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AI15

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Project Report

Introduction

When you are a decision maker, you first have a question. Then you need to distill to 2 to 3 keywords for finding documents containing keywords in a search engine like Google. Based on popularity, search engines deliver documents to you. Next, you read documents to find an answer. At last, you analyze if it's correct or not.

But for the robot, it's another different process. You ask a natural language question, the machine understand the question first. Then, it produces possible answers and offers evidence. Based on multiple answers, machine order them by evidence. It's called computing confidence. Machine deliver responses, evidence, and confidence to you. Last, you consider the answer.

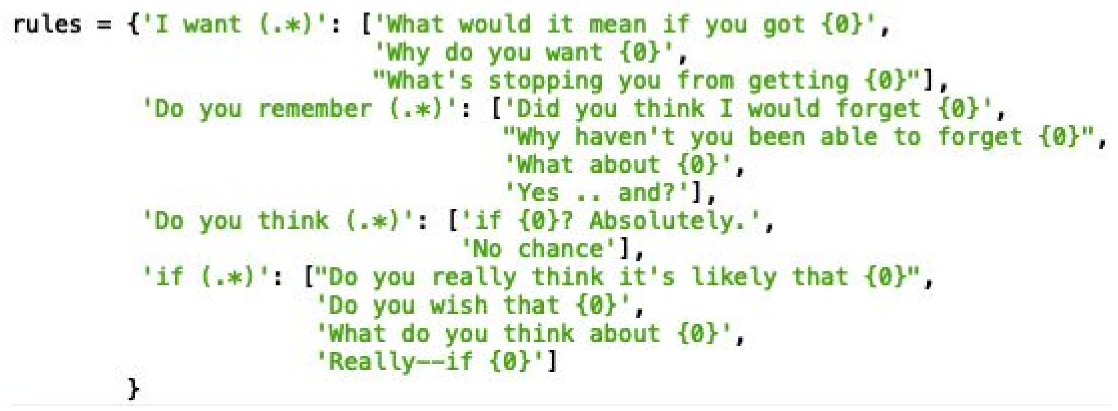
Nowadays, we are in automatic open-domain question answering, which is a long-standing challenge in Artificial Intelligence to emulate human expertise. Our goal is to give machine rich natural language questions over a broad domain of knowledge. And the machine delivers us precise answers, accurate confidences, consumable justifications and fast response time.

This project is to build chatbot in Python, using regular expressions and machine language to extract meaning from free-form text to querying stock data. The chatbot is integrated into Wechat, based on iexfiance API.

Part 1

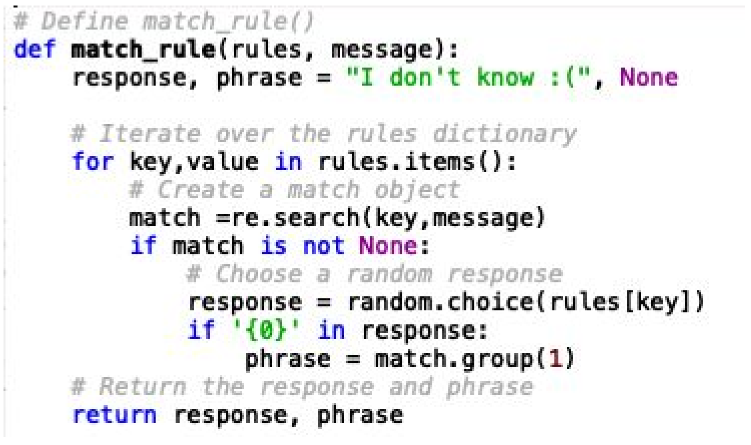
At the beginning of the project, I handle text with regular expressions. The regular expression is to match messages against known patterns, extract key phrases and transform sentences grammatically.

The following code has set a pattern. It will achieve multiple selective answers to the same question. For instance, if the user message contains “I want”, the chatbot will return the value of the key ‘I want (.*)’ randomly. But I only set four patterns, it’s limited for a chatbot.



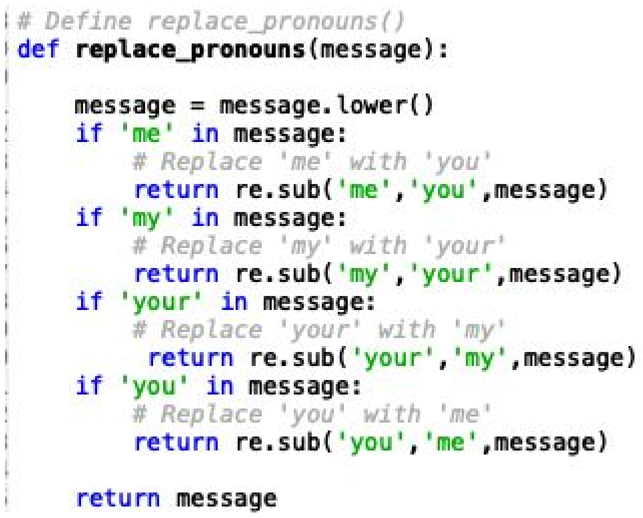
```
rules = {'I want (.*)': ['What would it mean if you got {0}',
                         'Why do you want {0}',
                         "What's stopping you from getting {0}"],
         'Do you remember (.*)': ['Did you think I would forget {0}',
                                  "Why haven't you been able to forget {0}",
                                  'What about {0}',
                                  'Yes .. and?'],
         'Do you think (.*)': ['if {0}? Absolutely.',
                               'No chance'],
         'if (.*)': ["Do you really think it's likely that {0}",
                     'Do you wish that {0}',
                     'What do you think about {0}',
                     'Really--if {0}']
        }
```

Then, I check if the user message has matched the rules I wrote above. If it has matched, it will return a random response. If no pattern has matched, chatbot will reply “I don’t know :(“.



