CHATBOT AS A SERVICE USING LARGE LANGUAGE MODELS(LLM)

A PROJECT REPORT

Submitted by

NESHMA K (961621104040)
ABINA M S (961621104003)
ABI V (961621104008)

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING

MARTHANDAM COLLEGE OF ENGINEERING AND TECHNOLOGY
KUTTAKUZHI, KANNIYAKUMARI DISTRICT-629 177

ANNA UNIVERSITY: CHENNAI 600 025

MAY 2025

ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report **"CHATBOT AS A SERVICE USING LARGE LANGUAGE MODELS (LLM)"** is the bonafide work of **"NESHMA K (961621104040), ABINA M S (961621104003), ABI V (961621104008)"** who carried out the project work under my supervision.

SIGNATURE

Mrs. S.S. SREEJA, M.E, (Ph.D)

HEAD OF THE DEPARTMENT

Computer Science &Engineering

Marthandam College of

Engineering and Technology

Kuttakuzhi-629177

SIGNATURE

Mrs. SINDHU.S, M.E

SUPERVISOR

Computer Science &Engineering

Marthandam College of

Engineering and Technology

Kuttakuzhi-629177

Submitted for project viva-voice held on……

INTERNAL EXAMINER

EXTERNAL EXAMINER

ABSTRACT

Chatbots have become essential tools for businesses, enabling automated and intelligent interactions with users. This project introduces a Chatbot-as- a-Service (CaaS) platform that allows users to create custom chatbot instances via an admin page. Each instance is uniquely configured with a custom name, data, and Al model. The service provides an endpoint for interacting with the chatbot using POST requests, maintaining conversation history for context-aware responses. This flexible and scalable solution simplifies chatbot deployment without requiring extensive technical expertise. As businesses increasingly integrate artificial intelligence into their operations, chatbots have emerged as a crucial tool for enhancing customer engagement, automating workflows, and improving service delivery. By leveraging LLMs, such as GPT-based models, chatbots are capable of processing and understanding natural language with high accuracy, that mimic human-like conversations report delves into the architecture of LLM-based chatbot systems, including their ability to process vast amounts of data, learn from interactions, and continuously improve performance over time. Key aspects such as the underlying machine learning techniques, deployment models, integration with existing business infrastructure, and scalability are explored. It also highlights potential challenges, such as ethical considerations, data privacy concerns, and the limitations of current technology in handling complex or highly specific queries. The future of CaaS is also examined, with a focus on emerging trends.

ACKNOWLEDGEMENT

It gives us pleasure to acknowledgement our Indebtedness to all those who have helped us in completing this project. First and foremost we would like to thank **GOD** almighty for the blessings he has showered upon us to complete this project successfully.

We wish to convey our immense gratitude and thanks to our respected Chairman **Er. F.Prince Vino, B.E.,** for providing us all facilities for the successful completion of the project.

We are grateful to **Dr. C.Sudhahar, M.E., Ph.D,** Principal for our institution for arranging the facilities for successful completion of our project. We are deeply indebted to **Mrs. S.S.Sreeja, M.E, Ph.D** Head of Computer Science and Engineering Department who gave us splendid help, valuable suggestions and support in bringing out this dissertation work successfully.

We would like to express our sincere thanks to **Mrs.Sindhu.S,M.E,** Asst.Professor Computer Science and Engineering Department for her valuable guidance, encouragement and immense help in making the project success. We extend our sincere thanks to all our computer science department staff members.

NESHMA K (961621104040)
ABINA M S (961621104003)
ABI V (961621104008)

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	3
	ACKNOWLEDGMENT	4
	TABLE OF CONTENT	5
	LIST OF FIGURES	7
	LIST OF ABBREVIATION	8
1.	**INTRODUCTION**	9
2.	**LITERATURE REVIEW**	10
3.	**SYSTEM ANALYSIS**	10
	3.1. EXISTING SYSTEM	10
	3.2. PROPOSED SYSTEM	11
	3.3. SYSTEM REQUIREMENTS	12
	3.4. LANGUAGE DISCRIPTION	15
4.	**SYSTEM DESIGN**	16
	4.1. ARCHITECTURAL DIAGRAM	17
	4.2. DATA FLOW DIAGRAM	18
	4.3. USE CASE DIAGRAM	19
	4.4. ACTIVITY DIAGRAM	

4.5. DATABASE DESIGN DIAGRAM 20

4.6. CLASS DIAGRAM 21

5. IMPLEMENTATION 22

6. CONCLUSION 25

7. APPENDIX 26

A1.SCREENSHOTS 26

A2.SOURCE CODE 35

8. REFERENCE

LIST OF FIGURES

FIGURE NAME	FIGURE	PAGE NO.
1	Architectural Design Diagram	**1**
2	Dataflow Diagram	1
3	Use case Diagram	1
4	Activity Diagram	1
5	Database Design Diagram	1
6	Class Diagram	1
7	Execution Page	1
8	Home Page	1
9	Admin Page	1
10	Instance Page	1
11	Model Selection	1
12	Upload Data	1
13	Copy URL	1
14	Set Instance URL	1
15	User Page	1

LIST OF ABBREVIATIONS

ACRONYMS	MEANINGS
CaaS	Chatbot As A Service
LLM	Large Language Models
SPA	Single Page Application
API	Application performance Indicator
HTTP	Hyper Text Transfer Protocol
CRUD	Create Read Update Delete
RAG	Retrieval Augmented Generator

CHAPTER 1

INTRODUCTION

In the modern digital era, businesses and organizations are increasingly relying on automation and artificial intelligence (AI) to enhance their operational efficiency and improve customer engagement. One of the most significant advancements in Al technology is the development of chatbots, which have become a key component in customer service, sales, and various other business functions.

The introduction of Large Language Models (LLMs), such as OpenAI's GPT, has revolutionized the chatbot landscape by enabling more sophisticated, context-aware, and human-like interactions. "Chatbot as a Service" (CaaS) refers to the provision of AI- driven conversational agents on a cloud-based platform, offering businesses the ability to integrate chatbot capabilities into their operations without the need for in-house AI development.

Powered by these chatbots are capable of processing complex language patterns, understanding context, and generating responses that are highly relevant to user queries. By leveraging the vast computational power and extensive training data behind LLMs, businesses can deploy chatbots that continuously improve their performance, deliver personalized experiences, and scale to handle a wide variety of customer needs.

This report delves into the concept o1 Chatbot as a Service using Large Language Models, highlighting its key benefits, challenges, and practical applications across industries.

CHAPTER 2

LITERATURE REVIEW

Deng et al. (2023) developed Jailbreaker, a framework for analyzing and generating jailbreak attacks on large language model (LLM) chatbots. They used a time-based SQL injection-inspired method to reverse-engineer defenses in ChatGPT, Bard, and Bing Chat. Their approach included automatic jailbreak prompt generation using a fine-tuned LLM. The system achieved a 21.58% success rate in bypassing safeguards, outperforming existing techniques. However, defending LLMs against evolving jailbreak strategies remains a significant challenge.

Mengze Hong et al. (2024) proposed a context-aware similar question generation (SQG) method to improve customer service chatbots using LLMs. They introduced a one-to-many objective that uses contextual information for generating diverse yet semantically consistent questions. An optimization framework was developed to select an optimal subset of questions under resource constraints. Their method achieved over 120% improvement in meeting business-specific requirements via human evaluation. Despite improvements, computational efficiency and scalability are key concerns for industrial applications.

Alexei et al. (2024) developed a study to assess the quality of first aid advice provided by a large language model-powered chatbot (Bing Chat) in response to queries about heart attack emergencies. The researchers simulated user prompts (“heart attack what to do”) from three countries: The Gambia, India, and the USA, evaluating 20 responses per country. A checklist based on the International First Aid, Resuscitation, and Education Guidelines 2020 was used to assess response congruence. The findings showed that while the chatbot consistently provided some form of guidance, critical omissions were common, such as failure to advise stopping physical activity, taking antianginal medication, or initiating CPR for an unresponsive person. The mean percentage of fully congruent responses ranged from 7.3% (India) to 16.8% (USA). Additionally, 25% of responses from The Gambia and USA, and 45% from India included superfluous or guideline-inconsistent directives. The study highlighted significant inaccuracies and misleading instructions in the chatbot’s advice. Consequently, the chatbot was deemed unreliable for first aid guidance in heart attack scenarios. The authors emphasized the need for further research and regulatory measures to ensure the trustworthiness of AI-mediated health counseling.

Bhattacharyya et.al (2024) conducted a qualitative study to explore the adoption of AI technology-driven natural large language model (LLM)-based chatbots by firms for customer service interaction. The study employed in-depth interviews with 32 experts in digital content AI + LLM chatbot services. Thematic content analysis was used to interpret the data. The findings identified 15 key factors influencing customer adoption of AI-driven LLM-based chatbots, structured within the push-pull-mooring (PPM) theoretical framework. The study highlighted that AI-powered chatbots are transforming human-firm interactions by reshaping consumer behavior and expectations. The research provided empirical contributions to the literature on PPM theory in the context of AI chatbot adoption. A practical implication was the need for managers to reconfigure organizational processes to align with evolving customer interactions mediated by AI chatbots. The study emphasized the managerial necessity of adapting to technology-induced changes in service delivery. A limitation noted was the qualitative scope, suggesting future quantitative research for generalizability. Overall, the study offered a novel application of PPM theory in understanding AI chatbot adoption.

Benjamin et al. conducted a study to improve the performance of customer service chatbots by comparing various fine-tuning strategies and evaluation metrics. The research introduced a novel approach, highlighting the effectiveness of Domain-Adaptive Pretraining (DAPT) in enhancing chatbot accuracy, robustness, and contextual relevance. Experiments were conducted across three large language models to evaluate response quality. The research also underscored the growing complexity of ensuring accurate and coherent chatbot responses as customer query complexity increases. This work provides practical guidance for deploying scalable and effective AI-driven customer service chatbots.

CHAPTER 3

SYSTEM ANALYSIS

2.1 EXISTING SYSTEM

The deployment of chatbots powered by Large Language Models (LLMs) has emerged as a transformative technology for businesses, offering scalable and highly efficient customer service, sales automation, and user engagement solutions. However, before the adoption of LLM-based chatbot systems, several other types of chatbot technologies were in use, each with its limitations and distinct characteristics. To understand the evolution and advantages of LLM-based systems, it is essential to analyze the existing systems, including traditional rule-based chatbots, machine learning-based chatbots, and early Al-driven models.

1.1.1 PROBLEMS IN EXISTING SYSTEM

1. Data Privacy and Security Concerns
2. Limited Contextual Understanding and Continuity
3. Scalability and Performance Challenges
4. Maintenance and Updates
5. Dependency on Large Training Data

2.2 PROPOSED SYSTEM

The proposed system for Chatbot as a Service (CaaS) using Large Language Models (LLMs) focuses on addressing key challenges by optimizing resource use through cloud scalability and model compression, ensuring data privacy with encryption and anonymization, and reducing biases through

regular monitoring and ethical guidelines. It enhances contextual understanding by incorporating both short-term and long-term memory, while improving performance with load balancing and real-time monitoring. The system emphasizes transparency with explainable AI features, continuous improvement through automatic updates and user feedback, and better ambiguity handling by prompting clarification when needed. By using synthetic data for training and fine-tuning the chatbot for specific industries, it ensures robustness and relevance, while offering a user-friendly interface and clear communication to build trust and drive adoption.

2.2.1 ADVANTAGES

1. Data Privacy and Security
2. Bias Reduction and Ethical AI
3. Improved User Experience and Context Awareness
4. Continuous Improvement and Performance Optimization

2.3 SYSTEM REQUIREMENTS

2.3.1 HARDWARE REQUIREMENTS

Processor

RAM : 4GB

Hard Disk

Mouse

Keyboard

Standard Monitor

2.3.2 SOFTWARE REQUIREMENTS

Ollama

Python

Lang chain

MongoDB

MySQL

Flask

React

2.4 LANGUAGE DESCRIPTION

1. Ollama

Ollama is a platform that allows developers to create and deploy powerful AI models for various tasks, including Natural Language Processing (NLP). It provides a simple way to integrate AI capabilities into applications, such as chatbots and virtual assistants. In this project, ollama might be used to manage and deploy Large Language Models (LLMs) for natural language understanding and conversational interfaces. It helps in scaling Al-based features efficiently and integrating them seamlessly into web applications.

2. Python

Python is a versatile, high-level programming language known for its simplicity and readability. It is widely used in web development, data analysis, machine learning, and artificial intelligence. In this project, Python serves as the primary backend language to develop the logic, handle database interactions, and integrate AI models. Libraries like Flask for web development, Lang chain for AI orchestration, and others like pandas, numpy and sklearn for data handling are commonly used in Python-based projects.

3. Langchain

Langchain is an open-source framework designed to simplify the development of applications using language models (LLMs). It provides tools to manage and interact with various language models, making it easier to build complex workflows like chatbots, document processing, and automated reasoning. In this project, langchain helps in structuring the flow of Al-powered responses, managing conversation context, and integrating LLMs into the system seamlessly.

4. MongoDB

MongoDB is a popular NoSQL database known for its scalability, flexibility, and ease of use with unstructured data. It stores data in a JSON-like format, making it highly adaptable for projects that involve diverse or dynamic datasets. In this project, MongoDB may be used to store unstructured or semi-structured data, such as user interactions, chatbot logs, and dynamic content. It enables efficient data retrieval and scalability, making it a good choice for managing large amounts of real-time data.

5. MySQL

MySQL is a widely used relational database management system known for its speed, reliability, and ease of integration with web applications. It stores structured data in tables, making it ideal for handling applications that require data relationships, such as user accounts, transactions, or structured content. In this project, MySQL may be used for storing user data, authentication information, and other structured elements that need to be queried and updated frequently.

6. Flask

Flask is a lightweight and flexible web framework written in Python. It is known for its simplicity and ease of use, making it a popular choice for small to medium-scale web applications. Flask provides all the tools needed to build the backend of web applications, including handling routes, HTTP requests, and serving APIs. In this project, Flask is used to create and

manage the API endpoints for the chatbot service, handle user requests, and interact with the databases.

7. React

React is a JavaScript library used to build user interfaces, especially for single-page applications (SPAs). It enables developers to create reusable UI components, which helps in building dynamic and responsive web applications. React is used in this project to create the frontend of the chatbot service, providing users with an interactive, responsive, and real-time interface for chatting with the AI. It integrates seamlessly with the backend, allowing real-time communication between the user and the chatbot.

These technologies combined offer a full-stack solution for building an AI-powered chatbot application. Python handles the backend logic and integration of LLMs, Flask serves the API, MongoDB and MySQL store the necessary data, React builds the user interface, and Langchain manages the AI workflows.

CHAPTER 4

SYSTEM DESIGN

The system was designed using various tools as explained below;

Context diagrams -this was used to illustrate how the system interacts with the other external entities and other systems.

Data flow diagram - this shows the order followed in the process and data flow and the various data stores that the system has.

Flow charts -this was used to describe the various processes and restrictions involved in their execution.

Entity relationship diagrams - this was to show the relationship between the various entities of the system.

Data dictionary - this describes the contents of the system entities in detail including the various attributes.

TESTING

Testing was done to discover and correct errors in the system. It was suffice/serve to note that regression errors often developed as the system is more complex. This necessitates a number of tests Unit, system and user test. Unit testing was conducted on the individual components of the database, interface, algorithms, components employed and developed. System testing was done to find out errors upon integration of the individual system components into one major system. After this page, we tested the system using test data to ensure that results generated links with those got using the current system. Testing was done by transforming raw data and loading it in the database. And was done to discover the dirty and corrupted data in the system.

