

HelloPol: An Adaptive Political Conversationalist

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ABSTRACT

Dialogue systems allow user to interact with computers through human language. The problem with such systems today is they require the users to learn a sublanguage and their knowledge are fixed. The goal is to provide an easy-to-use and naturalness in conversing with the user. This paper presents HelloPol, a dialogue system, which is not only capable of interacting, but is also adaptive based on the user's topic preference. Through the Information Extraction (IE) component incorporated in the system, HelloPol is capable of extracting information from political articles, making its knowledge dynamic.

Categories and Subject Descriptors

F.4.2 [Grammars and Other Rewriting Systems]. *Decision problems, Grammar types (e.g., context-free, context-sensitive), Parallel rewriting systems (e.g., developmental systems, L-systems), Parsing, Thue systems.*

General Terms

Algorithms, Design, Languages, Theory.

Keywords

Adaptive Dialogue Systems, Information Extraction, Natural Language Processing

1. INTRODUCTION

Dialogue systems are applications that allow humans to interact with computers using natural language. The greatest challenge for these systems is to make each dialogue experience as natural as conversing with another human being. To allow dialogue that mimics human day-to-day conversation without requiring the user to learn and use a specific syntax.

Dialogue systems have numerous applications. It can be used to aid in education, business, and even for personal matters. For example, ELIZA is a computer therapist that tries to help people with their personal problems. It poses analytical questions for all answers given by the user.

Existing dialogue systems may appear to handle advanced dialogue discourse. However, these systems still require the user to learn a fixed-sublanguage. Users still need to battle with the "knowledge in the head" problem to know the answer to the question "What can I ask about and how?" [4]. In addition, each user is a different individual who has different needs, preferences, and abilities that are only known at use-time. In conversations between humans, one can detect when the person he/she is talking to is disinterested or has a specific topic of interest. In such instances, humans usually adapt to the situation. Thus, to develop a dialogue system that adapts to the preferences of the user is beneficial to promote naturalness in conversations.

Most dialogue system has a fixed knowledgebase containing information used for the response to the user. Once the user knows the system's dialogue responses, he/she loses interest in conversing with it. It is like talking to a person with a fixed set of responses, sooner or later, you'll lose interest in conversing with them. By allowing the system to retrieve its knowledge from a vast source, such as a daily newspaper or magazines, the system becomes more flexible during conversation. The dialogue system now mimics a person who just read the news and one can ask any question regarding today's headlines.

2. RELATED WORK

Dialogue systems have been around since the 1960s. Most of these systems have been the basis for the next generation dialogue systems. By adding an adaptive component, interaction improved because the system is able to learn and adapt to the changing situations. Adaptivity in dialogue systems may be in different forms such as adapting to new vocabularies, mood, personality, and intellectual capacity of a user.

The paper by Dusan [3] presented a dialogue system capable of adapting its language by learning new words from users. The user's increased vocabulary is acquired from spoken speech, text, pointing device, and even human touch. The acquired knowledge is permanently stored in a rule grammar and semantic database. The system's ability to expand its vocabulary is a significant factor in human-computer interaction,

as though the system is a person that can learn and adapt to the user's way of speech. On the other hand, AdFilm or Adaptive Film Recommender [4] is an adaptive movie information and recommendation dialogue system. Recommendations are extracted through the ongoing dialogue. The more the user interacts with the system, the better recommendations are produced.

Information extraction is a field of NLP that mines relevant data from a source knowledge base in order to convert it into another form. Some systems extract information from documents like books or newspapers. The paper presented by Setzer [8] describes a system that extracts temporal information from the natural language text in the genre of newspaper articles.

3. HELLOPOL

HelloPol is an adaptive dialogue system capable of conversing with users through English. The dialogues of the system will rely on political newspaper articles entered by the user. The system is adaptive, adjusting to the user's topic preference. Through these features, HelloPol becomes a simulated conversationalist, capable of communicating and acquiring information from the stored political articles.

