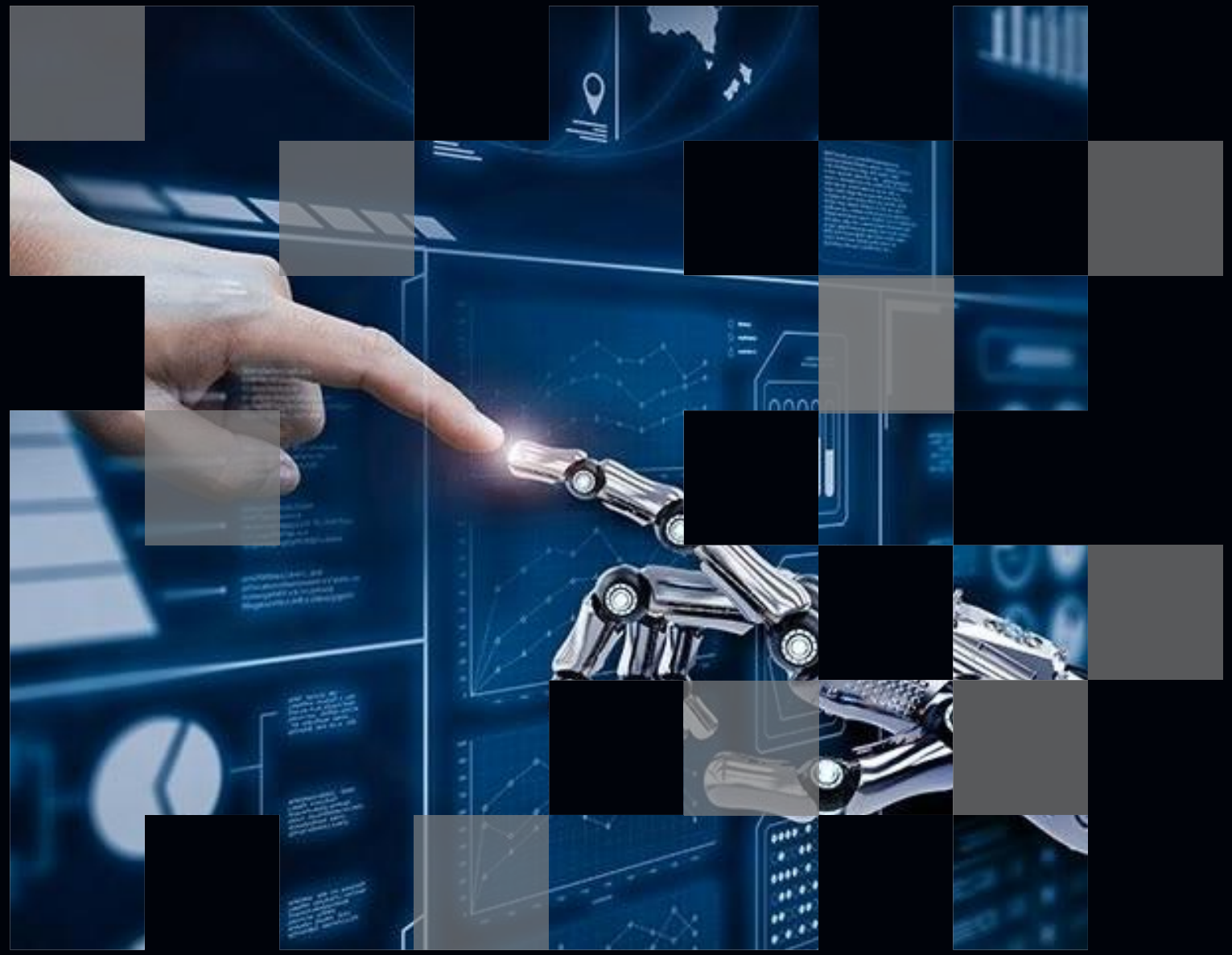
Dynamic and Creative Response Generation