4.1 ARCHITECTURAL DESIGN

This gives a high level view of the system with the main components and the services they provide and how they communicate in the system.

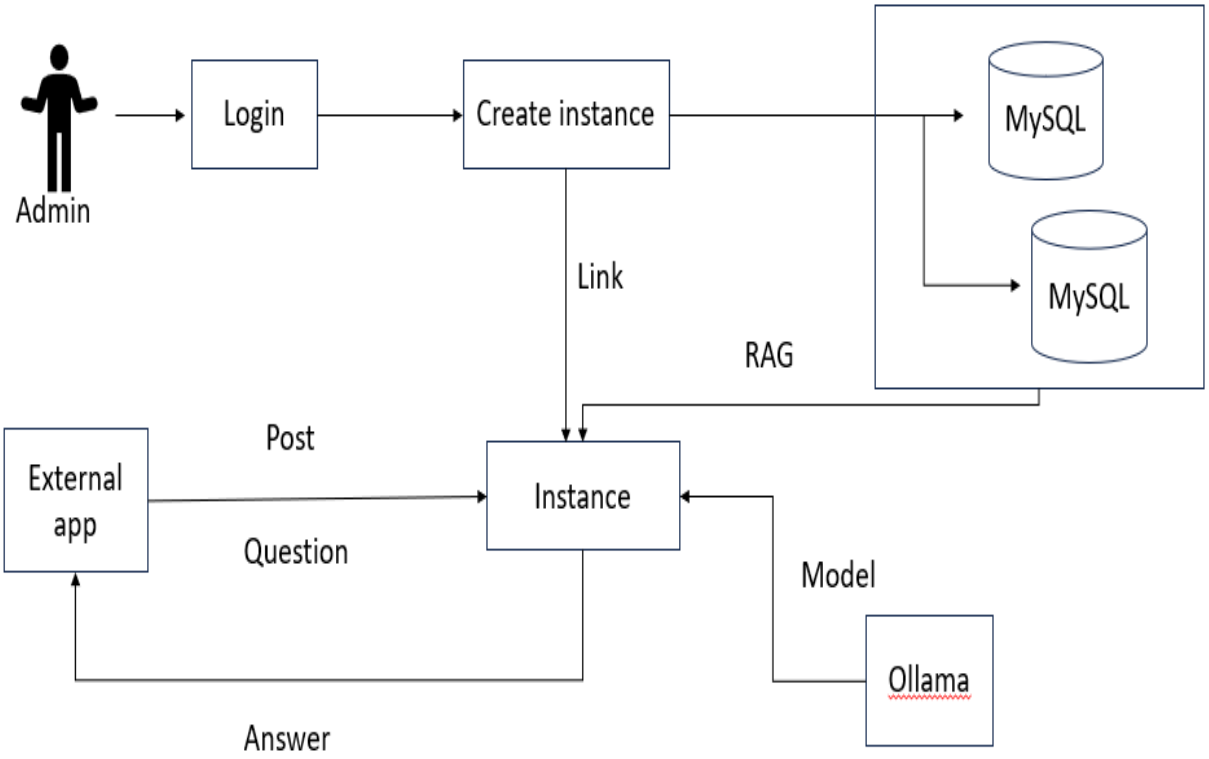

FIGURE 4.1: ARCHITECTURAL DIAGRAM

4.2 DATA FLOW DIAGRAM

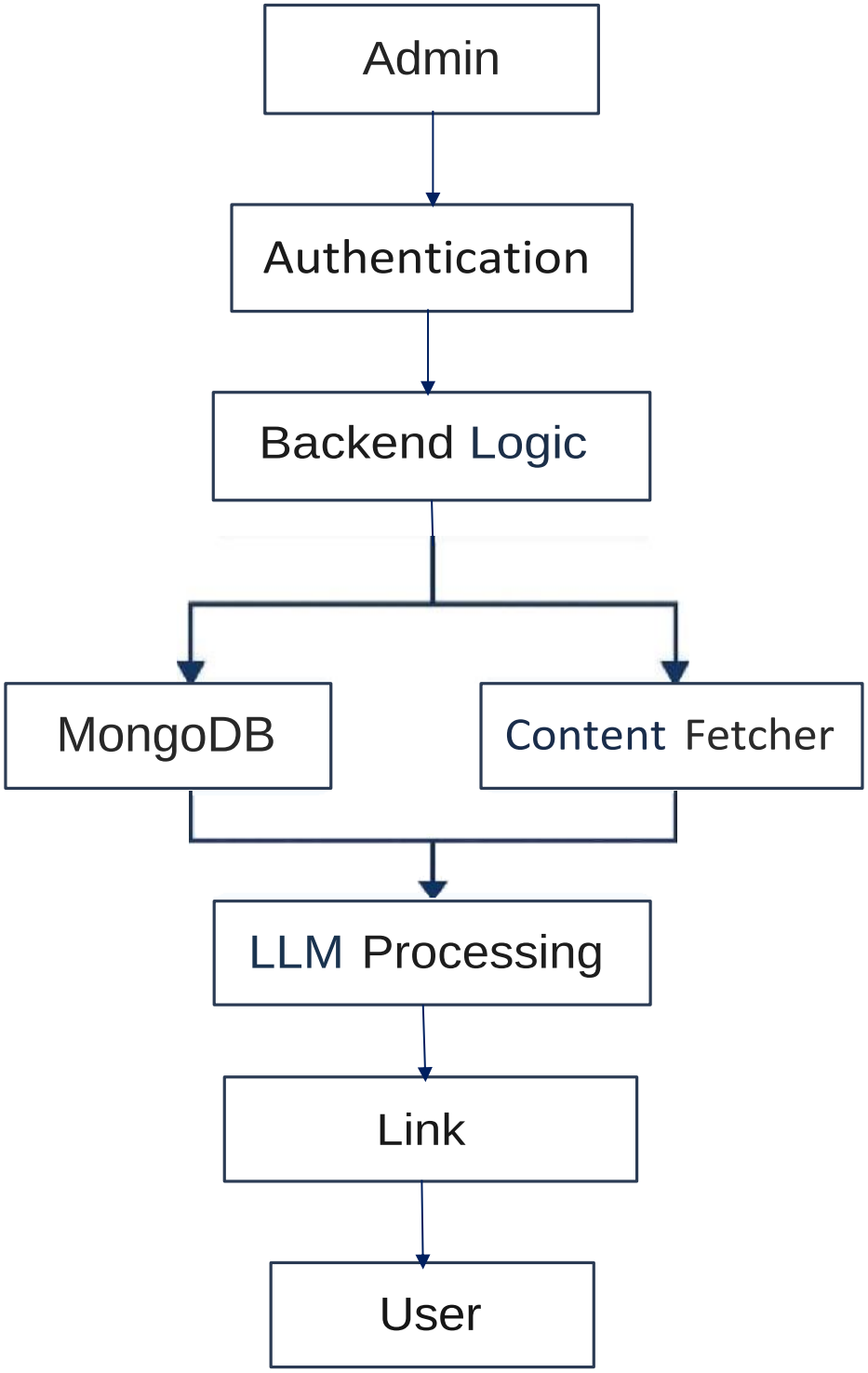

FIGURE 4.1: DATA FLOW DIAGRAM

4.3. USECASE DIAGRAM

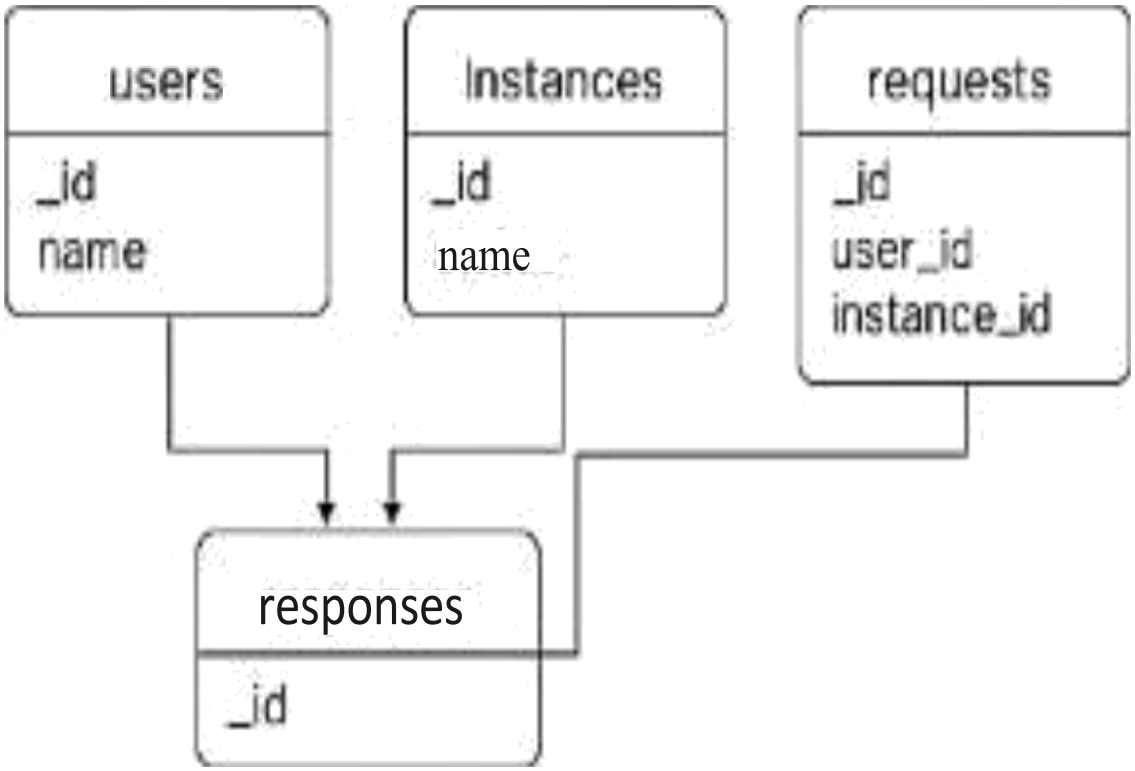

FIGURE 4.3: USECASE DIAGRAM

4.4. ACTIVITY DIAGRAM

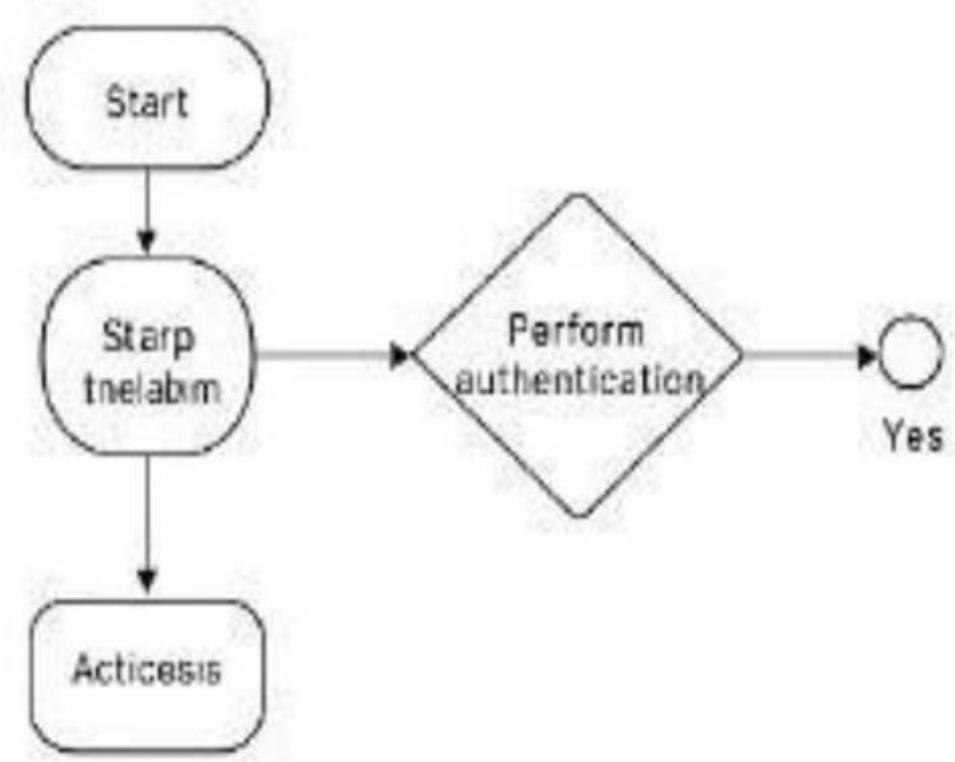

FIGURE 4.4: ACTIVITY DIAGRAM

4.5. DATABASE DESIGN DIAGRAM

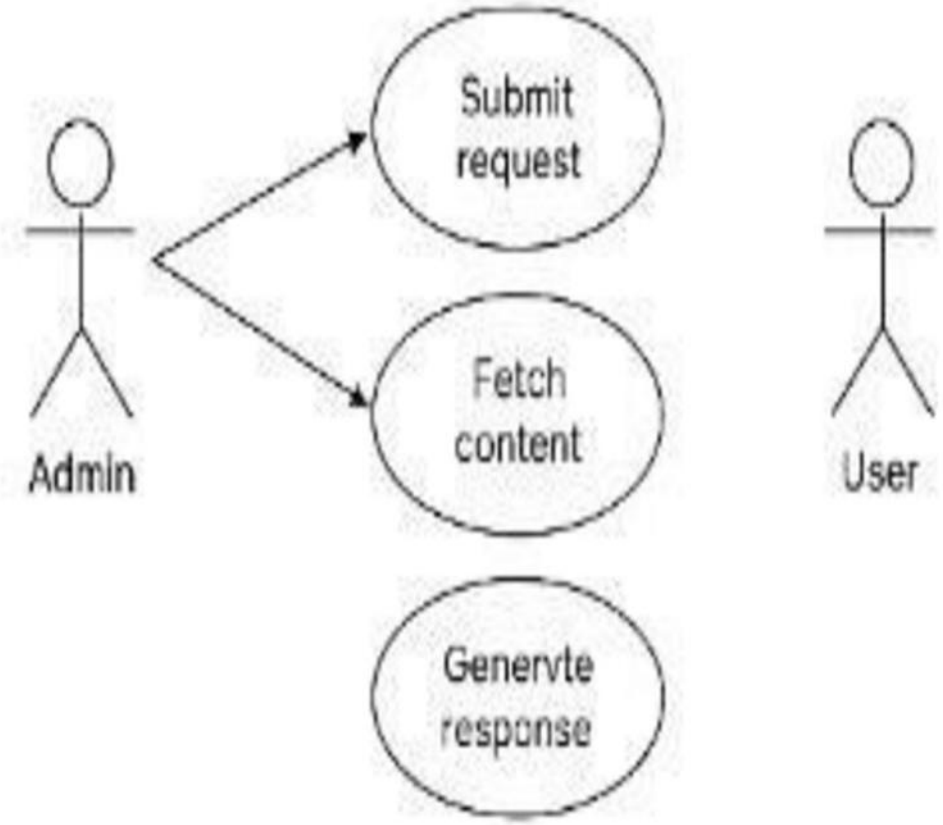

FIGURE 4.5:DATABASE DESIGN DIAGRAM

4.6 CLASS DIAGRAM:

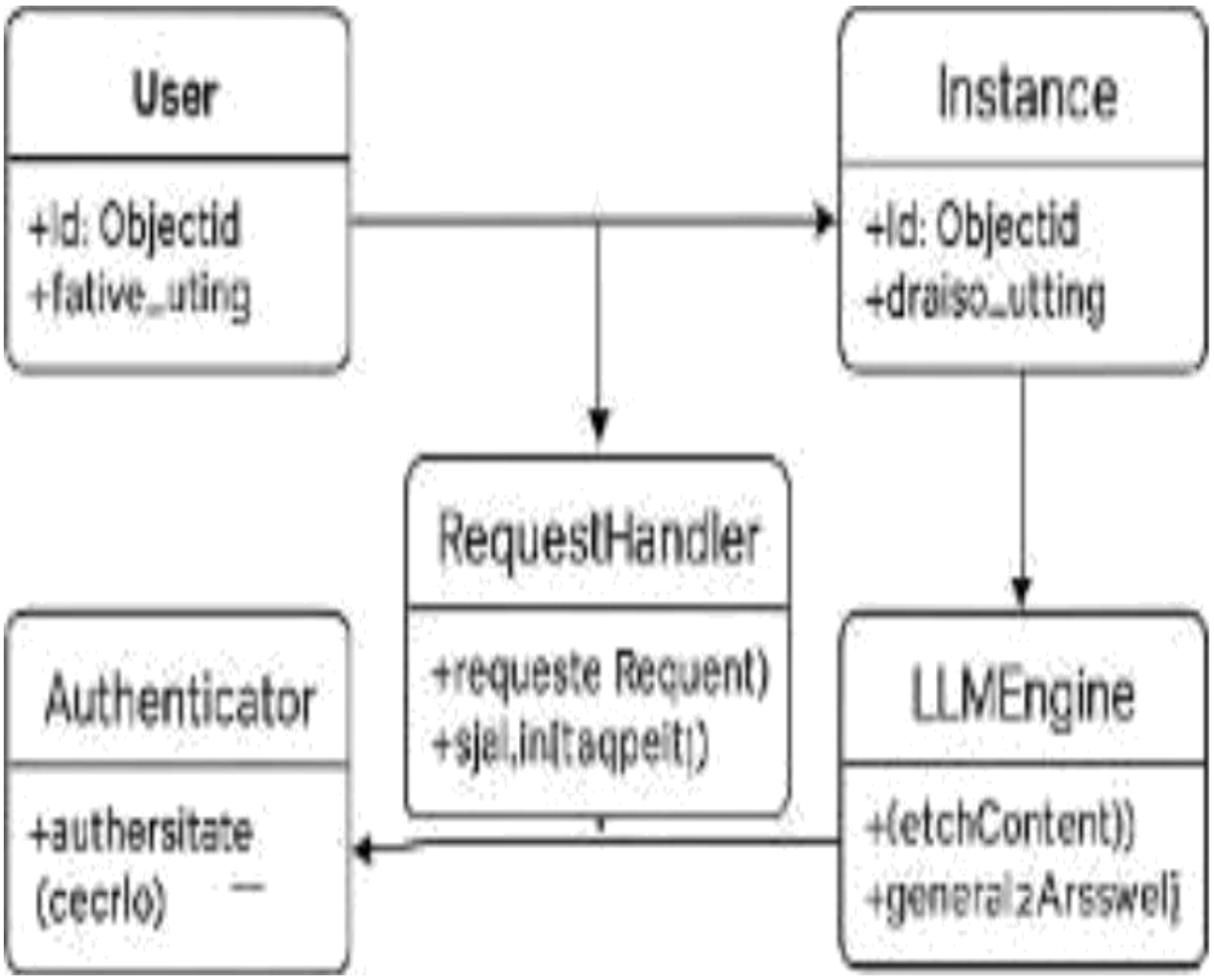

FIGURE 4.6: CLASS DIAGRAM

CHAPTER 5
IMPLEMENTATION

The chatbot platform is designed to be modular, scalable, and extensible. The implementation spans across frontend, backend, database, model integration, and orchestration layers.

5.1. Frontend Implementation

- Built with React.js or similar SPA frameworks for responsive design.
- Admin Dashboard:
  - Allows admins to create, configure, and monitor instances.
  - II elements for setting: instance name, model type, RAG content, and API keys.
- Chat Interface:
  - Real-time communication via WebSockets or HTTP polling.
  - Handles streaming responses if supported by LLM APIs.

5.2. API Gateway & Authentication

- All frontend requests pass through an API Gateway.
- Auth layer:
  - Token-based (e.g., JWT or OAuth2).
  - VIllidates user/session and scopes (admin, user).
- Rate limiting and abuse prevention policies are enforced.

5.3. Backend Implementation

- Framework: Python (FastAPVFlask) or Node.js (Express/Nest.js).
- Core modules:
  - **Instance Manager:** Handles CRUD for chatbot instances.

    - **Query Handler:** Receives chat input and routes to appropriate logic.
    - **Retriever Module:** Uses vector similarity search (e.g., FAISS, Pinecone) if RAG is enabled.
    - **Model Router:** Chooses the appropriate LLM engine based on instance config.
- Environment Variables or Secrets Managers used to secure API keys and DB credentials.

5.4. Database Design

- **MongoDB Collections:**
    - users: auth credentials, metadata
    - instances: each instance's configuration and status
    - conversations: logs of chat history
    - documents: indexed knowledge base for RAG-enabled bots
- Indexes optimized for read-heavy operations (e.g., conversations by timestamp and user).

5.5. LLM Integration

- APIs used: OpenAI GPT-4, Claude, etc.
- Dynamic model selection based on:
    - Cost
    - Accuracy
    - Domain-specific configuration