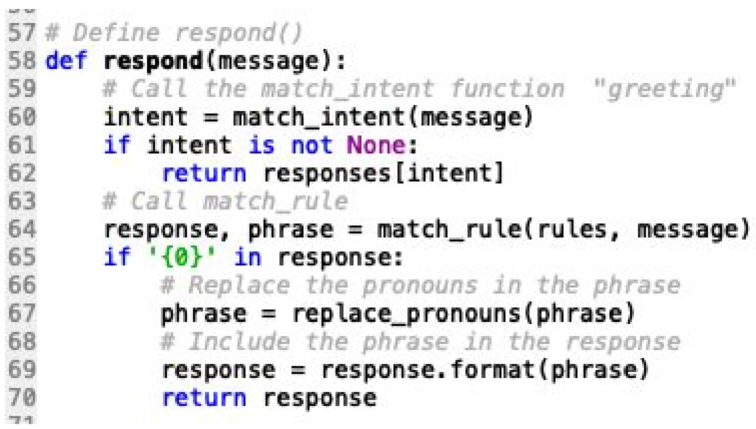
```
# Define match_rule()
def match_rule(rules, message):
    response, phrase = "I don't know :(", None

    # Iterate over the rules dictionary
    for key,value in rules.items():
        # Create a match object
        match =re.search(key,message)
        if match is not None:
            # Choose a random response
            response = random.choice(rules[key])
            if '{0}' in response:
                phrase = match.group(1)
    # Return the response and phrase
    return response, phrase
```

Later, I wrote the code to swap the pronouns in order to transform the answer from the question. For example, if ‘you’ occurs in the user message, the bot message will replace ‘you’ to ‘me’.

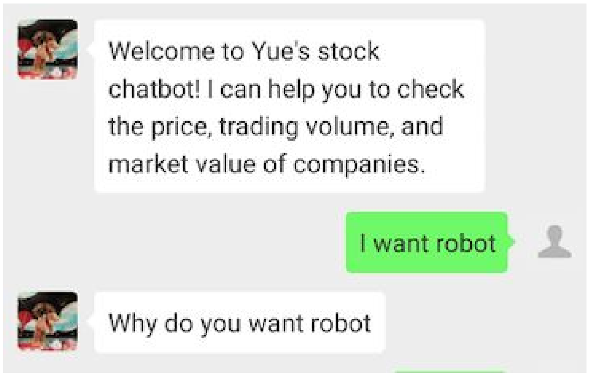


```python
# Define replace_pronouns()
def replace_pronouns(message):

    message = message.lower()
    if 'me' in message:
        # Replace 'me' with 'you'
        return re.sub('me','you',message)
    if 'my' in message:
        # Replace 'my' with 'your'
        return re.sub('my','your',message)
    if 'your' in message:
        # Replace 'your' with 'my'
         return re.sub('your','my',message)
    if 'you' in message:
        # Replace 'you' with 'me'
        return re.sub('you','me',message)

    return message
```

At last, in respond(message) function, I combine all the processed I said above to return a chatbot message from line63 to line 70.



```python
57 # Define respond()
58 def respond(message):
59     # Call the match_intent function  "greeting"
60     intent = match_intent(message)
61     if intent is not None:
62         return responses[intent]
63     # Call match_rule
64     response, phrase = match_rule(rules, message)
65     if '{0}' in response:
66         # Replace the pronouns in the phrase
67         phrase = replace_pronouns(phrase)
68         # Include the phrase in the response
69         response = response.format(phrase)
70         return response
```



Welcome to Yue's stock chatbot! I can help you to check the price, trading volume, and market value of companies.

