

Chatbot Project Report

By: Harshith Nanda & Charith Muppidi

What is our Chatbot?

Our chatbot is named Inflation Bot. Inflation Bot is knowledgeable about the post-pandemic Inflation surge, and you can ask it various questions regarding the causes of the inflation, responses, and its relation to unemployment. However, this isn't all it can do. Inflation bot also has the added functionality to talk about the weather (which is extremely limited to only weather this week, which I will expand on later) and tell jokes/riddles!

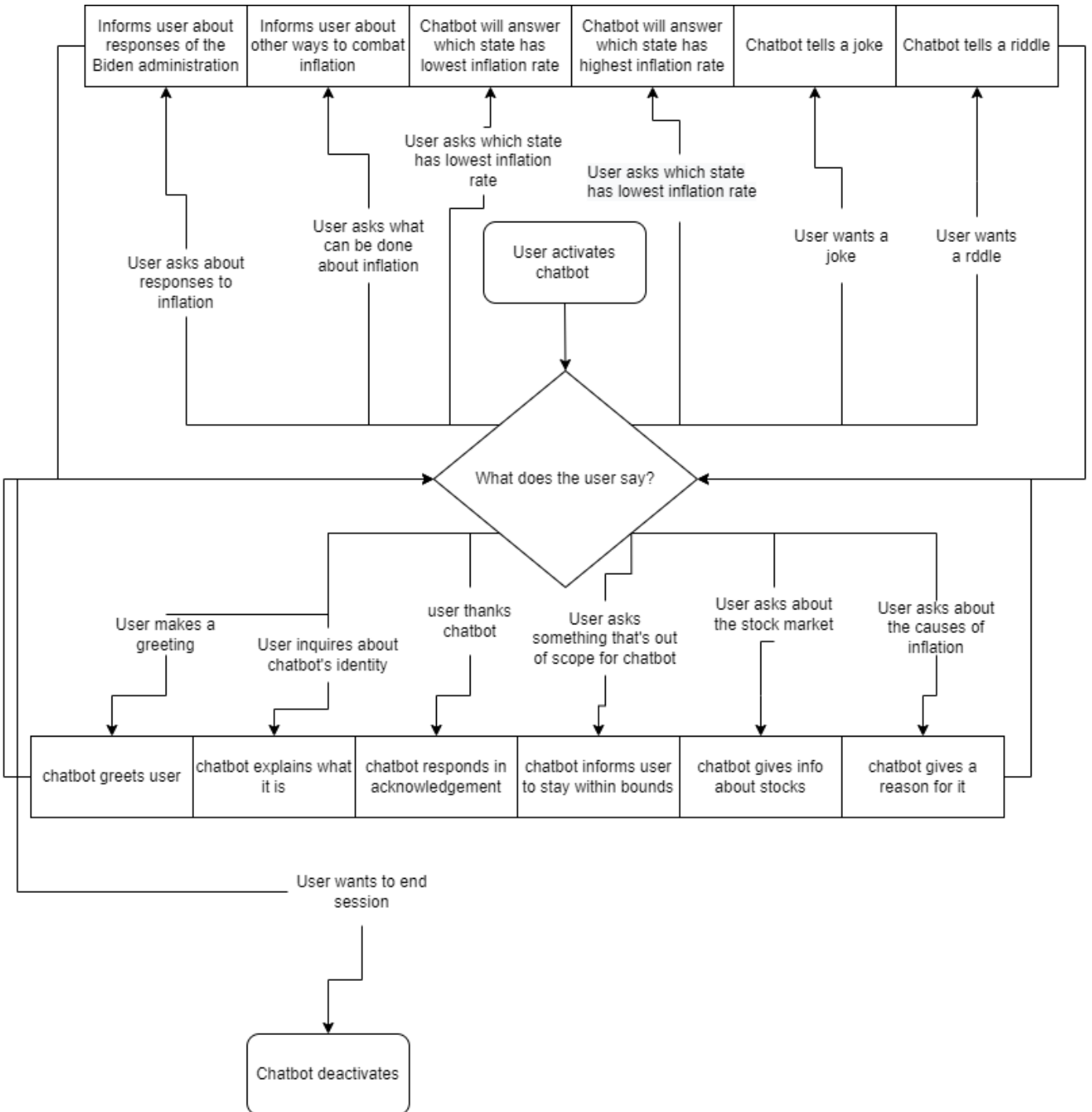
How to run Inflation Bot:

- The chatbot folder contains three programs, "webcrawler.py", "neural_network.py", and "InflationBot.py". You only need the last two programs to run the bot.
- First, run "neural_network.py" (download any nltk packages if prompted by an error), which builds and trains the neural network, then run "InflationBot.py", which uses the deep learning model to run the actual bot.
- First you'll be prompted to enter a username. Enter a random name, then you'll be able to talk to the bot. You can't enter the same username because users are stored in a dictionary with the username as the hash. I was not able to add functionality for users to store multiple conversations under the same username due to bugs and issues with pickling, but I will in the future. The dictionary is stored as a pickle file (named "users.pkl" in the folder after you run InflationBot.py), so it remembers users each time the bot is run. However, it will be reset when the neural network is run again.
- You can type "End" to end the conversation. Once it ends, the file "Conversation.txt" (which documents your conversation) will both be stored as a pickle and will be available in regular txt format in the folder.
- Once you've run the bot multiple times, you can take the pickle file from the folder and unpickle it with a simple command (pickle.load() function) and print the dictionary, which contains all of your user data.

NLP Techniques and How Inflation Bot works

- We made a chatbot using [NeuralNine](#)'s code as a baseline, but made changes to the pre-processing step, neural network itself, and the functions to process user input in order to improve accuracy and better fit the knowledge base we're using.
- Inflation bot's knowledge base is stored in the "intents.json" file.
- First we take the knowledge base and tokenize the patterns and lemmatize the tokenized words to get unique tokens without the excessive aggression that a stemmer might bring. This is to ensure that we simplify the input as much as possible without losing meaning.
- Then, we used the [NLP technique called "bag-of-words"](#) to feed the words into a neural network. We used 1s and 0s to represent whether a specified word occurs in a given pattern associated with a tag. This is our way of converting qualitative data into quantitative data and having that be used for textual outputs. What the neural network does is use the training data to recognize that each tag (category) is associated with a certain pattern of 1s and 0s (which represents keywords that occur in each tag).
- For our machine learning algorithm, we used a Sequential model from Keras with the first and last dense layer having inputs and outputs shaped to match the knowledge base with two different activation functions sigmoid and softmax. There are two dense layers in-between of 64 and 128 neurons each respectively, and two dropout layers to prevent overfitting. We used the Adam optimizer, which boasts the highest accuracy with the lowest training time.
- The model is then used to interpret input from the user, classify the input by returning the tag most likely to be associated, then identify the appropriate output.

Logic Diagram



Sample Dialog Interactions

```
InflationBot is online! You may talk.
Hello
1/1 [=====] - 0s 83ms/step
Good to see you again! I'm Inflation bot, and I'm excited to be your friend!
How are you
1/1 [=====] - 0s 14ms/step
Hi there. I'm Inflation Bot! How may I help?
I want to know what's causing all the inflation
1/1 [=====] - 0s 14ms/step
Used cars have drastically increased in prices due to a chip shortage halting car manufacturing.
Oh ok, what should we do to reduce inflation
1/1 [=====] - 0s 15ms/step
The federal reserve is raising interest rates to reduce inflation
I see, is president Biden doing anything to reduce inflation?
1/1 [=====] - 0s 16ms/step
President Biden ordered the release of oil from strategic reserves to reduce the price of gas, thus reducing inflation!
Oh ok, that makes sense.
1/1 [=====] - 0s 16ms/step
Sorry, I can't understand you. Perhaps this is off-topic?
So what's the weather like today?
1/1 [=====] - 0s 15ms/step
It's pretty chilly outside, might rain. Make sure to bring a jacket!
Thanks for the recommendation!
1/1 [=====] - 0s 14ms/step
My pleasure
Is the federal reserve doing anything to combat inflation?
1/1 [=====] - 0s 17ms/step
President Biden ordered the release of oil from strategic reserves to reduce the price of gas, thus reducing inflation!
I see, what is causing all the inflation?

What is causing all the inflation
1/1 [=====] - 0s 19ms/step
The Ukraine war has lead to higher food and grain prices worldwide due to a drop in exports by Ukraine!
Oh ok, thank you!
1/1 [=====] - 0s 15ms/step
My pleasure
Goodbye
1/1 [=====] - 0s 14ms/step
After a while crocodile! ;)
and
```

Evaluation, What we did, tried to do, and could have done better

Our chatbot performed well overall. The model turned out better than expected and it is remarkable how accurate it is. It was able to reach around 97% accuracy (varies between 94-99% each time it is trained). However, in testing, we found that not all responses entirely matched the question... not because of the model itself, but rather because of the knowledge base, which ended up being our biggest limitation. What we could do to improve the chatbot by expanding our knowledge base, but this is difficult to do because it was created manually. Right now, it is limited to specific topics and

questions regarding the economy. While our chatbot is known as 'InflationBot', it is not able to go very in-depth about the topic of inflation due to the limited knowledge base.