- Prompt engineering strategies used:
    - System prompts per instance
    - Injected context via RAG
    - User prompt formatting and sanitization

5.6. Retrieval-Augmented Generation (RAG)

- **Indexing Pipeline:**
  - Documents are chunked, embedded, and stored in vector DB.
  - Embedded using OpenAI Embeddings or HuggingFace Transformers.
- **Retrieval:**
  - Given a query, top-k relevant chunks are fetched and prepended to the prompt.

5.7. Response and Logging

- Responses are formatted and streamed to users when supported.
- All chat interactions are stored:
  - For audit
  - For analytics
  - For fine-tuning or retraining

5.8. Scalability & Deployment

- Hosted using Docker + Kubemetes.
- Horizontal scaling of backend pods.
- Redis or Celery used for async job queuing (e.g., for background document processing).

5.9. Monitoring and Error Handling

- Logging: Integrated with tools like ELK stack or LogRocket.
- Monitoring: Prometheus + Grafana dashboards track:
  - Latency
  - Error rates
  - Model usage
- Alerts configured for downtime or high latency.

CHAPTER 6
CONCLUSION

This project successfully implements a scalable and flexible **Chatbot-as-a-Service** platform that leverages the power of modern **Large Language Models (LLMs)** combined with **Retrieval-Augmented Generation (RAG)** and robust backend infrastructure. By allowing the dynamic creation of chatbot instances tailored to different datasets and use cases, the system demonstrates a high degree of modularity, configurability, and adaptability. The integration of secure authentication, real-time communication, and intelligent model routing ensures that users receive fast, accurate, and contextually relevant responses.

Additionally, the use of **MongoDB** for storing conversation history, user profiles, and instance configurations provides a reliable and efficient data storage layer. The platform lays the foundation for further enhancements such as analytics dashboards, chatbot fine-tuning, user personalization, and integration with third-party services (e.g., Slack, WhatsApp, CRMs). With its modular design, the system is well-positioned for real-world deployment in enterprise and educational settings.

CHAPTER 7
APPENDIX

A1. SCREENSHOTS

Execution page:

Frontend and backend codes are executed to get the result.

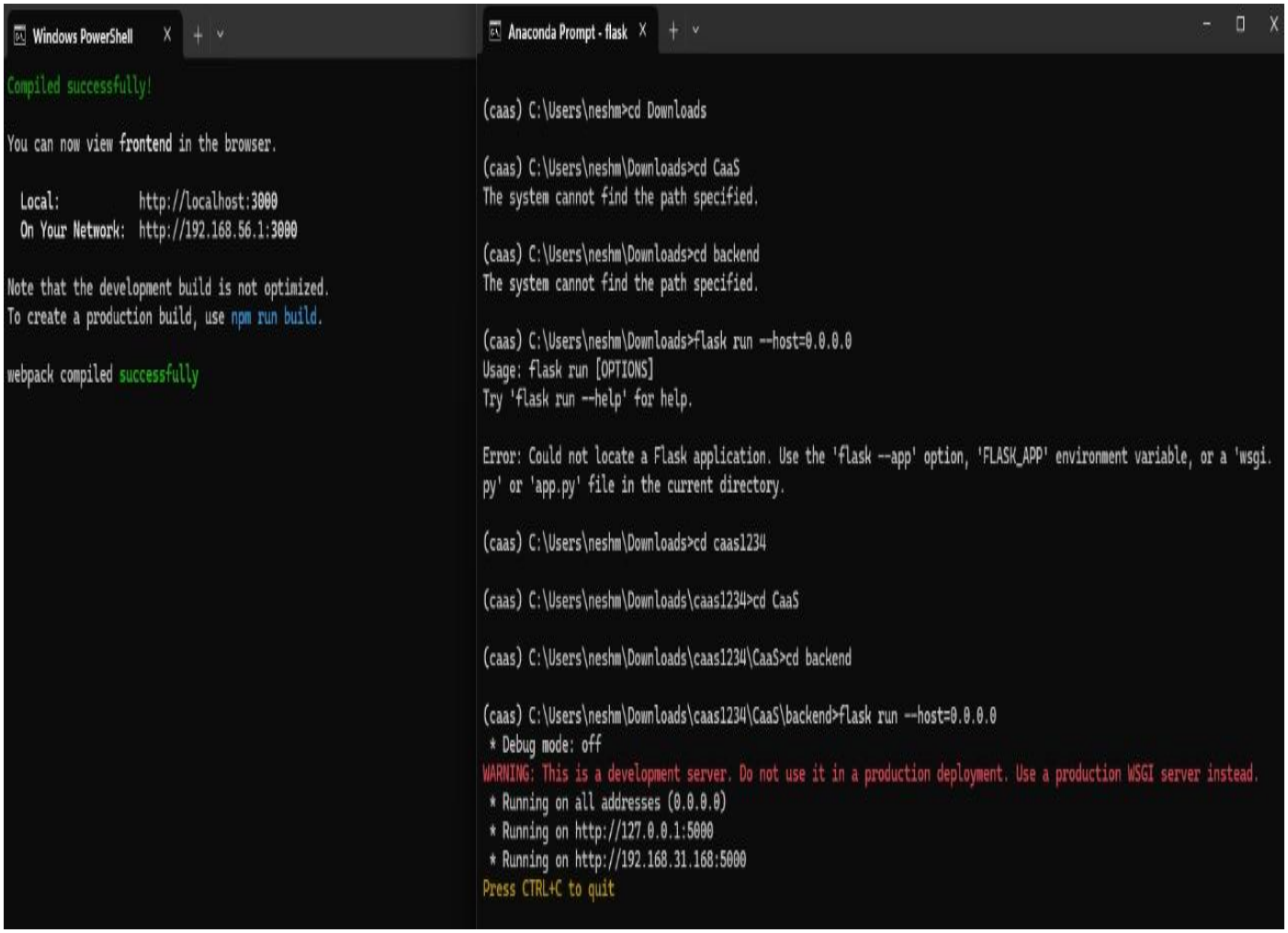

FIGURE 7.1: EXECUTION PAGE

Home page :

This page is the main entry point of a website serving as gateway to other pages.

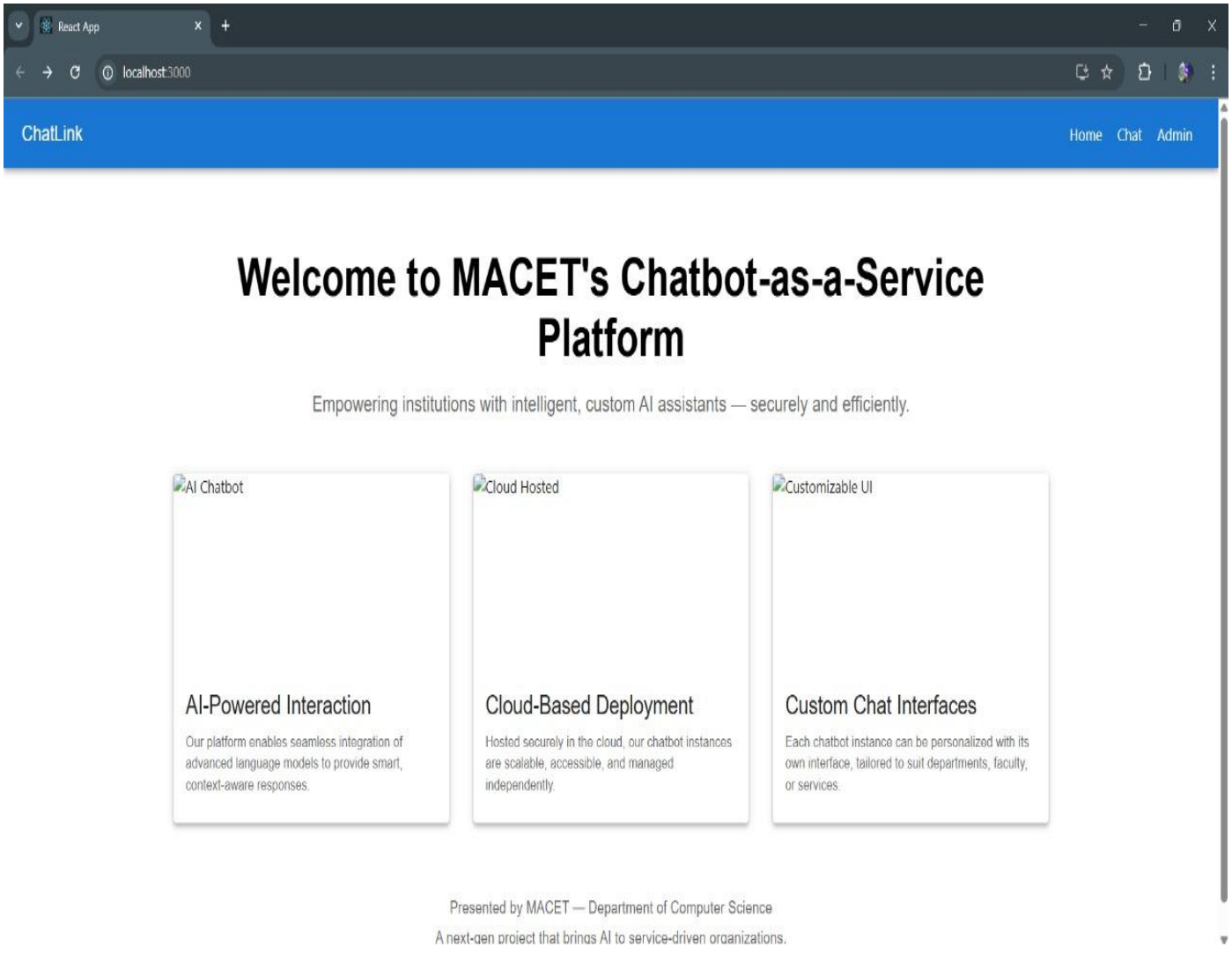

FIGURE 7.2: HOME PAGE

Admin Page

This page is used by the admin to upload files and generate URL.