Excellent Support for Complex and Long-Form Conversations

Upgradable through Techniques

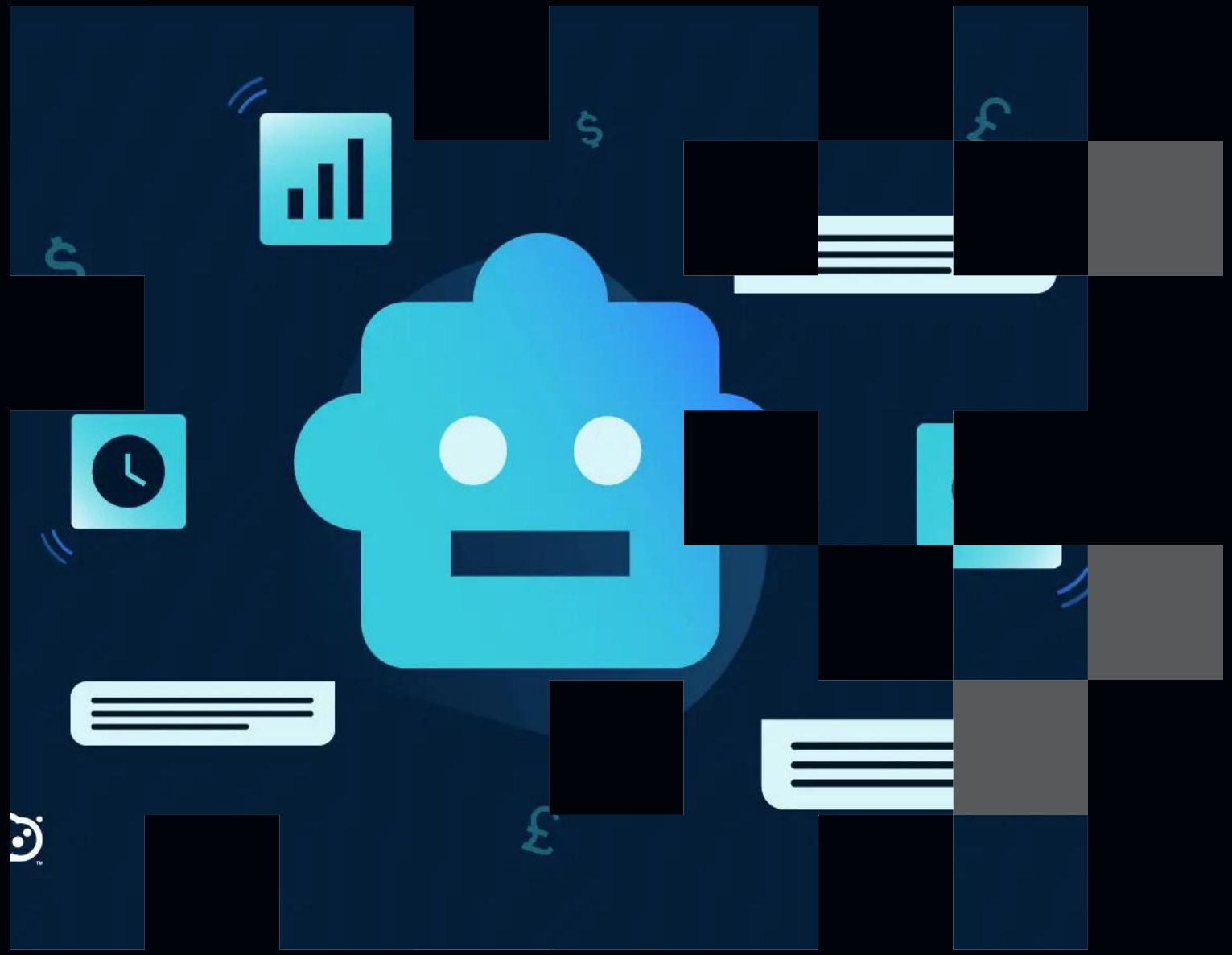
Pros & cons, challenges

Advantage and Disadvantage



Advantages of Chatbots

- **24/7 Availability:** Providing uninterrupted services at all hours of the day and night
- **High Response Speed:** Instant responses to a large number of users simultaneously
- **Cost Reduction:** Decreasing the need for human labor in repetitive tasks
- **Increased Productivity:** Freeing up human resources to focus on more complex tasks
- **Consistency in Responses:** Delivering standardized answers with minimal human error
- **Scalability:** The ability to serve a large number of users without a decline in quality

