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C951 Introduction to Artificial Intelligence, Task 3.

Introduction.

As of August 24th, 2023, Western Governors University presents the introduction to a performance assessment as the following:

"Machine learning is the "science and art of programming computers so they can learn from data" (Géron, 2019, p. 1). Machine learning is a collection of approaches that automates analytical model building and supports the discovery of insights from data. This assumes that algorithms can learn and improve from data, including examples, direct experience, or instruction; identify relationships; and help make decisions with minimal interventions from the human user. It is the pivotal engine behind artificial intelligence efforts supporting supervised, unsupervised, and reinforced learning algorithms enabling the analysis of massive amounts of data.

While early forms of machine learning have existed for decades, in recent years the applications of machine learning fueled by vast new amounts of "big data" have grown exponentially. Advertisement placements, dating recommendations, genetic medicines, baseball, stock market investing, and self-driving cars are just a few domains that are heavily driven by machine learning technologies. Ethical issues are emerging from these developments that still have not been fully resolved by society. But one thing appears certain: machine learning is here to stay.

In this course you have read about many of the foundational concepts and techniques of machine learning. This task asks you create a detailed proposal concerning how machine learning techniques could be applied to a relevant data set of your choosing, what possible outcomes might be expected, and why such outcomes could be organizationally significant." (WGU, *NIP2 — NIP2 TASK 3: MACHINE LEARNING PROJECT PROPOSAL* 2023.)

Scenario.

As of August 24th, 2023, Western Governors University presents the scenario applicable to the introduction via a performance assessment as the following:

"In this assignment, you will assume the role of a recently hired machine learning engineer in an organization that has been asked to use available data to identify an organizational need that could be solved by machine learning. The organization then needs to outline a plan for designing and executing a machine learning model to solve this organizational need. You will explore available data sets and machine learning algorithms supporting the construction of a model that the organization would use, following the plan that you put together. You will outline the problem, the solution, and the project plan, as well as the framework for evaluating the success of the model and the project." (WGU, *NIP2 — NIP2 TASK 3: MACHINE LEARNING PROJECT PROPOSAL* 2023.)

Project Overview

Create a proposal for a machine learning project.

A1. Organizational Need

Describe an organizational need that your project proposes to solve.

Machine learning allows for better business functionality by providing artificial intelligence solutions specific to any organization. An internet service provider supplies Internet connectivity, assists customers, and troubleshoots service issues. The company wishes to improve its customer service consistently and automate assistance.

A2. Project Context and Background

Describe the context and background for your project.

An up-and-coming internet service provider in a growing city has experienced a consistently higher-than-average volume of calls to customer service representatives, resulting in long wait times and frustrated customers. The number of calls will continue to grow with the city. Employees have described some calls as 'quick fixes.' The employees suggested an artificial intelligence implementation to reduce the volume of calls and reduce wait times while providing solutions.

A3. Review of Background Works

Review three outside works that explore machine learning solutions that apply to the need described in part A1.

1. *'The Ultimate Guide to Machine-Learning Chatbots and conversational AI'* (IBM Watson Advertising, 2022.)

Summary:

The article above summarizes machine-learning chatbots and their tie to conversational artificial intelligence via International Business Machines (IBM). Using an AI chatbot, companies such as "Facebook's Messenger app and Google Assistant" to name a few, demonstrate chatbots effective use in real-world company applications (The Ultimate Guide to Machine-Learning Chatbots and Conversational AI: IBM Watson Advertising 2022). Additionally, the capabilities of a machine-learning chatbot along with rule-based, menu-based, hybrid, and keyword-based chatbots, stating, "…They enable users to ask advanced, open-ended questions and offer the most natural responses." The machine-learning chatbot capabilities are much-needed to assist in the company's efforts to improve customer service while automating assistance in a near-human aspect.