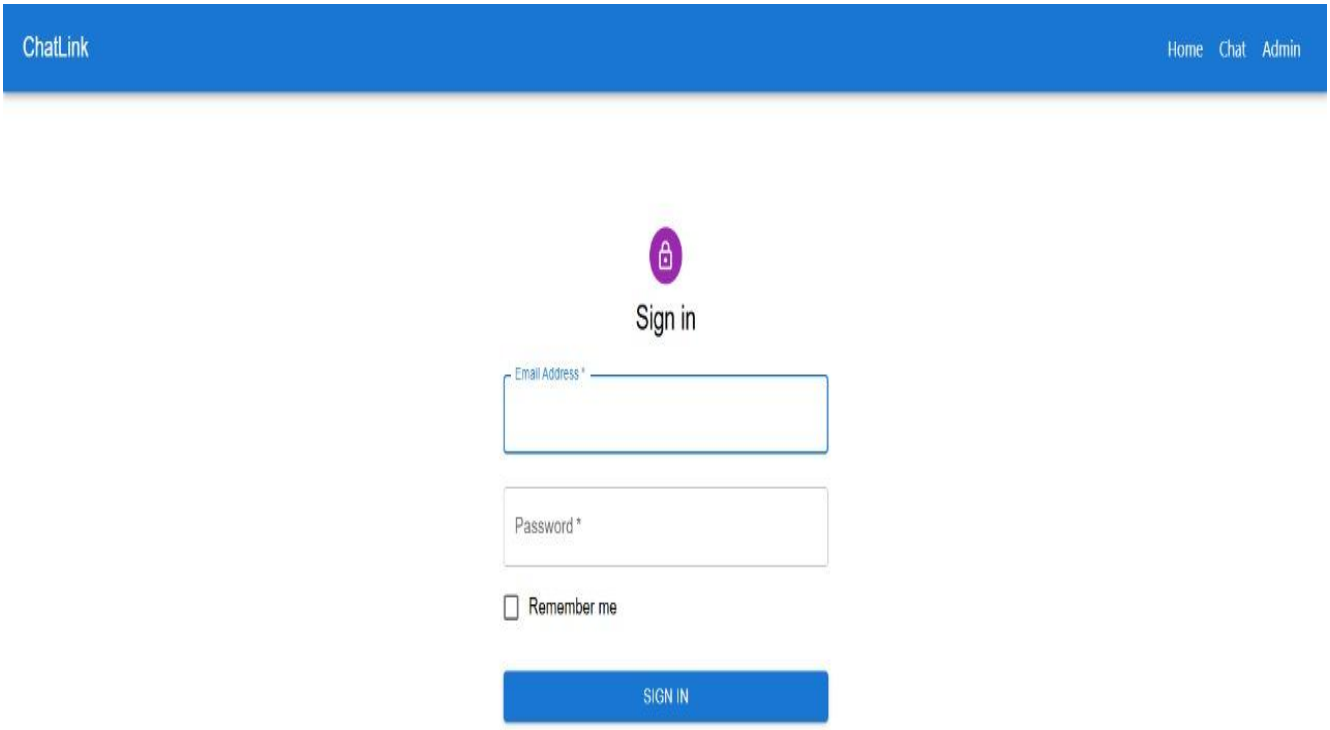

FIGURE 7.3: ADMIN PAGE

Instance Page:

Instance page is created with specific name for specific usages.

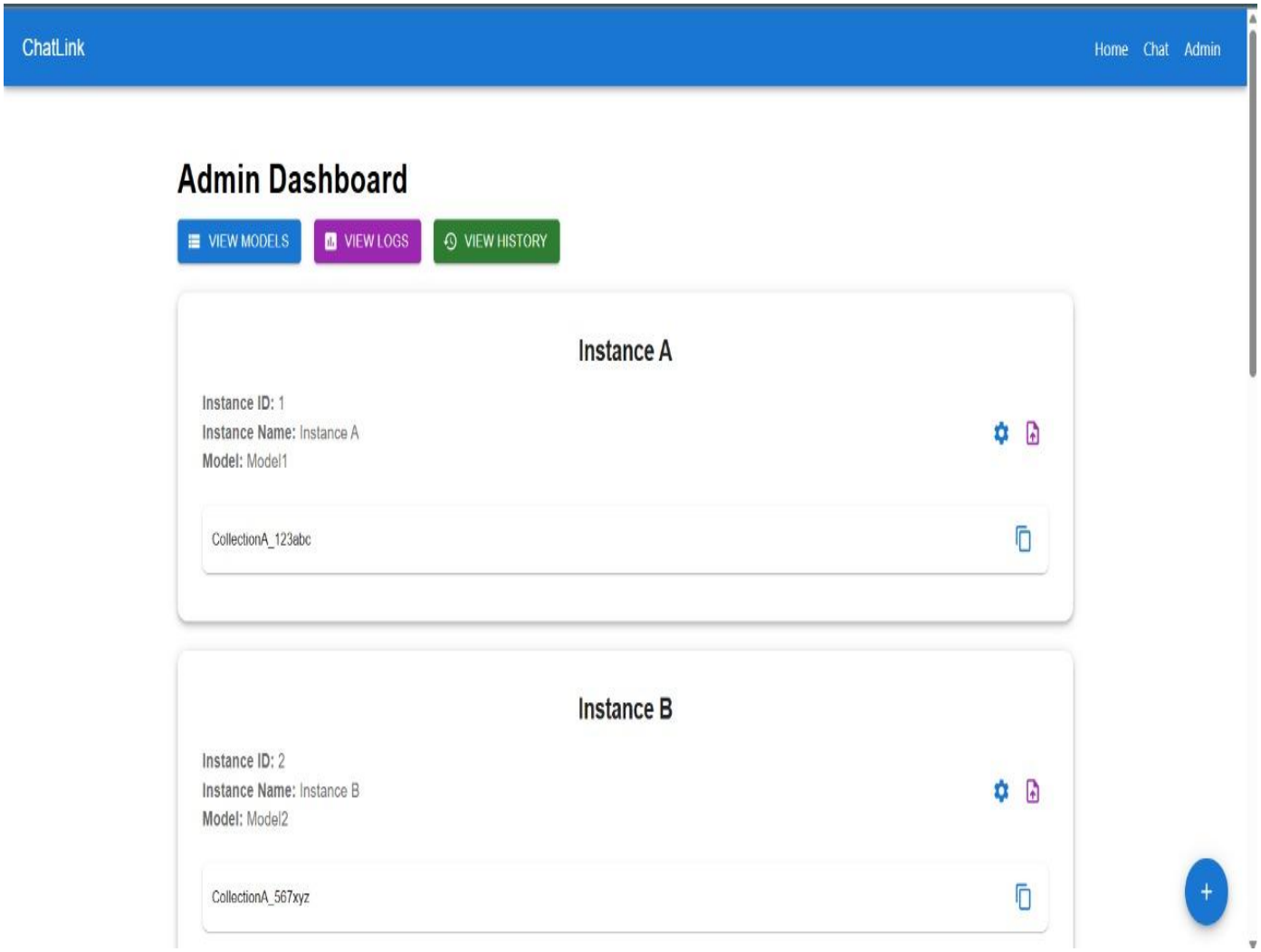

FIGURE 7.4: INSTANCE PAGE

Model Selection:

Model selection is set up to select the models like deep seeker etc.

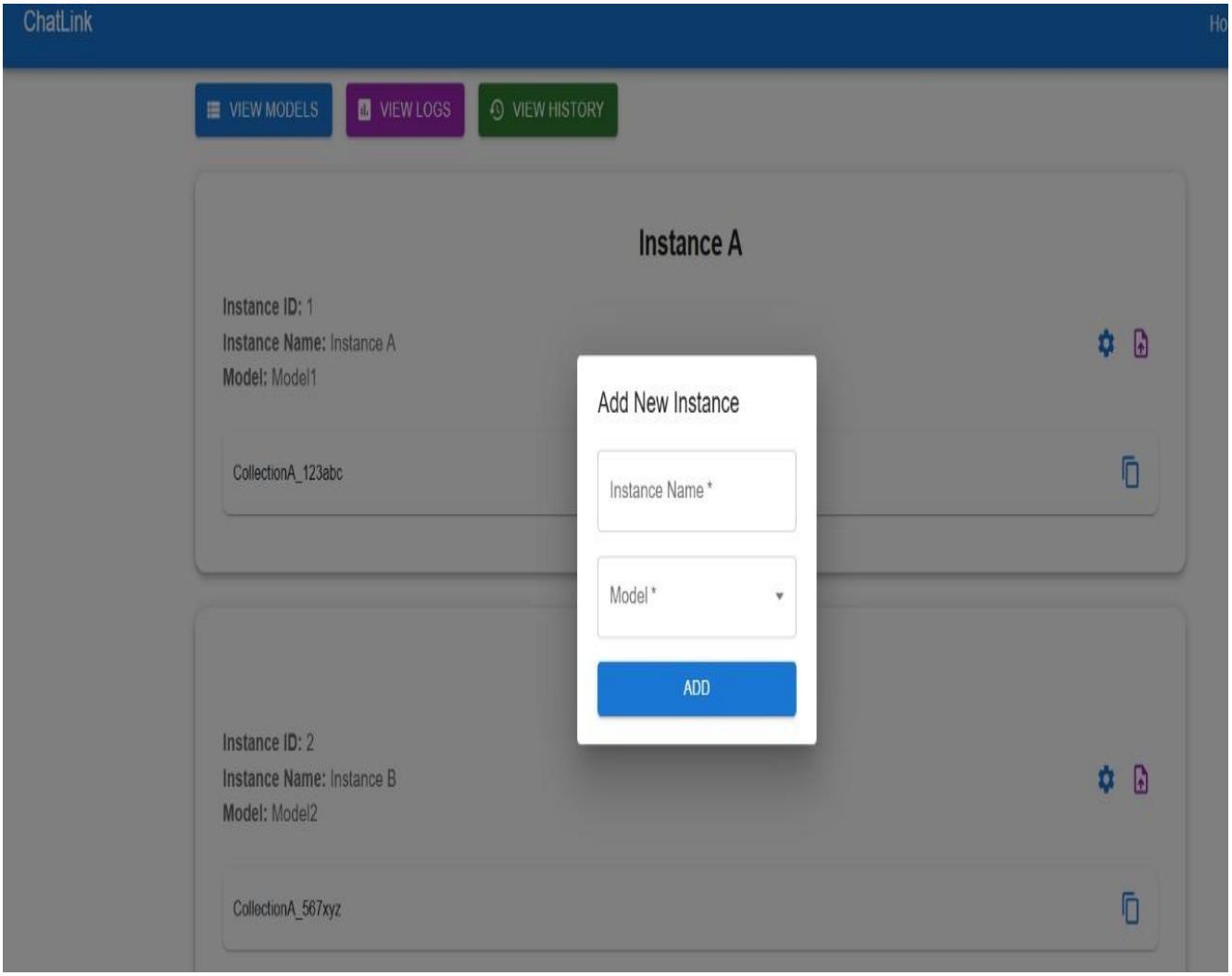

FIGURE 7.5: MODEL SELECTION

FIGURE 7.5: MODEL SELECTION

Upload Data:

Upload the files which can be a pdf /doc / CSV / excel / website link format.

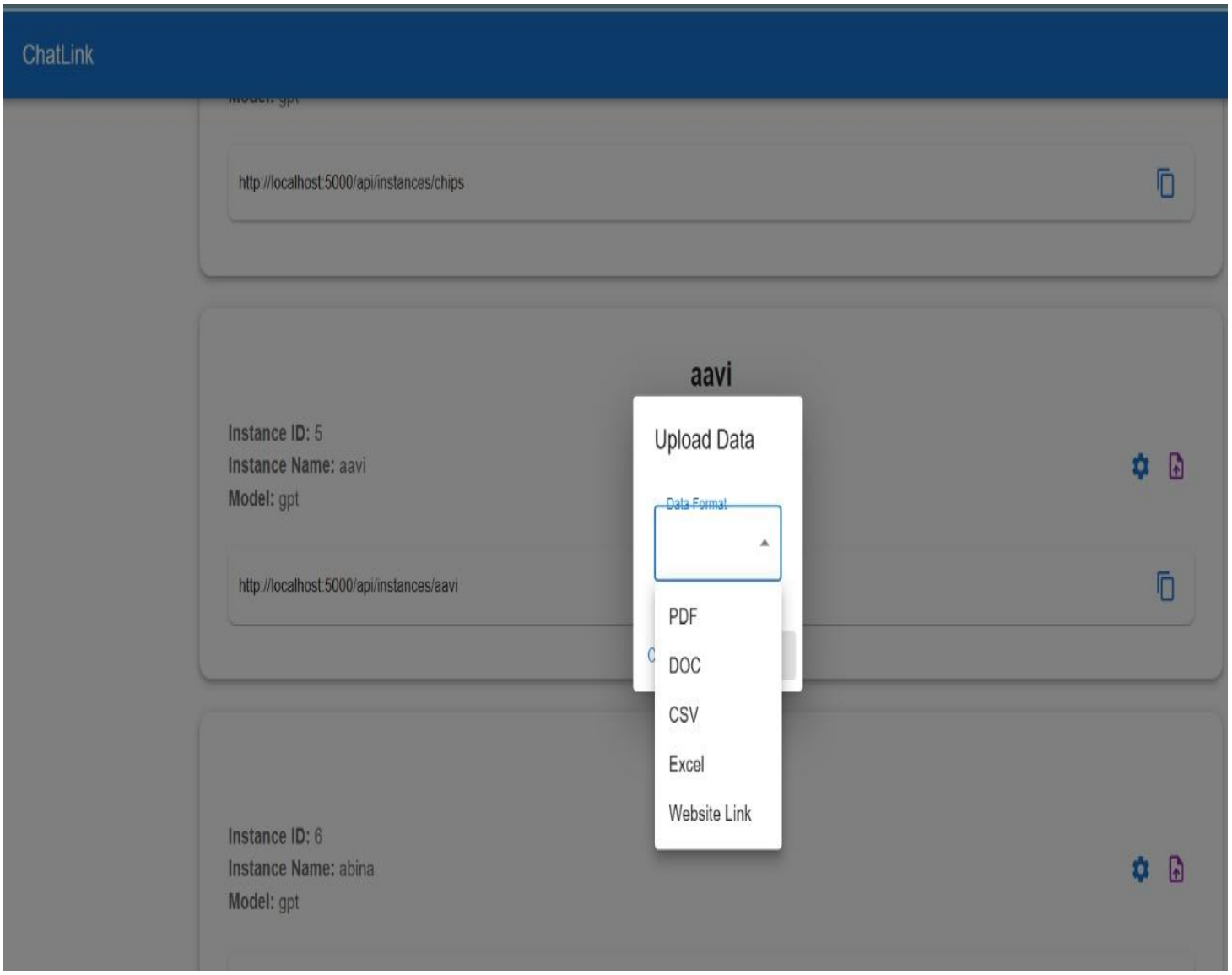

FIGURE 7.6: UPDATE DATA

Copy URL:

The generated URL after uploading the file is copied to the clipboard.

