Designing a scalable Conversational Interfaces

Cristian Gutierrez[1§], **Darshi Kasondra**[1§], **Archana Ravi**[1§], **Mounica Dingari**[1§]

[1]California State University of Northridge

Additional work related to this paper can be fournd at https://github.com/thehamop1/AdvSoftwareEngineeringProject;

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Abstract The way we use interact with systems is contantly evolving with new advances in technology. As buisness continue to need flexible user interfaces many of them are implementing conversatinal interfaces in order to fufill customer needs without having to require users to learn how to use an entirely seperate application in order to make transactions. Modern conversatinal interfaces are fairly powerful with recent adavancements in natural language processing, integration with mobile asistants, and flexible frameworks. In this paper we provide background to some of the concepts of conversatinal interfaces, examing the current state of commercially available solutions, and provide a reference architecture for implementing a system centered around a conversatinal interface.

***For correspondence:**
cristian.gutierrez.56@my.csun.edu (CG)
Present address: §Department of Engineering and Computer Science, California State University of Northridge, United States of America

1 Introduction

1.1 Previous Work, Methods, Procedures

There is a growing need for approchable user interfaces as more interactions become digital. For example banking, transactions, and flights are all largely growing to be digital. In order to easily accessed and usable for all types of users conversatinal interfaces are the most ideal due to their low learning curve. If a user can use their native language in order to complete actions on any given system the need for 24/7 support or complex user interfaces become obsolete. This allows buisness to keep user satisfaction high while keeping costs low. Additionally it provides several benefits to users as they are able to access data from large databases easily, complete transactions even if their not so tech savy, have multilingual support, and have 24/7 support.

1.2 Previous Work, Methods, Procedures

The development and interest of conversatinal interfaces was has been a subject of interest since the 1970's. Early examples of these early chatbots include ELIZA, ALICE, and PARRY. Many of these early chatbots worked with the use of simple pattern matching. This simple regular expression based matching was combined with a tree design for controlling the flow of conversations. One of the major drawbacks of this naive form of design was the frequent matching of user utterances with conversation points that happened further up the tree. This would often lead to looping conversations. Researchers at the time had to develop markup based langugues such as AIML in order to develop expert systems. These large complex forms of nested databases had to be constantly maintined in order to add new features to these chatbots. With the modern development of machine learning algorithms in order to parse and extract meaning from user utterances. Many commercial solutions for developing conversatinal interfaces are now widely available and come with many integrations for various platforms.

1.3 Background

There are some basic concepts that are universal to most conversatinal interface platforms. The first is the user utterance which can either come in the form of a text entry or speech with the use of a microphone. Additional signal processing is required to transcribe the audio signals into text. This text is usually normalized where all text has its puntuation removed and all letters are moved into the same letter case. Next depending on the platform various machine learning algorithms are used in order to extract certain key tokens from the string. The most intent which is the objective of the user. For example the utterance "What is the weather in Los Angeles" would have the intenet of weather. This is a topic that the application would have to be designed to respond to. Next would be entities which are certain tokens the application will use to complete requests once an intenet has been deduced.

2 Implementation Guide 1

2.1 Use Cases

The following implementation guide was designed with the assumption that a Conversational Interface would be designed for a large enterprise supporting a large amount of customers and is required to interface with existing large databases. Refer to reference architecture 1 in order to get a broader overview of the different services that could integrate with this architecture. This guide will primarily be based on using microsoft azure. alternatively a platform such as AWS or IBM Jarvis could be used to accomplish the same things. An environment such as healthcare or airlines would be most appropriate for this type of system. Given the example of airlines a conversational interface to book, change, and check the status of flight could be created to give users the ability to interact with their travel plans via Google Assistant or Siri.

2.2 Technical Stack

For this technical stack C is highly recommended as it's offical library has the most chat based front-ends to integrate. A community devleoped library exists for several languages that give additional functionality with chat platforms if required..

3 Implementation Guide 2

3.1 Use Cases

The following implementation guide was designed with the assumption that it would be used in a buisness context such as e-commerce site, resturant, or customer support. Additionally little sensitive information would be transmitted between the conversatinal interface and the service could be an addition to existing buisness infrastructure. Additionally this Implementation guide is more suitable for small to medium sized buisness who are looking to provide the user with the ability to retrieve basic data and transactions. Refer to Figure 1 for a reference architecture for this guide (The seperation of logic should be similar however the frameworks themeselves have been switched in order to support Google DialogFlow V2/V3).

An example use case for this reference architecture would be a small chain of resturants. In this scenario a customer may want to make reservations for instance while the resturant is closed. In this scenario integrating a conversatinal interface on the buisnesses website and mobile assistant would provide the user with the ability to create or cancel reservations while the buisness is currently closed. Even customers with little knowledge of how to browse the internet or create reservations online would be able to interact with their mobile asistants in order to interact with the system.

