PSEBot: A Mobile Assistant Chatbot with Natural Language Processing that Provides

Stock Data from the Philippine Stock Exchange

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ABSTRACT

PSEBot is a mobile assistant chatbot developed using the React Native framework and DialogFlow for online NLP service. This chatbot aims to provide pertinent stock information on the go. It recognizes intent based on the user's text query and provides corresponding real-time price and technical indicator of the stocks listed in PSE. Upon the conducted SUS survey of 30 testers, the chatbot is considered usable.

INDEX TERMS

android, chatbot, dialogflow, natural language processing, stock, stock market, mobile

INTRODUCTION

A. Background of the Study

The Philippine Stock Exchange (PSE) is one of the oldest exchanges in Asia when it was established in 1927 (Philippine Stock Exchange, 2019). It is a private, non-profit and non-stock organization which aims to provide a platform for trading locally listed stocks. According to the report of PSE in 2017 (Online Stock Market, 2018), the number of people registered online rose to 388, 864 from 302,516 in 2016 which shows the consecutive years where participants with online accounts continuously rises. Despite this, most online brokerage does not have mobile support and needs for the user to log in if they want to know more about the current stock market.

Chatbot is a program or agent that communicates with a user to accomplish specific tasks (Huang, Zhou, & Yang, 2007). It has been used more frequently by many organizations throughout the years. According to BusinessInsider, around 80 percent of organizations and enterprises would be using chatbots for their needs by 2020 (Brain.AI, 2019).

Mobile phones have been a popular site for different chatbots to be deployed on given its accessibility and number of users. Chatbots have been used as the communication medium because of its quick and quality answers to users' questions (Brain.AI, 2019). Besides that, 68 percent of respondents believe that chatbots enhance customer experience.

In the Philippines, smartphone users have increased on a year-on-year basis. This may further encourage people in using chatbots to provide for their needs. In addition, Statista Research Department (Statista Research Department, 2019), reported that around 40 percent of the population will use a smartphone by 2021. ABS-CBN (2019), on the other

hand, reported that Filipinos is one of the world's top social media users averaging 10 hours a day. Given these factors, a chatbot will be more accessible to Filipinos.

B. Statement of the Problem

The number of Filipinos investing and trading stocks online has continuously grown throughout the years. However, access to its data is difficult and would need users to be logged in over the computer all the time even though they do not need to buy or sell any stocks. A chatbot that could give them detailed information through a mobile platform regarding the listed stocks may aid them in their financial endeavors.

C. Significance of the Study

A chatbot that could give information and technical indicators regarding stocks in PSE may help investors and traders know when to buy or sell their stocks without the need of logging into their accounts all the time. Furthermore, since it is a mobile-based chatbot, users will have better user experience and access to it given that smartphone use has risen throughout the years.

D. Objectives of the Study

The general objective of the study is to create a chatbot that will serve information on the go regarding the publicly listed stocks in PSE which may help stock investors in their financial endeavors. Specifically, this study aims to:

1) to get historical and real-time data of stocks from the Philippine Stock Exchange;

2) to recognize the user's intent (ask price, ask volume, ask simple moving average (SMA), ask WMA, ask VolumeSMA, ask stochastic oscillator, ask relative strength index, help) based on query;

3) to compute for the technical indicators of a specified stock, and;

4) to determine the usability of the chatbot

E. Scope and Limitations

The chatbot will only give data as is from the stock market based on the information given by the Philippine Stock Exchange Composite Index API (formerly known as PHISIX) and historical data from PSE Lookup. Computations on the technical indicators of a stock will be based only on the data given by the aforementioned APIs. The language of communication to be used is in English only. Furthermore, the chatbot will only give one information on only one stock per query. Since this is a mobile-based chatbot, access to it will be necessary with an Android Operating System and an Internet connection.

REVIEW OF RELATED LITERATURE

A. Chatbot

A chatbot is also known as a virtual agent or assistant, bot, talkbot, or interactive agent. It is a smart agent capable of processing natural language inputs such as voice or text.

A chatbot is able to converse with a human with a response in their language and accomplish different tasks according to the user (Radziwill & Benton, 2017). Chatbot technology has been around since the 1960s and has only begun to take popularity due to its accessibility and ease of use due to many open-source code for different platforms. It also helps the quality of support given to customers which boosted its popularity (Radziwill & Benton, 2017; Brain.AI, 2019).

Many chatbots have been created throughout the years ranging from bots handling scheduling requests to catering the frequently asked questions (faq) of customers. In the field of stock market, there have been bots created to give information regarding their respective markets.