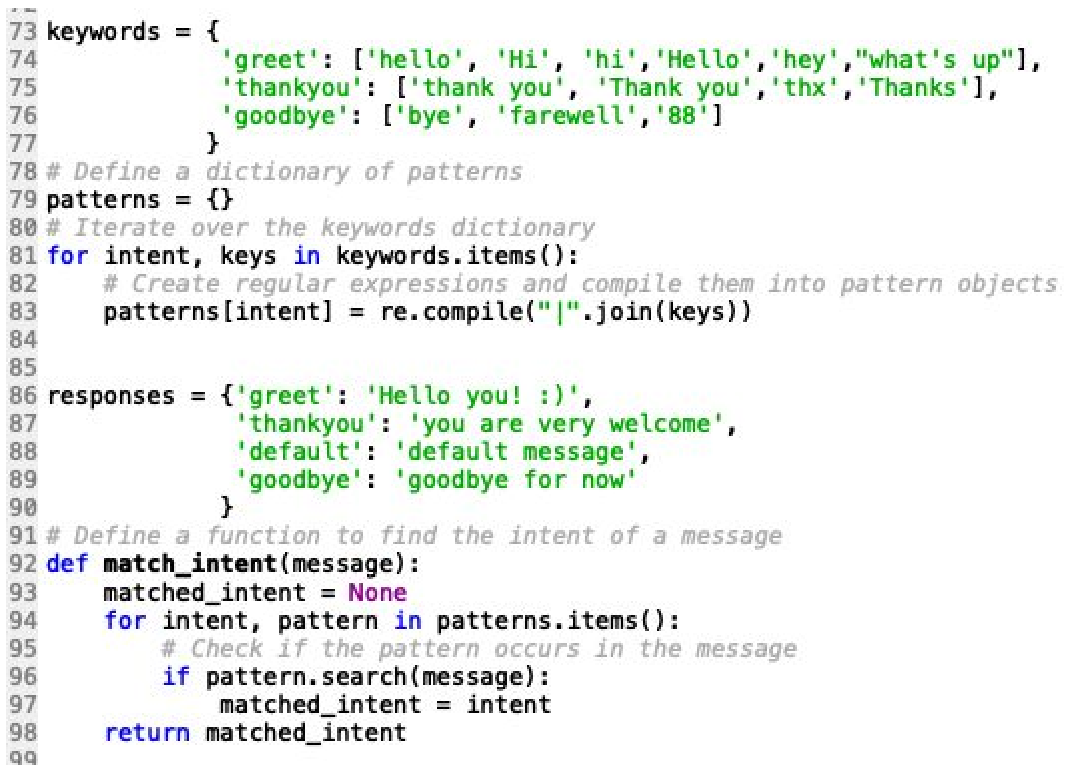
I want robot

Why do you want robot

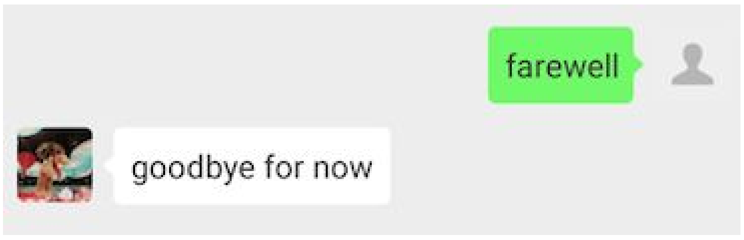
You may notice the code from line 59 to line 62. These codes extract the intent of the user message by regular expression.

The following code illustrates how I extract the intent from the user message. I create a dictionary called “keywords”, it contains three intents: greet, thank you and goodbye. These three intents each has some keywords. If the user sends 'bye' in the message, this message will be included in ‘goodbye’ intent. Then I compile these keywords into a regular expression. So, I can use re.search() in match_intent() function.

I also define a response dictionary according to these three intents. For example, if the program detects the intent is ‘greet’, the chatbot will reply ‘Hello you! :’. The match_intent(message) will return the intent the program has detected. I initialize the intent is None. In the respond(message) function, if the intent called from match_intent is not None, the chatbot will return the response based on the user’s intent.



```
73 keywords = {
74              'greet': ['hello', 'Hi', 'hi','Hello','hey',"what's up"],
75              'thankyou': ['thank you', 'Thank you','thx','Thanks'],
76              'goodbye': ['bye', 'farewell','88']
77             }
78 # Define a dictionary of patterns
79 patterns = {}
80 # Iterate over the keywords dictionary
81 for intent, keys in keywords.items():
82     # Create regular expressions and compile them into pattern objects
83     patterns[intent] = re.compile("|".join(keys))
84 
85 
86 responses = {'greet': 'Hello you! :)',
87               'thankyou': 'you are very welcome',
88               'default': 'default message',
89               'goodbye': 'goodbye for now'
90              }
91 # Define a function to find the intent of a message
92 def match_intent(message):
93     matched_intent = None
94     for intent, pattern in patterns.items():
95         # Check if the pattern occurs in the message
96         if pattern.search(message):
97             matched_intent = intent
98     return matched_intent
```