Initially, we attempted to use the knowledge base generated by our original web crawler code (included in the folder), but we ran into several problems:

1. We were limited to wikipedia because using non-Wikipedia articles on inflation led to the code failing because sites tend not to allow web scraping.
2. Web crawling with the [initial wikipedia link on inflation](#) did not work because preprocessing the data was difficult, and whatever unnecessary information got through damaged the bots accuracy, which was already bad because the bot was prone to outputting random jumbled text.
3. Expanding on #2, sometimes the bot would output words in an entirely different language because the web crawler code returned a knowledge base with passages in French and Spanish. We attempted to use code from a previous assignment to identify and remove words from another language but a. it took an EXTREMELY long time to run and b. It wasn't perfect and some English sentences were removed while other languages stayed, which affected the bot's already poor accuracy.
4. Next we tried to use the [wikipedia link on this specific inflation surge](#), but this simply took too long to run. I had to wait for half-an-hour just to retrieve the knowledge base, and it wasn't worth the effort because too much of it was gibberish text from the beginning, margins, and end of the articles, and it often wandered into unrelated web-pages.

This is why we instead decided to use the manually created knowledge base we used now. Regarding our current knowledge base though, the main thing hindering the accuracy of this knowledge base is that once the model interprets and classifies user input with the correct tag (often very accurate), it simply picks one of the many possible responses associated with that tag at random rather than picking the one most relevant, so sometimes the output is very accurate by chance, but other times, it's meh. We tried to write a function to pick the best associated response by comparing the words in the input to all the responses but this slowed the chatbot significantly and the accuracy didn't seem to be much better based on testing, so we scrapped it. Given more time, I think we should have created a good, accurate function.

We used many different optimizers and parameters for the neural network, but it was the optimizers that made the biggest difference, so I'll only list those and their respective accuracy: Adam = 0.97, Nadam = 0.93, SGD = 0.11, Adamax = 0.32, and Adagrad = 0.74. Due to Adam's high accuracy, we chose to stick with it.

Evaluation (continued):

In the introduction, I talked about enabling Inflation Bot to display real time weather when asked. My plan was to add this function using the open weather API, but this was later scrapped because the API costs money to actually run and I didn't want to be charged.

