THINK INDIA JOURNAL

ISSN:0971-1260
Vol-22- Issue-14-December-2019

Question Answering based Dialogue System in Punjabi language

Suket Arora[1], Sarabjit Singh[2], Simrandeep Singh Thapar[3]

[1]IKJPTU, Jalandhar, Punjab, India
[2]IKJPTU, Jalandhar, Punjab, India
[3]IIM, Amritsar, Punjab, India

Abstract. At present many fields of Natural Language Processing (NLP) come into existence with highly advanced applications and technology. Question Answering Based Dialogue System is an application of Natural Language Understanding (NLU). It has now become top choice for the researchers. In the Question Answering Based Dialogue System (QABDS) user gives questions or queries to the system to obtain correct and accurate answers. By using this system, a user gets valid and accurate answers to the natural language questions instead of SQL query. In this paper we have proposed a comparison of QABD systems and found some research gaps in these systems. Based on this we are introducing an NLP based QABD system for an Indian Language 'Punjabi'.

Keywords: Dialogue system; Natural language processing; Natural language understanding

1 Introduction

A computer program that interacts with human in a natural way is called the Dialogue System. The dialogue system provides an interface between user and computer based application. This interaction of human user with the computer based application is in natural manner. Question Answering Based Dialogue (QABD) System is a method used to extract the needed information from a structured database or the web. For this purpose, the system needs to understand the query in native language. To understand the user's query the approach is to comprehend the linguistic point of view of the query and understand what the user wants to ask. These tasks are performed by different components of the system. These components interact with each other to give correct answer to the user.Different Dialogue Systems have different architectures but they are composed of components which are Input Recognition, Natural Language Understanding, Dialogue Management, Response Generator and Output Renderer. [1]

Today, there is huge amount of information is available on the web. User expects concise, correct and comprehensible answer from the web in their native language for his queries. User don't want to be restricted to a specific query language, query formulation rules, linguistic knowledge etc. while search engine provide ranked list of websites, documents etc. So there becomes vital need of Question Answering Dialogue System.*Question Answering Dialogue System (QADS)*is an advance Web based assistant to users in Punjabi for accessing public website rather than Keyword search or Menu driven navigations or FAQs.Some popular languages that people of India speak are Hindi, Punjabi, Malayalam, Telugu, Marathi, Bengali etc. Currently researchers are considering these Indian languages to work in the field of natural language processing. Millions of people around India & Pakistan have mother tongue Punjabi and also in America, Canada and Europe.In this paper we discuss QADS, terminology used in Natural Language Processing (NLP), history of QADSs,design of system and dialogue flow. In the end we conclude with future research in this field. This paper also illustrates how computer give reply to the user in natural language text of the natural language query or question given by user.

2 Natural Language Processing

Natural Language is that language which is written or spoken by human forgeneral purpose communication e.g. Punjabi, Hindi and English etc. Natural language processing permits computers to extract meaning from the words and phrases that persons use and respond in a similar way once presenting information back to them. It include:-

- **Natural Language Understanding(NLU)**
- **Natural Language Generation (NLG)**

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ISSN:0971-1260
Vol-22- Issue-14-December-2019

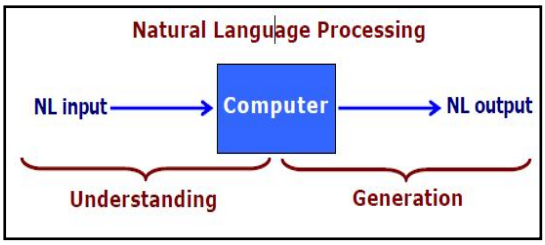

Fig.1. Natural Language Processing

In Fig.1, Natural Language Understanding (NLU) takes input in natural language given by the user, understands it and also reasons it. On the other side,we have Natural Language Generation (NLG), which is a natural language processing task concerned with computer programs to produce output in natural language from the machine representation system.

The objective of a Natural Language Understandingis to interpretan input text fragment. The process of interpretation is often viewed as a translation of the text from a natural language to a representation in an unambiguous formal language. This representation is further used for performing concrete tasks to respond to the user's request.To understand and process natural language query,the system should have linguistic knowledge. Morphological analysis, syntactic analysis, semantic analysis, pragmatics analysis, shallow parser etc. are various tools and techniques available. Every researcher used its own algorithm, technique, model and architecture for query processing. Natural languageunderstanding has four phases [2] or stages.These phases are shown in Fig.2. These all phases are discussed below:

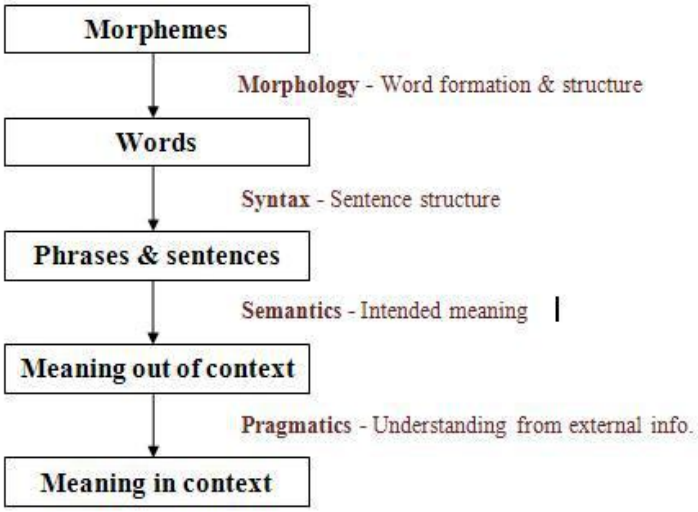

Fig.2. Phases of Natural Language Understanding

Morphology is the initial stage of analysis once input has been received. It looks at the ways in which words break down into their components and how that affects their grammatical status. Morphology is generally useful for identifying the parts of speech in a sentence and words that interact together.Morphologyis identification,analysis and description of structure of words.

Syntax involves applying the laws of the target language's grammar.Its task is to determine the role of every word in a sentence and manage this data into astructure that is more easily manipulated for furtheranalysis.

Semanticsdetermines possible meanings of words and sentence in a context.After determining the structure of a sentence the next step is to determine the meaning of the words and sentence.

Pragmaticsis the order of steps that exposes the overall purpose of the statement being analyzed. This will be broken down into Ambiguity and Disambiguation to facilitate understanding.

3 Literature Survey

Only in little span of years, there is drastic increase in the field of NLP, because of the need of the user to search the precise information from the web. So, Simmons (1965) [3] introduced the survey article " Answering English Questions-

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ISSN:0971-1260
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by Computer" in English language. Further, other work is done by Grosz, Sparck Jones and Webber on articles PLANES [4], LADDER [5], and TEAM [6] respectively. Review of work through 1990 is done by Copestake and Sparck Jones [7].The most prominent early work here is START [8] and it is still running on the World Wide Web since1993. START uses decomposition based on syntactic analysis approach to answers complex questions. Over the years, Question answering system is emerging rapidly. There is huge improvement in the field of Natural Language Processing (NLP) from the last decade e.g. research has been carried on Hindi, Punjabi, Telugu, Bengali, Malayalam languages etc. such as Sekine et al. (2003) [9]launched Hindi-English cross lingual QA system. This system accepts and responds in English language by taking the input from Hindi newspaper.In the following sections, we are classifying the QA systems.

3.1 Rule Based QA System

Rules Based Systems can apply to implement lexical analysis in natural language Processing [10]. An example of Rule based systems are domain dependent Expert System that used to specify rules or choices [11]. A variety of algorithms are also developed to process the documents such as Gupta et al. (2013) [12] described an algorithm for accepting user's query in Punjabi and a paragraph text as input from which answer are to be extracted.

3.2 IR/IE Based QA System

Information Retrieval (IR)/Information Extraction (IE) [13] are the attractive areas for research. Users ask the query and system gives answer in the form of documents with relevant passages. The IE community developed the Message Understanding Conferences (MUC) for its own evaluation and which ran between 1987 and 1998. Besides this, Chung et. al. (2007) [14] developed QA and IE engine to obtain weather information from the website. Contrasting others, Sahu et al. (2012) [15] has followed the QA system using Query Logic Language (QLL) and Hindi shallow parser which is developed by IIIT Hyderabad. They developed architecture for the QA system and involved the various modules such as Query Processing, Query Generation, DB search etc. The given QA system gives the response to users in Hindi Language. The system handles on four types of questions where, when, what & how many types of questions.

3.3 Web Based QA System

A very large amount of information is available on the Internet. It is considered best source to obtain the information. Web based QA systems depend on the search engines to provide the potential web pages containing answers to the questions of the users. This method provides the answers in text documents, PDF, XML documents, Wikipedia etc. The data on the web has heterogeneity, distributive and semi structure properties. There are two most popular techniques for QA systems. These are Open Domain System and Restricted Domain QA System [16] while Web based QA systems work for open domain [17]. TREC is the major scale evaluation environment for open domain QA system. TREC is focused to build a fully automatic open-domain QA System. This system can answer a huge variety of questions based on a large amount of data. Kumar et al. (2005) [18] introduces a light weight stemmer for Hindi and also developed case-based rules to classify the question. Stalin et al. (2012) [19] implemented the web based QA system that retrieve the answers from Hindi documents for user's query in Hindi language. Again, Gupta (2013) [20] has proposed a technique of question answering for Punjabi and English text.