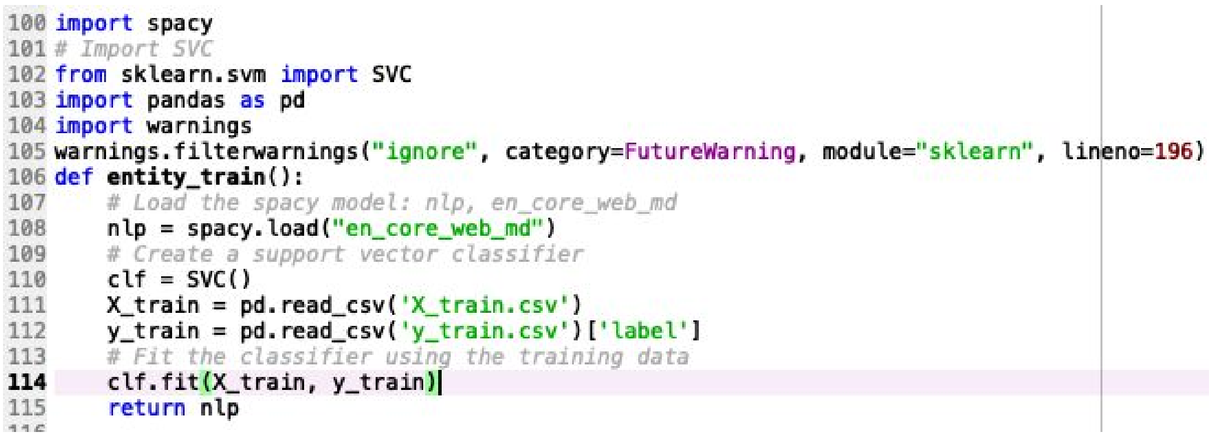

farewell

goodbye for now

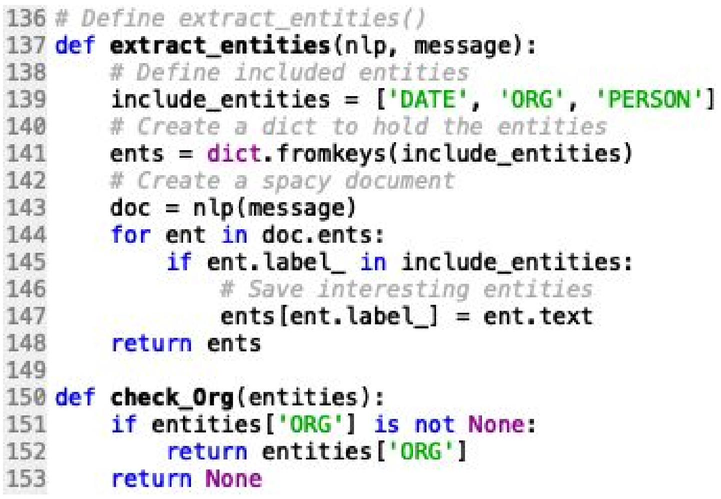
Part 2

We can extract intent from user message. We can also extract the entities, right? How to express “ Can you help me please” in computer language? The computer use vectors to express, the units can be characters, words or sentences.

The word vector attempts to represent the meaning of a word with a fixed-length numerical vector. Words that appear in similar contexts have similar vectors. Words with similar meaning have similar vectors. Training word vector requires a lot of data. More data, more precise of the prediction. We use spaCy to use word vector. And use Support Vector Machines to calculate the similarity for prediction. The following code first loads the spaCy model: nlp, en_core_web_md. Then create a support vector classifier.


```
import spacy
# Import SVC
from sklearn.svm import SVC
import pandas as pd
import warnings
warnings.filterwarnings("ignore", category=FutureWarning, module="sklearn", lineno=196)
def entity_train():
    # Load the spacy model: nlp, en_core_web_md
    nlp = spacy.load("en_core_web_md")
    # Create a support vector classifier
    clf = SVC()
    X_train = pd.read_csv('X_train.csv')
    y_train = pd.read_csv('y_train.csv')['label']
    # Fit the classifier using the training data
    clf.fit(X_train, y_train)
    return nlp
```

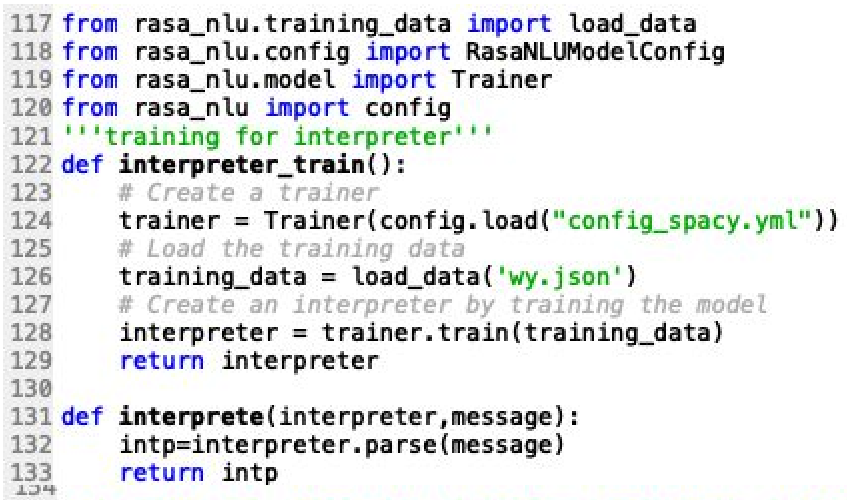
Hence, I use spacy(nlp) to extract the entities from the user message. Using spaCy's entity recogniser, I define extract_entities(). In this function, it only extracts the entities if it is a date, organization or person.



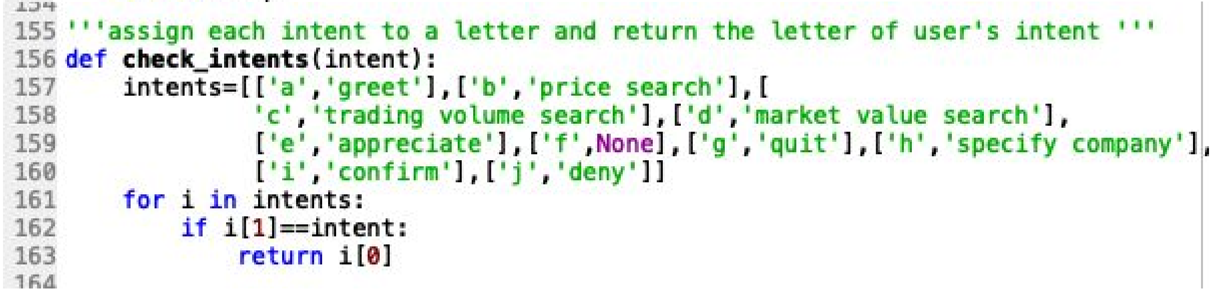
```python
# Define extract_entities()
def extract_entities(nlp, message):
    # Define included entities
    include_entities = ['DATE', 'ORG', 'PERSON']
    # Create a dict to hold the entities
    ents = dict.fromkeys(include_entities)
    # Create a spacy document
    doc = nlp(message)
    for ent in doc.ents:
        if ent.label_ in include_entities:
            # Save interesting entities
            ents[ent.label_] = ent.text
    return ents

def check_Org(entities):
    if entities['ORG'] is not None:
        return entities['ORG']
    return None
```

We are only interested in the company which the user ask. So there is a check_Org function to check if the entities in the message contain ORG, if so, this function returns the name of ORG, which is a company name.