In India's BSE, they rolled-out a chatbot that could provide "on-demand" data from its stock exchange website (PTI, 2018). This bot aimed to provide users with a convenient and accessible stock and market information. This bot works by having a text-based conversation between the bot and user after which the bot mines the desired data directly from their website and display it to the user.

In the Philippines, a chatbot was created in 2017 that provides stock quote of listed stocks in PSE. This, however, has limited functionality that tells only the price for the day of a certain stock.

B. Natural Language Processing (NLP)

Natural language processing (NLP) is an approach to how computers make use and understand text and speech information for doing tasks in a human-like way. NLP's foundations lie on many key aspects such as linguistics, psychology, mathematics, and artificial intelligence (Chowhury, 2002).

With NLP, it is possible for systems to analyze, extract, and use textual or vocal information to cater to the user's need.

Information retrieval is one of the processes in NLP. It focuses on extracting data given a query based on human language. This process takes into account the key terms used in the query and returns the appropriate information based on the stored knowledge back to the user (Feldman, 1999).

NLP is vital for a more effective and engaging conversation with the user. Integrating NLP with chatbots will enable them to do tasks on a higher and human-like level.

C. Stock Market

Stock markets around the world have been around for a long time. Stock investing has been used by many people in hopes of growing their capital. Fundamental and Technical analysis are commonly used by investors so that they would have a guide on when and what stock to buy.

Fundamental analysis is used by investors to know if the company is sound financially (Fidelity Investments, 2017). This type of analysis usually involves three types of ratios which are: Price-to-Book (P/B), Price-to-Earnings (P/E), and Price-to-Sales (P/S).

These ratios help stock investors know the company's valuation (either overvalued or undervalued), overall earnings quality, and growth and financial stability.

Technical analysis, on the other hand, is used by investors to know when to buy or sell a specific stock (Fidelity Investments, 2017). This type of analysis mainly relies on the supply-demand economic principle. This tries to predict trends going on in a market but with no assurance.

Some of the commonly used indicators in technical analysis include the candlestick chart, moving averages, stochastic oscillator, and relative strength index (RSI). Charts help in easily spotting trends. This also helps in knowing the resistance and support level of a specific stock. The moving average is the average price of a certain stock over a period of time. This is computed by getting n number closing day price of a specific stock and getting its ratio with the n number of trading days. Weighted Moving Average (WMA) on the other hand is similar to it, but puts more importance on recent closing prices compared to older ones. It is computed by:

$$WMA = (P1 * n) + (P2 * (n-1)) + ... + (Pn * 1) / \Sigma i \text{ from 1 to n}$$

where P1 is the most recent closing price over n periods. Stochastic oscillator is one of the common technical indicators. It helps tell whether a stock is overbought or oversold in a market. The formula for the stochastic oscillator is given by:

$$\backslash \% K = (C - Ln / Hn - Ln) * 100$$

where C is the latest closing price, Ln and Hn is the lowest and highest price respectively traded over the last n periods. The RSI is currently one of the most popular momentum oscillator. RSI is computed given by the formula:

$$RSI = 100 - 100/1 + RS$$

where RS is the ratio between the average gain and average loss that is computed by getting the total number of gains in n time period divided by n. Average loss is computed likewise as the average gain. Wilder (1978) recommends to use n = 14 for the time periods in a calculation.

These technical indicators will be useful in knowing the right signals when to buy or sell a stock.

METHODOLOGY

A. Architecture and Technologies

The technologies to be used in the development of the chatbot are the following:

1) NodeJS - an open-source, cross-platform JavaScript runtime environment that executes JavaScript code.

2) React Native - a JavaScript framework for developing native applications.

3) Dialogflow V2 - an open-source tool for natural language processing.

4) RestDB.io - a simple online database service in the cloud with NoSQL, REST API, and MongoDB support.

5) Simple PSEi formerly known as (PHISIX) - an open-source API for real-time and historical prices of stocks listed in the PSE

6) Huawei P20 Lite - EMUI 9.1.0 based on Android 9 ”Pie” Operating System

B. Chatbot

1) Overview

The chatbot will provide pertinent information regarding stocks in the PSE such as its price, volume and some technical indicators such as Simple Moving Average (SMA),Volume Simple Moving Average (VolumeSMA), Weighted Moving Average (WMA), Stochastic Oscillator (KD) and RSI. The chatbot will provide these information based on the intent of the user.

In figure 1, the basic interaction with the chatbot is demonstrated. First, it will wait for the user to ask about a certain stock and which information they want from it. After parsing the data collected from the API, it would then check if computations are necessary depending on what information the user requested for.