3.2 Technical Stack

For this particular implementation guide a stack such as ReactJs, SQL, nodejs, dialogflow, and Google Assistant/Siri would be used. NodeJS would be used on the lambda functions and buisness enterprise. Any in buisness databases would be created with an SQL flavor and an ORM such as knex.js would be used to store various information. If a buisness did not have an existing website it would be created in ReactJS, alternatively if an existing website was already available a simple iframe based solution could be used from the existing dialogflow API integrations.

As stated before any interaction needed with existing buisness infrastructure could be handled with lambda funcitons. The existing language most supported by the Dialogflow API is NodeJS. It is extermly cost effective and easy to integrate using Google Cloud Functions. In order to fully take advantage of deploying to various platforms different buisness logic needs to created to interact with various front-ends. The Dialogflow API allows you to create specific reponses based on the clients platform in order not to overwhelm the client with long responses or provide more relevant information to the user.

An added benefit to using lambda functions is that all of the heavy machine learning processing is carried out on the

Dialogflow API side so no heavy processing is required within the runtime of the lambda itself. This allows the call from the client to be quickly parsed via a RESTful API call and intenets, entities, and context can already be deduced ahead of time. By allowing the buisness logic to be compeltley free of all machine learning it allows the particular buisness implemnting the system save money on renting a fully dedicated server to run the machine learning algorithm. Keep in mind that although the use of lambda functions reduces cost there is an additonal cost required for every call to the Dialogflow service. Additionally the version of the DialogFlow API used also factors into cost. If the complexity of the conversations are relativley simple version 2 of the API can be used to increase savings on this implementation.

The Dialogflow dashboard would need to be trained using a set of sample training data. Most of the internal machine learning algorithms are abstracted on this platform. What this means for the buisness trying to develop their platform with this tool is that the develop who they chose to hire doesnt need an extensive background in machine learning in order to get things working in the first place. In addition to this sample training data simple regular expressions would be given to the DialogFlow agent in order to fall back on when confidence scores get too low.

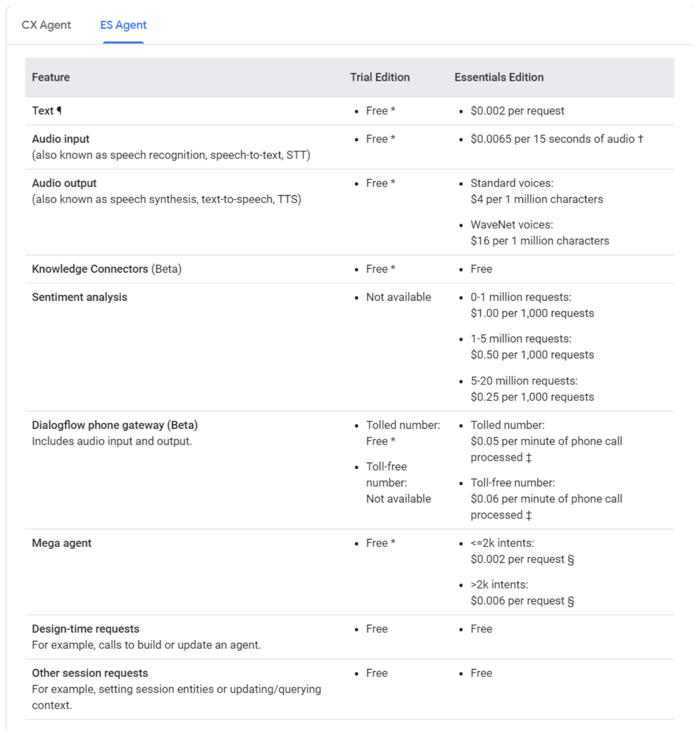
Lastly in terms of getting a voice enabled conversatinal interface for this systmem would require the use of the newer DialogFlow V3 API or the use of a deprecated API in order to interface wtih the older DialogFlow version 2. Although this option is available using the newer nodejs package it is highly discouraged as this part of the library is no longer receiveing updates. Additionally in order to connect this service to iOS an additionial layer of buisness logic has to be placed between the dialogflow API calls and the Siri front-end. The buisness should consider the development cost required in order to keep iOS integration supported versus how benefical it is from a buisness stand-point to keep it supported.

3.3 Cost Benefit Analysis

In order to understand the on-going cost of having lambda function costs and DialogFlow API calls the following charts should be considered when considering the benefit of adding a converstaional interface to an e-commerce site.

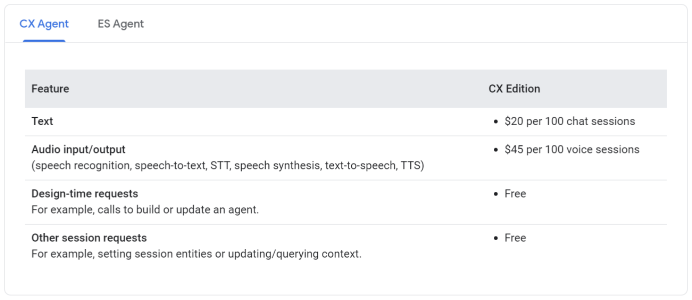
As seen above the cost of supporting the converstational interface API version 3 is far different that supporting version 2. If the buisness needs don't demand strict requirements that users will be generating complex utterances then version 2 of the API should be considered. If integration with google assistant and siri is an important feature then it's recommended that Google Actions API be used (DialogFlow v3). Additionally the price of Google Cloud Function calls should also be considered. This service has a much lower cost espe-