We'd like to explore the database using natural language. Rasa NLU is an open-source natural language processing tool for intent classification and entity extraction in chatbots. I wrote wy.json which contains the training data. The interpreter_train() create an interpreter by training. Then interpreter function will be called in the main by “intent=interprete(interpreter,msg.text)['intent']['name']”. Because there are lots of intents, I assign each intent to a letter.



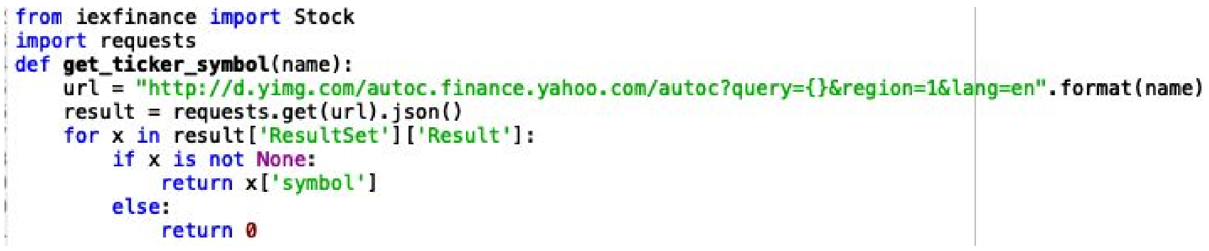
```python
from rasa_nlu.training_data import load_data
from rasa_nlu.config import RasaNLUModelConfig
from rasa_nlu.model import Trainer
from rasa_nlu import config
'''training for interpreter'''
def interpreter_train():
    # Create a trainer
    trainer = Trainer(config.load("config_spacy.yml"))
    # Load the training data
    training_data = load_data('wy.json')
    # Create an interpreter by training the model
    interpreter = trainer.train(training_data)
    return interpreter

def interprete(interpreter,message):
    intp=interpreter.parse(message)
    return intp
```



```python
'''assign each intent to a letter and return the letter of user's intent '''
def check_intents(intent):
    intents=[['a','greet'],['b','price search'],[
              'c','trading volume search'],['d','market value search'],
              ['e','appreciate'],['f',None],['g','quit'],['h','specify company'],
              ['i','confirm'],['j','deny']]
    for i in intents:
        if i[1]==intent:
            return i[0]
```

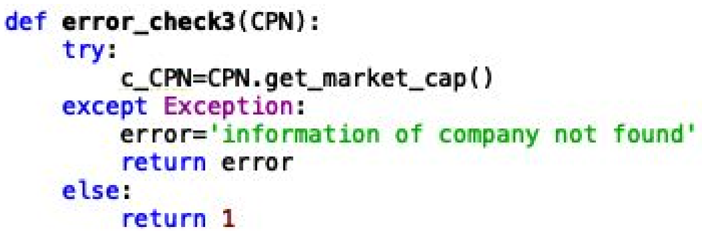
Part 3

In order to achieve a robot which can ask the price, marketing value and trading volume of stock, I apply the iexfinace API. Also, I have a function to convert the company name to the stock symbol, which is efficient to check value in iexfinance API.

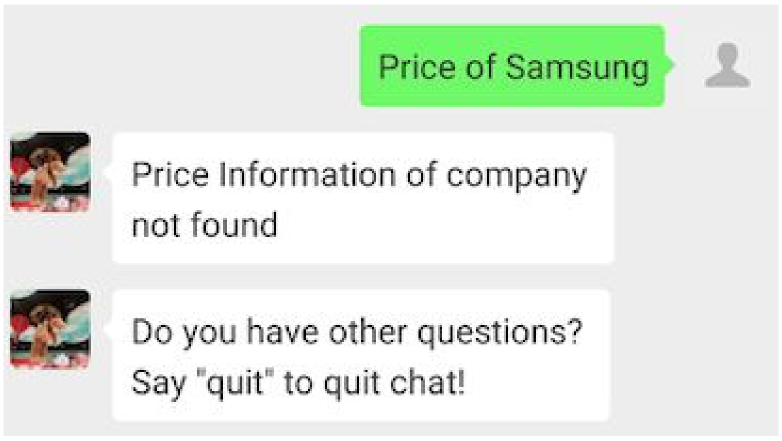


```python
from iexfinance import Stock
import requests
def get_ticker_symbol(name):
    url = "http://d.yimg.com/autoc.finance.yahoo.com/autoc?query={}&region=1&lang=en".format(name)
    result = requests.get(url).json()
    for x in result['ResultSet']['Result']:
        if x is not None:
            return x['symbol']
        else:
            return 0
```

Sometimes, it cannot search the price of some company like Samsung, the chatbot will send information of company not found. This goal is achieved by error_check function.



```python
def error_check3(CPN):
    try:
        c_CPN=CPN.get_market_cap()
    except Exception:
        error='information of company not found'
        return error
    else:
        return 1
```