Afterwards, the user could ask for another stock's quotation. This process will continue until the user decides to terminate communication with the chatbot.
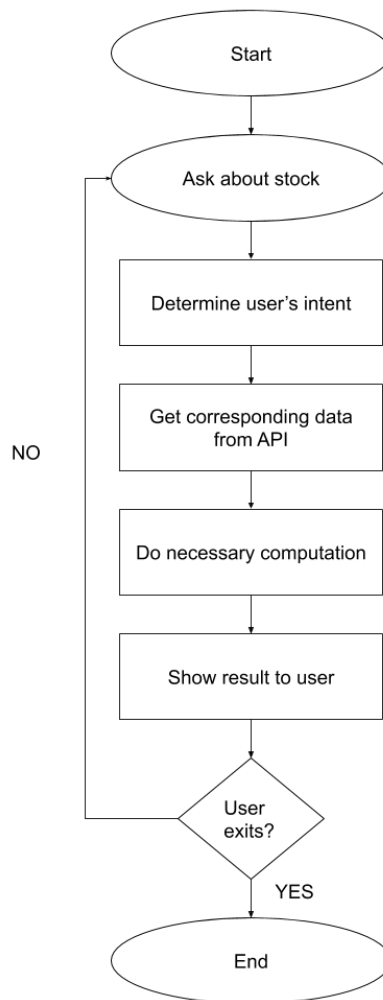
Figure 1. Basic Flow of Chatbot

Figure 2 shows how the flow of the chatbot happens every time a query is made. First, the front-end part react native will call dialogflow's API to determine the user's intent. Afterwards, dialogflow will run sentiment analysis on the query based on the phrases that were used in training the agent. Then, the response back to the react native interface will contain an array with the text response, intent, and

entity which will determine the next step of the bot. A node query via the axios package will be made depending on the intent of the user. If the intent is with regards to the real-time price or volume of a stock, then an API call to PHISIX will be made. Else, it will be to the API created through the historical information of the stocks in csv file format and hosted in restdb.io. After getting the response array, if it does not need any computations, then it will be parsed to show the result to the user. Else, computations will be made for the technical indicator of the stock before showing the result to the user.

```
        ┌─────────────────────┐
        │   User asks about   │◄──────┐
        │       stock         │       │
        └─────────┬───────────┘       │
                  │                   │
        ┌─────────▼───────────┐       │
        │  React Native call  │       │
        │  to DialogFlow API  │       │
        └─────────┬───────────┘       │
                  │                   │
        ┌─────────▼───────────┐       │
        │ DialogFlow return   │       │
        │ array with intent   │       │
        │    and/or entity    │       │
        └─────────┬───────────┘       │
                  │                   │
        ┌─────────▼───────────┐       │
        │ React native API    │       │
        │ call to PHISIX or   │       │
        │     restdb.io       │       │
        └─────────┬───────────┘       │
                  │                   │
        ┌─────────▼───────────┐       │
        │  Parse resultant    │       │
        │ array and compute   │       │
        │ technical indicator │       │
        └─────────┬───────────┘       │
                  │                   │
        ┌─────────▼───────────┐       │
        │ Show result to user │───────┘
        └─────────────────────┘
```
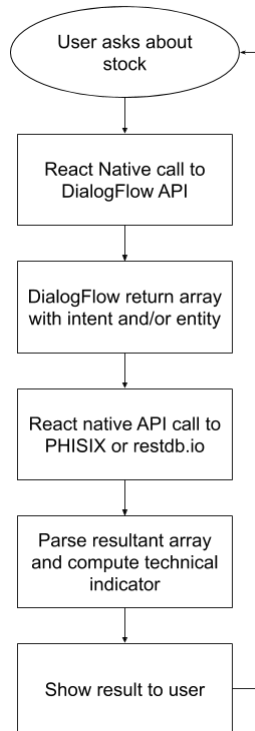
Figure 2. Backend Flow of Chatbot

2) Chatbot Development

The chatbot will be developed using React Native and DialogFlow. The former will serve as the front-end of the application while the latter will serve as

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the platform where the agent will be created and trained. Information regarding the stocks will be taken from two APIs namely Simple PSEi and another API to be created and deployed in restdb.io. The former API will be used for getting real-time information regarding a stock's price, volume, and percent change. The latter will be used for getting historical data of a stock for the computation of technical indicators.

3) API Development

For the historical information of stocks, it will be created with data coming from PSE Lookup, an open-source web service that allows anyone to get historical stock information in csv form. This will be used to populate the database hosted in restdb.io. The web hosting service allows for csv files to be imported and automatically inserted and synced to the current pool of data. Information from this database will be used to compute for the technical indicators of the stock and can be accessed through REST API with a corresponding API key. However, due to limitations of restdb.io's free use, it can only store a finite amount of information regarding the stocks and API calls to it is limited to one per second and a total of 50,000 per month.