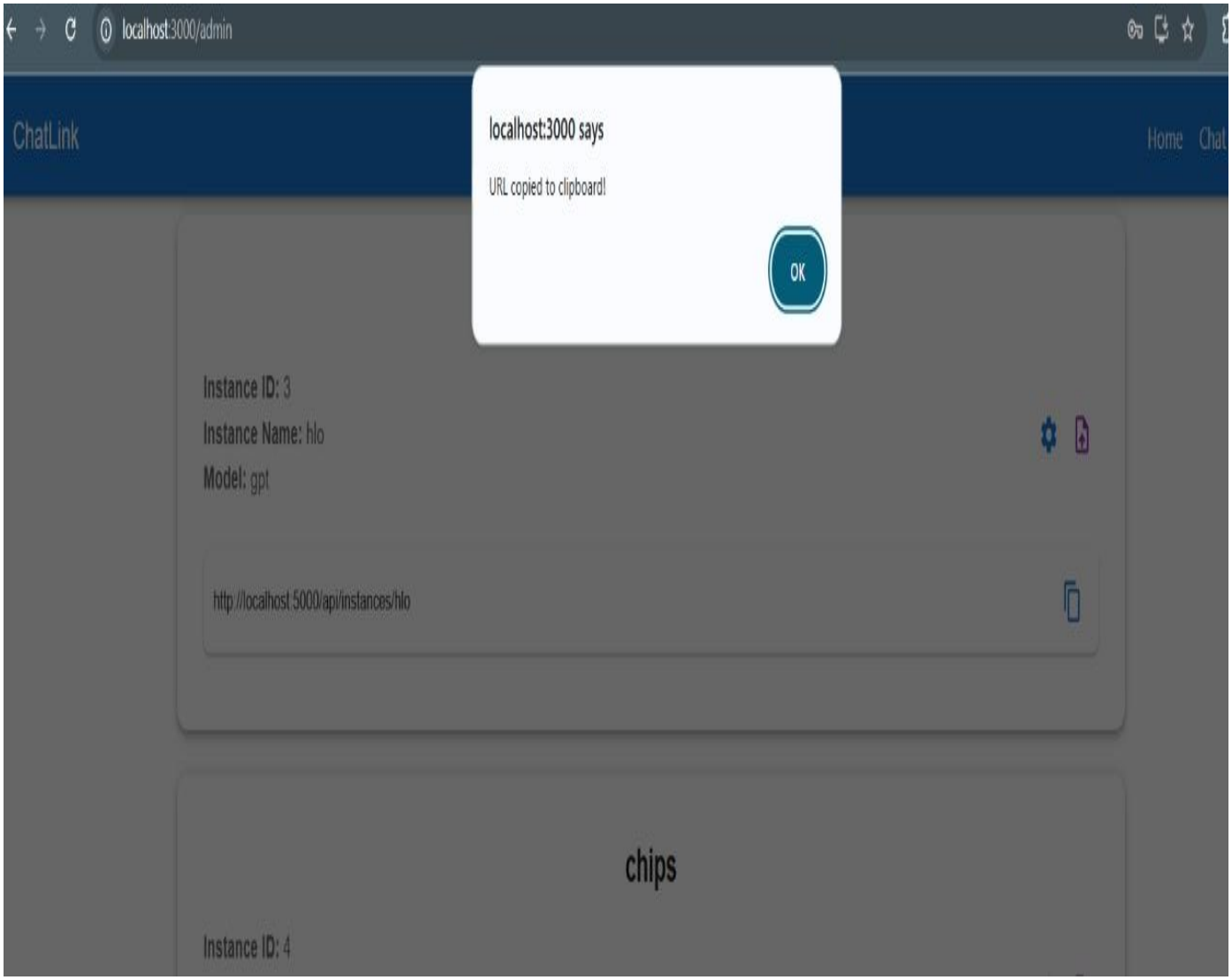

FIGURE 7.7: COPY URL

Set Instance:

The URL sent by the admin is used by the user to begin the communication, the copied URL is pasted here.

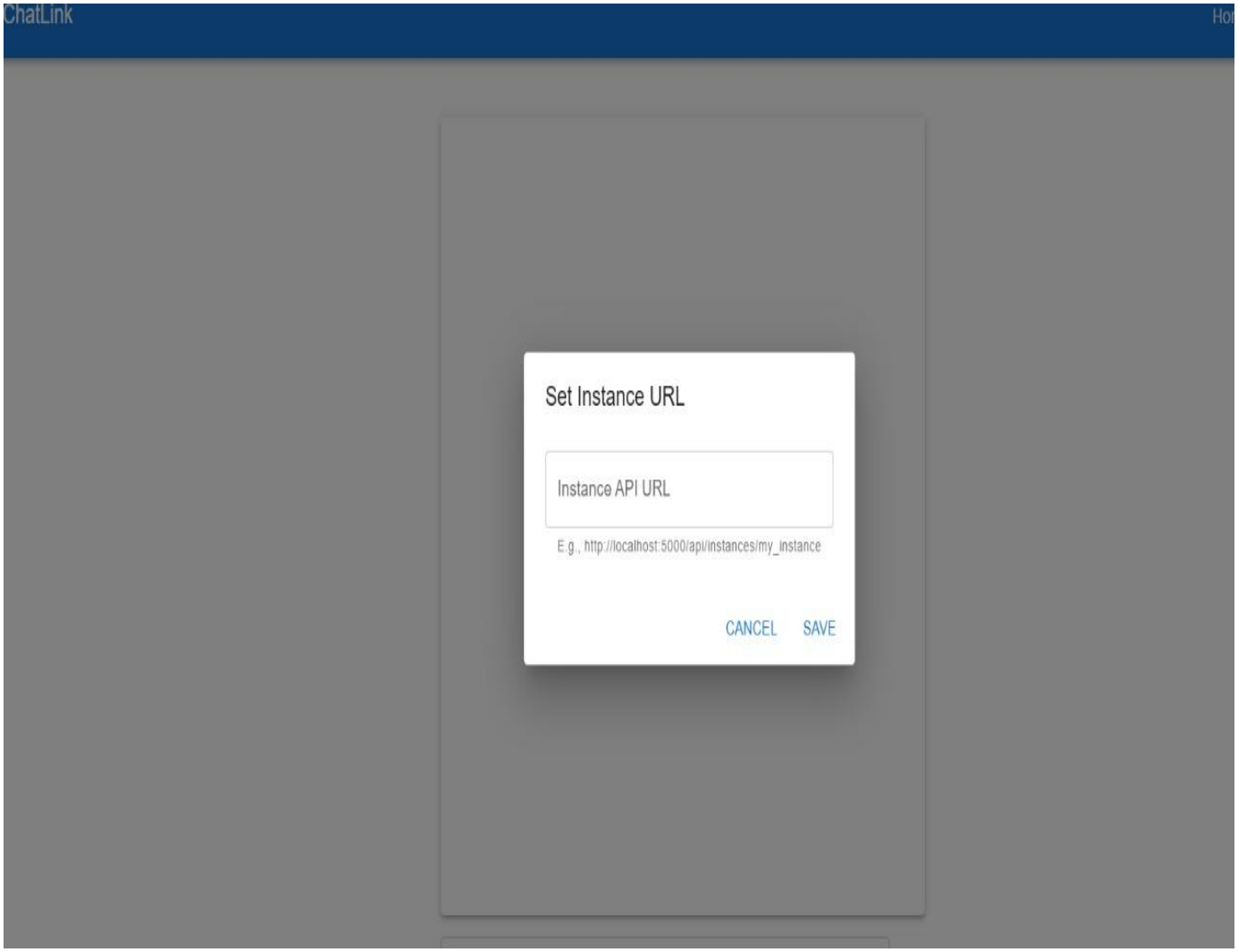

FIGURE 7.8: SET INSTANCE

User page:

User page is used to communicate with the specific URL sent by the admin.

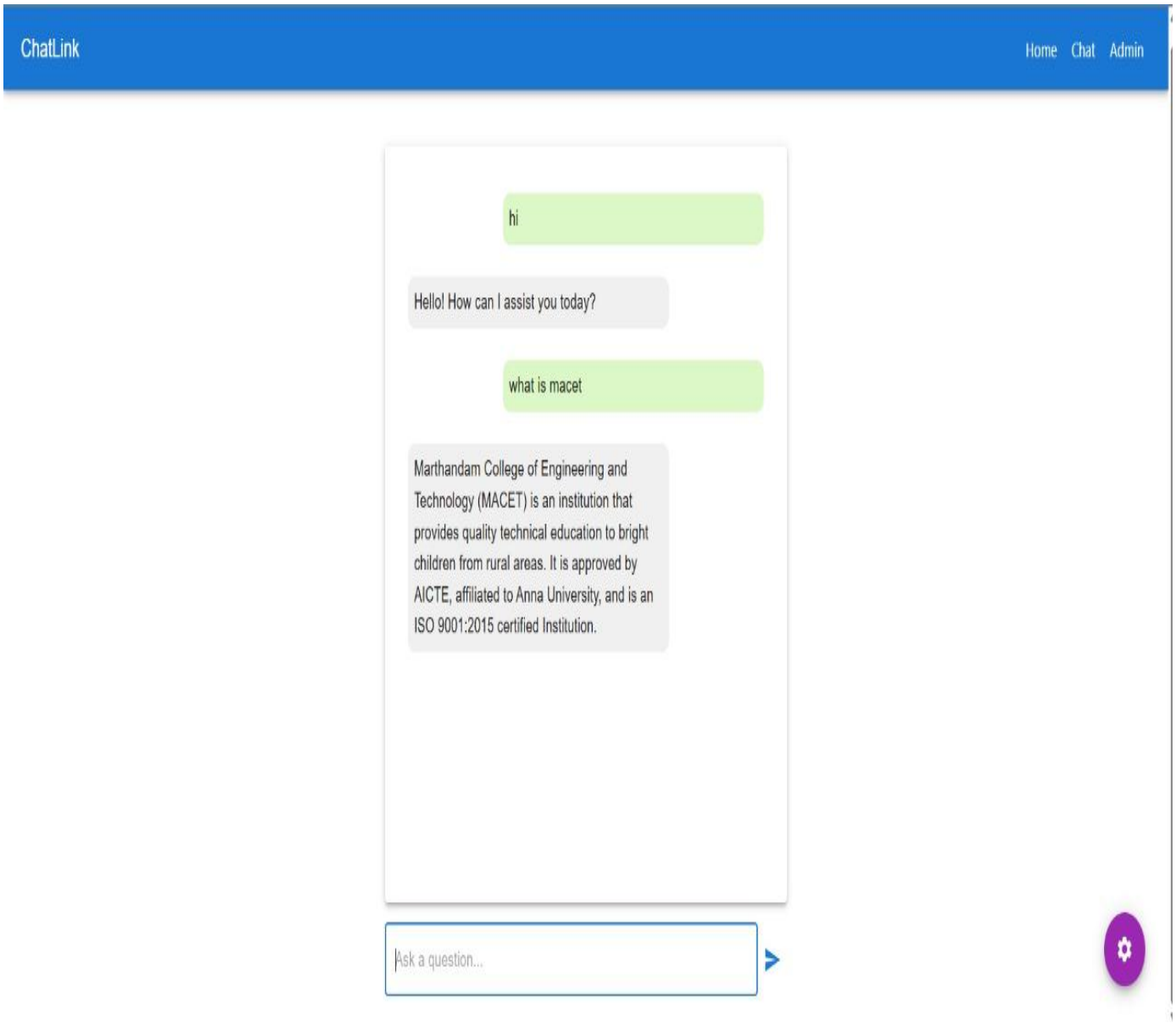

FIGURE 7.9: USER PAGE

A2.SOURCE CODE:


```
        {
 "name": "frontend",
 "version": "0.1.0",
 "lockfileVersion": 3,
 "requires": true,
 "packages": {
  "": {
   "name": "frontend",
   "version": "0.1.0",
   "dependencies": {
    "@emotion/react": "^11.14.0",
    "@emotion/styled": "^11.14.0",
    "@mui/icons-material": "^6.4.6",
    "@mui/material": "^6.4.6",
    "@testing-library/dom": "^10.4.0",
    "@testing-library/jest-dom": "^6.6.3",
    "@testing-library/react": "^16.2.0",
    "@testing-library/user-event": "^13.5.0",
    "axios": "^1.8.1",
    "react": "^19.0.0",
    "react-dom": "^19.0.0",
    "react-router-dom": "^7.2.0",
    "react-scripts": "5.0.1",
    "web-vitals": "^2.1.4"
   }
  },
  "node_modules/@adobe/css-tools": {
   "version": "4.4.2",
   "resolved": "https://registry.npmjs.org/@adobe/css-tools/-/css-tools-4.4.2.tgz",
   "integrity": "sha512-
baYZExFpsdkBNuvGKTKWCwKH57HRZLVtycZS05WTQNVOiXVSeAki3nU35
zlRbToeMW8aHlJfyS+1C4BOv27q0A==",
   "license": "MIT"
  },
  "node_modules/@alloc/quick-lru": {
   "version": "5.2.0",
   "resolved": "https://registry.npmjs.org/@alloc/quick-lru/-/quick-lru-5.2.0.tgz",
   "integrity": "sha512-
UrcABB+4bUrFABwbluTIBErXwvbsU/V7TZWfmbgJfbkwiBuziS9gxdODUyuiecf
dGQ85jglMW6juS3+z5TsKLw==",
   "license": "MIT",
```

```
      "engines": {
        "node": ">=10"
      },
      "funding": {
        "url": "https://github.com/sponsors/sindresorhus"
      }
    },
    "node_modules/@ampproject/remapping": {
      "version": "2.3.0",
      "resolved": "https://registry.npmjs.org/@ampproject/remapping/-/remapping-
2.3.0.tgz",
      "integrity": "sha512-
30iZtAPgz+LTIYoeivqYo853f02jBYSd5uGnGpkFV0M3xOt9aN73erkgYAmZU43
x4VfqcnLxW9Kpg3R5LC4YYw==",
      "license": "Apache-2.0",
      "dependencies": {
        "@jridgewell/gen-mapping": "^0.3.5",
        "@jridgewell/trace-mapping": "^0.3.24"
      },
      "engines": {
        "node": ">=6.0.0"
      }
    },
    "node_modules/@babel/code-frame": {
      "version": "7.26.2",
      "resolved": "https://registry.npmjs.org/@babel/code-frame/-/code-frame-
7.26.2.tgz",
      "integrity": "sha512-
RJlIHRueQgwWitWgF8OdFYGZX328Ax5BCemNGlqHfplnRT9ESi8JkFlvaVYbS
+UubVY6dpv87Fs2u5M29iNFVQ==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-validator-identifier": "^7.25.9",
        "js-tokens": "^4.0.0",
        "picocolors": "^1.0.0"
      },
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/compat-data": {
      "version": "7.26.8",
      "resolved": "https://registry.npmjs.org/@babel/compat-data/-/compat-data-
7.26.8.tgz",
```

```
      "integrity": "sha512-
oH5UPLMWR3L2wEFLnFJ1TZXqHufiTKAiLfqw5zkhS4dKXLJ10yVztfil/twG8E
DTA4F/tvVNw9nOl4ZMslB8rQ==",
      "license": "MIT",
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/core": {
      "version": "7.26.9",
      "resolved": "https://registry.npmjs.org/@babel/core/-/core-7.26.9.tgz",
      "integrity": "sha512-
lWBYIrF7qK5+GjY5Uy+/hEgp8OJWOD/rpy74GplYRhEauvbHDeFB8t5hPOZxC
Z0Oxf4Cc36tK51/l3ymJysrKw==",
      "license": "MIT",
      "dependencies": {
        "@ampproject/remapping": "^2.2.0",
        "@babel/code-frame": "^7.26.2",
        "@babel/generator": "^7.26.9",
        "@babel/helper-compilation-targets": "^7.26.5",
        "@babel/helper-module-transforms": "^7.26.0",
        "@babel/helpers": "^7.26.9",
        "@babel/parser": "^7.26.9",
        "@babel/template": "^7.26.9",
        "@babel/traverse": "^7.26.9",
        "@babel/types": "^7.26.9",
        "convert-source-map": "^2.0.0",
        "debug": "^4.1.0",
        "gensync": "^1.0.0-beta.2",
        "json5": "^2.2.3",
        "semver": "^6.3.1"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "funding": {
        "type": "opencollective",
        "url": "https://opencollective.com/babel"
      }
    },
    "node_modules/@babel/core/node_modules/semver": {
      "version": "6.3.1",
      "resolved": "https://registry.npmjs.org/semver/-/semver-6.3.1.tgz",
      "integrity": "sha512-
```