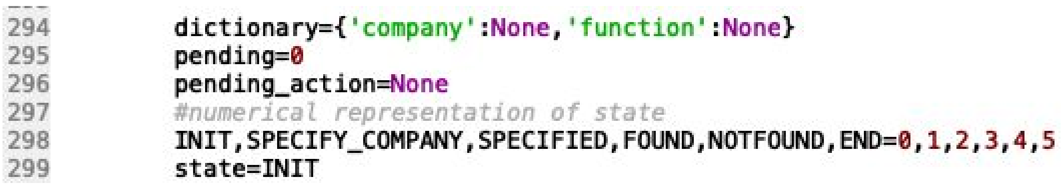


Price of Samsung

Price Information of company not found

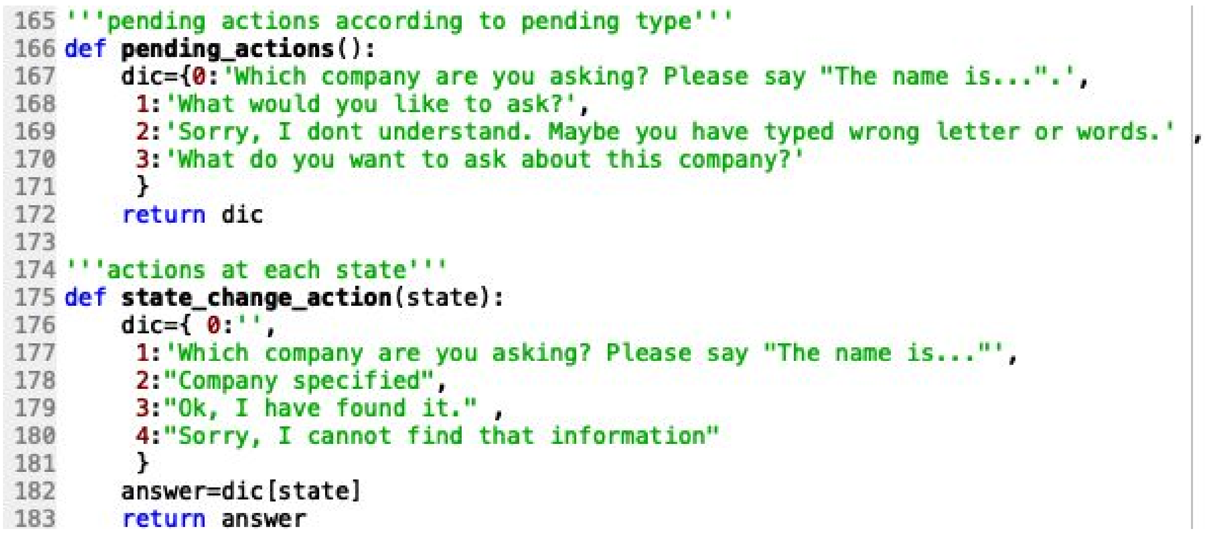
Do you have other questions? Say "quit" to quit chat!

When meeting the situation that the user continues to ask different things of the same company, or the information is not found, the chatbot needs to reply to different information. I need to achieve state machine. This machine can have six states, and I assign a number to different states. Also, it has pending and pending_action. In the dictionary, the value of the company is the company the user want to ask, the function's value is which information the user ask about.



```
        dictionary={'company':None,'function':None}
        pending=0
        pending_action=None
        #numerical representation of state
        INIT,SPECIFY_COMPANY,SPECIFIED,FOUND,NOTFOUND,END=0,1,2,3,4,5
        state=INIT
```

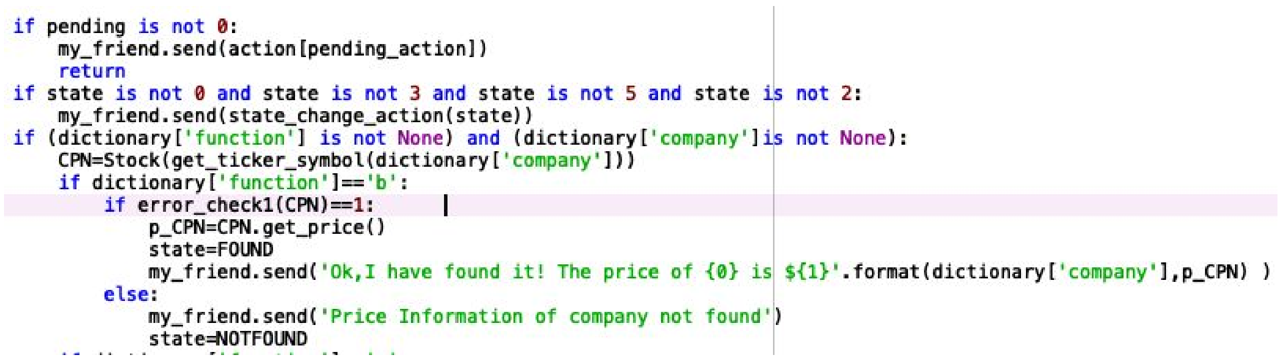
Using the state machine, we need to change state. If the intent is confirm, we do the pending_action. Or the intent is deny, we clear the pending_action.



```
'''pending actions according to pending type'''
def pending_actions():
    dic={0:'Which company are you asking? Please say "The name is...".',
     1:'What would you like to ask?',
     2:'Sorry, I dont understand. Maybe you have typed wrong letter or words.' ,
     3:'What do you want to ask about this company?'
     }
    return dic

'''actions at each state'''
def state_change_action(state):
    dic={ 0:'',
     1:'Which company are you asking? Please say "The name is..."',
     2:"Company specified",
     3:"Ok, I have found it." ,
     4:"Sorry, I cannot find that information"
     }
    answer=dic[state]
    return answer
```

