

Towards a Conversational Agent for Contact Centres

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Abstract— The usability of touch-tone interactive voice response (IVR) systems is dismal. Clients would rather speak to a contact centre agent than navigate through the menu structure found in these systems. Contact centres, however, due to various reasons, such as high personnel costs, tend to use IVR as their solution for automation. This paper compares a rule based system, which is designed to resemble an IVR system, against a natural language interface which uses text as input. The evaluation is conducted to determine whether natural language interfaces provide a more effective automation technique in comparison to current techniques employed by contact centres. A conclusion is made that a hybrid system using both techniques could produce the better solution.

Index Terms— ALICE, Chatbot, Contact Centres, Natural Language Interface and Rule Based Experts Systems.

I. INTRODUCTION

Contact centres are often the first point of contact with a company by a client, after the purchase of a product. This highlights customer service at these centres as a critical success factor [5]. Because of high personnel costs contact centres have, however, not always been able to hire as many agents as they would like. This lead to the introduction of automation techniques such as interactive voice response (IVR). These types of systems typically utilise touch-tone input from users as a form of input to the various interactive menu options available to the client. IVRs are designed using principles from rule based expert systems and share the same properties as these systems. Due to a variety of reasons IVRs have often lead to poor interactions with clients, which resulted in a low resolution of calls posted by clients [8].

Natural language interfaces (NLI) provide a means by which certain IVR related problems can be alleviated. These interfaces allow for natural everyday language in the form of speech or text, to be used as input to a system. NLIs could be used to flatten or eliminate menus found in IVR and allow clients to access exactly what they need through natural dialogues. Client interaction with contact centres can be made more effective, efficient, satisfying and useful. Contact centres can save money through reduced contact centre agent personnel costs, greater call densities and building better customer relationships through better interactions. NLIs, however, do come with their disadvantages. The main disadvantage is that of ambiguity [13]. Furthermore, the memory of most NLI systems is short term.

ALICE is a NLI that utilises pattern matching to converse with its users. Its conversational patterns are stored in files know as Artificial Mark-up Language (AIML) files [18]. These AIML files are then used to match the users input to a certain output.

This paper compares the advantages and disadvantages of a rule based IVR with ALICE as an example of an NLI. The domain will be restricted to contact centres while its operations will only include that of diagnosing printer problems and generating information to solve these problems.

The related work section will give an in depth look at contact centres, its operations, operating structure and current automation techniques. It concludes with discussions on rule based systems as well as natural language interfaces. Particular attention is given to ALICE. This will be followed by sections related to the implementation and evaluation of NLI and rule based systems.

II. RELATED WORK

A. Contact Centres

A traditional call centre can be defined as an operation that uses telephones, Call Centre Agents (CCAs) and computer technology in various sophisticated ways to assist clients and deliver a value added service [1]. They are restricted by domain and can be implemented by any company willing to provide a value added service to their clients [3]. Contact centres are the contemporary successors to call centres. A contact centre is a support facility for clients, which can be accessed through the telephone, email, snail mail, instant messaging and various other communication media utilised by clients [2]. The variety in communications channels have made contact centres the preferred and prevalent means for clients to receive services from companies. Interaction in a contact centre occurs between clients and the CCAs, between the CCAs and the computer and between the client and the computer [4]. Two critical issues relating to contact centres and its operations are the reduction in call durations and increased customer satisfaction [5]. The means by which a contact centre provides its customer service allows for it to retain its existing clients and also serves as a campaign to attract new clients.

Contact centres are classified in a variety of ways, but usually follow two popular classifications in accordance to functionality and areas of operation. In terms of functionality, there are two main types of contact centres: Inbound and Outbound [6]. Furthermore contact centres are classified regarding their operation as either a Helpdesk or a Service Desk. The reported research focuses on helpdesks which are defined as a single point that deals in resolving client queries [7].

Although contact centres can be classified differently, they are based upon the same operating structure. With respect to this paper it is important to understand the technologies utilised by contact centres at various levels of their operating structure.

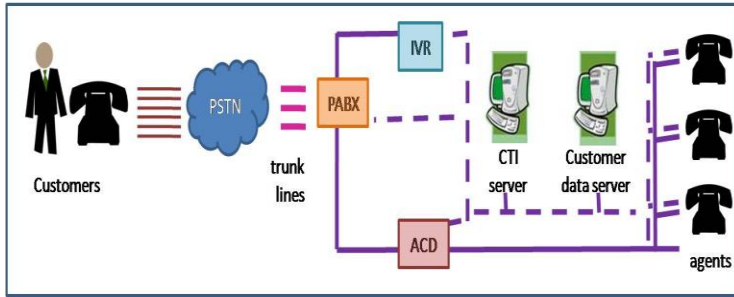


Fig. 1. Structure of a typical Contact Centre

Fig. 1 illustrates the core technologies utilised by contact centres when an incoming call reaches the CCA. Clients dial in using the contact centre number using the Public Service Telephone Network (PSTN) which provides the contact centre with two valuable pieces of information about the call: Automatic Number Identification (number from where the call originates) and the Dialed Number Identification Service (DNIS). The call reaches the privately owned switch called a Private Automatic branch Exchange (PABX) and the callers DNIS locates the PABX on the PSTN.