3.4 Restricted Domain QA System

Restricted domain QA Systems are under specific domain queries and are related to that particular domain [21] and based on general corpus provides a list of documents. Therefore, restricted domain gives more accurate result as compared to listing a set of related websites and documents.

In recent years, closed domain systems and open domain systems has emerged very fast. Currently, users have no time to search the particular information from the web. So, Question answering dialogue system becomes worthy and provides unerring information but in a restricted domain. As we start from near the beginning systems, these are very restricted to the domain and provide limited information of the user's query. The famous early program with restricted domain was BASEBALL [22], a program to provide answers about one season of American league but domain is limited to baseball only.

SHRDLU [23] is perhaps the first AI System to take the user query and send back respond to the user.The SHRDLU system performs to control the robot hand which help to arrange the blocks as requested by the user. The GUS(Genial Understand System) [24] system is developed to help the travel advisor on restricted domain about Airlines Flights. After this system, many upcoming systems follow the same approaches to retrieve appropriate data in restricted domain.

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ISSN:0971-1260
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Another well remembered system in this practice is the LUNAR system.This system provides the simple way to access, compare and assess the chemical analysis data of Lunar Rock [25]. Early dialogue system such as UC (Unix Consultant) [26] and The Berkeley Unix Consultant project (UC) gives the reply of user's question about UNIX operating system [27]. One more early dialogue system is GENIES [28]. It is developed in 1999. The system extracts structured information related to molecular pathways. Subsequently another method implemented by Reddy et al. (2006) [29]. They introduced the Question answering based dialogue system in Telugu Language for Indian railways. Another QA system based on Hindi language is proposed by Sinha (2006) [30]. The system uses same approach for Railway in Hindi Domain along with system using shallow syntactic and semantic analysis on the input query. Moreover, Godavarthy et al. (2007) [31] has discussed the dialogue management with multilingual restricted domain QA system for Bengali and Telugu language. By following the same practice, another work in this line is done by Kangavari et al. (2008) [32] developed a system to retrieve accurate answer in the domain of "weather forecasting". QUARS(2016) [33] system is a keyword based system, employed for an Indian Railways System in Hindi language for Northern India.

A survey of various restricted domain Question Answering systems has been mentioned in Table 1

Table 1. Comparison table of various systems

SR NO	SYSTEM	ACCURACY	QATYPE	MODEL/TECHNIQUE FOR QUERY PROCESSING	LIMITATIONS
1.	BASEBALL [22]	Not given and Unsatisfied results	Restricted Domain	Linguistic, Semantic Analysis	1. Questions are limited to a single clause. 2. *and, or, not* are prohibited. 3. Semantic ambiguities unsolved
2.	SHRDLU [23]	Quiet accurate	Restricted Domain	Backward chaining or means-ends analysis	Not useful for commercial field
3.	Lunar [25]	90%	Restricted Domain	Syntactic and semantic analysis	Narrow domain
4.	UNIX Consultant [26]	Good efficiency	Restricted Domain	Minsky's theory of frames	Narrow domain
5.	The Berkeley UnixConsultant Project [27]	Quiet Satisfactory	Restricted Domain	Language analysis using ALANA	1. Components are not integrated i.e. flow of the system unidirectional 2. repeated question responds no answer
6.	GENIES[28]	Precision=96 % Recall=63%	Restricted Domain	Own architecture using-MedLEE	1. Incomplete lexicon 2.Grammar rules are incomplete
7.	START[8]	Satisfactory Results	Open Domain	Morphological, semantic and syntactic analysis	Unstructured data because of open domain
8.	Hindi-English cross-lingual question answering system[9]	Each component is calculated separately but accuracy is Acceptable	Open Domain	Monolingual QA systems with Named Entity Tagger	Errors in Keyword translation
9.	Hindi Question Answering system for E-learning documents[18]	Directly answered of the questions=75% Directed to the relevant document=12%	Open Domain	A light – weight stemmer for Hindi & case based rules to classify the Question	To lack of clear boundary between classes of classification & inadequate use of syntactic information.
10.	Dialogue based Question Answering System in Telugu [29]	Dialogue success rate = 83.96% Precision =96.34%	Restricted Domain	Architecture consists of Query analyzer, query frames, dialogue manager, dialogue history, SQL generation and answer generation	Query frames for some natural language queries were not correctly identified.
11.	A Practical QA System in Restricted Domains [14]	Precision =90.9% Recall = 75.0%	IR/IE	QA system with QA system and IE engine	1. Insufficient data of weather domain ontology 2. Error due to query frame analysis 3. Low recall rate due to invalid data and topic.
12.	Multilingual Restricted Domain QA System with Dialogue Management	**Without Dialogue Management:** Bengali System: Precision=85.70%	Restricted Domain	Shallow parser	NLP queries are not perfectly identified and some queries are out of database coverage. Unable to obtain chunks, so generating wrong