Figure 1. DialogFlow Version 2


CX Agent
ES Agent

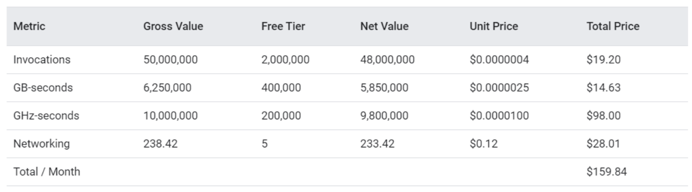
Feature	Trial Edition	Essentials Edition
Text ¶	• Free *	• $0.002 per request
Audio input (also known as speech recognition, speech-to-text, STT)	• Free *	• $0.0065 per 15 seconds of audio †
Audio output (also known as speech synthesis, text-to-speech, TTS)	• Free *	• Standard voices: $4 per 1 million characters • WaveNet voices: $16 per 1 million characters
Knowledge Connectors (Beta)	• Free *	• Free
Sentiment analysis	• Not available	• 0-1 million requests: $1.00 per 1,000 requests • 1-5 million requests: $0.50 per 1,000 requests • 5-20 million requests: $0.25 per 1,000 requests
Dialogflow phone gateway (Beta) Includes audio input and output.	• Tolled number: Free * • Toll-free number: Not available	• Tolled number: $0.05 per minute of phone call processed ‡ • Toll-free number: $0.06 per minute of phone call processed ‡
Mega agent	• Free *	• <=2k intents: $0.002 per request § • >2k intents: $0.006 per request §
Design-time requests For example, calls to build or update an agent.	• Free	• Free
Other session requests For example, setting session entities or updating/querying context.	• Free	• Free

Figure 2. DialogFlow Version 3


CX Agent
ES Agent

Feature	CX Edition
Text	• $20 per 100 chat sessions
Audio input/output (speech recognition, speech-to-text, STT, speech synthesis, text-to-speech, TTS)	• $45 per 100 voice sessions
Design-time requests For example, calls to build or update an agent.	• Free
Other session requests For example, setting session entities or updating/querying context.	• Free

Figure 3. Google Cloud Function Pricing



Metric	Gross Value	Free Tier	Net Value	Unit Price	Total Price
Invocations	50,000,000	2,000,000	48,000,000	$0.0000004	$19.20
GB-seconds	6,250,000	400,000	5,850,000	$0.0000025	$14.63
GHz-seconds	10,000,000	200,000	9,800,000	$0.0000100	$98.00
Networking	238.42	5	233.42	$0.12	$28.01
Total / Month					$159.84

cially if compute times are kept low. See Figure 3.

4 Development Plan

4.1 Configuration Management

Within the Google Cloud Function dashboard a repository should be connected as the main source code for the lambda functions that will be servicing DialogFlow requests. This repository should be configured with either the Github Flow or Git Flow configuration style. That being said in order to prevent disastrous situation such as a novice developer pushing to the deployment branch Continous Integration should be implemented in order to verify that the deployed source code will work in production. Google Cloud can be configured in such a way most of the source conrol lives in Github or Bitbucket where the git server can be configured to interact with Jenkins CI or Travis CI. Upon certain actions such as merging to the master the repository can automatically launch the newest source code to the active lambdas.

4.2 Development Environment

Developers should use an environment where the same version of Node.JS that the Cloud Functions will be using. The appropriate version of DialogFlow for Node.js should be installed along with firebase lambda emulator. This package allows developers to locally host a Google Cloud Function. Either ngrok or a similar package should be used in order to provide an https public facing URL in order to test with the DialogFlow agent via the DialogFlow dashboard. Additionally each developer should be given his/her own dashboard in order to connect their publically facing URL and test their code.

5 Conclusion

5.1 Implementation

In order to test our design while being platform agnostic the proposed objective was to create a DialogFlow agent that would interact with Github's RESTful API. Basic function available to the user would be searching repositories, querying the git database for logs, merges, and pull requests. The front-end user interfaces would interact with the DialogFlow agent directly and once all necessary entities were detected the dialogflow agent would make a request to the Web hook via Google Cloud Function (lambda function). The available front-ends deployed where integrations with Slack, basic web based GUI, and directly from the dashboard. The development enviroment consisted of Visual Studio Code, ngrok, firebase emulator, and the dialogflow test dashboard. A Git repository containing the DialogFlow fufillment code was hosted on Google Cloud where the master branch was set to deploy its newest commit.

5.2 Challenges

Several challenges were faced while implementting this converstational interface. For example the dialogflow version 2 API was deprecated and full documentation to interact with the agent was no longer provided. Additionally in order to migrate an existing workspace from DialogFlow V2 to Google Actions (v3) a length process needed to be followed in order to verify that the paths that the converstation could follow were correct.