Work Done:

IBM provides a surface-level article as an advertisement introducing its machine-learning chatbot AI model, 'Watson Assistant'. While not a study case, the work done provides a thorough demonstration of describing a chatbot, and its implementation in real-world company applications and outside research into the chatbot market. The research looks into the chatbot market and provides market reasoning for a chatbot implementation for a company (Chatbot market size worth $27,297.2 million by 2030).

Technical Details:

The chatbot as a product brings 24/7/365 support to customers, regardless of whether the customer service representative team works with no downtime. Implementing conversational AI allows dynamic development to improve customer service while relieving human representatives of several calls. The size of a chatbot remains small while capable of an endless number of conversations. Additionally, the chatbot only reaches a physical limit by the hardware it operates on or contextual limits set in development.

2. '*An overview of chatbot technology*' (Adamopoulou et al., 2020.)

Summary:

The article above summarizes chatbots and how chatbots are involved in our daily lives, introducing AI as "intelligent agents." Adamopoulou et al, describe a key reason users use chatbots are that they are "productive." (Adamopoulou et al., 2020.) With this, Adamopoulou et al, describe the Natural Language Processing (NLP) field, for an algorithm seen later in the proposal. The company wishes to improve customer service by advancing efficiency and relocating volume, though customers will avoid an unproductive chatbot. Furthermore, the chatbot using the NLP algorithm is needed for the machine-learning solution as NLP generally develops the chatbot to understand human language and perform accordingly.

Work Done:

The article is a conference paper on the book, 'Artificial Intelligence Applications and Innovations', (Adamopoulou et al., 2020). Figure 1 in the article demonstrates the public use of machine-learning chatbots and their exponential growth over the years. The figure showcases why a fundamental understanding of chatbots in the real world is helpful, later introducing one of many fields commonly seen in machine-learning chatbots, Natural Language Processing (NLP), a field used for later algorithm declaration, 'sentiment analysis.'

Technical Details:

The evolution of the chatbot brings the need to understand how a chatbot operates. Motivated by this background work, the machine-learning solution proposes to demonstrate how implementation of a

chatbot for the company will improve customer service and assist automation using the mentioned NLP

by the sentiment analysis algorithm.

3. '*The New Chatbots Could Change The World. Can You Trust Them?*' (Metz, 2022.)

Summary:

The article above summarizes an artificial intelligence researcher's interaction with AI, a brief interview into a personal experience with AI, and top company response to accuracy issues AI presents. Published in December of 2022, Cade Metz, an editor for the New York Times interviewed Jeremy Howard, an artificial intelligence researcher who shared a personal interaction with their daughter's use of AI. Howard, expresses joy seeing their daughter interact with AI as humans are now learning from AI methods. However, Howard, clarifies with their daughter by stating "Don't trust everything it gives you. It can make mistakes." Later in the article, Metz writes that top companies "Google, Meta and other companies are also addressing accuracy issues…" with its AI. (Metz, 2022)

Work Done:

Metz writes a detailed report on a personal experience, along with top leaders in AI development, introducing that computers and machine-learning solutions alike do as we program them. The chatbots described at the highest level, at Google and Meta, should expect accuracy issues as the bigger the company, the more objectives.

Technical Details:

This proposal acknowledges that careful implementation with the machine-learning solution, and the actions the chatbot will perform will adapt over time but must remain in parallel with the company's goals and objectives.

A3a. Relation to Project Development

Describe how each reviewed work from part A3 relates to the development of your project.

1. '*The Ultimate Guide to Machine-Learning Chatbots and conversational AI*'

The emphasis on machine learning is necessary for why this chatbot is critical to the company's needs, stating, "…They enable users to ask, advanced, open-ended questions and offer the most natural responses. These chatbots continue to learn from conversations and improve their responses over time." (*The Ultimate Guide to Machine-Learning Chatbots and conversational AI: IBM Watson Advertising* 2022.) Quoted is critical for the AI chatbot's scope, as a chatbot should not be manually re-configured for a 'new' question identical to a question with an existing solution.