IVR is probably the most popular technology utilised by contact centres and is used as a self-service option for customers [8]. When the call is first received and there are no agents free it is passed onto the Interactive Voice Response (IVR). This software is used as a means of automation for contact centres. IVR is software that provides a series of interactive options to a client that calls a contact centre. It accepts touch-tone keypad input from the caller and is used by contact centres to answer repetitive queries from clients. This approach ensures that the CCAs are not required to answer standard queries and hence they are free to take care of complicated issues queried by clients that require specific individual attention. Clients can also interact with CCAs and may be routed directly if one is available or through certain touch-tone inputs in IVR mode. When clients calls in to the contact centre and exits the IVR, they are passed on to an Automatic Call Distributor (ACD). The ACD is designed to route calls connected via a PABX to individual CCA within the contact centre.

Though IVR is advantageous to contact centres, they have recently come into scrutiny mainly due to two reasons [8]:

- poor interactions with the client and
- a low resolution of queries posted by clients.

The limitations were identified when it was discovered that there was a high abandonment of calls by clients encountering the interface associated with IVR. Dimension Data [15], for example, states that the average abandonment rate of calls in IVR is 12% and the average time of abandonment is 65 seconds. The main reasons that were cited for these problems were [12]:

- IVR menu structure being difficult to use and navigate;
- IVR menu choices being too long and vague;
- IVR menu structure not being aligned to caller usage patterns; and,
- unnecessary or irrelevant information being directed at clients.

As mentioned previously, IVR in contact centres can be viewed as a simple rule based expert system as rule based expert systems gather information through the use of menu options which are either numbers or short phrases [19], which is similar to the techniques that IVRs utilise.

B. Rule Based Expert Systems

“Expert systems is a branch of artificial knowledge that makes use of specialised knowledge to solve problems at the level of a human expert” [20]. Rule based systems (RBSs) constitute a means for codifying the problem -solving know-how of human experts [21]. They have been used in various fields including computer configuration tasks, computer aided design, medicine, and oil exploration. Conventional systems perform tasks in accordance to a particular algorithm written to solve that specific problem [22]. Rule based expert systems have a knowledge base which is used to reason through a problem, using rules that are appropriate. Many different techniques have emerged for organising rules in automated experts but all RBSs share some key properties [21]:

- Practical human knowledge is incorporated through conditional if-then rules;
- The larger the knowledge bases the higher the skill of the system;
- A wide range of problems can be solved by selecting the right rules and then combining the results in the appropriate way;
- The best sequence of rules to be executed are done adaptively and,
- Conclusions are explained by retracing their actual steps taken and translating rules into natural language.

The architecture of RBSs consists of a knowledge base and an inference engine. The knowledge base consists of rules and facts. Rules specify the actions that should be triggered when a certain condition is triggered. These conditions define important patterns of data that can arise in working memory. The system represents data in terms of relations, propositions or equivalent logical expressions. Facts define static, true propositions. An RBS also has working memory in addition to its static memory and uses it to store temporary assertions. The contents of working memory are described as problem-solving state information [21].

Giarrantano and Riley [19] state that the basic components of a rule based expert system are the following:

- Rules – Define actions and conditions through special grammar;
- Interpreters – Component that is used to match rules according to input given by user. They generally make use of pattern matching;
- Translations – Used to interpret results the system has made. In other words how the system deduced a conclusion; and,
- Explanations – This component is used to explain to the user how the system reached a certain result.

There have been numerous ways in which RBSs have been categorised, but they all share a basic configuration – they are sets of decisions about what meaning to give rules, and how and when to interpret them. Two organisations are most common [20]:

- *Stimulus driven or forward chaining*- initial facts are processed first, and keep using the rules to draw conclusions given those facts; and,
- *Goal directed or backward chaining*- the hypotheses (or solution/goal) that one is trying to reach is processed first. The system then keeps looking for rules that would allow concluding that hypothesis.

IVR in contact centres can be viewed as an example of a forward chaining rule based expert system as it is data driven (touch-tone input) and according to user inputs a conclusion is reached.

Natural language interfaces could be utilised to overcome the limitations of IVR. The next section discusses NLI in detail, their various forms of input modalities and their advantages and disadvantages. An overview on ALICE, which was used in the implementation of a prototype, is also given.

C. Natural Language Interfaces

Computers need some sort of interaction in order to perform a specific goal or task [9]. Natural language is one of many interface styles that can be used in the dialogue between a human user and a computer through the use of speech or text [10]. The scope of this research focuses on text-based input, though speech-based input's sole difference is that it is converted into text prior to processing.