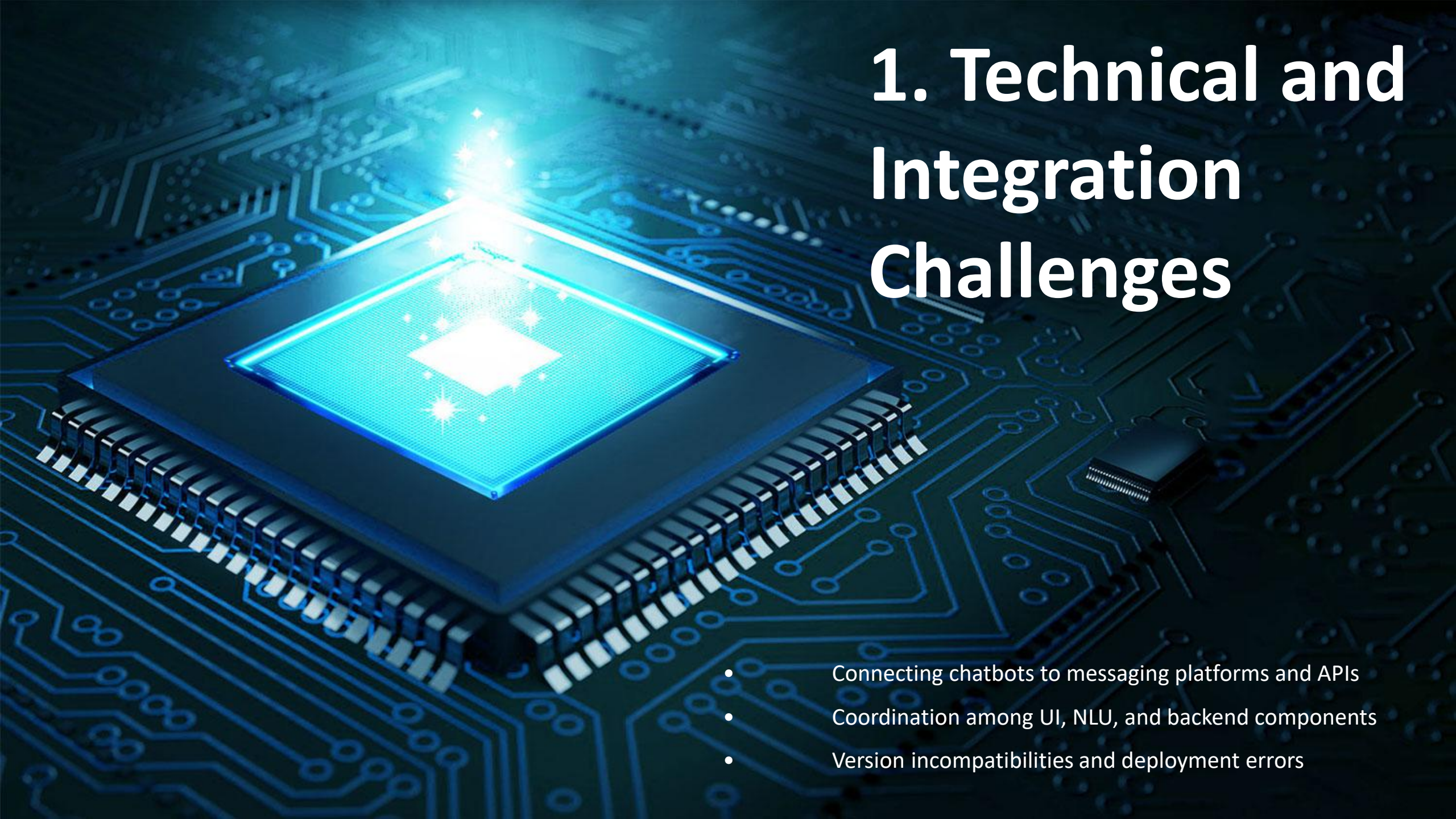


Limitations and Disadvantages of Chatbots

- **Limited Natural Language Understanding:** Difficulty in interpreting complex sentences, sarcasm, or ambiguity
- **Data Dependency:** Response quality depends heavily on the volume and quality of training data
- **Lack of Emotional Understanding:** Inability to accurately recognize users' emotions and emotional contexts
- **Response Errors:** The possibility of providing incorrect or misleading answers
- **Security and Privacy Concerns:** Risks related to data leakage or misuse of users' information
- **Need for Continuous Monitoring and Updates:** **Required to maintain accuracy and overall performance**