BR7VvDCVHO+q2xBEWskxS6DJE1qRnb7DxzUrogb71CWoSficBxYsiAGd+Kl0
mmq/MprG9yArRkyrQxTO6XjMzA==",
    "license": "ISC",
    "bin": {
      "semver": "bin/semver.js"
    }
  },
  "node_modules/@babel/eslint-parser": {
    "version": "7.26.8",
    "resolved": "https://registry.npmjs.org/@babel/eslint-parser/-/eslint-parser-
7.26.8.tgz",
    "integrity": "sha512-
3tBctaHRW6xSub26z7n8uyOTwwUsCdvIug/oxBH9n6yCO5hMj2vwDJAo7RbBM
KrM7P+W2j61zLKviJQFGOYKMg==",
    "license": "MIT",
    "dependencies": {
      "@nicolo-ribaudo/eslint-scope-5-internals": "5.1.1-v1",
      "eslint-visitor-keys": "^2.1.0",
      "semver": "^6.3.1"
    },
    "engines": {
      "node": "^10.13.0 || ^12.13.0 || >=14.0.0"
    },
    "peerDependencies": {
      "@babel/core": "^7.11.0",
      "eslint": "^7.5.0 || ^8.0.0 || ^9.0.0"
    }
  },
  "node_modules/@babel/eslint-parser/node_modules/eslint-visitor-keys": {
    "version": "2.1.0",
    "resolved": "https://registry.npmjs.org/eslint-visitor-keys/-/eslint-visitor-keys-
2.1.0.tgz",
    "integrity": "sha512-
0rSmRBzXgDzIsD6mGdJgevzgezI534Cer5L/vyMX0kHzT/jiB43jRhd9YUlMGYL
Qy2zprNmoT8qasCGtY+QaKw==",
    "license": "Apache-2.0",
    "engines": {
      "node": ">=10"
    }
  },
  "node_modules/@babel/eslint-parser/node_modules/semver": {
    "version": "6.3.1",
    "resolved": "https://registry.npmjs.org/semver/-/semver-6.3.1.tgz",
    "integrity": "sha512-

BR7VvDCVHO+q2xBEWskxS6DJE1qRnb7DxzUrogb71CWoSficBxYsiAGd+Kl0mmq/MprG9yArRkyrQxTO6XjMzA==",
"license": "ISC",
"bin": {
"semver": "bin/semver.js"
}
},
"node_modules/@babel/generator": {
"version": "7.26.9",
"resolved": "https://registry.npmjs.org/@babel/generator/-/generator-7.26.9.tgz",
"integrity": "sha512-kEWdzjOAUMW4hAyrzJ0ZaTOu9OmpyDIQicIh0zg0EEcEkYXZb2TjtBhnHi2ViX7PKwZqF4xwqfAm299/QMP3lg==",
"license": "MIT",
"dependencies": {
"@babel/parser": "^7.26.9",
"@babel/types": "^7.26.9",
"@jridgewell/gen-mapping": "^0.3.5",
"@jridgewell/trace-mapping": "^0.3.25",
"jsesc": "^3.0.2"
},
"engines": {
"node": ">=6.9.0"
}
},
"node_modules/@babel/helper-annotate-as-pure": {
"version": "7.25.9",
"resolved": "https://registry.npmjs.org/@babel/helper-annotate-as-pure/-/helper-annotate-as-pure-7.25.9.tgz",
"integrity": "sha512-gv7320KBUFJz1RnylIg5WWYPRXKZ884AGkYpgpWW02TH66Dl+HaC1t1CKd0z3R4b6hdYEcmrNZHUmfCP+1u3/g==",
"license": "MIT",
"dependencies": {
"@babel/types": "^7.25.9"
},
"engines": {
"node": ">=6.9.0"
}
},
"node_modules/@babel/helper-compilation-targets": {
"version": "7.26.5",
"resolved": "https://registry.npmjs.org/@babel/helper-compilation-targets/-/helper-compilation-targets-7.26.5.tgz",

```
      "integrity": "sha512-
IXuyn5EkouFJscIDuFF5EsiSolseme1s0CZB+QxVugqJLYmKdxI1VfIBOst0SUu4r
nk2Z7kqTwmoO1lp3HIfnA==",
      "license": "MIT",
      "dependencies": {
        "@babel/compat-data": "^7.26.5",
        "@babel/helper-validator-option": "^7.25.9",
        "browserslist": "^4.24.0",
        "lru-cache": "^5.1.1",
        "semver": "^6.3.1"
      },
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-compilation-targets/node_modules/semver": {
      "version": "6.3.1",
      "resolved": "https://registry.npmjs.org/semver/-/semver-6.3.1.tgz",
      "integrity": "sha512-
BR7VvDCVHO+q2xBEWskxS6DJE1qRnb7DxzUrogb71CWoSficBxYsiAGd+Kl0
mmq/MprG9yArRkyrQxTO6XjMzA==",
      "license": "ISC",
      "bin": {
        "semver": "bin/semver.js"
      }
    },
    "node_modules/@babel/helper-create-class-features-plugin": {
      "version": "7.26.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-create-class-features-
plugin/-/helper-create-class-features-plugin-7.26.9.tgz",
      "integrity": "sha512-
ubbUqCofvxPRurw5L8WTsCLSkQiVpov4Qx0WMA+jUN+nXBK8ADPlJO1grkF
w5CWKC5+sZSOfuGMdX1aI1iT9Sg==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-annotate-as-pure": "^7.25.9",
        "@babel/helper-member-expression-to-functions": "^7.25.9",
        "@babel/helper-optimise-call-expression": "^7.25.9",
        "@babel/helper-replace-supers": "^7.26.5",
        "@babel/helper-skip-transparent-expression-wrappers": "^7.25.9",
        "@babel/traverse": "^7.26.9",
        "semver": "^6.3.1"
      },
      "engines": {
```

```
      "node": ">=6.9.0"
     },
     "peerDependencies": {
      "@babel/core": "^7.0.0"
     }
    },
    "node_modules/@babel/helper-create-class-features-
plugin/node_modules/semver": {
     "version": "6.3.1",
     "resolved": "https://registry.npmjs.org/semver/-/semver-6.3.1.tgz",
     "integrity": "sha512-
BR7VvDCVHO+q2xBEWskxS6DJE1qRnb7DxzUrogb71CWoSficBxYsiAGd+Kl0
mmq/MprG9yArRkyrQxTO6XjMzA==",
     "license": "ISC",
     "bin": {
      "semver": "bin/semver.js"
     }
    },
    "node_modules/@babel/helper-create-regexp-features-plugin": {
     "version": "7.26.3",
     "resolved": "https://registry.npmjs.org/@babel/helper-create-regexp-features-
plugin/-/helper-create-regexp-features-plugin-7.26.3.tgz",
     "integrity": "sha512-
G7ZRb40uUgdKOQqPLjfD12ZmGA54PzqDFUv2BKImnC9QIfGhIHKvVML0oN
8IUiDq4iRqpq74ABpvOaerfWdong==",
     "license": "MIT",
     "dependencies": {
      "@babel/helper-annotate-as-pure": "^7.25.9",
      "regexpu-core": "^6.2.0",
      "semver": "^6.3.1"
     },
     "engines": {
      "node": ">=6.9.0"
     },
     "peerDependencies": {
      "@babel/core": "^7.0.0"
     }
    },
    "node_modules/@babel/helper-create-regexp-features-
plugin/node_modules/semver": {
     "version": "6.3.1",
     "resolved": "https://registry.npmjs.org/semver/-/semver-6.3.1.tgz",
     "integrity": "sha512-
BR7VvDCVHO+q2xBEWskxS6DJE1qRnb7DxzUrogb71CWoSficBxYsiAGd+Kl0
```

```
mmq/MprG9yArRkyrQxTO6XjMzA==",
      "license": "ISC",
      "bin": {
        "semver": "bin/semver.js"
      }
    },
    "node_modules/@babel/helper-define-polyfill-provider": {
      "version": "0.6.3",
      "resolved": "https://registry.npmjs.org/@babel/helper-define-polyfill-provider/-
/helper-define-polyfill-provider-0.6.3.tgz",
      "integrity": "sha512-
HK7Bi+Hj6H+VTHA3ZvBis7V/6hu9QuTrnMXNybfUf2iiuU/N97I8VjB+KbhFF8
Rld/Lx5MzoCwPCpPjfK+n8Cg==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-compilation-targets": "^7.22.6",
        "@babel/helper-plugin-utils": "^7.22.5",
        "debug": "^4.1.1",
        "lodash.debounce": "^4.0.8",
        "resolve": "^1.14.2"
      },
      "peerDependencies": {
        "@babel/core": "^7.4.0 || ^8.0.0-0 <8.0.0"
      }
    },
    "node_modules/@babel/helper-member-expression-to-functions": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-member-expression-to-
functions/-/helper-member-expression-to-functions-7.25.9.tgz",
      "integrity": "sha512-
wbfdZ9w5vk0C0oyHqAJbc62+vet5prjj01jjJ8sKn3j9h3MQQlflEdXYvuqRWjHnM
12coDEqiC1IRCi0U/EKwQ==",
      "license": "MIT",
      "dependencies": {
        "@babel/traverse": "^7.25.9",
        "@babel/types": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-module-imports": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-module-imports/-/helper-
```

```
module-imports-7.25.9.tgz",
      "integrity": "sha512-
tnUA4RsrmflIM6W6RFTLFSXITtl0wKjgpnLgXyowocVPrbYrLUXSBXDgTs8Blb
mIzIdlBySRQjINYs2BAkiLtw==",
      "license": "MIT",
      "dependencies": {
        "@babel/traverse": "^7.25.9",
        "@babel/types": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-module-transforms": {
      "version": "7.26.0",
      "resolved": "https://registry.npmjs.org/@babel/helper-module-transforms/-
/helper-module-transforms-7.26.0.tgz",
      "integrity": "sha512-
xO+xu6B5K2czEnQye6BHA7DolFFmS3LB7stHZFaOLb1pAwO1HWLS8fXA+eh
0A2yIvltPVmx3eNNDBJA2SLHXFw==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-module-imports": "^7.25.9",
        "@babel/helper-validator-identifier": "^7.25.9",
        "@babel/traverse": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0"
      }
    },
    "node_modules/@babel/helper-optimise-call-expression": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-optimise-call-expression/-
/helper-optimise-call-expression-7.25.9.tgz",
      "integrity": "sha512-
FIpuNaz5ow8VyrYcnXQTDRGvV6tTjkNtCK/RYNDXGSLlUD6cBuQTSw43CSh
GxjvfBTfcUA/r6UhUCbtYqkhcuQ==",
      "license": "MIT",
      "dependencies": {
        "@babel/types": "^7.25.9"
      },
```

```
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-plugin-utils": {
      "version": "7.26.5",
      "resolved": "https://registry.npmjs.org/@babel/helper-plugin-utils/-/helper-
plugin-utils-7.26.5.tgz",
      "integrity": "sha512-
RS+jZcRdZdRFzMyr+wcsaqOmld1/EqTghfaBGQQd/WnRdzdlvSZ//kF7U8VQTxf
1ynZ4cjUcYgjVGx13ewNPMg==",
      "license": "MIT",
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-remap-async-to-generator": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-remap-async-to-
generator/-/helper-remap-async-to-generator-7.25.9.tgz",
      "integrity": "sha512-
IZtukuUeBbhgOcaW2s06OXTzVNJR0ybm4W5xC1opWFFJMZbwRj5LCk+ByYH
7WdZPZTt8KnFwA8pvjN2yqcPlgw==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-annotate-as-pure": "^7.25.9",
        "@babel/helper-wrap-function": "^7.25.9",
        "@babel/traverse": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0"
      }
    },
    "node_modules/@babel/helper-replace-supers": {
      "version": "7.26.5",
      "resolved": "https://registry.npmjs.org/@babel/helper-replace-supers/-/helper-
replace-supers-7.26.5.tgz",
      "integrity": "sha512-
bJ6iIVdYX1YooY2X7w1q6VITt+LnUILtNk7zT78ykuwStx8BauCzxvFqFaHjOpW
1bVnSUM1PN1f0p5P21wHxvg==",
      "license": "MIT",
```

```
      "dependencies": {
        "@babel/helper-member-expression-to-functions": "^7.25.9",
        "@babel/helper-optimise-call-expression": "^7.25.9",
        "@babel/traverse": "^7.26.5"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0"
      }
    },
    "node_modules/@babel/helper-skip-transparent-expression-wrappers": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-skip-transparent-
expression-wrappers/-/helper-skip-transparent-expression-wrappers-7.25.9.tgz",
      "integrity": "sha512-
K4Du3BFa3gvyhzgPcntrkDgZzQaq6uozzcpGbOO1OEJaI+EJdqWIMTLgFgQf6lrfi
DFo5FU+BxKepI9RmZqahA==",
      "license": "MIT",
      "dependencies": {
        "@babel/traverse": "^7.25.9",
        "@babel/types": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-string-parser": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-string-parser/-/helper-
string-parser-7.25.9.tgz",
      "integrity": "sha512-
4A/SCr/2KLd5jrtOMFzaKjVtAei3+2r/NChoBNoZ3EyP/+GlhoaEGoWOZUmFmoI
TP7zOJyHIMm+DYRd8o3PvHA==",
      "license": "MIT",
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-validator-identifier": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-validator-identifier/-
/helper-validator-identifier-7.25.9.tgz",
```

```
      "integrity": "sha512-
Ed61U6XJc3CVRfkERJWDz4dJwKe7iLmmJsbOGu9wSloNSFttHV0I8g6UAgb7q
nK5ly5bGLPd4oXZlxCdANBOWQ==",
      "license": "MIT",
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-validator-option": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-validator-option/-/helper-
validator-option-7.25.9.tgz",
      "integrity": "sha512-
e/zv1co8pp55dNdEcCynfj9X7nyUKUXoUEwfXqaZt0omVOmDe9oOTdKStH4Gm
Aw6zxMFs50ZayuMfHDKlO7Tfw==",
      "license": "MIT",
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helper-wrap-function": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/helper-wrap-function/-/helper-
wrap-function-7.25.9.tgz",
      "integrity": "sha512-
ETzz9UTjQSTmw39GboatdymDq4XIQbR8ySgVrylRhPOFpsd+JrKHIuF0de7GC
Wmem+T4uC5z7EZguod7Wj4A4g==",
      "license": "MIT",
      "dependencies": {
        "@babel/template": "^7.25.9",
        "@babel/traverse": "^7.25.9",
        "@babel/types": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      }
    },
    "node_modules/@babel/helpers": {
      "version": "7.26.9",
      "resolved": "https://registry.npmjs.org/@babel/helpers/-/helpers-7.26.9.tgz",
      "integrity": "sha512-
Mz/4+y8udxBKdmzt/UjPACs4G3j5SshJJEFFKxlCGPydG4JAHXxjWjAwjd09tf6oI
Nvl1VfMJo+nB7H2YKQ0dA==",
      "license": "MIT",
```

```
    "dependencies": {
      "@babel/template": "^7.26.9",
      "@babel/types": "^7.26.9"
    },
    "engines": {
      "node": ">=6.9.0"
    }
  },
  "node_modules/@babel/parser": {
    "version": "7.26.9",
    "resolved": "https://registry.npmjs.org/@babel/parser/-/parser-7.26.9.tgz",
    "integrity": "sha512-
81NWa1njQblgZbQHxWHpxxCzNsa3ZwvFqpUg7P+NNUU6f3UU2jBEg4OlF/J6r
l8+PQGh1q6/zWScd001YwcA5A==",
    "license": "MIT",
    "dependencies": {
      "@babel/types": "^7.26.9"
    },
    "bin": {
      "parser": "bin/babel-parser.js"
    },
    "engines": {
      "node": ">=6.0.0"
    }
  },
  "node_modules/@babel/plugin-bugfix-firefox-class-in-computed-class-key": {
    "version": "7.25.9",
    "resolved": "https://registry.npmjs.org/@babel/plugin-bugfix-firefox-class-in-
computed-class-key/-/plugin-bugfix-firefox-class-in-computed-class-key-
7.25.9.tgz",
    "integrity": "sha512-
ZkRyVkThtxQ/J6nv3JFYv1RYY+JT5BvU0y3k5bWrmuG4woXypRa4PXmm9Rh
OwodRkYFWqC0C0cqcJ4OqR7kW+g==",
    "license": "MIT",
    "dependencies": {
      "@babel/helper-plugin-utils": "^7.25.9",
      "@babel/traverse": "^7.25.9"
    },
    "engines": {
      "node": ">=6.9.0"
    },
    "peerDependencies": {
      "@babel/core": "^7.0.0"
    }
```

```
    },
    "node_modules/@babel/plugin-bugfix-safari-class-field-initializer-scope": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/plugin-bugfix-safari-class-field-initializer-scope/-/plugin-bugfix-safari-class-field-initializer-scope-7.25.9.tgz",
      "integrity": "sha512-MrGRLZxLD/Zjj0gdU15dfs+HH/OXvnw/U4jJD8vpcP2CJQapPEv1IWwjc/qMg7ItBlPwSv1hRBbb7LeuANdcnw==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0"
      }
    },
    "node_modules/@babel/plugin-bugfix-safari-id-destructuring-collision-in-function-expression": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/plugin-bugfix-safari-id-destructuring-collision-in-function-expression/-/plugin-bugfix-safari-id-destructuring-collision-in-function-expression-7.25.9.tgz",
      "integrity": "sha512-2qUwwfAFpJLZqxd02YW9btUCZHl+RFvdDkNfZwaIJrvB8Tesjsk8pEQkTvGwZXLqXUx/2oyY3ySRhm6HOXuCug==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0"
      }
    },
    "node_modules/@babel/plugin-bugfix-v8-spread-parameters-in-optional-chaining": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/plugin-bugfix-v8-spread-parameters-in-optional-chaining/-/plugin-bugfix-v8-spread-parameters-in-optional-
```

```
chaining-7.25.9.tgz",
      "integrity": "sha512-
6xWgLZTJXwilVjlnV7ospI3xi+sl8lN8rXXbBD6vYn3UYDlGsag8wrZkKcSI8G6K
gqKP7vNFaDgeDnfAABq61g==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.25.9",
        "@babel/helper-skip-transparent-expression-wrappers": "^7.25.9",
        "@babel/plugin-transform-optional-chaining": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.13.0"
      }
    },
    "node_modules/@babel/plugin-bugfix-v8-static-class-fields-redefine-readonly": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/plugin-bugfix-v8-static-class-
fields-redefine-readonly/-/plugin-bugfix-v8-static-class-fields-redefine-readonly-
7.25.9.tgz",
      "integrity": "sha512-
aLnMXYPnzwwqhYSCyXfKkIkYgJ8zv9RK+roo9DkTXz38ynIhd9XCbN08s3MG
vqL2MYGVUGdRQLL/JqBIeJhJBg==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.25.9",
        "@babel/traverse": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0"
      }
    },
    "node_modules/@babel/plugin-proposal-class-properties": {
      "version": "7.18.6",
      "resolved": "https://registry.npmjs.org/@babel/plugin-proposal-class-properties/-
/plugin-proposal-class-properties-7.18.6.tgz",
      "integrity": "sha512-
cumfXOF0+nzZrrN8Rf0t7M+tF6sZc7vhQwYQck9q1/5w2OExlD+b4v4RpMJFaV1
Z7WcDRgO6FqvxqxGlwo+RHQ==",
```

```
    "deprecated": "This proposal has been merged to the ECMAScript standard and thus this plugin is no longer maintained. Please use @babel/plugin-transform-class-properties instead.",
    "license": "MIT",
    "dependencies": {
      "@babel/helper-create-class-features-plugin": "^7.18.6",
      "@babel/helper-plugin-utils": "^7.18.6"
    },
    "engines": {
      "node": ">=6.9.0"
    },
    "peerDependencies": {
      "@babel/core": "^7.0.0-0"
    }
  },
  "node_modules/@babel/plugin-proposal-decorators": {
    "version": "7.25.9",
    "resolved": "https://registry.npmjs.org/@babel/plugin-proposal-decorators/-/plugin-proposal-decorators-7.25.9.tgz",
    "integrity": "sha512-smkNLL/O1ezy9Nhy4CNosc4Va+1wo5w4gzSZeLe6y6dM4mmHfYOCPolXQPHQxonZCF+ZyebxN9vqOolkYrSn5g==",
    "license": "MIT",
    "dependencies": {
      "@babel/helper-create-class-features-plugin": "^7.25.9",
      "@babel/helper-plugin-utils": "^7.25.9",
      "@babel/plugin-syntax-decorators": "^7.25.9"
    },
    "engines": {
      "node": ">=6.9.0"
    },
    "peerDependencies": {
      "@babel/core": "^7.0.0-0"
    }
  },
  "node_modules/@babel/plugin-proposal-nullish-coalescing-operator": {
    "version": "7.18.6",
    "resolved": "https://registry.npmjs.org/@babel/plugin-proposal-nullish-coalescing-operator/-/plugin-proposal-nullish-coalescing-operator-7.18.6.tgz",
    "integrity": "sha512-wQxQzxYeJqHcfppzBDnm1yAY0jSRkUXR2z8RePZYrKwMKgMlE8+Z6LUno+bd6LvbGh8Gltvy74+9pIYkr+XkKA==",
    "deprecated": "This proposal has been merged to the ECMAScript standard and thus this plugin is no longer maintained. Please use @babel/plugin-transform-
```