4) Intent Recognition

To know what the user wants regarding a stock, DialogFlow will be used to determine the intent of the user's query. Dialogflow is an open-source Google-owned NLP service that allows developers to create, train, and use agents which could be deployed in many platforms. It is used to build chatbots which provide a rich and natural interaction with the user. It also uses sentiment analysis on queries

which makes the agent better in understanding intents. The agent will be trained on different phrases and contexts to better understand a user's needs. The intents that will be incorporated with the agent are: ask price, ask volume, ask SMAVolume, ask SMA, ask WMA, ask RSI, ask KD, help, default welcome, and default fallback. To know which stock the user wants to know about, entities are created with DialogFlow. Entities are dynamic variables that can take any value that corresponds to the specifications of a specific entity. With this, the agent will know not only the intent of the query but also the specific stock the user is requesting for.

In training the bots to the different intents, phrases can be supplied to it which will be part of the training data for the sentiment analysis of the queries. Some example training phrases on the intent ask price are:

1. What is the price of jfc

2. bdo price

3. price of gma7

With these sample training phrases, DialogFlow will tag the words price as related to the intent *ask price* given that its occurrence to the training phrases is plenty. The same will also apply in the training phrases of other intents. Those in red highlights are considered as an entity, called stock_code which can take on any value. An entity can be custom-made in the DialogFlow interface. It can be a set of words or a regex which encompasses the possible values for the entity.

With that, when react native calls the DialogFlow API, it will return a json object like this:

```
{

    intent: ask price,

    text_response: "",

    stock_code: <stock_code>

}
```

5) Stock Quote

After knowing the user's intent, information corresponding to it will be taken from the APIs via the npm axios package. For real-time information, Simple PSEi will be used. The data coming from the APIs will be parsed for proper representation to the user. If in case the user is asking for a stock's technical indicator, computations will be done first before sending the information back to the user. The technical indicators that the chatbot will provide are the simple moving average, weighted moving average, volume simple moving average, relative strength index, and stochastic oscillator.

C. Testing

The usability of the chatbot will be tested by using the System Usability Scale (SUS). Thirty (30) participants with background on the stock market or investors, and traders will evaluate the system.

RESULTS AND DISCUSSION

The chatbot was developed using React Native and integrated it with an agent from DialogFlow. To establish connection between the two, the access token of the agent was used. The chatbot was built using the Android OS with EMUI version 9.1.0. The device where the chatbot is installed should at least be version 4.1 to be stable enough to run the application. To use the NLP services of the chatbot and get necessary data of a stock, an Internet connection is required.

A. Chatbot

The chatbot was able to use and incorporate different technologies from scouring the Internet for historical stock information to incorporating it to a usable API hosted in restdb.io which allowed the chatbot to get necessary information depending on the user's needs. The agent was also successfully integrated with the react native framework which allowed a simple yet rich user experience. Combining these technologies resulted to a chatbot that could provide stock information on the go.

B. System Usability Scale (SUS) Survey

To test the usability of the application, 30 testers were asked to use the application and answer a survey. The survey was acquired from SUS which is one of the most widely used questionnaire for measuring the usability of a hardware, software, mobile devices, and applications.

In conducting the SUS survey, testers are asked to answer 10 items from 1 to 5, 1 being Strongly Disagree and 5 being Strongly Agree. These 10 items are:

1. I think that I would like to use this system frequently.

2. I found the system unnecessarily complex.

3. I thought the system was easy to use.

4. I think that I would need the support of a technical person to be able to use this system.

5. I found the various functions in this system were well integrated.

6. I thought there was too much inconsistency in this system.

7. I would imagine that most people would learn to use this system very quickly.

8. I found the system very cumbersome to use.

9. I felt very confident using the system.

10. I needed to learn a lot of things before I could get going with this system.

To interpret the results, SUS has a specific set of steps to compute the scores. These are:

1. Subtract 1 from the score of odd items.

2. Subtract the score of even items from 5.

3. Add all and multiply by 2.5

To interpret the result of the survey, the scores computed will be averaged based on the number of testers. An average SUS score of above 68 is considered as above average and anything below it is considered below average. Table 1 in the appendix section shows the results of the survey of 30 testers. The average SUS score of PSEBot is 78.92.

