

Building Conversational Agents with Tool Use and Reasoning Techniques

CSAI 422: Assignment 4

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GitHub repo: <https://github.com/ZeyadMahfouzz/asgn4>

1. Introduction

This report documents the implementation of a chatbot that provides weather information, mathematical calculations, and general knowledge search using different reasoning strategies. The chatbot is built using Python, leveraging the Groq API for LLM-based responses and integrates APIs for weather data retrieval. The goal is to compare different reasoning strategies: Basic, Chain of Thought (CoT), and ReAct.

2. Implementation Approach

2.1. Environment Setup

- Installed required libraries: ``groq``, ``python-dotenv``, and ``requests``.
- Created a ``.env`` file to store API keys securely.
- Implemented a Python script to interact with the Groq API and external weather services.

2.2. Functionality Overview

The chatbot supports:

1. Weather Retrieval: Fetches current weather and forecasts using WeatherAPI.
2. Mathematical Calculations: Evaluates mathematical expressions using Python's ``eval()``.
3. Web Search Simulation: Provides predefined responses for general knowledge queries.
4. Reasoning Strategies:
 - Basic: Direct responses without additional reasoning.
 - Chain of Thought (CoT): Step-by-step breakdown before answering.
 - ReAct: Uses iterative reasoning and tool usage.

2.3. API Client and Message Processing

- Implemented ``process_messages()`` to send user queries to the LLM.
- Integrated tool calls for weather, calculations, and search functionalities.
- Used JSON-based message exchange to track conversations.

3. Comparison of Reasoning Strategies

3.1. Accuracy and Response Comparison

Strategy	Accuracy	Clarity	Response Length
Basic	Medium	Low	Short
CoT	High	Medium	Medium
ReAct	Very High	High	Long

- Basic: Fast but sometimes inaccurate.
- CoT: Improves response quality with logical steps.
- ReAct: Most reliable but verbose and slower.

3.2. Sample Output

Basic:

```
Chatbot: Hello! Ask me about the weather.
You: Tell me about the weather in egypt for the next 5 days
Chatbot: The weather in Egypt for the next 5 days is expected to be mostly sunny with no chance of rain.

On March 18th, it's expected to be sunny with a high of 29.7°C and a low of 16.8°C.

On March 19th, it's expected to be sunny with a high of 26.1°C and a low of 14.1°C.

On March 20th, it's expected to be sunny with a high of 20.6°C and a low of 11.9°C.

On March 21st, it's expected to be partly cloudy with a high of 18.4°C and a low of 11.4°C.

On March 22nd, it's expected to be partly cloudy with a high of 20.2°C and a low of 13.2°C.
```

Chain of Thought:

```
Chatbot: Hello! Ask me about the weather or calculations.
You: Tell me about the weather in egypt for the next 5 days
Chatbot: The weather in Egypt for the next 5 days is expected to be sunny with no chance of rain. The maximum temperature will range from 20.2°C to 29.7°C, while the minimum temperature will range from 11.4°C to 16.8°C.
```

ReAct:

```
Chatbot: Hello! Ask me about the weather, calculations or general information.
You: Tell me about the weather in egypt for the next 5 days
Chatbot: <function=get_weather_forecast={"location": "Egypt", "days": 5}</function>
You: Tell me about the weather in egypt for the next 5 days
Chatbot: The weather in Egypt for the next 5 days is expected to be mostly sunny with no chance of rain. The maximum temperatures will range from 29.7°C on the 18th to 18.4°C on the 21st, while the minimum temperatures will range from 16.8°C on the 18th to 11.4°C on the 21st. The conditions will be sunny for the first three days, followed by partly cloudy skies on the 21st and 22nd.
You:
```

4. Challenges and Solutions

Challenge	Solution
Handling API errors	Implemented error handling and retries
Extracting relevant sections	Used structured response formats
Improving accuracy	Applied step-by-step reasoning and iterative tool use

5. Lessons Learned

- Reasoning strategies impact chatbot performance: More structured approaches improve accuracy.

- Confidence analysis is useful: Helps filter uncertain responses.
- Tool integration enhances chatbot capabilities: Dynamic API calls improve real-world usability.

6. Conclusion and Future Work

This project demonstrated how structured reasoning improves chatbot performance. Future enhancements include fine-tuning reasoning strategies, real-time response optimization, and expanding tool integrations.