3.1 System Architecture

HelloPol has two modules namely, the Training Module or Information Extraction Subsystem (IES), and the Runtime Module or Dialogue Subsystem (DS). During training, political articles are entered into the system. The IES extracts relevant information and converts it into XML format. These are stored in the knowledge database and used during actual discourse. During runtime, the DS retrieves this information based on the user's input. An appropriate response is determined and displayed in the user interface. Figure 3-1 illustrates the architecture of HelloPol.

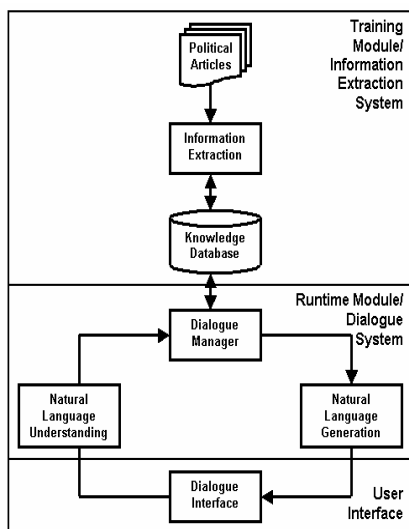


Figure 3-1 HelloPol System Architecture

3.1.1 Training Module/ Information Extraction Subsystem

General Architecture for Text Engineering or GATE is a development environment that aids NLP developers in building applications that entail language processing tasks. GATE provides independent resources, making the development of NLP systems easier since developers can opt to modify one module at a time. The IES of HelloPol uses the open-source IE system of GATE called ANNIE. ANNIE is an information extraction system designed to be portable and usable for different application domains.

The results of ANNIE were formatted into XML that served as the knowledge base of the system. The configuration of the ANNIE system was modified to accommodate the domain of HelloPol which is political newspaper articles.

3.1.2 Runtime Module/ Dialogue Subsystem

The DS consists of several subsystems namely, Dialogue Manager (DM), Natural Language Understanding (NLU), Dialogue Interface (DI), and Natural Language Generation (NLG). The dialogue begins with the DI component. The user initiates the dialogue. The system limits the user to input one sentence at a time. The input is passed to the NLU component where the sentence is tagged, parsed, and classified. The output of this component is an object containing the expected response of HelloPol. The object is passed to the DM in order to access the knowledge database. An information retrieval is performed to input the answers to the variables in the object. Finally, NLG component identifies the appropriate template based on the object to come up with the dialogue system's response. Each of these component is discussed in detail in the following sections.

3.1.2.1 Dialogue Interface

The DI component provides the interface for the actual conversation between the user and the computer. It allows the user to input sentences and the system to display its responses generated by the NLG. Input to this subsystem is in the form of text entered by the user. After the process of understanding the input sentence and generating the appropriate response, the process is repeated through the DI.

3.1.2.2 Natural Language Understanding

The NLU component receives the user's input through the interface. NLU begins by performing part-of-speech tagging using GATE's tagger. A module then resolves the intersentential and intrasentential anaphora of the tagged sentence. The parser is used to generate the parse tree containing the chunks of the sentence. Finally, the parse tree is analyzed and classified according to the type and description it holds. This output is then passed to the next module, the Dialogue Manager.

3.1.2.2.1 POS Tagger

NLU begins by tagging the input sentence. This is done using GATE's POS Tagger. The input sentence is entered and the corresponding tag of each word is identified through the use of GATE's lexicon. For example:

Input Sentence: Who is the president of the Philippines?

Tagged Sentence: Who[pronoun]is[linking-verb]
the[determiner] president[noun] of[prep]
the[det] Philippines[proper noun]

3.1.2.2.2 Anaphora Resolution

The tagged sentence is then passed through the Anaphora Resolution module. If there are words tagged as pronouns, this module identifies a corresponding noun to replace it. This module resolves both intersentential and intrasentential anaphora.