Chatbots Challenges

Challenges in Chatbot Development: A Study of Stack Overflow Posts



1. Technical and Integration Challenges

- Connecting chatbots to messaging platforms and APIs
- Coordination among UI, NLU, and backend components
- Version incompatibilities and deployment errors

2. Development and Implementation Challenges

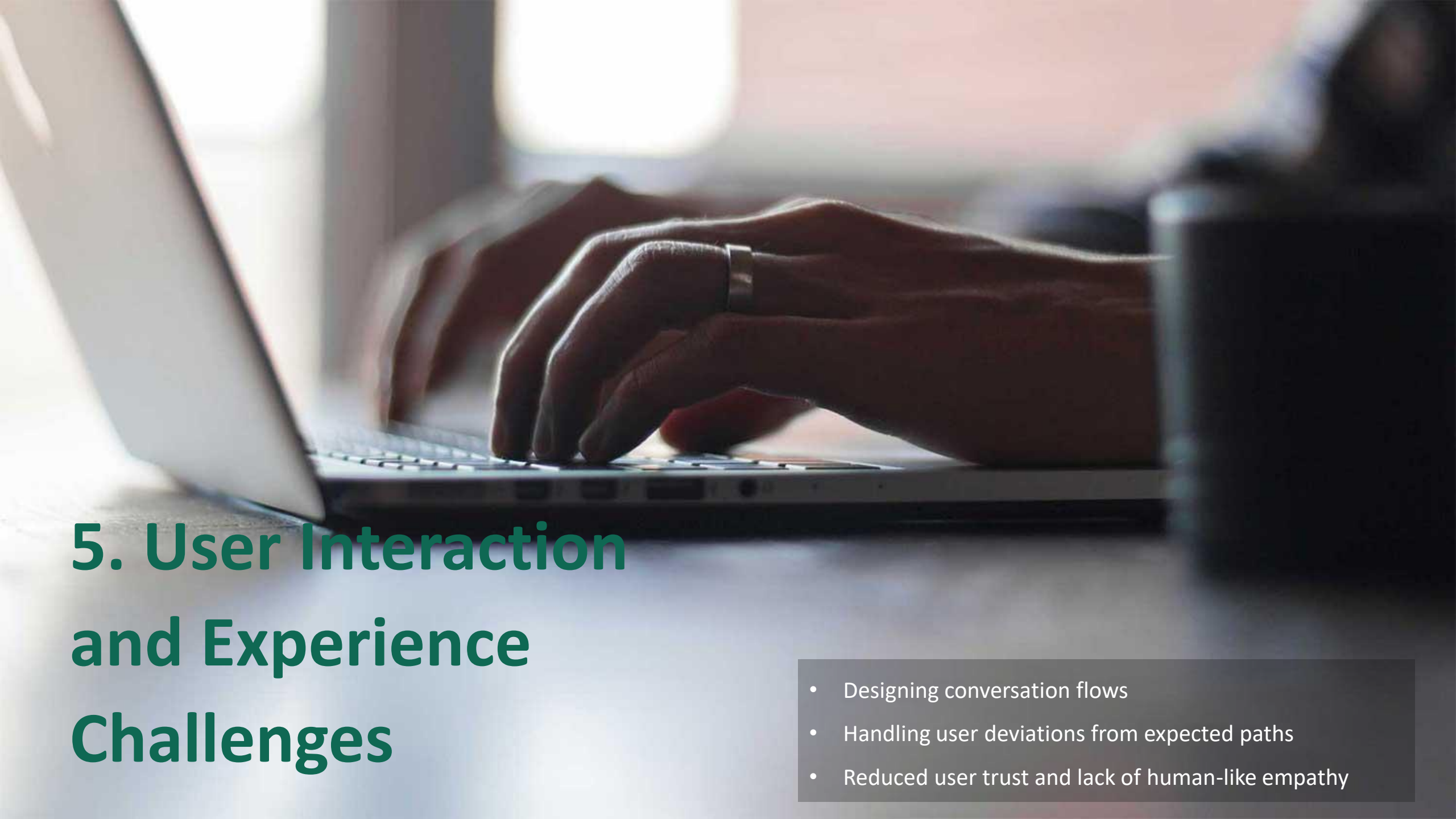
- Complexity of chatbot frameworks
- Insufficient documentation and unclear tool capabilities
- Dependency on specific technologies