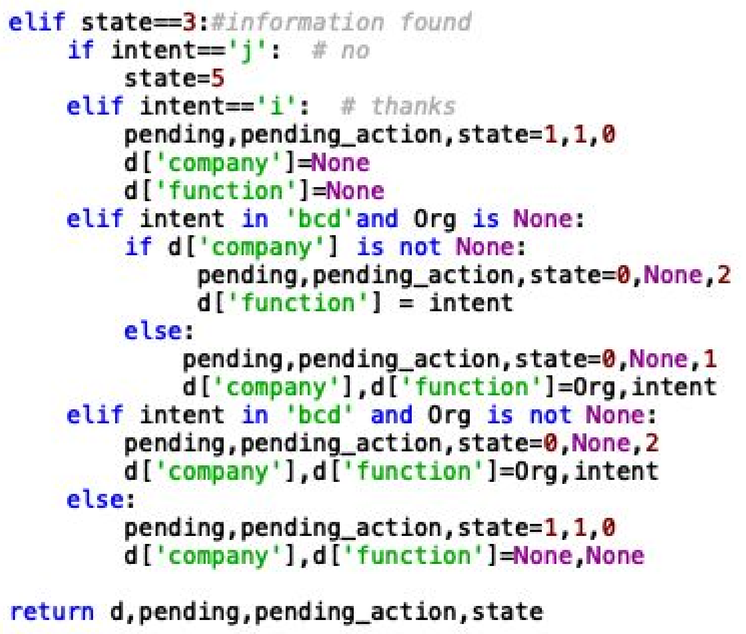
In the main program, the bot_reply function will be called if there is no answer get from respond function. "dictionary,pending,pending_action,state=bot_reply(intent_,state,pending,Org,pending_action,dictionary)". These value will automatically be changed every time when the chatbot receive the user message.

Unless pending is 0, the chatbot will always call pending_actions. When the state is 1 or 4, I will call the state_change_action to ask for more information or say I cannot find that information. After calling bot_reply, if the value is dictionary is not None, I will distinguish which function the user wants to ask and return the information.



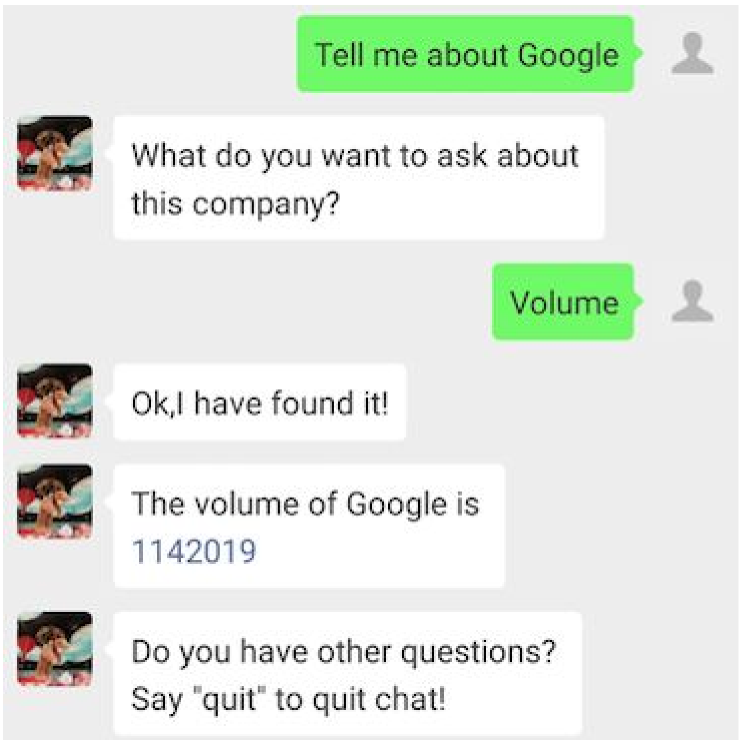
```
if pending is not 0:
    my_friend.send(action[pending_action])
    return
if state is not 0 and state is not 3 and state is not 5 and state is not 2:
    my_friend.send(state_change_action(state))
if (dictionary['function'] is not None) and (dictionary['company']is not None):
    CPN=Stock(get_ticker_symbol(dictionary['company']))
    if dictionary['function']=='b':
        if error_check1(CPN)==1:
            p_CPN=CPN.get_price()
            state=FOUND
            my_friend.send('Ok,I have found it! The price of {0} is ${1}'.format(dictionary['company'],p_CPN) )
        else:
            my_friend.send('Price Information of company not found')
            state=NOTFOUND
```

You may curious how I change the state in bot_rely function. I will use the state=3 to illustrate this process using the following code.



```
elif state==3:#information found
    if intent=='j':  # no
        state=5
    elif intent=='i':  # thanks
        pending,pending_action,state=1,1,0
        d['company']=None
        d['function']=None
    elif intent in 'bcd'and Org is None:
        if d['company'] is not None:
             pending,pending_action,state=0,None,2
             d['function'] = intent
        else:
            pending,pending_action,state=0,None,1
            d['company'],d['function']=Org,intent
    elif intent in 'bcd' and Org is not None:
        pending,pending_action,state=0,None,2
        d['company'],d['function']=Org,intent
    else:
        pending,pending_action,state=1,1,0
        d['company'],d['function']=None,None

return d,pending,pending_action,state
```

When chatbot found information already, if the intent from the user is denying, the state will change to end. Or the intent is appreciate, the machine will fo back the initialized state and clear dictionary. The third situation is that the user continues to ask the question, but do not mention the company. There are two situations inside it. One is the company already save in dictionary, it's multiple round questions. The other one is that chatbot ask for the user to specify the company. Fourth, the user asks a complete question which contains company name the function. The machine goes back to state 2. Expect these situations, the machine goes to initialized state and clear dictionary.



Tell me about Google

What do you want to ask about this company?