2. '*An overview of chatbot technology*'

Machine learning is the brain of the chatbot implemented. As stated, "…Knowledge of the understanding and use of human language is gathered to develop techniques that will make computers understand and manipulate natural expressions to perform desired tasks. Most NLP techniques are based on machine learning." (Adamopoulou et al., *An overview of chatbot technology* 2020.) When customers wish to find an answer, they equally do not desire repetitive rehearsal, one can assume. The chatbot must then develop to carefully navigate a conversation and successfully provide a solution appropriate for a situation, tying linguistics and AI together.

3. *'The New Chatbots Could Change The World. Can You Trust Them?'*

Regardless of the algorithm or the type of chatbot, many factors can come into play to produce an undesired response. Metz reports from an interviewee, an artificial intelligence researcher, that "…Don't trust everything it gives you. It can make mistakes." (Metz, *The New Chatbots Could Change The World. Can You Trust Them?* 2022.) The chatbot will relieve the stress on the customer service representatives, though by design if the chatbot cannot suggest a desired resolution, the chatbot will then advise to speak to a human representative, directly.

A4. Summary of the Machine Learning Solution

Summarize the machine learning solution you plan to use to address the organizational need described in part A1.

AI Chatbot:

The machine learning solution will use IBM's 'Watson Assistant', an AI chatbot. With machine learning, the chatbot welcomes many variations of the same question, brings diverse problem-solving, and adapts to conversation appropriately, to suit for the company's needs. The chatbot allows for easy integration as solutions are introduced by human-made descriptions of the action the chatbot needs to perform, an important feature of the plan, as helping a customer will vary on customer needs. As stated in part A3a, AI is not always correct. With the use of Watson, the chatbot can transfer to a human agent should the interaction require such.

Machine Learning Algorithm:

The machine learning solution will use an algorithm of the Natural Language Processing (NLP) field. NLP aims to understand interactions by words typed by a human in a chatbot interface. While NLP is a subfield of computer science algorithms, the machine learning solution will use 'sentiment analysis' via 'Decision Trees.' Decision Trees are made of a parent/decision node(s) then followed by children/leaf nodes attached by outcomes reached by branches. Parent nodes will represent an action such as the customer asking a question to the chatbot, then followed by child nodes where there is a match in a dataset, I.E, the question exists in the dataset, a, or the question does not exist in the dataset, b. Leaf nodes themselves could become parent nodes in the algorithm. Say, the question does not exist in the dataset, the chatbot may advise to speak with a human representative via phone call. Similarly, the question does exist in the dataset, then the chatbot makes appropriate recommendations. Should the recommendations be valid to the customer, the result in the dataset is aligned with positive sentiment.

A5. Benefits of the Machine Learning Solution

Describe the benefits of your proposed machine learning.

Benefits:

1. 24/7/365 access to customer service with a connection to the website (WI-FI, Cellular, etcetera.)

2. Self-serve customer service as communication is between the customer and chatbot.

3. Customer service in multiple languages.

4. Reduction to calls made directly to the human team with chatbot interaction, relieving team stress.

5. Reduced wait time for direct calls as assistance is now concurrently provided via chatbot implementation on the company website, re-locating customers from the phone callback/wait list.

Machine Learning Project Design

Describe your proposed machine learning project plan.

B1. Scope of Project

Define the scope of the proposed machine learning project.

Scope:

Inbounds:	Out of bounds:
Discovering a cost-friendly solution for automated assistance and customer service.	Live agent assistance/takeover through the chatbot.
Implementation of a machine-learning chatbot to the company website.	No chatbot involvement with customer personally identifiable information (PII), meaning payment, change of address, or government identification. PII exchange is for human representative directive or exclusive to the customer through the webpage.
Implementing the chatbot with a sentiment analysis algorithm, to increment on conversational intelligence.	Replace current customer service representatives.
Maintain the current customer service representatives.	Restructuring website to accommodate for the solution, the solution must work on the current website with ease.
Maintain the current company website, make the chatbot an add-on.	Sales automation/recommendation, I.E., upgrading plans.
	Public marketing. This is left to the marketing department of the company.