To determine the noun to be used, the module uses a stack data structure. Whenever a noun is introduced, this is pushed on top of the stack. When a pronoun is encountered, the topmost element of the stack that matches the type of the pronoun is used. If a new noun is encountered, then this is again pushed on top of the stack while the old one is neglected. The following illustrates the process of the Anaphora.

Dialogue:
User: Who is the president of the Philippines?
System: Gloria Macapagal Arroyo.
User: Who is her running mate?
System: Noli de Castro.
User: When did she assume office?

Stack Contents:

Noli de Castro [male]
Gloria Arroyo [female]
Philippines [country_loc]
Makati [city_loc]
Loi Ejercito [female]

In this example, the input “When did she assume office?” contains the pronoun she. In order to replace this, the stack is searched for the top most noun having a type female. As such, this module attaches the noun “Gloria Arroyo” with the pronoun “she”.

3.1.2.2.3 Parser

During parsing, a predefined set of grammar rules is used to generate the parse tree. This is by using the POS tags to find a rule that satisfies the ordering. If there are no grammar rules that matches the sentence structure, then the system will generate a “I can’t understand. Please rephrase” statement through the NLG subsystem. Otherwise, the generated parse tree will be pruned. This in return would be used to combine each word to form sub-phrases such as noun phrase, prepositional phrase, etc.

3.1.2.2.4 Classifier

Given the sub-phrases, the NLU component fills up an object used to determine the expected response of the dialogue system. An example object is shown in Figure 3-2.

Input Sentence: Who is the president of the Philippines?

Sentence Chunks: [Who [NP]] [is [the president of the Philippines?][NP]][VP]]

Type:	Question, Who, Person
Description :	president of the Philippines

Figure 3-2 Sample NLU Object

3.1.2.3 Dialogue Manager

The DM uses the object passed by the NLU component and prepares data to be passed into the NLG component. The DM initially performs user modeling to keep track of the topics of the dialogue. The Information Retrieval (IR) module fills up the object with necessary information by retrieving information from the knowledge database.

3.1.2.3.1 User Model

The user model handles the adaptiveness of the dialogue system by recognizing the topic preference of the user. In order to do this, the component models the user with every conversation to determine the topic of interest. For every input, the system identifies if a new subject was introduced. A new subject is added into the system and the frequency is initialized to 1. For every input where the subject is the same, the frequency is incremented.

To determine when to introduce a new topic, the module checks the type of the sentence entered by the user. If the same question is asked two times, the dialogue manager informs the NLG component to display the statement “You already asked that question.” If the user enters similar sentences that the object contents contain the same information, then it is assumed that the user’s dialogues are not progressing. For example,

User: Gloria Arroyo is the president

System: Yes, she is.

User: She is always wearing blue.

System: I don’t seem to know that.

User: She is from Pampanga.

System: Let’s have another topic. Did you know that Noli de Castro is the current vice president?

In this situation, the system notices that the format is the same. In this case, the system suggested a new topic that has the highest frequency value. The user model also keeps track of the topics recently discussed. So if the topic with the highest frequency has been used, the next highest is selected.

3.1.2.3.2 Information Retrieval

The IR module uses the object generated by the classifier. It fills up the information missing from the NLU component. The information is taken from the knowledge database. First, the IR uses the synonym matcher module to determine the synonyms of the words. This is done to enhance retrieval of data from the knowledge database.

NLU Object:

Type:	Question, Who, Person
Description :	Died in the election

Synonyms:

Died	murdered, killed, terminated,
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	past away, departed
Election	Poll, ballot

In the example, the synonyms of the noun and verbs are identified and used during IR. Each of these is searched in the knowledge database. For noun and verb matching the result, a point is given. The result with the highest value is considered to be the most appropriate answer and is passed to the NLG component. If there are several results of the same value, a random result is selected. After finding the result, the IR component replaces the unknown elements into the object.

