

LLM Project - report

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1 Introduction

The overarching goal of this project is to develop a Large Language Model (LLM) agent capable of gathering data from various sources to generate stock market recommendations for users. In doing so, it is crucial to consider the ethical and societal implications associated with such an application. Additionally, this project aims to propose strategies for incorporating a broad range of perspectives into the development process.

2 Ethical and Societal considerations

2.1 Understanding Myself and My Role

I am passionate about automation and drawn to technologies that simplify workflows. My coding background and hobbyist interest in the stock market inspired me to explore the intersection of finance and AI. This project, which involves building an AI-powered stock analysis app, aligns with my aspiration to work in the financial technology sector.

My goal is to create a tool that helps individuals stay informed about market trends and make data-driven decisions, even with limited time for research. By automating financial research—like tracking stock performance and analyzing news—the app aims to democratize access to financial insights. I recognize the importance of balanced data in AI, and I strive to make investing more accessible and user-friendly for everyone.

2.2 Online Ethics Canvas

To consider all the stakeholders and potential ethical and societal consequences, I have decided to use the Online Ethics Canvas framework, which can be found in my github repository (with username of mibrix) in the references. My focus has been on conceptualizing a theoretical LLM application that serves as a large-scale financial stock advisor, rather than merely a course project. To effectively include all stakeholders, I suggest distributing the canvas to as many individuals as possible to encourage their contributions. Additionally, organizing a gamified

workshop where participants from various backgrounds and financial interests can brainstorm and add new ideas to the canvas would be highly beneficial. Implementing a feature in the app that allows users to effortlessly provide feedback directly would also enhance stakeholder engagement.

Below is a summary of the ideas I have developed to incorporate into the canvas.

Individuals Affected

At the core of this application is a stock trading app designed for everyday users. These users include individuals who may not have time for in-depth updates, as well as those who wish to learn about stock trading. For instance, busy individuals appreciate an application that provides concise and informative notes. Moreover, investors from diverse backgrounds, including women and other minorities, feel encouraged by the opportunity to engage with financial markets. By using the app, they can take significant steps to overcome the challenges that have previously held them back.

Behaviour

However, this increased accessibility may lead to behavioral changes among users. Some may begin to accept the app's suggestions without further investigation, which could result in underdeveloped critical thinking skills. For example, an investor might be ready to execute a transaction based on the app's recommendations, assuming they are sufficient, regardless of potential market fluctuations. Conversely, some users actively engage with the app's educational features, improving their understanding of financial concepts. This illustrates that self-awareness and the practical application of knowledge can differ significantly.

Relations

The app also enhances interaction among users. When individuals share opinions and investment tips, a new dynamic develops within their social networks. For instance, family members may begin discussions about investments, impacting their collective decisions rather than viewing investing as an individual endeavor. Additionally, experienced investors may take on mentorship roles, guiding novices on how to use the app and fostering a supportive environment. These relationships highlight how technology can facilitate connections and enhance interactions among those interested in financial success.

What Can We Do?

To mitigate the potential negative effects of the application, certain safeguards can be implemented. Continuous monitoring of algorithms can help eliminate inconsistencies in data tailored for specific segments of the app. There is a

normalization of inclusion, as more individuals engage with the platform, enhancing overall inclusivity. Educating users about trading risks instills a sense of responsibility. Such initiatives can build trust with users and enhance their overall experience.

Worldviews

This application has the potential to shift users' perceptions of investing. Users may start to view investing as a more accessible activity rather than a domain reserved for the upper class. The app encourages users to consider the ethical practices of the companies they invest in, reinforcing the notion that financial literacy is an essential skill for everyone.

Group Conflicts

While the app presents numerous benefits, it may also lead to group conflicts. For instance, if the app disproportionately favors developed market stocks, it could unintentionally alienate users interested in emerging markets. These tensions highlight the importance of considering diverse attitudes toward the application from various groups.

Groups Affected

Multiple groups are involved in developing the financial AI application. The most active group consists of users seeking to make informed investment choices, alongside market data analysis professionals.

Product or Service Failure

The risk of product or service failure is inherent in any technology project. Technical errors could result in poor investment decisions, leading to significant losses for users. If many users experience frequent app downtime, their trust may diminish, prompting them to seek alternative investment tools. This loss of trust could trigger a domino effect, causing users to act on misinformation that influences market trends. Therefore, it is crucial to ensure the app's reliability, as well as users' ability to manage their investments effectively.

Problematic Use of Resources

Finally, the application's resource consumption raises additional concerns. The high demands of real-time data processing may lead to increased energy consumption and higher greenhouse gas emissions. Additionally, a short-sighted approach to resource management can result in insufficient monitoring of market-based opportunities for rational investments. The costs associated with updating and redesigning the app—both financial and human—can be burdensome for many organizations, including nonprofits, raising questions about resource allocation and mission effectiveness.

3 Technical Implementation

For the technical implementation of the LLM-based app, I chose to build it using the Python library Langchain, which offers a range of powerful features. Langchain is particularly suited for constructing LLM agents that can retrieve data from various sources and generate responses based on user prompts.