Appendix A: Knowledge Base

```
{
  "tag": "greeting",
  "patterns": ["Hi", "How are you", "Is anyone there?", "Hello", "Good day", "Whats up", "Hey", "greetings"],
  "responses": ["Hello! I'm Inflation Bot! How many I help you?", "Good to see you again! I'm Inflation bot, and I'm ex",
  "context_set": ""
},
{
  "tag": "identity",
  "patterns": ["Who are you", "what are you", "Who", "you"],
  "responses": ["I'm InflationBot, a cool chatbot who can tell you jokes, riddles, and whatever you want to know about"],
},
{
  "tag": "programmer",
  "patterns": ["Who made you", "who designed you", "who programmed you", "created", "programmed", "designed", "made"],
  "responses": ["I was programmed by Harshith Nanda and Charith Muppidi, two amazing students at UT Dallas!"]
},
{
  "tag": "thanks",
  "patterns": ["Thanks", "Thank you", "That's helpful", "Awesome, thanks", "Thanks for helping me"],
  "responses": ["Happy to help!", "Any time!", "My pleasure"],
  "context": ""
},
{
  "tag": "goodbye",
  "patterns": ["cya", "See you later", "Goodbye", "I am Leaving", "Have a Good day", "bye", "cao", "see ya"],
  "responses": ["Sad to see you go :((", "Cya later alligator! :)", "After a while crocodile! ;)",
  "context_set": ""
},
{
  "tag": "out-of-scope",
  "patterns": ["abcdefghijklmnopqrstuvwxyz", "ice cream"],
  "responses": ["Sorry, I can't understand you. Perhaps this is off-topic?", "I don't understand. Maybe because that is off-topic"],
  "context": ""
},
{
  "tag": "weather",
  "patterns": ["weather", "what is the weather like today", "what's the temperature", "how hot is it outside"],
  "responses": ["It's pretty chilly outside, might rain. Make sure to bring a jacket!"],
  "context": ""
},
{
  "tag": "stocks",
  "patterns": ["how is the stock market doing", "which stocks have increased the most in value", "stocks"],
  "responses": ["The stock market follows a cycle", "Most tech companies have seen a slight dip recently",
  "context_set": ""
},
{
  "tag": "invest",
  "patterns": ["invest", "what should I invest in", "are there any safe stocks to invest in"],
  "responses": ["Invest in the S&P 500 index fund! It provides safe and reliable returns to investment."]
},
{
  "tag": "out-of-scope",
  "patterns": ["abcdefghijklmnopqrstuvwxyz", "ice cream"],
  "responses": ["Sorry, I can't understand you. Perhaps this is off-topic?", "I don't understand. Maybe because that is off-topic"],
  "context": ""
}
```

```

{"tag": "inflation-causes",
 "patterns": ["why is there inflation", "what is causing inflation", "will we ever recover from inflation",
  | "which products are driving inflation", "why is inflation so high", "why is inflation so high"],
 "responses": [
  "Inflation has many causes! Would you like to know more?",
  "According to the Federal Reserve, supply chain issues due to COVID lockdowns contributed to inflation by reducing manufacturing",
  "The Economist states that excessive government spending from American Rescue Plan increased inflation by 1-2%!",
  "Barriers to trade such as tariffs increase the price of imports, which raises prices domestically, leading to higher inflation",
  "The Ukraine war has lead to higher food and grain prices worldwide due to a drop in exports by Ukraine!",
  "The Ukraine war has contributed to higher gas prices worldwide due to an embargo against Russia preventing oil exports!",
  "Used cars have drastically increased in prices due to a chip shortage halting car manufacturing."
 ],
 "context_set": ""
},
{"tag": "inflation-responses",
 "patterns": ["Is there anything being done to stop inflation", "who is responsible for handling inflation?",
  | "has the government done anything about inflation?", "has federal reserve done anything about inflation"],
 "responses": ["Yes! The federal reserve has raised interest rates by over 200 points thus far, which will reduce inflation!",
  | "President Biden ordered the release of oil from strategic reserves to reduce the price of gas, thus reducing inflation!",
  | "The Inflation Reduction Act reduces the deficit, which will marginally reduce inflation!"],
 "context_set": ""
},
{"tag": "possible-inflation-responses",
 "patterns": ["what can we do to stop inflation", "what do experts recommend we do to reduce inflation", "how can we reduce inflation",
  | "is there anything we can do to reduce inflation?"],
 "responses": ["Experts recommend we reduce tariffs to make imports cheaper and reduce inflation", "The federal reserve is raising inter
  | "It is recommended that we raise taxes and cut spending to reduce the national debt and reduce inflation",
  | "Experts recommend that we invest in building more housing to alleviate the housing shortage and reduce rents, thereby reducing infla
 "context_set": ""
},
{"tag": "unemployment",
 "patterns": ["Which state has the lowest unemployment rate?", "What is the unemployment rate"],
 "responses": ["As of September 2022, Minnesota has the lowest unemployment rate at 2%",
  | "As of September 2022, Illinois has the highest unemployment rate at 4.5%",
  | "The average unemployment rate for the USA is 3.5% as of September 2022, which is below pre-pandemic levels!",
  | "Goldman Sachs estimates that unemployment is decreasing steadily",
  | "JP Morgan expects unemployment to reach its lowest point in 2023!"],
 "context_set": ""
},
{"tag": "Biden",
 "patterns": ["What has Biden done to improve the economy", "Has the Biden administration taken any action?",
  | "Has Biden done anything to reduce inflation?"],
 "responses": ["President Biden ordered the release of oil from strategic reserves to reduce the price of gas, thus reducing inflation!"
  | "The Inflation Reduction Act reduces the deficit, which will marginally reduce inflation!",
  | "The Inflation Reduction Act provides clean energy tax credits to improve long term resilience to climate change and reduce energy pr
  | "The Inflation reduction Act includes healthcare subsidies to reduce the amount people pay for health insurance, which helps them han
  | "President Biden wants to reduce food prices by providing farmers with resources to increase food production"],
 "context_set": ""
},
{"tag": "jokes",
 "patterns": ["Tell me a joke", "Joke", "Make me laugh"],
 "responses": ["A perfectionist walked into a bar. Apparently, the bar wasn't set high enough! Hahaha.",
  | "I ate a clock yesterday, it was very time-consuming",
  | "Never criticize someone until you've walked a mile in their shoes. That way, when you criticize them, they won't be able to hear you
  | "The world tongue-twister champion just got arrested. I hear they're gonna give him a really tough sentence.",
  | "I own the world's worst thesaurus. Not only is it awful, it's awful.",
  | "What did the traffic light say to the car? \"Don't look now, I'm changing.\",
  | "What do you call a snowman with a suntan? A puddle.",
  | "How does a penguin build a house? Igloos it together",
  | "I went to see the doctor about my short-term memory problems - the first thing he did was make me pay in advance",
  | "As I get older and I remember all the people I've lost along the way, I think to myself, maybe a career as a tour guide wasn't for m
  | "Eh its okay if I don't know what 'Armageddon' means? It's not the end of the world."],
 "context": "jokes"
}

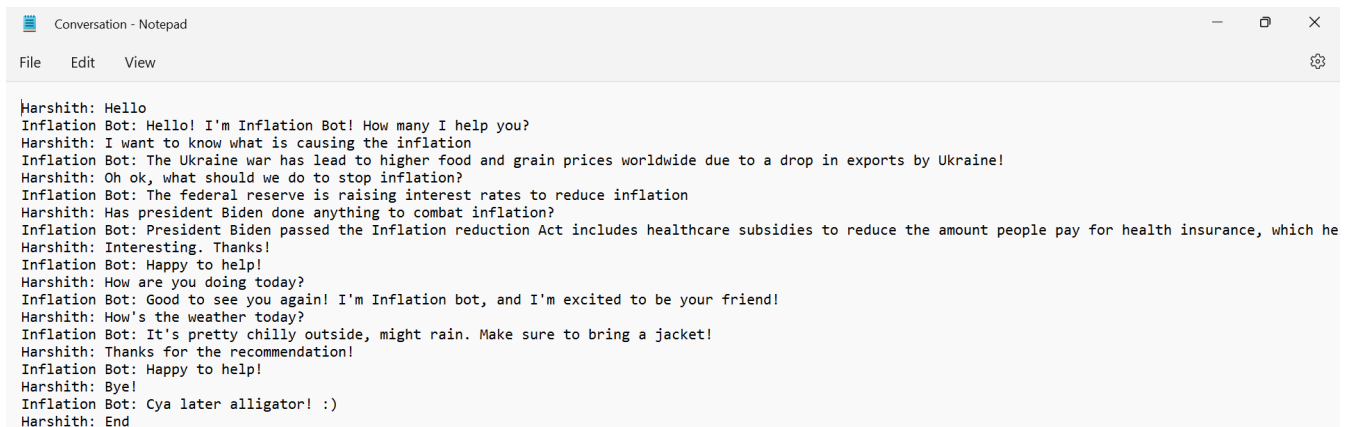
```

```
{
  "tag": "riddle",
  "patterns": ["Ask me a riddle", "Ask me a question", "Riddle", "Tell me a Riddle", "Riddle me"],
  "responses": ["What two things can you never eat for breakfast?.....Lunch and Dinner!",
    "What word is spelled incorrectly in every single dictionary?.....Incorrectly",
    "How can a girl go 25 days without sleep?.....She sleeps and night!",
    "How do you make the number one disappear?.....Add the letter G and it's 'gone'!",
    "What will you actually find at the end of every rainbow?.....The letter 'w'",
    "What can be caught but never thrown?.....A cold!",
    "What has a thumb and four fingers but is not actually alive?.....Your Gloves!",
    "What 5-letter word becomes shorter when you add two letters to it?.....Short",
    "Why can't a bike stand on it's own?.....It is two-tired."],
  "context": "riddles"
}
```