nullish-coalescing-operator instead.",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.18.6",
        "@babel/plugin-syntax-nullish-coalescing-operator": "^7.8.3"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-proposal-numeric-separator": {
      "version": "7.18.6",
      "resolved": "https://registry.npmjs.org/@babel/plugin-proposal-numeric-separator/-/plugin-proposal-numeric-separator-7.18.6.tgz",
      "integrity": "sha512-ozlZFogPqoLm8WBr5Z8UckIoE4YQ5KESVcNudyXOR8uqIkliTEgJ3RoketfG6pmzLdeZF0H/wjE9/cCEitBl7Q==",
      "deprecated": "This proposal has been merged to the ECMAScript standard and thus this plugin is no longer maintained. Please use @babel/plugin-transform-numeric-separator instead.",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.18.6",
        "@babel/plugin-syntax-numeric-separator": "^7.10.4"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-proposal-optional-chaining": {
      "version": "7.21.0",
      "resolved": "https://registry.npmjs.org/@babel/plugin-proposal-optional-chaining/-/plugin-proposal-optional-chaining-7.21.0.tgz",
      "integrity": "sha512-p4zeefM72gpmEe2fkUr/OnOXpWEf8nAgk7ZYVqqfFiyIG7oFfVZcCrU64hWn5xp4tQ9LkV4bTIa5rD0KANpKNA==",
      "deprecated": "This proposal has been merged to the ECMAScript standard and thus this plugin is no longer maintained. Please use @babel/plugin-transform-

optional-chaining instead.",
"license": "MIT",
"dependencies": {
"@babel/helper-plugin-utils": "^7.20.2",
"@babel/helper-skip-transparent-expression-wrappers": "^7.20.0",
"@babel/plugin-syntax-optional-chaining": "^7.8.3"
},
"deprecated": "This proposal has been merged to the ECMAScript standard and thus this plugin is no longer maintained. Please use @babel/plugin-transform-private-methods instead.",
"license": "MIT",
"dependencies": {
"@babel/helper-create-class-features-plugin": "^7.18.6",
"@babel/helper-plugin-utils": "^7.18.6"
},
"engines": {
"node": ">=6.9.0"
},
"peerDependencies": {
"@babel/core": "^7.0.0-0"
}

"engines": {
"node": ">=6.9.0"
},
"peerDependencies": {
"@babel/core": "^7.0.0-0"
}
},
"node_modules/@babel/plugin-proposal-private-methods": {
"version": "7.18.6",
"resolved": "https://registry.npmjs.org/@babel/plugin-proposal-private-methods/-/plugin-proposal-private-methods-7.18.6.tgz",
"integrity": "sha512-nutsvktDItsNn4rpGItSNV2sz1XwS+nfU0Rg8aCx3W3NOKVzdMjJRu0O5OkgDp3ZGICSTbgRpxZoWsxoKRvbeA==",
"deprecated": "This proposal has been merged to the ECMAScript standard and thus this plugin is no longer maintained. Please use @babel/plugin-transform-private-methods instead.",
"license": "MIT",
"dependencies": {
"@babel/helper-create-class-features-plugin": "^7.18.6",
"@babel/helper-plugin-utils": "^7.18.6"
},

```
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-proposal-private-property-in-object": {
      "version": "7.21.0-placeholder-for-preset-env.2",
      "resolved": "https://registry.npmjs.org/@babel/plugin-proposal-private-property-in-object/-/plugin-proposal-private-property-in-object-7.21.0-placeholder-for-preset-env.2.tgz",
      "integrity": "sha512-SOSkfJDddaM7mak6cPEpswyTRnuRltl429hMraQEglW+OkovnCzsiszTmsrlY//qLFjCpQDFRvjdm2wA5pPm9w==",
      "license": "MIT",
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-async-generators": {
      "version": "7.8.4",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-async-generators/-/plugin-syntax-async-generators-7.8.4.tgz",
      "integrity": "sha512-tycmZxkGfZaxhMRbXlPXuVFpdWlXpir2W4AMhSJgRKzk/eDlIXOhb2LHWoLpDF7TEHylV5zNhykX6KAgHJmTNw==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.8.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-bigint": {
      "version": "7.8.3",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-bigint/-/plugin-syntax-bigint-7.8.3.tgz",
      "integrity": "sha512-wnTnFlG+YxQm3vDxpGE57Pj0srRU4sHE/mDkt1qv2YJJSeUAec2ma4WLUnUPe
```

KjyrfntVwe/N6dCXpU+zL3Npg==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.8.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-class-properties": {
      "version": "7.12.13",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-class-properties/-/plugin-syntax-class-properties-7.12.13.tgz",
      "integrity": "sha512-fm4idjKla0YahUNgFNLCB0qySdsoPiZP3iQE3rky0mBUtMZ23yDJ9SJdg6dXTSDnulOVqiF3Hgr9nbXvXTQZYA==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.12.13"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-class-static-block": {
      "version": "7.14.5",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-class-static-block/-/plugin-syntax-class-static-block-7.14.5.tgz",
      "integrity": "sha512-b+YyPmr6ldyNnM6sqYeMWE+bgJcJpO6yS4QD7ymxgH34GBPNDM/THBh8iunyvKIZztiwLH4CJZ0RxTk9emgpjw==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.14.5"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-decorators": {
      "version": "7.25.9",

```
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-decorators/-
/plugin-syntax-decorators-7.25.9.tgz",
      "integrity": "sha512-
ryzI0McXUPJnRCvMo4lumIKZUzhYUO/ScI+Mz4YVaTLt04DHNSjEUjKVvbzQj
ZFLuod/cYEc07mJWhzl6v4DPg==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-flow": {
      "version": "7.26.0",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-flow/-/plugin-
syntax-flow-7.26.0.tgz",
      "integrity": "sha512-
B+O2DnPc0iG+YXFqOxv2WNuNU97ToWjOomUQ78DouOENWUaM5sVrmet9
mcomUGQFwpJd//gvUagXBSdzO1fRKg==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.25.9"
      },
      "engines": {
        "node": ">=6.9.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-import-assertions": {
      "version": "7.26.0",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-import-assertions/-
/plugin-syntax-import-assertions-7.26.0.tgz",
      "integrity": "sha512-
QCWT5Hh830hK5EQa7XzuqIkQU9tT/whqbDz7kuaZMHFl1inRRg7JnuAEOQ0Ur
0QUl0NufCk1msK2BeY79Aj/eg==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.25.9"
```

```
    },
"dependencies": {
      "@babel/helper-plugin-utils": "^7.25.9"
    },
    "engines": {
      "node": ">=6.9.0"
    },
"node_modules/@babel/plugin-syntax-json-strings": {
    "version": "7.8.3",
    "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-json-strings/-
/plugin-syntax-json-strings-7.8.3.tgz",
    "integrity": "sha512-
lY6kdGpWHvjoe2vk4WrAapEuBR69EMxZl+RoGRhrFGNYVK8mOPAW8VfbT/
ZgrFbXlDNiiaxQnAtgVCZ6jv30EA==",
    "license": "MIT",
    "dependencies": {
      "@babel/helper-plugin-utils": "^7.8.0"
    },

    "engines": {
      "node": ">=6.9.0"
    },
    "peerDependencies": {
      "@babel/core": "^7.0.0-0"
    }
  },
  "node_modules/@babel/plugin-syntax-import-attributes": {
    "version": "7.26.0",
    "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-import-attributes/-
/plugin-syntax-import-attributes-7.26.0.tgz",
    "integrity": "sha512-
e2dttdsJ1ZTpi3B9UYGLw41hifAubg19AtCu/2I/F1QNVclOBr1dYpTdmdyZ84Xiz
43BS/tCUkMAZNLv12Pi+A==",
    "license": "MIT",
    "dependencies": {
      "@babel/helper-plugin-utils": "^7.25.9"
    },
    "engines": {
      "node": ">=6.9.0"
    },
"node_modules/@babel/plugin-syntax-json-strings": {
    "version": "7.8.3",
    "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-json-strings/-
/plugin-syntax-json-strings-7.8.3.tgz",
```

```
      "integrity": "sha512-
lY6kdGpWHvjoe2vk4WrAapEuBR69EMxZl+RoGRhrFGNYVK8mOPAW8VfbT/
ZgrFbXlDNiiaxQnAtgVCZ6jv30EA==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.8.0"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-jsx": {
      "version": "7.25.9",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-jsx/-/plugin-
syntax-jsx-7.25.9.tgz",

      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-import-meta": {
      "version": "7.10.4",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-import-meta/-
/plugin-syntax-import-meta-7.10.4.tgz",
      "integrity": "sha512-
Yqfm+XDx0+Prh3VSeEQCPU81yC+JWZ2pDPFSS4ZdpfZhp4MkFMaDC1UqseoovEKwSUpnIL7+vK+Clp7bfh0iD7g==",
      "license": "MIT",
      "dependencies": {
        "@babel/helper-plugin-utils": "^7.10.4"
      },
      "peerDependencies": {
        "@babel/core": "^7.0.0-0"
      }
    },
    "node_modules/@babel/plugin-syntax-json-strings": {
      "version": "7.8.3",
      "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-json-strings/-
/plugin-syntax-json-strings-7.8.3.tgz",
      "integrity": "sha512-
lY6kdGpWHvjoe2vk4WrAapEuBR69EMxZl+RoGRhrFGNYVK8mOPAW8VfbT/
ZgrFbXlDNiiaxQnAtgVCZ6jv30EA==",
      "license": "MIT",
      "dependencies": {
```

```
      "@babel/helper-plugin-utils": "^7.8.0"
     },
     "peerDependencies": {
      "@babel/core": "^7.0.0-0"
     }
    },
    "node_modules/@babel/plugin-syntax-jsx": {
     "version": "7.25.9",
     "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-jsx/-/plugin-
syntax-jsx-7.25.9.tgz",
     "integrity": "sha512-
ld6oezHQMZsZfp6pWtbjaNDF2tiiCYYDqQszHt5VV437lewP9aSi2Of99CK0D0X
B21k7FLgnLcmQKyKzynfeAA==",
     "license": "MIT",
     "dependencies": {
      "@babel/helper-plugin-utils": "^7.25.9"
     },
     "engines": {
      "node": ">=6.9.0"
     },
     "peerDependencies": {
      "@babel/core": "^7.0.0-0"
     }
    },
    "node_modules/@babel/plugin-syntax-logical-assignment-operators": {
     "version": "7.10.4",
     "resolved": "https://registry.npmjs.org/@babel/plugin-syntax-logical-
assignment-operators/-/plugin-syntax-logical-assignment-operators-7.10.4.tgz",
     "integrity": "sha512-
    },
    "node_modules/@babel/plugin-transform-export-namespace-from": {
     "version": "7.25.9",
     "resolved": "https://registry.npmjs.org/@babel/plugin-transform-export-
namespace-from/-/plugin-transform-export-namespace-from-7.25.9.tgz",
     "integrity": "sha512-
2NsEz+CxzJIVOPx2o9UsW1rXLqtChtLoVnwYHHiB04wS5sgn7mrV45fWMBX0
Kk+ub9uXytVYfNP2HjbVbCB3Ww==",
     "license": "MIT",
     "dependencies": {
      "@babel/helper-plugin-utils": "^7.25.9"
     },
"resolved": "https://registry.npmjs.org/@babel/plugin-transform-private-methods/-
/plugin-transform-private-methods-7.25.9.tgz",
     "integrity": "sha512-
```