3. Natural Language Understanding (NLU) Challenges

- Defining and managing intents and entities
- Training and improving models
- Opaque and unpredictable model behavior

- Low-quality or outdated data
- Domain knowledge limitations
- Need for continuous knowledge updates

4. Data and Knowledge Challenges



5. User Interaction and Experience Challenges

- Designing conversation flows
- Handling user deviations from expected paths
- Reduced user trust and lack of human-like empathy

6. User Input and Context Management Challenges

- Validating user input
- Storing and maintaining conversational context

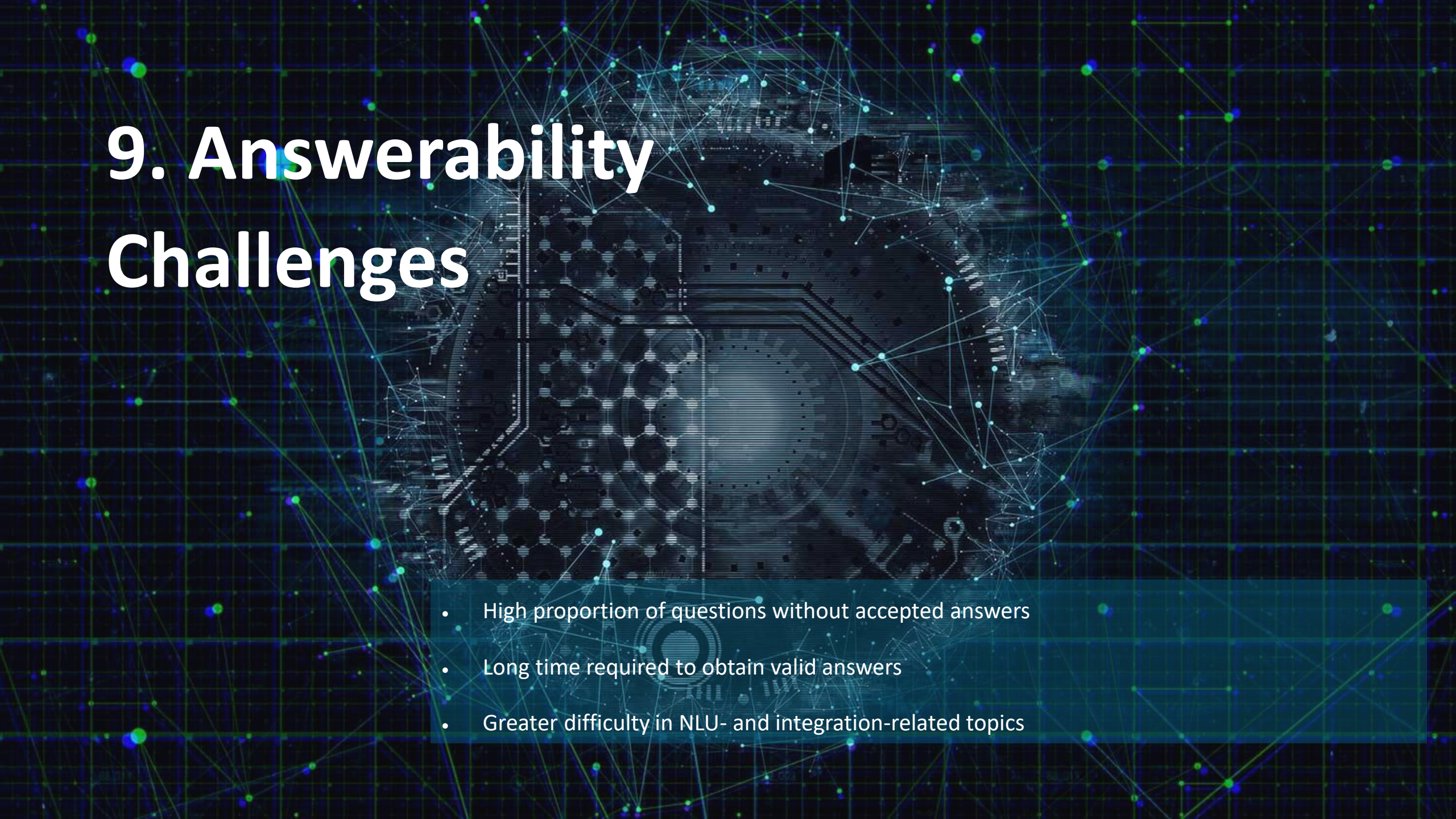
7. Ethical and Legal Challenges

- Data privacy and security concerns
- Accountability for chatbot responses
- Lack of transparency in response generation

