Capstone Project Final Paper

Title

Virtual Kathy: A conversational agent for the CS Department

Mentor

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Team Members

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1. **What programming language did you use? Why?**

In this project, Python was used as our primary programming language. To implement an AI-powered chatbot, we should use a programming language that is stable, flexible and has tools available. Python offers all of these. More importantly, both Machine learning and Deep learning rely on extremely complex algorithms and multi-stage workflows, Python, with its rich technology stack, has an extensive set of libraries for artificial intelligence and machine learning, which allows us to reach some useful functionality directly.

2. **Were there things about the choice of language you liked? Disliked?**

Python is a perfect programming language for our project. Its abundance of libraries and frameworks that facilitate coding and save development time really helps us get our chatbot off the ground. Natural language processing, machine learning, and deep learning are exceptionally well catered for. Additionally, the boto3 library allows us to easily integrate our chatbot application with AWS services (i.e., in our case, Amazon DynamoDB).

3. **What frameworks did you use?**

Virtual Kathy will be presented on a website within the pitt.cs domain so everybody from School of Computing and Information can use it. We used the Flask framework (Python) to develop the main frame/structure of the webpage and were taking full advantage of Flask's many addons such as Flask Bootstrap and Flask WTF Forms.

4. **What technical problems did you face?**

The biggest technical problem which was found during the implementation of chatbot is that the chatbot is created in such a way that it follows a specific route and very likely fails to satisfy anything outside of the previously defined scripts. This means that if they are not part of predefined scripts, there is a significant possibility that the bot will fail in understanding even the most fundamental kind of queries, which results in a repeating and horrendous experience. To resolve this issue, active learning can be introduced to the system to make probabilistic assessments and provide autonomous responses to the users. Active learning is an algorithm that interactively queries the user to obtain the desired output. Whenever a user asks anything which is outside of the script the chatbot will ask questions to the user by giving two to three options and based on the user's input, the bot returns the answer to that query. However, we have no time to get it done.

5. How did you ensure quality code?

To ensure the quality of our code, we would update our progress with everyone in the group so that we can all check out each other's code. If there are any confusion or problems, we would then solve the problem collaboratively. On top of that, each group member, before sharing their code with the group, tests their own code to make sure it meets the requirements.

6. What was the development process like?

The design process was divided into different parts among the group members. At the very beginning, each group member introduced their strength, and we divided the work according to that. One group member worked on the website design, one group member worked on the Python code and other group members worked on intents and databases.

Each member worked on their parts and designs separately and at the end, we combined our works together.

7. How did you communicate with other developers/testers/customers/etc?

The communication among team members was conducted through group chat. Group members could easily ask questions or update their progress in the group chat, and other group members would respond quickly. The group also held work sessions via zoom to discuss larger and more complicated problems or work on parts of the code/report. Communication with our sponsor was conducted through email and zoom meetings. The group only met the sponsor three times throughout the semester due to our sponsor's busy schedule, and each meeting lasted about thirty minutes. Our group has also spoken to Luis a couple of times to discuss the progress or other difficulties we had.

8. Did you have non-technical problems that you had to face?

A major non-technical problem we had was communicating with our sponsor. It was extremely difficult to arrange meetings with our sponsor due to Alex's busy schedule, so the group was deciding how to implement the project by ourselves, which in the end led to some unsatisfactory results. Other non-technical problems we had were also about communication: group members have their own schedules and sometimes group members are less responsive, which means we had to divide work into parts and work on them independently. The lack of communication was also the main problem we had throughout the entire development process.

9. What were the biggest challenges you faced during the capstone?

The biggest challenge we faced, other than communication, was to learn how to build a chatbot from scratch. Since we decided to go with the do it by ourselves approach, we had to learn lots of new skills in order to complete the project. We have also underestimated the difficulty of building a chatbot, so we would work on part of the code and later learn that we have taken the wrong approach.

10. Were you able to take what you learned during the capstone and apply it to classes? Conversely, were you able to use what you learned in class for the capstone project?

The answer to both questions would be yes. There were many skills we learned from classes that helped us to complete the project. Such skills include: databases, software quality assurance, algorithms and many others. It's very nice to see that the knowledge we gained from classes could be used to accomplish some real-life tasks. The converse is also true, we have all learned some new skills and lessons throughout the entire CAPSTONE semester: for example, I have never learned about databases before, and the skills I learned could definitely help me in my future classes. Additionally, the collaboration and communication skills we learned could also help us in future classes/work.