Our knowledge base is divided into “intents”. Each intent has a “tag” to represent a topic for the chatbot to converse in. The “patterns” are potential inputs of the user (representing key words) and the “responses” are the outputs of the chatbot.

Appendix B: Sample User Model

The conversation is stored in a text file, and users are stored in a pickle.



```
Conversation - Notepad
File Edit View

Harshith: Hello
Inflation Bot: Hello! I'm Inflation Bot! How many I help you?
Harshith: I want to know what is causing the inflation
Inflation Bot: The Ukraine war has lead to higher food and grain prices worldwide due to a drop in exports by Ukraine!
Harshith: Oh ok, what should we do to stop inflation?
Inflation Bot: The federal reserve is raising interest rates to reduce inflation
Harshith: Has president Biden done anything to combat inflation?
Inflation Bot: President Biden passed the Inflation reduction Act includes healthcare subsidies to reduce the amount people pay for health insurance, which he
Harshith: Interesting. Thanks!
Inflation Bot: Happy to help!
Harshith: How are you doing today?
Inflation Bot: Good to see you again! I'm Inflation bot, and I'm excited to be your friend!
Harshith: How's the weather today?
Inflation Bot: It's pretty chilly outside, might rain. Make sure to bring a jacket!
Harshith: Thanks for the recommendation!
Inflation Bot: Happy to help!
Harshith: Bye!
Inflation Bot: Cya later alligator! :)
Harshith: End
```