NLU Object:

Type:	Question, Gloria Arroyo, Person
Description :	president of the Philippines

3.1.2.4 Natural Language Generation

The NLG component of HelloPol is template based. Given the object filled by the IR component, the component searches for a template appropriate for the response based on the sentence type. The template is simply filled up using the elements of the object. Several templates may match but only one is selected at random. After this, the stack used by the Anaphora Resolution module is updated.

4. RESULTS

The paper presented an adaptive dialogue system that is able to respond to the user according to the topic preference. HelloPol uses political articles as its knowledge database. Although it can communicate to the user, the system has its limitations. First, since the system is using some of GATE's POS tagger, some of the tags are incorrect. As such, the resulting components will incorrectly use this information. Aside from this, the system uses the lexicon of GATE thus preventing solution for some of the problems encountered in the anaphora resolution module.

The anaphora resolution module has several limitations. Although it is able to identify the correct noun to replace the pronoun, several levels cannot be detected. For example, "Gloria Arroyo and Imelda Marcos have a lot in common. But the difference is that she is wealthier." For the anaphora resolution, the pronoun she is replaced with the most recent, Imelda Marcos. Even if a human is given this statement, he/she will also inquire which person. Aside from this, sentences that have an intangible relation cannot be detected by the module. For example if the user inputs the series of statements, "Mar Roxas opposes to the new VAT law. It is raining." The pronoun "it" is replaced to the VAT law noun.

The system also requires that information will be entered to determine the gender of a name. A list of reference is required to determine if "President Arroyo" is a he or a she. It cannot infer that Arroyo is linked to a female name Gloria.

To evaluate the system's performance, the three-tiered approach was used. The three-tiered approach "measures user satisfaction (US), mission success and component performance". To qualitatively measure user satisfaction and system support for task success, an acceptance test/survey using the user satisfaction and mission metric was conducted. The respondents

were students who were briefed with the contents of the political articles used by the system.

Criteria for user satisfaction include ease of use, system response, system understanding, user expertise, task ease, response time, expected behavior and future use. On the other hand, criteria for task success contain task completion, task complexity, dialogue complexity, task efficiency, dialogue efficiency, task pace, dialogue pace, and user frustration.

Overall, the respondents gave HelloPol a user satisfaction of 6 (from a scale of 10) and task success of 6. It was observed that user satisfaction and the capability of the system to produce intelligent answers and relevant queries are correlated based from the length of dialogue made between the user and the system. The table summarizes the data gathered from the test.

User	User Satisfaction	# of utterances	# of repair utterances
1	6	20	10
2	7	22	9
3	8	22	13
4	5	33	14
5	5	28	13
6	5	27	14
7	6	19	8
8	5	29	15
9	6	22	11
10	7	19	8

In particular, 55% of the respondents identified frustration to the line of responses. The system generally answered "I don't know. That is not in my database" for queries without results. In addition, respondents complained about the limited grammar the system can accept. Furthermore, respondents suggested to remove the limit to more than one sentence input for the interface.

5. CONCLUSION AND FUTURE WORK

HelloPol incorporated adaptivity in the dialogue system. The objective is to provide a system that can link to an electronic newspaper resource. The idea allowing the system to extract the resource instead a person reading through numerous newspaper. The user can just inquire HelloPol about information he/she is interested in. HelloPol tries to mimic a conversationalist who has read the newspaper articles.

HelloPol is an ambitious project, using many NLP areas into place. Though user satisfaction is acceptable, further improvements are recommended for the different modules. Modules such as the anaphora resolution module and dialogue manager can be further improved. It is also recommended to increase the size of the grammar rules in order to accommodate complex sentence structure.

User satisfaction is very difficult to assess since results may be subjective. The proponents will be evaluating the system further using different evaluation techniques.

Overall, the system is able to fulfill its objective to converse with the user the political domain. It is able to adapt to the topic preference of the user to improve naturalness in dialogue.

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