For the user interface, I used the Streamlit library. Streamlit provides an easy way to develop features such as side panels with user instructions, background images, and other UI components, making it ideal for creating interactive applications.

As for the LLM model, I utilized the "gemini-1.5-flash" model, which allows a generous number of requests per minute. This is crucial since the agent needs to process multiple data sources, often requiring more than one prompt per interaction. The model's temperature is set to 0, which ensures deterministic output, although the results might not be exactly replicable due to varying inputs (e.g., different news articles may be available on different days).

3.1 Langchain

I defined three core functions that the LLM agent uses to generate a response:

- `get_financial_statements(ticker)`: Retrieves the last three financial statements of a given company using the well-known `yfinance` library.
- `get_stock_price(ticker)`: Retrieves the historical stock prices for the last year of a given company, also using the `yfinance` library.
- `get_recent_stock_news(ticker)`: Retrieves recent news summaries and metadata related to a company's stock, using the `Finnhub` API.

Next, a prompt template is defined for the agent, which is used when it receives a user query. The agent calls the aforementioned functions to retrieve the necessary data and assess whether the user should buy, hold, or sell the asset in question. Prompt template can be seen in the picture below.

```
# Adding predefined evaluation steps in the agent Prompt
stock_prompt="You are a financial advisor. Give stock recommendations for given query. You are not allowed to use dollar sign ($) in your answer but you can use the word dollar(s).

(tools)
Question: the input question you must answer
Thought: you should always think about what to do.
Action: the action to take, should be one of [[tool_names]]
Action Input: the input to the action
Observation: make an observation about the action you took.
... (this Thought/Action/Action Input/Observation can repeat N times, if Thought is empty go to the next Thought and skip Action/Action Input and Observation)
Thought: I now know the final answer
Final Answer: Break down the analysis into five distinct steps and write two paragraphs of text for each of the category :
Recent Performance, Market Sentiment, Financial Health, Growth Potential, Risk and
Overall advice either buy, sell or hold. (In the text use concrete prices, percentages, and reasons to justify your answer, and make references to concrete news articles):
Begin!

Question: {input}
Thought:{agent_scratchpad}"
```

Figure 1: Langchain instructions for the Agent

This process follows a step-by-step "thought" mechanism, where the LLM agent gathers the required data before forming a final recommendation. The

internal workings of Langchain are not fully documented, but an example of the agent's thought process looks like this:

1. Thought: I need to gather information about Amazon to make a recommendation. Action: `get_stock_price(AMZN)`.
2. Thought: I need more information about Amazon. Action: `get_recent_stock_news(AMZN)`.
3. Thought: I still need more information. Action: `get_financial_statements(AMZN)`.
4. Thought: I now have all the information to make a recommendation.

The final answer will be generated based on the agent's analysis. The output follows the structure defined in the template, which can be seen below in the appendix.

Another feature I implemented allows users to request further elaboration on specific parts of the agent's response. The additional details follow the same format as the initial response but provide more in-depth information on the particular section the user inquires about. For example, if a user asks, "Can you elaborate more on market sentiment and include the name of the article you used to generate the answer?" the agent adjusts its output for the **Market Sentiment** section as follows:

```
1 Market Sentiment: Market sentiment towards Amazon remains
    ↳ positive, with many analysts predicting continued
    ↳ growth in the coming years. The company's strong brand
    ↳ recognition, its dominant position in e-commerce, and
    ↳ its growing presence in cloud computing and other
    ↳ emerging markets are all seen as key drivers of future
    ↳ growth. However, some analysts are concerned about
    ↳ the company's high valuation and its dependence on
    ↳ consumer spending, which could be impacted by a
    ↳ potential recession. For example, an article titled "
    ↳ Can Amazon Stay Ahead of PDD's Temu ad Shein in 2024?"
    ↳ published on December 27, 2023, highlights the
    ↳ potential competition Amazon faces from new players in
    ↳ the e-commerce market.
```

The article referenced for this analysis is titled "*Can Amazon Stay Ahead of PDD's Temu and Shein in 2024?*" which can be found online [7].

This feature enables the agent to keep track of its previous responses, allowing the user to request clarification or further elaboration on the latest response.

3.2 Validation

In my opinion, the agent generates well-reasoned recommendations and explanations, considering both the pros and cons of a given company. The responses I reviewed provided accurate assessments of historical stock prices and data from financial reports. However, a more in-depth analysis would be necessary, including backtesting the recommendations to fully evaluate their performance, which goes beyond the scope of this course project.