B2. Goals, Objectives, and Deliverables

Explain the goals, objectives, and deliverables for the proposed project.

Goals:

The long-term outcome of the project is to continuously provide quality customer service with automated assistance in the growing city the company resides. The automation, via a conversational chatbot, will use machine learning to produce quality conversations with customers similar to the current customer service representatives. The customer service automation also targets reduction in cost/hiring allocations for financial benefit.

Objectives:

1. Develop a cost-friendly solution to reduce the necessity of hiring extra human customer service representatives enabling the goal by automating assistance while assisting in cost/hiring allocations of extensive human resources.

2. Implement the IBM Watson Assistant chatbot AI with an end-of-interaction survey to meet a minimum acceptable accuracy percentage of eighty percent to enable the goal of providing quality customer service.

3. Integrate a sentiment analysis algorithm, an algorithm under Natural Language Processing, to better interact with customers as the chatbot learns to understand text in the same way as humans, for human-like customer service. The algorithm will enable the goal to both automate assistance and provide quality customer service as it learns to better interact with customers by classification of data.

Deliverables:

1.   A list of costs and resources for the development of the chatbot implementation must be procured.

   The long-term goal to provide quality customer service while automating assistance should then be

   less financially impactful than extensive hiring, saving the company money long-term.

2.   Documentation of the algorithm the chatbot uses, sentimental analysis, along with the standard

   methodology in order to keep the chatbot running properly with a supervised approach to the

   algorithm. Changes to the supervised algorithm then are influenced by the end-of-interaction survey

   to provide quality customer service. Proper documentation may assist in making changes to the

   solution.

3.   Documentation of the developmental/setup process for the chatbot and the infrastructure it resides

   on must be delivered in order to provide training/understanding. Proper documentation may assist in

   providing quality customer service representation overall.

B3. Standard Methodology

Explain how you will apply a standard methodology (e.g., CRISP-DM, SEMMA) to the implementation of your proposed project.

The 'Knowledge Discovery in Databases' (KDD) process has been chosen as the methodology for this project as it is iterative, improving on knowledge from data (customer conversation). KDD follows a pattern involving:

1. Data Cleaning

    i.   Cleaning data such that only data relevant to what the chatbot is to do remains often involving discrepancy or extensive variance cleaning.

2. Data Selection

    ii. Retrieval of data relevant to what the chatbot does (for Watson Assistant, what is defined with actions.)

3. Data Mining

    iii. Often referred as the core of KDD, extraction of data patterns useful to the chatbot should a pattern be significant to the chatbot.

4. Pattern Evaluation & Deployment

    iv. After the data is retrieved and effectively extracted as a pattern, the pattern is evaluated in ways useful to the implementor. As KDD is an iterative process, it allows for improvements over time.

B4. Timeline and Milestones

Provide a projected timeline for the proposed project, including the start and end dates for each task.

The projected timeline starts on September 1ˢᵗ, 2023 with an ending date of November 1ˢᵗ, 2023 with the following schedule:

Database, Knowledge Base setup, IBM Watsonx Code Assistant Webinar 09/01/2023 – 10/01/2023:

1. A considerable amount of the heavy lifting is done within the month as the database, with appropriate datasets, and the knowledge base create the context on which the chatbot operates. With this, attendance of Watsonx Code Assistant is needed to develop a supervised sentiment analysis model.

Website API integration, 10/01/2023 – 10/08/2023:

2. The chatbot will be implemented into the company's current website via HTML.

Testing & Refinement, 10/08/2023 – 10/15/2023:

3. Testing will happen against the API chatbot, with a note introduces the chatbot as in 'Beta' state.

Project closure, 10/15/2023 – 11/01/2023:

4. Over the last two weeks, final changes will be implemented iteratively until the first of November. Should the chatbot need further development, the deadline will then be extended.

B5. Resources and Costs

List resources (e.g., hardware, software, work hours, third-party services) and all associated costs

needed to implement the proposed solution.