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ISSN:0971-1260
Vol-22- Issue-14-December-2019

	(Bengali and Telugu) [31]	Recall=80% Telugu System: Preci-sion=97.63% Recall=93.93% **With Dialogue Management:** Bengali System: DSR =72.91% Precision= 83.67% Telugu System: DSR=89.06% Precision =96.49%			answers.
13.	A New Model for Question-Answering System [32]	**Version no.1** (based on fixed pattern which user cannot change)=70% **Version no. 2** (based on system can check the dictation of word)=90%	Restricted Domain	Syntax n semantic analysis	Low accuracy due to query reformulation due to syntax and semantic relation
14.	Prashnottar [15]	68%	IR/IE	Hindi Shallow Parser using Query logic language (QLL)	Accuracy of Question type 'Where' is low be-cause the answer type of this question is Proper noun i.e. location.
15.	Web Based Application for Hindi Question Answering System [19]	Inconclusive Re-sult	Restricted Domain	POS tagging	Less semantic implemen-tation of answer extraction
16.	Algorithm for Punjabi Question Answering System [12]	Average accuracy=73%	Restricted Domain	Develop step algorithm and hybrid model (Pattern matching +new proposed answer finding scoring system)	Do not support which, how much, how many type of questions.
17.	A Proposed Online approach of English and Punjabi Question Answering [20]	Accuracy of half implementa-tion=70%	Open Domain	Architecture consists of-query analysis, query generator, open web search, snippet extractor and answer ranker	1.Insufficiency of consis-tency 2. Punjabi dictionary is not correct
18.	QUARS[33]	Precsion=99.4% Recall 98.8%	Restricted Domain	Keyword based approach	Sometime keyword not found

4 Purpose of Study

Every QA system has its own limitations. Some have similar limitations such as insufficient data of domain in Database (DB). Also they have some more limitations i.e. error due to Query Frame Analysis and another error was caused by the flaw of keyword based Query Frame Decision approach. Our proposed system will achieve the 100% accuracy to extract the correct keyword from the user's query and further it will also generates the correct query frame through look up table method. While some other systems follows question classification approach due to this some type of questions are not identified by these QA systems. In addition to this, some systems have Word Error Rate (WER) for some restricted words. Our proposed system has also limitation of some restricted vocabulary but it also overcomes the various limits of above mentioned approaches. Our System has sufficient data related to domain in Database. It does not support question classification, so provides better results.

5 System Design

The purposed system is based on the Information seeking domain. A common application of dialogue systems is as a frontend to a database. Here the dialogue system acts as a natural language interface, and such dialogues are referred to

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ISSN:0971-1260
Vol-22- Issue-14-December-2019

as information-seeking dialogues. The system tries to elicit enough information from the user as is needed to search for the information that the user wants.

The methodology applied and steps followed to answer a particular question by the system are described below with following example and work flow is shown in Figure - 1

User: what is the fee of MCA Course in General Category at ACET College?
System:The fee of MCA course in ACET College is 50000.

