

Designing a scalable Conversational Interfaces

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

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

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1 Introduction

1.1 Previous Work, Methods, Procedures

There is a growing need for approachable 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 conversational 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 business 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 they're not so tech savvy, have multilingual support, and have 24/7 support.

1.2 Previous Work, Methods, Procedures

The development and interest of conversational interfaces 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 languages such as AIML in order to develop expert systems. These large complex forms of nested databases had to be constantly maintained 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 com-

mercial solutions for developing conversational 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 conversational 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 punctuation 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 intent 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 intent has been deduced.

2 Implementation Guide

2.1 Use Cases

The following implementation guide was designed with the assumption that it would be used in a business context such as e-commerce site, restaurant, or customer support. Additionally little sensitive information would be transmitted between the conversational interface and the service could be an addition to existing business infrastructure. Additionally this Implementation guide is more suitable for small to medium sized business who are looking to provide the user with the ability to retrieve basic data and transactions.

An example use case for this reference architecture would be a small chain of restaurants. In this scenario a customer may want to make reservations for instance while the restaurant is closed. In this scenario integrating a conversational interface on the businesses website and mobile assistant would provide the user with the ability to create or cancel reservations while the business 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 assistants in order to interact with the system.

2.2 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

business enterprise. Any in business databases would be created with an SQL flavor and an ORM such as knex.js would be used to store various information. If a business 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 business infrastructure could be handled with lambda functions. The existing language most supported by the Dialogflow API is NodeJS. It is extremely cost effective and easy to integrate using Google Cloud Functions. In order to fully take advantage of deploying to various platforms different business logic needs to be created to interact with various front-ends. The Dialogflow API allows you to create specific responses based on the client's 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 intents, entities, and context can already be deduced ahead of time. By allowing the business logic to be completely free of all machine learning it allows the particular business implementing 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 additional 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 relatively 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 business trying to develop their platform with this tool is that the developer who they chose to hire doesn't 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 conversational interface for this system would require the use of the newer DialogFlow V3 API or the use of a deprecated API in order to interface with 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 receiving updates. Additionally in order to connect this service

Figure 1. DialogFlow Version 2

CX Agent <u>ES Agent</u>		
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.	• Toll-free number: Free * • Toll-free number: Not available	• Toll-free 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 <u>ES Agent</u>	
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

to iOS an additional layer of business logic has to be placed between the dialogflow API calls and the Siri front-end. The business should consider the development cost required in order to keep iOS integration supported versus how beneficial it is from a business stand-point to keep it supported.

2.3 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 conversational interface to an e-commerce site.

As seen above the cost of supporting the conversational interface API version 3 is far different than supporting version 2. If the business 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

Figure 3. Google Cloud Function Pricing

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

3 Development Plan

3.1 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 Continuous 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 control 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.

3.2 Developer Environment References