Third-Party Services:

Watson Assistant:

1. $140 a month for Watson Assistant Plus, otherwise advised to meet with IBM to negotiate price.

    (*IBM Watson assistant pricing* 2023.)

IBM's Db2 Database Standard Plan

2. $99 a month, similar benefits as enterprise plan for a lower price. Database service provided as

    outsourced cloud (*DB2 database – pricing.*)

Hardware:

No additional hardware is needed as the implementation of the chatbot will be integrated on the

current company website. Hardware used is IBM's Db2 Database stored in IBM's cloud.

Software:

Microsoft Visual Studio Code

3. $0, needed for IBM Watsonx Code Assistant to implement supervised sentiment analysis model.

IBM Watsonx Code Assistant

4. $0, add-on to Visual Studio Code to assist in modeling the sentiment analysis into the Watson
   Assistant.

Work Hours:

5. Assuming an assembly for a team of at least ten employees, ranging from database specialists to
   customer service reps, the following lists an estimate for work hours:

   a. Database Specialist(s), 09/01/2023 – 10/01/2023, 160 hours at $30/hour = $4,800.00

   b. Webmaster, 10/01/2023 – 10/08/2023, 40 hours at $30/hour = $1200.00

   c. Quality Assurance Specialist(s), 10/08/2023 – 10/15/2023, 40 hours at $25/hour =
      $1,000.00

   d. Customer Service Rep(s), 10/15/2023 – 11/01/2023, 80 hours at $20/hour = $1600.00

Total projected cost: > $8,599.99 + 239.99 monthly

B6. Criteria for Successful Execution of Project

Describe the criteria that you will use to evaluate the success of the project once it is completed.

The success of the project will be compared against the following criteria:

Customer Service Representation:

      The goal of the project is to implement a chatbot, Watson Assistant, to help relieve stress on the current customer service representatives by reducing the volume of phone calls and wait times while maintaining a growing number of customers. Though some questions will require a phone call, the goal of the chatbot is to provide customer service for interactions that will be of similar or quicker time, avoiding wasting customer time while assisting human representatives. The success criterion for the chatbot experience will involve an end-of-interaction survey, with a goal of 80% (4/5^{ths} rating) customer satisfaction.

Labor Reduction:

      An additional goal of the project is to save money with a chatbot implementation that will answer questions that do not necessarily require a human representative. Though the implementation cost is nearly nine-thousand dollars, the monthly payments of approximately two-hundred-fifty dollars are more cost-effective than hiring for a ranging salary as the aggregate of customers grows.

Machine Learning Solution Design

Describe the proposed machine learning solution you will use to address the organizational need

identified in part A1.

C1. Hypothesis

*Identify the hypothesis of the proposed project.*

The implementation of Watson Assistant Chatbot AI will assist the company in customer service efforts improving the company overall. By reducing the volume of calls to the human representatives and wait times, the customers will have a better overall experience with efficient and effective communication via phone or the website chatbot. The feedback from each interaction with the AI's machine-learning structure and customer review will continue to improve the chatbot over time.

C2. Analytical Method

Identify the machine learning algorithm(s) (i.e., supervised, unsupervised, or reinforced learning) you

will implement in your proposed solution.

Machine Learning Algorithm:

Watson Assistant's selection of algorithms allows for supervised or unsupervised, as 'automatic retraining.' The machine-learning solution proposes to use a Natural Language Processing (NLP) method known as 'sentiment analysis,' with the help of 'Decision Trees'. The decision trees, will assist the development of the chatbot to analyze customer interaction to identify a customer interaction helpful or not, classifying such with positive or negative sentimental values. Sentiment analysis can be either a supervised or unsupervised model. As explained further in part C2a, the learning of choice is supervised. Sentiment analysis makes use of text analysis to identify and extract whether the text is positive, negative, or sometimes neutral. Supervised learning assists in real-world problems by classifying labeled datasets for training. Supervised learning is ideal as the customers need assistance with real-world problems.
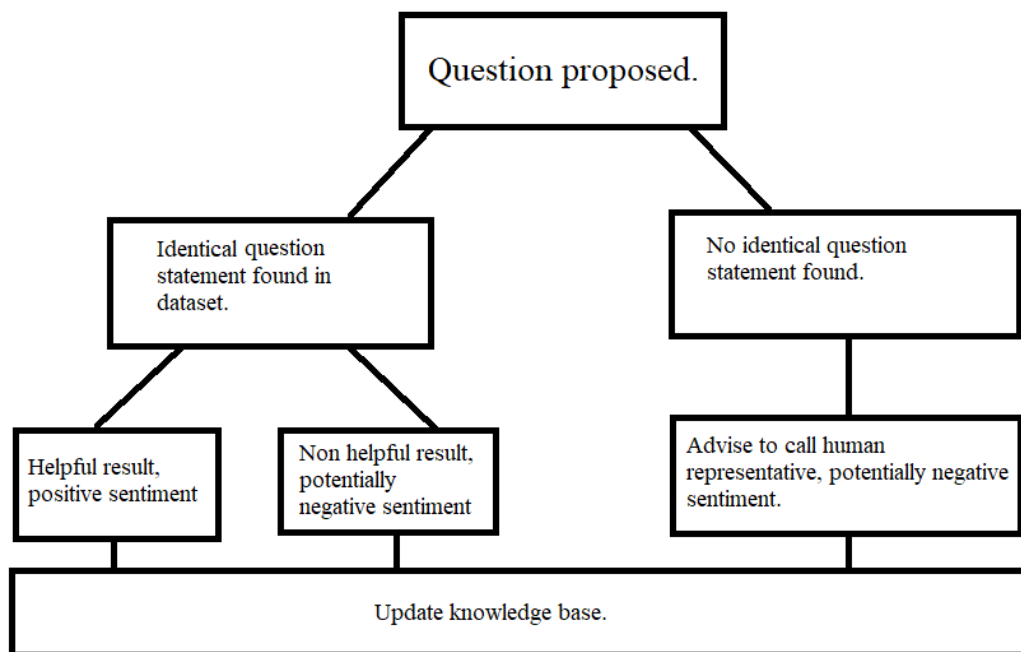
C2a. Justification of Algorithm Selection

Justify the selection of the algorithm in part C2. Include one advantage and one limitation of the selected machine learning method.

Advantage:

The selection of the Decision Trees algorithm will help deliver meaningful responses to customers as it learns whether a response is of positive or negative sentiment defined within the children leaf nodes reached by branches from the decision node, and build to collect positive responses and use them further. By learning questions a customer will ask, similarly, the sentiment of the problem response then relayed into the general dataset, the algorithm makes for better experiences with the company overall when a customer is in need of assistance. With supervised learning, the raw data a customer inputs will be classified into a dataset including correlated sentiment values to advance how the chatbot interacts with customers.

Limitation:

A limitation of 'Decision Trees' is a sudden change to the data in a dataset is unstable. Training a chatbot to recognize a when an outcome is of negative sentiment, will advance the intelligence to find relations to that data to be of negative sentiment similarly. If suddenly, the expectations of the chatbot where to change or a response to provide should no longer be provided, this will cause trouble for the solution as the chatbot has an "understanding" of what is "right" and it is no longer such, potentially providing incorrect solutions to customers.

C3. Tools and Environments of Solution

Describe the tools and environments that will be used to develop the proposed machine learning solution, including any third-party code.

Tools:

The solution will use two IBM tools mentioned in part B5, IBM's Watson Assistant and DB2 cloud database. The database is outsourced to IBM's DB2 cloud, and Watson Assistant is implemented via HTML. The HTML to start the chatbot will be via IBM's third-party code. The tools will implement no changes to the tools the webmaster uses for the website currently.

Environment:

The solution will provide IBM's database environment via web connectivity. Watson Assistant will integrate into the company website via IBM's third-party code (HTML) and make a minimal change to the current website environment.