8. Organizational and Operational Challenges

- Development and maintenance costs
- Organizational adoption
- Difficulty in performance evaluation

9. Answerability Challenges



- High proportion of questions without accepted answers
- Long time required to obtain valid answers
- Greater difficulty in NLU- and integration-related topics

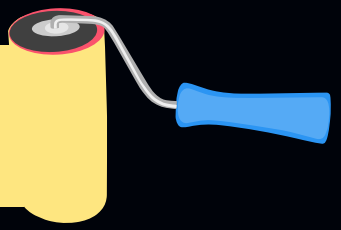
The Future of Chatbots

Future and Conclusion

The future of chatbots

- **From chatbots to agents:** They will not only answer questions but also plan, execute tasks, and use tools autonomously.
- **Knowledge-grounded systems (RAG):** Chatbots will increasingly rely on retrieved, verifiable sources to improve accuracy and reduce hallucinations.
- **Multimodality:** They will understand and generate text, images, audio, video, and documents together.
- **Specialization:** More domain-specific chatbots (education, healthcare, law) with stricter evaluation and reliability.
- **Safety and controllability:** Stronger safeguards against misuse, jailbreaks, and unsafe autonomous behavior.
- **Stronger core abilities:** Continued improvements in reasoning, coding, instruction following, and contextual understanding.

Conclusion



This presentation reviewed the concept, types, and architecture of chatbots, with a focus on intelligent chatbots such as rule-based, machine learning–based, NLP-based, and LLM-based systems. The advantages, challenges, and limitations of chatbots were also discussed.

Overall, chatbots are rapidly evolving toward more natural, accurate, and personalized interactions and are expected to play an increasingly important role in future digital services across various domains.

- ***References:***

- *From ELIZA to ChatGPT: A brief history of chatbots and their evolution*
- *A Brief History of Chatbots*
- *Adamopoulou E, Moussiades L, editors. An overview of chatbot technology. IFIP international conference on artificial intelligence applications and innovations; 2020: Springer*
- *INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE «INTELLECTUAL SYSTEMS AND INFORMATION TECHNOLOGIES»: Classification of chatbots*
- *An overview of chatbot technology.*
- *Development and Evaluation of the Child Vaccination Chatbot Based on a Real-time Consultation Messenger Service- Hong*
- *https://code-b.dev/blog/detailed-guide-on-how-to-develop-a-chatbot*
- *Ontology-based Integration of Knowledge Base for Building an Intelligent Searching Chatbot*
- *A RAG Chatbot for Precision Medicine of Multiple Myeloma*
- *The Effectiveness of a Custom AI Chatbot for Type 2 Diabetes*
- *Mellitus Health Literacy: Development and Evaluation Study*
- *LLM-Based Chatbots for Mining Software Repositories: Challenges and Opportunities*
- *Challenges in Chatbot Development: A Study of Stack Overflow Posts*
- *HybridRAG: A Practical LLM-based ChatBot Framework based on Pre-Generated Q&A over Raw Unstructured Documents*
- *VaxBot-HPV: a GPT-based chatbot for answering HPV vaccine-related questions*
- *Generative AI Chatbots Across Domains: A Systematic Review.* Applied Sciences (MDPI). 2025-10-20. https://www.mdpi.com/2076-3417/15/20/11220
- Kumar P. *Large language models (LLMs): survey, technical frameworks, and future challenges.* Artificial Intelligence Review (Springer). 2024. https://link.springer.com/article/10.1007/s10462-024-10888-y
- OpenAI. *GPT-5. Technical Report.* arXiv:2303.08774 (v6 revised 2024). https://arxiv.org/abs/2303.08774
- Future directions for chatbot research: an interdisciplinary research agenda
- Intelligent Agents with LLM-based Process Automation
- A vaccine chatbot intervention for parents to improve HPV vaccination uptake among middle school girls: a cluster randomized trial

Thank You For Your Attention