11. How did you design the software you were writing?

The virtual-Kathy project was divided into two parts, which are a web design and back-end implementation. *Virtual Kathy* will be presented on a website within the pitt.cs domain so everybody from School of Computing and Information can use it. We used the Flask framework (Python) to develop the main frame/structure of the webpage and were taking full advantage of Flask's many addons such as Flask Bootstrap and Flask WTF Forms. For

back-end implementation, once the project is complete, these files will be left. Train_Vkathy.py is to build and train the deep learning model that can classify and identify what the user is asking to the bot. Main.py is where the webpage we built that allows users to chat with our trained chatbot. Intents.json has all the data that we will use to train the model. It contains a collection of tags with their corresponding patterns and responses.

12. Did you present the project to customers? How did you plan for it?

We have not presented the complete final product to our sponsor yet. There have been issues with some group members tasks, or issues with scheduling, thus, we didn't have the chance to present the deliverable to Alex in a complete form during our two meetings. We have, however, shown parts of the project to Alex and asked for feedback towards the end of the semester. The group will present the complete project to Alex during final presentation time, as part of our presentation.

13. What was day-to-day life like?

The day-to-day life for our group was simple: we each get assigned some tasks to work on, and we would work on those tasks independently. For the most part, group members just worked on their tasks, and if anyone encountered problems, we would mention that in our group chat, where we collaboratively come up with a solution. When group members have completed their tasks, we would also update it in our group chat/GitHub, so that other members can take a look at it and provide some feedback. Every other week, we would meet with Luis or our sponsor to discuss our progress and report other problems we have.

14. Did you have a mentor? What did they teach you?

Yes, Alex is our mentor. He has been working on this project for two semesters. At the beginning of the semester, he pointed out a clear path of how we should start the project and what the product is going to be like. Alex was pretty busy, and we did not have a lot of chances to meet and update our work, but Alex was there to point out our problems and set us back to the correct path. Unfortunately, we only met him twice towards the end of the semester, where there were many features we didn't get to change/improve.

15. What was the worst part of the capstone project?

The worst part of the CAPSTONE project was perhaps the lack of guidance where we have to design the project from scratch. Also, the uncertainty of not knowing if we are doing things correctly or if our final product would work. Other than that, for lots of the group members, working in a group project is a new experience, so getting used to working in a group was challenging. The actual making of the chatbot and learning how to build the chatbot was very interesting.

16. How did you deal with ambiguity in requirements or direction?

If there is an ambiguity in requirements, our team members will communicate in the group chat about what we each think about the ambiguity in requirements. If we make an agreement, we will start working on it. If we are still not sure about the requirements, we would write an email to Alex and ask him if we can meet up and talk about it. Overall, we know our requirements pretty well after meeting with our mentor for the first time. Our team members also talked about the details while writing our project proposal. Alex gave us several suggestions about how he wanted us to improve our program, but our big direction did not go wrong at all.

17. Did you learn any interesting skills during the capstone project?

Absolutely, we learned a lot including but not limited to

- Communication — we applied constructive communication strategies and different communication tools to document work and advance the project.
- Collaboration — we recognized how individuals contribute differently to reaching team goals to complete the capstone project, supported different points of view, and identified steps or incentives for reaching team goals.
- Initiative — we have to teach ourselves some critical knowledge such as machine learning and natural language processing, and integrate them with skills and knowledge across several disciplines in order to complete the work required.

18. Conclusion and future work

To conclude, Virtual Kathy Chatbot is helpful in guiding students with correct and most up to date sources of information. It is advantageous for international applicants for queries such as fee payment and academic matters. Students can get the information at their fingertips rather than visiting department office. It improves efficiency by taking over tasks for which humans are not essential. However, the system was partially successful since the scope of these queries is vast and the system requires more rigorous data to handle all the questions which are out of the script.

To improve the current functionalities of Virtual Kathy Chatbot, in the future, the scope of the chatbot can be increased by inserting data for all the departments, training the bot with varied data, testing it on live website, and based on that feedback inserting more training data to the bot. Some of the new features which can be added to the bot are

- speech recognition feature through which students can ask their queries verbally and get the answers from the bot,

- active learning that helps to improve the bot performance for handling off-script queries,

- integration with multiple channels such as phone call, SMS, and various social media platforms like Skype, Facebook and Twitter,

- integration with services such as password reset and course enrollment, and

- adding a capability for the bot to perform analytics based on user's sentiment based on which the bot can be re-trained on human emotions so that more empathy can be added to the bot.