C4. Measuring Performance

Explain the process you will use to measure the performance of your proposed machine learning solution.

In the second week of the projected timeline, the performance of the proposed machine learning solution is then extensively evaluated before official deployment. Doing so will guarantee a quality chatbot that will continue evaluation as it is supervised (the foundation of the algorithm) and assessed by the end-of-interaction reviews provided by the customer's experience. Upon official release, the performance measures can be overseen by, but not limited to, customer service representatives, webmasters, higher management, etc. The measures then are evaluated for the need for changes to the algorithm. Changes are then made with documentation of the algorithm in mind, mentioned in part B2 under the second deliverable.

Description of Data Set(s)

Describe the data of your proposed project.

D1. Source of Data

Identify the source(s) of the data for your proposed project.

Initial Data:

The data source will need to be a preliminary implementation of data for the actions the chatbot is to perform as the chatbot does not know the business rules as a blank canvas. Following the development of the model, the dataset will be defined in-house and implemented with data to begin the training process. In the initial data, the sentiment of a conversation will be classified internally.

Recursive Data:

The data source is self-generating from real-time conversations with customers. Each interaction with a customer will improve the chatbot through its supervised sentiment analysis model as it continues to redefine appropriate responses and learn to interact similarly to a human.

D2. Data Collection Method

Describe the data collection method.

The collection of data will stem from the conversations the chatbot has with a customer. These interactions then directly go to the database to follow the KDD methodology. The KDD methodology once proposed for pattern evaluation has a direct impact on how the chatbot will continue to conversate in future customer interactions.

D2a. Advantages and Limitations

Discuss one advantage and one limitation of the data collection method described in part D2.

Advantage:

The collection of data provides the database with a history of conversations and has a thorough process to improve all interactions iteratively. The more conversations the chatbot has, the better objectively the chatbot becomes as all interactions vary by what the expected outcome should be and will be.

Limitation:

A limitation of the data collection method is the fact that text has no tone. While the chatbot will adapt to interactions in principle, the processing of emotion will not be consistently stable; The chatbot will absolutely 'evolve' with more interactions, yet can only assume the tone of the conversation and navigate accordingly. Although unlikely to affect the general actions the chatbot may perform, the data must not go unsupervised for an extensive period of time.

D3. Quality and Completeness of Data

Explain how you will prepare your data for use by the machine learning algorithm(s) from part C2 for your proposed project, including data set formatting, missing data, outliers, dirty data, or mitigation of other data anomalies.

For the chatbot to function as desired, the format that format the data set uses must be beneficial to the functionality of the chatbot. In the data set, there will be columns set for natural language text, a general intent for how the chatbot should identify the text, and where the text is from e.g., customer name, expected results, final results e.g., (outage mapping or redirect advising), and sentiment. Dirty data will move to the database regardless and be cleaned out later before the pattern evaluation and deployment, as all data will then be assessed and assist in the iterative development of the chatbot.

D4. Precautions for Sensitive Data

Describe behaviors that should be exercised when working with and communicating about sensitive data in your project.

As previously mentioned in part B1, the solution is not to handle conversations containing PII. In part D3, the data set will contain expected and final destinations about what the customer wishes to know or where the customer should be on the website. Should a customer result in going to the account information page of the company website containing personally identifiable information, the chatbot will notify the customer of the end-of-conversation and not exist in the redirected site. If PII data were to be communicated to the chatbot, since the chatbot has no design to conversate upon this information, the chatbot will process the data as a string of text as 'NULL – unallowed conversation' to the first column in the data set (natural language text) rather than storing the PII in the database where it does not belong.

E. Sources

Acknowledge sources, using in-text citations and references, for content that is quoted, paraphrased, or summarized.

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F. Professional Communication

Demonstrate professional communication in the content and presentation of your submission.

Thank you for your time. All questions/comments/concerns are best posted through the evaluation,

otherwise:

    Email: acoots5@wgu.edu