3.3 User Interface

For the user interface, I utilized the Streamlit library, which allows for the creation of interactive web applications. A glimpse of the interface can be seen in the figure below:

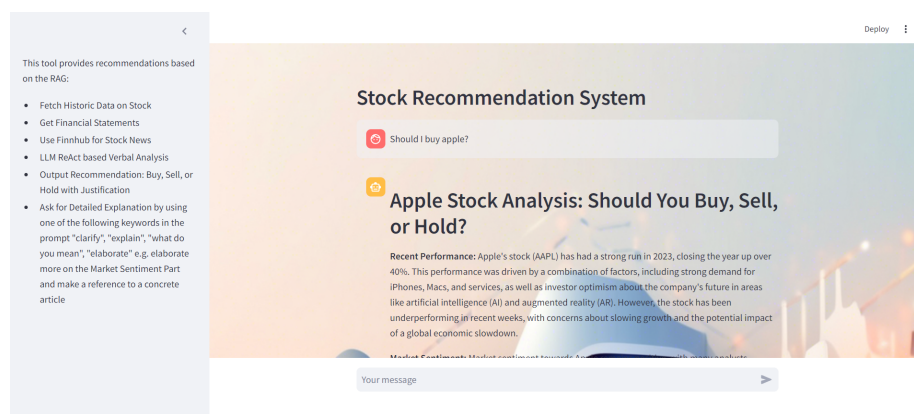


Figure 2: User interface of the LLM agent.

4 Conclusion

In this project, I have explored the societal and ethical aspects of a theoretical large-scale LLM agent used for stock market recommendations. Additionally, I designed a system to include stakeholders in the development of such an application.

I created a functional implementation of the LLM agent, complete with a user interface that I briefly tested. However, further validation of the agent's recommendations is necessary; for instance, backtesting these recommendations against actual price movements would be beneficial. Nevertheless, the agent encourages users to approach its recommendations with caution and consideration.

References

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- [6] Ethics Canvas. *Ethics Canvas*. <https://www.ethicscanvas.org/>.
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5 Appendix

```
1 Recent Performance: Amazon's stock price has been on an
  ↳ upward trend in recent months, rising from around 120
  ↳ dollars per share in October 2023 to over 180 dollars
  ↳ per share in June 2024. This strong performance is
  ↳ likely due to a combination of factors, including the
  ↳ company's continued growth in its cloud computing
  ↳ business (AWS), its expansion into new markets like
  ↳ healthcare, and the overall positive sentiment
  ↳ surrounding the tech sector. However, the stock has
  ↳ experienced a significant drop in August 2024, falling
  ↳ to around 160 dollars per share, likely due to
  ↳ concerns about the company's profitability and the
  ↳ potential impact of a recession.
2
3 Market Sentiment: Market sentiment towards Amazon remains
  ↳ positive, with many analysts predicting continued
  ↳ growth in the coming years. The company's strong brand
  ↳ recognition, its dominant position in e-commerce, and
  ↳ its growing presence in cloud computing and other
  ↳ emerging markets are all seen as key drivers of future
  ↳ growth. However, some analysts are concerned about
  ↳ the company's high valuation and its dependence on
  ↳ consumer spending, which could be impacted by a
  ↳ potential recession.
4
5 Financial Health: Amazon's financial health is strong, with
  ↳ a large amount of cash on hand and a growing revenue
  ↳ stream. The company's debt levels are also manageable,
  ↳ and its profitability has been improving in recent
  ↳ years. However, the company's high capital
  ↳ expenditures and its investments in new businesses are
  ↳ putting pressure on its bottom line.
6
```

7 Growth Potential: Amazon has significant growth potential in
 ↳ the coming years, driven by its continued expansion
 ↳ in e-commerce, cloud computing, and other emerging
 ↳ markets. The company's investments in artificial
 ↳ intelligence, robotics, and other technologies are
 ↳ also expected to drive future growth. However, the
 ↳ company faces stiff competition from other tech giants
 ↳ like Microsoft and Google, and its growth could be
 ↳ slowed by a potential recession.

8

9 Risk: The main risks associated with investing in Amazon
 ↳ include its high valuation, its dependence on consumer
 ↳ spending, and its competition from other tech giants.
 ↳ The company's investments in new businesses are also
 ↳ risky, and there is no guarantee that they will be
 ↳ successful.

10

11 Overall Advice: Despite the recent drop in the stock price,
 ↳ Amazon remains a strong company with significant
 ↳ growth potential. However, investors should be aware
 ↳ of the risks associated with the stock, including its
 ↳ high valuation and its dependence on consumer spending
 ↳ . For investors with a long-term horizon and a high
 ↳ risk tolerance, Amazon could be a good investment.
 ↳ However, investors with a shorter-term horizon or a
 ↳ lower risk tolerance may want to consider other
 ↳ investment options.

12

13 Now another feature I implemented is the capability of a
 ↳ user to elaborate more on a certain part. For instance
 ↳ , when a user prompts, "Can you elaborate more on
 ↳ market sentiment giving me also the name of the
 ↳ article based on which you generated the answer?" the
 ↳ agent outputs the adjusted section of Market Sentiment
 ↳ :

14

15 "Market Sentiment: Market sentiment towards Amazon remains
 ↳ positive, with many analysts predicting continued
 ↳ growth in the coming years. The company's strong brand
 ↳ recognition, its dominant position in e-commerce, and
 ↳ its growing presence in cloud computing and other
 ↳ emerging markets are all seen as key drivers of future
 ↳ growth. However, some analysts are concerned about
 ↳ the company's high valuation and its dependence on
 ↳ consumer spending, which could be impacted by a
 ↳ potential recession."