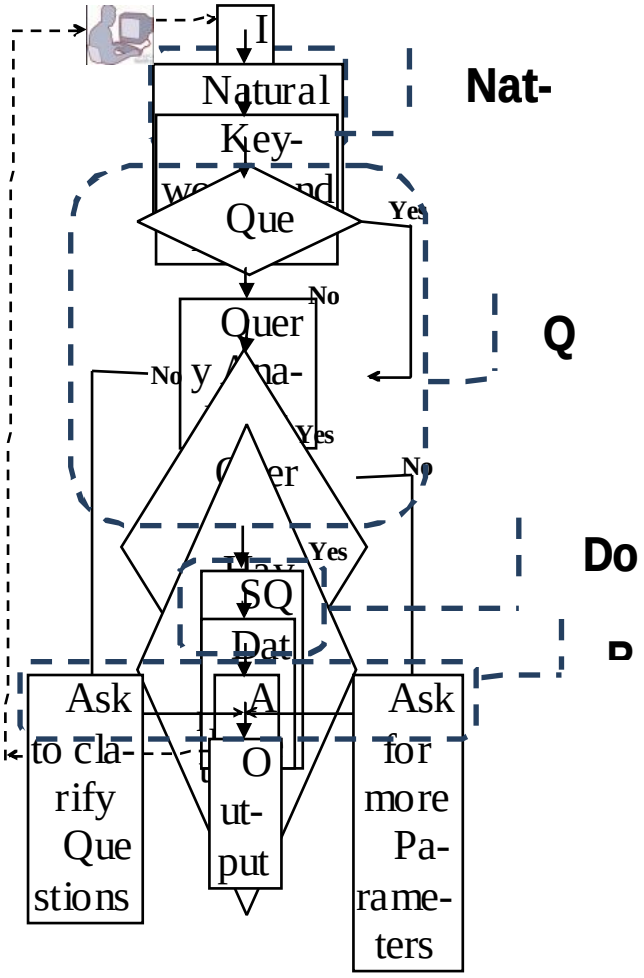

Figure 1: Work Flow Diagram of Dialogue System

5.1 Punjabi Language Input Text

In this, input is taken from the user. User can provide input text in Punjabi language or user can use phonetic typing or Punjabi transliteration for inputting the Punjabi text.

User: A.C.E.T college vichM.C.A. course di general category di fees dasso?

5.2 Natural Language Understanding

Natural language text is taken as input and used for understanding. In this phase system identifies tokens. This component converts input text words into keywords & tokens that can be used by query frame analyzer.

Tokens: what is the fee of MCA Course in General Category at ACET College?

Keywords:MCA, General Category, Course, ACET , College.

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ISSN:0971-1260
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5.3 Query Frame Analyzer

From these tokens this component tries to make semantic representation that could identify the query frame from the user input. These tokens help deciding proper query frame. These tokens help deciding proper query frame. Following are the cases arises

Frame is complete - If the frame is already complete then query will be generated by the SQL Generator.

Frame is incomplete – If the system is not able to make decision on the query frame then system starts the dialogue with the user through the dialogue manager.

In our example our Query Frame is selected as following query frame.

Fee (College, Course, Category)

5.4 Domain Specific Component

After selecting the appropriate query and acquiring all parameters. SQL query is executed for the answer from the database. Following is the query

Select AMOUNT from FEES where college='ACET', course='MCA' and category='GENERAL'

The database contains the information about the Colleges, Course, fees and number of intake etc. SQL query is than executed against database and the result is given to the Dialogue Manager. Following is the result of the query.

50000

5.5 Response Generator

This phase constructs the message that is to be shown to theuser. Dialogue manager makes the decision regarding choice of words and syntactic structure. It also take care of regarding what information should be included and how the information should be structured t form the message.

System: System:The fee of MCA course in ACET College is 50000.

6 Discussion and Future Aspects

The purpose of QA system is to provide accurate, definite and precise answers to users rather than to offer documents or ranked website links. In this paper, we discussed several existing QA systems, their applied tools and techniques, various approaches, algorithms and models to retrieve appropriate and unambiguous answers. A review of various QA systems has been shown in this paper. Researchers used morphology, POS tagging, syntactic and semantic tools etc. to process the query input andfurther to generate the accurate answer.The produced results are fairlyacceptable and satisfactory.The results are good because of consideration of specific domain. The limited domain filters the choice of question asked by user but the results can be improved. In many models, dialogue manager and query processing are the main components of the common system architecture. We can improve the query processing module with the addition of their own logic because as we can observe from comparison table that their own developed architecture provides the more accurate results as compare to morphological, syntactic and semantic analysis etc. tools applied on general architecture.

In future, systems will have to consider multimedia data. Systems should consider audio, videos, images, metadata etc. Thus, QA system is all about human computer communication, to understand and interpret query and intelligent tutor system.

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ISSN:0971-1260
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7 Conclusion

The Question Answering basedDialogue System will assists the usersspecially, the rural areas of Punjab who are not comfortable in communication in English.The system helps them to get information without searching on internet. It is first time any dialogue system is to be developed for Punjabi language. It will also help to develop dialogue system in other Indian languages. The system starts with detailed analysis of input query with the help of tokenizing. Then the keywords found help us to select appropriate SQL Query frame. SQL Query is generated with the help of these Query frames. At last system give answer to user in Punjabi language text. A good question answering dialogue system is one which allows user to interact with the system with fewer problems. There are problemswhich evolved while developing the text-based question answering dialogue question answering system because the understanding of natural language is very difficult task for the computer systems.

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