D/JUozNpQLAPUVusvqMxyvjzllRaF8/nSrP1s2YGQT/W4LHK4xxsMcHjhOGTS0
1mp9Hda8nswb+FblLdJornQw==",
"license": "MIT",
"dependencies": {
"@babel/helper-create-class-features-plugin": "^7.25.9",

"license": "MIT",
"dependencies": {
"@babel/helper-plugin-utils": "^7.25.9"
},

"engines": {
"node": ">=6.9.0"
},
"peerDependencies": {
"@babel/core": "^7.0.0-0"
}
},
"node_modules/@babel/plugin-transform-flow-strip-types": {
"version": "7.26.5",
"resolved": "https://registry.npmjs.org/@babel/plugin-transform-flow-strip-
types/-/plugin-transform-flow-strip-types-7.26.5.tgz",
"integrity": "sha512-
eGK26RsbIkYUns3Y8qKl362juDDYK+wEdPGHGrhzUl6CewZFo55VZ7hg+CyM
FU4dd5QQakBN86nBMpRsFpRvbQ==",
"license": "MIT",
"dependencies": {
"@babel/helper-plugin-utils": "^7.26.5",
"@babel/plugin-syntax-flow": "^7.26.0"
},
"engines": {
"node": ">=6.9.0"
},
"peerDependencies": {

"resolved": "https://registry.npmjs.org/@babel/plugin-transform-private-
methods/-/plugin-transform-private-methods-7.25.9.tgz",
"integrity": "sha512-
D/JUozNpQLAPUVusvqMxyvjzllRaF8/nSrP1s2YGQT/W4LHK4xxsMcHjhOGTS0
1mp9Hda8nswb+FblLdJornQw==",
"license": "MIT",
"dependencies": {
"@babel/helper-create-class-features-plugin": "^7.25.9",

"license": "MIT",
"dependencies": {
"@babel/helper-plugin-utils": "^7.25.9"
},
"engines": {
"node": ">=6.9.0"
},
"peerDependencies": {
"@babel/core"

CHAPTER 8

REFERENCE

Abbaspour, Mohammadreza, Qadir Esmaili, and Abas Ramiar. 2024. “Improving Vertical Solar Still Performance for Efficient Desalination: Investigating the Influence of Wick, Condensate Plate and Device Dimensions.” *Solar Energy* 272 (April):112468. https://doi.org/10.1016/j.solener.2024.112468.

Ai, Zhong, Yunliang Zhao, Licai Chen, Tong Wen, Shaoxian Song, and Tingting Zhang. 2022. “Floating MMT/MXene Janus Membrane for Solar Steam Generation and Mechanism of Improving Water Transportation by DFT Calculation.” *Separation and Purification Technology* 300 (November):121918. https://doi.org/10.1016/j.seppur.2022.121918.

Alenezi, Anwur, and Yousef Alabaiadly. 2023. “A Comprehensive Review of Performance Augmentation of Solar Stills Using Common Non-Metallic Nanofluids.” *Sustainability* 15 (13): 10122. https://doi.org/10.3390/su151310122.

AlMehrzi, Meera, Alaa Shaheen, Aya Ghazal, Noora Almarzooqi, Aikifa Raza, Tiejun Zhang, and Faisal AlMarzooqi. 2024. “Photothermal ZrN Composite Membranes for Solar-Driven Water Distillation.” *Journal of Environmental Chemical Engineering* 12 (5): 113763. https://doi.org/10.1016/j.jece.2024.113763.

Arunkumar, T., Hyeong Woo Lim, David Denkenberger, and Sang Joon Lee. 2022. “A Review on Carbonized Natural Green Flora for Solar Desalination.” *Renewable and Sustainable Energy Reviews* 158 (April):112121. https://doi.org/10.1016/j.rser.2022.112121.

Boucanova, Marcelo de P., Caio V. P. Vital, Diego Rativa, and Luis A. Gómez-Malagón. 2022. “Single Slope Solar Distiller Performance Using Metallic Nanofluids.” *Solar Energy* 245 (October):1–10. https://doi.org/10.1016/j.solener.2022.08.065.

Chekifi, Tawfiq, and Moustafa and Boukraa. 2023. “Solar Still Productivity Improvement Using Nanofluids: A Comprehensive Review.” *International Journal of Ambient Energy* 44 (1): 1396–1416. https://doi.org/10.1080/01430750.2023.2174185.

Chen, Shilin, Chang Geun Yoo, Dongjie Yang, Xueqing Qiu, and Dafeng Zheng. 2023. “Multifunctional Lignin-Mediated Biomass Hybrid Aerogel with Plasmon-Enhanced Solar-Driven Desalination and Sewage Purification.” *Desalination* 556 (June):116572. https://doi.org/10.1016/j.desal.2023.116572.

Chen, Wenjing, Jiaying Zhou, Fan Zhang, Xiaoke Li, and Junyuan Guo. 2023. “Stability Study of Low-Cost Carbon Quantum Dots Nanofluids with Saline Water and Their Application Investigation for the Performance Improvement of Solar Still.” *Diamond and Related Materials* 138 (October):110194. https://doi.org/10.1016/j.diamond.2023.110194.

Chen, Zhenhui, Yue Lin, Qun Qian, Penghao Su, Yi Ding, Phan Dinh Tuan, Lisu Chen, and Daolun Feng. 2022. “Picosecond Laser Treated Aluminium Surface for Photothermal Seawater Desalination.” *Desalination* 528 (April):115561. https://doi.org/10.1016/j.desal.2022.115561.

CiFci, Ahmet. 2024. “HARNESSING MACHINE LEARNING AND EXPLAINABLE AI FOR ACCURATE RECURRENCE PREDICTION IN DIFFERENTIATED THYROID CANCER.” *International Conference on Technology and Science* 18 (20).

Du, Yuping, Jin Wen, Kuan Deng, Lie Zou, Xuesong Liu, Peng Liu, Binyang Liu, Xingbin Lv, Wen Tian, and Junyi Ji. 2023. “Janus Film Evaporator with Improved Light-Trapping and Gradient Interfacial Hydrophilicity toward Sustainable Solar-Driven Desalination and Purification.” *Separation and Purification Technology* 322 (October):124312. https://doi.org/10.1016/j.seppur.2023.124312.

Elashmawy, Mohamed, Mohamed M. Z. Ahmed, Wissam H. Alawee, S. Shanmugan, and Z. M. Omara. 2024. “Scientometric Analysis and Review of Materials Affecting Solar Still Performance.” *Results in Engineering* 23 (September):102574. https://doi.org/10.1016/j.rineng.2024.102574.

Ghafurian, Mohammad Mustafa, Mohammad Reza Malmir, Zohreh Akbari, Mohammad Vafaei, Hamid Niazmand, Elaheh K. Goharshadi, Atefe Ebrahimi, and Omid Mahian. 2022. “Interfacial Solar Steam Generation by Sawdust Coated with W Doped VO2.” *Energy* 244 (April):123146. https://doi.org/10.1016/j.energy.2022.123146.

Guo, Haoxiang, Peng Yan, Xuhui Sun, Jiangnan Song, Fengbo Zhu, Xiaoyu Guan, Swellam W. Sharshir, et al. 2024. “Ion-Engineered Solar Desalination: Enhancing Salt

Resistance and Activated Water Yield." *Chemical Engineering Journal* 485 (April):149918. https://doi.org/10.1016/j.cej.2024.149918.

Hamzat, Abdulhammed K., Mayowa I. Omisanya, Ahmet Z. Sahin, Oluremilekun Ropo Oyetunji, and Nafiu Abolade Olaitan. 2022. "Application of Nanofluid in Solar Energy Harvesting Devices: A Comprehensive Review." *Energy Conversion and Management* 266 (August):115790. https://doi.org/10.1016/j.enconman.2022.115790.

Hu, Xiaoyun, Jianfang Yang, Yufei Tu, Zhen Su, Qingqing Guan, and Zhiwei Ma. 2024. "Hydrogel-Based Interfacial Solar-Driven Evaporation: Essentials and Trails." *Gels* 10 (6): 371. https://doi.org/10.3390/gels10060371.

Huang, Xiaopeng, Lingxiao Li, Xia Zhao, and Junping Zhang. 2023. "Highly Salt-Resistant Interfacial Solar Evaporators Based on Melamine@Silicone Nanoparticles for Stable Long-Term Desalination and Water Harvesting." *Journal of Colloid and Interface Science* 646 (September):141–49. https://doi.org/10.1016/j.jcis.2023.05.035.

Kang, Qianru, Yiwei Zhai, Fangbo Zhao, Liu Yang, Ye Yang, Hee-Deung Park, Zhiguo Li, Hongxu Chen, and Gaohui Sun. 2024. "Salt-Resistant and Antibacterial Polyvinyl Alcohol/Chitosan/Silver-Loaded Graphene Oxide Electrospun Nanofiber Membrane for High-Efficiency Solar-Driven Desalination." *Chemical Engineering Research and Design* 205 (May):107–17. https://doi.org/10.1016/j.cherd.2024.03.042.

Kaviti, Ajay Kumar, Siva Ram Akkala, Michal Jeremias, Michael Pohorely, and Vineet Singh Sikarwar. 2024. "Submerged Nanoporous Anodized Alumina Structure for Solar-Powered Desalination." *Environmental Science and Pollution Research* 31 (30): 43186–97. https://doi.org/10.1007/s11356-024-33971-x.

Khan, Faisal, Munawar Nawab Karimi, and Osama Khan. 2023. "Exploring the Scalability and Commercial Viability of Biosynthesized Nanoparticles for Cooling Panels with the Help of Artificial Intelligence and Solar Energy Systems." *Green Technologies and Sustainability* 1 (3): 100036. https://doi.org/10.1016/j.grets.2023.100036.

Kumar, Manish, Pallavi Kadian, Kanchan Kumari, Rajat Sharma, and Jaspreet Kaur Randhawa. 2024. "Efficient Solar-Powered Evaporator with Multifunctional Nanofiber." *Desalination* 583 (August):117646. https://doi.org/10.1016/j.desal.2024.117646.

lafta, Alaa M., and Karima E. Amori. 2022. "Hydrogel Materials as Absorber for Improving Water Evaporation with Solar Still, Desalination and Wastewater Treatment." *Materials Today: Proceedings*, International Conference on Latest Developments in Materials & Manufacturing, 60 (January):1548–53. https://doi.org/10.1016/j.matpr.2021.12.061.

Lawrence, A., C. Hariharan, A. Nagamani Prabu, and B. Janarthanan. 2021. “Influence of Nickel Oxide Nanoparticles on the Absorption Enhancement of Solar Radiation for Effective Distillation by Single Slope Wick-Type Solar Still.” *Materials Today: Proceedings*, International Conference on Advances in Materials Research - 2019, 45 (January):2357–63. https://doi.org/10.1016/j.matpr.2020.10.704.

Li, Jiwei, Benchi Ma, Hongxia Wang, Yizhou Zhu, Yujie Gu, and Dengwei Jing. 2024. “A Novel Photovoltaic-Thermal System Based on Spectral Splitting of Nanoparticle Suspensions for Simultaneous Hydrogen Production and Seawater Desalination.” *Energy Conversion and Management* 314 (August):118670. https://doi.org/10.1016/j.enconman.2024.118670.

Li, Yinan, Chenglong Fu, Zhaoqiang Wang, Liulian Huang, Lihui Chen, Guangfu Liao, Qinghong Zheng, and Yonghao Ni. 2024. “Novel Cellulose-Based Films with Highly Efficient Photothermal Performance for Sustainable Solar Evaporation and Solar-Thermal Power Generation.” *Journal of Cleaner Production* 458 (June):142416. https://doi.org/10.1016/j.jclepro.2024.142416.

Li, Yushan, Ting Wu, Hui Shen, Shiwen Yang, Yi Qin, Zongmin Zhu, Long Zheng, Xianjie Wen, Minggui Xia, and Xianze Yin. 2022. “Flexible MXene-Based Janus Porous Fibrous Membranes for Sustainable Solar-Driven Desalination and Emulsions Separation.” *Journal of Cleaner Production* 347 (May):131324. https://doi.org/10.1016/j.jclepro.2022.131324.

Li, Zichen, Dazhen Li, Shuxia Wei, Xin Jin, Zheng Zhang, Lin Liu, Yuanyuan Ge, and Zhili Li. 2024. “Chitosan-Derived Carbon Aerogel Modified with Lignin Carbon Quantum Dots for Efficient Solar Evaporation.” *Chemical Engineering Journal* 486 (April):150157. https://doi.org/10.1016/j.cej.2024.150157.

Liu, Changhui, Long Geng, Tong Xiao, Qingyi Liu, Shuqi Zhang, Hafiz Muhammad Ali, Mohsen Sharifpur, and Jiateng Zhao. 2023. “Recent Advances of Plasmonic Nanofluids in Solar Harvesting and Energy Storage.” *Journal of Energy Storage* 72 (November):108329. https://doi.org/10.1016/j.est.2023.108329.