Volume

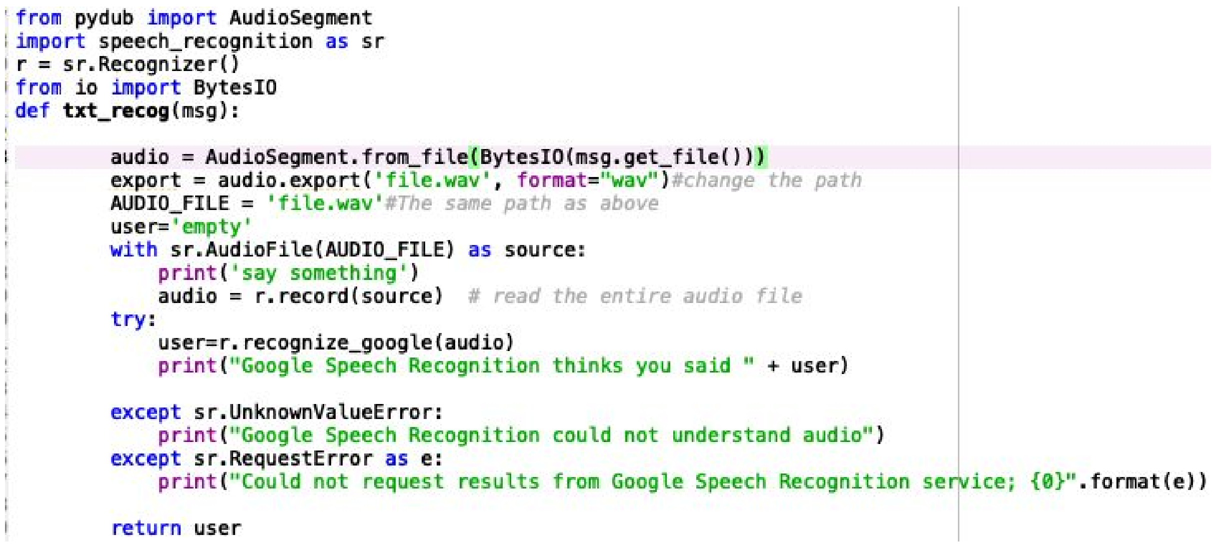
Ok,I have found it!

The volume of Google is 1142019

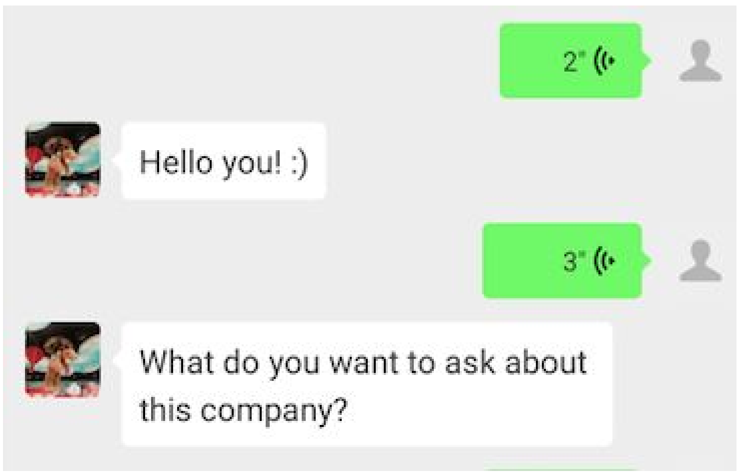
Do you have other questions? Say "quit" to quit chat!

Part 4

In order to deal with the audio sent from the user, I install Python Speech Recognition module and Pydub to implement the following code. msg.get_file will download the contents of the audio. Then I converted that file to be a wav file. I use the Google Speech Recognition to transfer the audio to text.



```
from pydub import AudioSegment
import speech_recognition as sr
r = sr.Recognizer()
from io import BytesIO
def txt_recog(msg):

        audio = AudioSegment.from_file(BytesIO(msg.get_file()))
        export = audio.export('file.wav', format="wav")#change the path
        AUDIO_FILE = 'file.wav'#The same path as above
        user='empty'
        with sr.AudioFile(AUDIO_FILE) as source:
            print('say something')
            audio = r.record(source)  # read the entire audio file
        try:
            user=r.recognize_google(audio)
            print("Google Speech Recognition thinks you said " + user)

        except sr.UnknownValueError:
            print("Google Speech Recognition could not understand audio")
        except sr.RequestError as e:
            print("Could not request results from Google Speech Recognition service; {0}".format(e))

        return user
```



2"

Hello you! :)

3"

What do you want to ask about this company?

Conclusion

In part 1, I achieve three goals. First one is multiple selective answers to the same question and provides a default answer. Second, chatbot can answer questions through regular expressions, pattern matching, keyword extraction, syntax conversion. Third, it can extract users' intents through regular expressions.

In part 2, the user’s entities can be extracted by a support vector machine. Based on predefined entities’ types to identify an entity. Also, I construct a local basic chat robot system through Rasa NLU to explore the database using natural language.

In part 3, I implement multiple rounds of multi-query technology for state machines and provide explanations and answers based on contextual issues.

In part 4, the chatbot can achieve receiving the audio from the user and reply the information.

Through these four parts and integrated into Wechat, there is a chatbot that can answer questions on stock price, trading volume, and marketing value. Users can send audio or text message to ask multiple questions about the stock.

Works Cited

https://pypi.org/project/iexfinance/

https://docs.python.org/3/library/re.html

https://spacy.io/

https://rasa.com/docs/nlu/

https://github.com/jiaaro/pydub

https://github.com/youfou/wxpy