CONCLUSION AND RECOMMENDATIONS

PSEBot was made to cater to the needs of stock investors and traders. It served as the pipeline which integrated different technologies to create a chatbot which could be the basis for its future work. The chatbot allowed its user to know important stock information on the go without the need to be logged in to their trading accounts. It is designed so that only what the user needs at a certain time is shown instead of the cluttered information shown on their respective trading platforms. The chatbot was able to show the users relevant information of the stocks requested in a simple manner. With an average SUS score of 78.92, it is considered to be a usable application.

For future work, an IOS counterpart of this application can be made so that users from another platform could benefit from the chatbot. An open-source API that could host more data regarding the historical information of stocks is useful and important in calculating some of the technical indicators of the stocks. Furthermore, a chatbot that could remember favorite queries of the user might be helpful in providing a richer user experience. Lastly, queries that could handle multiple stocks or information about the stock is also recommended.

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SCREENSHOTS OF THE CHATBOT'S CONVERSATION WITH THE USER

Fig.3 Welcome Message

Fig. 4. Ask Price

Fig. 5 Ask Moving Average
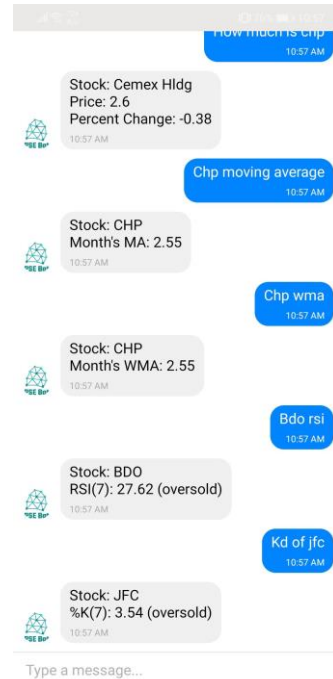

Fig. 6. Ask WMA
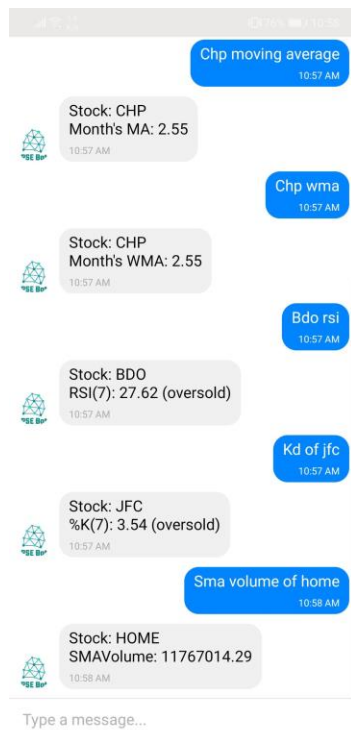

Fig. 7. Ask RSI

Fig 8. Ask KD

Fig. 9. Ask SMA Volume

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SCORE
5	1	5	2	5	1	5	1	5	2	95
4	1	5	3	5	1	5	1	5	4	85
5	3	5	5	4	2	5	2	5	1	77.5
5	1	5	1	5	1	5	1	5	1	100
3	2	3	2	4	2	3	3	5	1	70
4	2	5	3	5	2	4	1	4	2	80
4	2	4	3	3	2	4	2	3	2	67.5
4	2	4	1	4	3	2	1	4	1	75
4	3	4	2	4	2	3	1	3	2	70
5	3	5	2	5	2	4	2	4	1	82.5
3	2	4	2	4	1	4	2	4	2	75
4	2	4	2	5	2	4	2	3	2	75
4	2	5	1	4	1	5	2	4	3	82.5
4	2	4	1	4	3	5	2	4	1	80
5	1	5	1	4	2	4	1	5	1	92.5
3	2	4	1	4	2	3	2	3	2	70
3	1	4	1	4	2	4	1	5	2	82.5
5	1	5	1	5	1	5	1	5	1	100
4	2	3	2	4	4	3	3	4	1	65
5	2	4	3	4	1	4	2	4	2	77.5
5	2	5	1	5	2	4	2	4	1	87.5
4	1	4	2	3	2	4	1	4	2	77.5
4	1	4	1	4	2	4	1	4	3	80
3	2	4	2	4	1	3	2	3	3	67.5
4	3	4	2	3	2	4	1	4	2	72.5
4	2	3	1	4	2	5	2	3	1	77.5
4	2	3	2	4	2	4	2	3	2	70
3	2	4	3	4	1	3	2	4	2	70
5	1	4	2	3	1	4	1	4	1	85
4	2	4	2	4	2	4	2	4	1	77.5
									AVE	78.92

Table 1. Breakdown of SUS Scores