Much of the early literature on Natural Language Interfaces (NLIs) focuses on speech recognition and synthesis and how they can be optimized for interaction with a computer [13]. However, there is still not a single interface that is capable of interacting with a user through the use of a human language. This is due to the fact that natural languages are ambiguous and are heavily dependent on a huge repository of knowledge.

There are various techniques that could be used to combat ambiguity. Limiting syntax and vocabulary, using linguistic theories and engaging in a clarification dialogue are the three techniques that will be discussed. One of the oldest techniques used is to **limit the syntax and vocabulary** that exists in a natural language. NLIs do not require a computer to parse every single command that it receives from the user. Users, therefore, do not need to learn every single command but rather should be able to issue their commands in natural language and obtain the results that they were expecting [11].

Another technique used to combat ambiguities is through the **use of certain linguistic theories**. One such theory is Grice's Conversation Implicature theory, which reveals that interpretation and inference of an utterance made during communication are guided by four maxims [14]:

- Maxim 1: Quality;
- Maxim 2: Quantity;
- Maxim 3: Relevance; and,
- Maxim 4: Manner.

Only two out of these four maxims are relevant to this discussion: *Maxim of Quantity* and the *Maxim of Manner*.

The Maxim of Quantity has two components:

- Make your contribution as informative as is required, and
- Do not make your contribution more informative than required.

This maxim tells us that the user should not give more information and should not make unnecessary speech contributions than is necessary. This is essential for NLIs as only a subset of a natural language is often utilised as a crucial component in interpretation.

The Maxim of Manner has four components:

1. Avoid Obscurity (being unclear and hard to understand);
2. Avoid Ambiguity (unclearness by having more than one meaning);

3. Be brief; and,
4. Be Orderly.

The maxim states that users will not intentionally make ambiguous statements but rather state what they believe as being unambiguous. The information delivered resembles what the users' mental model believes it to be. The problem of ambiguity arises when the users' mental model is different to that of the computers model, which causes an information gap and leads to ambiguities.

The third technique is to engage in some form of **clarification or confirmation dialogue** to confirm whether the systems interpretation is in fact a correct one [13].

Contact centres have tried to adopt speech recognition to alleviate some of the problems faced by touch-tone IVRs. IVRs that use speech recognition are very restrictive in terms of input from the user. The mode of input usually involves speaking out a yes/no answer or the number of the menu option. This does not alleviate any of the disadvantages discussed in the previous section but simply changes the mode of input. Question answering (QA) systems, on the other hand, do not restrict the users input. QA systems have become an important and widely-researched technique for information access because it delivers the exact information that the user seeks [16]. Chatbots make use of QA techniques in order to deliver information needed by users.

One such chatbot is called ALICE which mainly uses text as input and is an intelligent agent implemented by Dr. Wallace [18]. An ALICE knowledge base makes use of conversational patterns which are stored in Artificial Intelligence Mark-up Language (AIML) files. The key to AIML is simplicity, allowing the average computer user to create a chatbot [17]. The basic unit of knowledge in AIML is a category. An AIML category always contains two elements: one pattern and one template. The pattern can be viewed as the input of stimulus and the template as the output or response.

AIML may also contain special characters known as wild cards which match one or more words. There are two wildcards: `_` and `*` (Fig. 2). The differences between the two are that the underscore takes preference over any specific word and any specific word takes precedence over the star.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<aiml>
  <category>
    <pattern>
      _ NEED * HELP
    </pattern>
    <template>
      How may i help you?
    </template>
  </category>
</aiml>
```

Fig. 2. AIML Format with Wildcards

ALICE makes use of a matching algorithm (also known as pattern matching) in order to trigger an output to a certain input. When the text is first received it goes through a process known as deperiodization [18]. This process removes punctuation marks from the input. The processed input then acts as an input for a process known as normalization. This is process where all input is converted to upper case and where certain contractions are expanded. For example "you'll" will become "you will" and "I'd" would be converted to "I would". Normalization also ensures that there is exactly one space between words in a

sentence. The completely processed string is then passed on to the matching algorithm. ALICE uses the matching algorithm to search for the best match to the users input. ALICE loads all AIML into a graph metaphor known as a graphmaster. The nodes of this graphmaster are known as nodemappers. The nodemappers map the branches from each node, while branches are either words or wild cards. The matching algorithm uses one of the following three steps [18]:

- Does the nodemapper contain a _? If it does then follow that node and try the tail of the input to see if they match. If not then try 2;
- Does the nodemapper contain the actual word? If so search the sub graph for the tail of the input. If not found then try 3; or,
- Does the nodemapper contain a *? If so then search the sub graph for the tail of the input. If no match is found then clarify input from user.

ALICE was created with the purpose of holding a conversation with a human as long as possible in order to create the perception that the conversation is with another human. Though this may seem advantageous there are drawbacks to this:

- Conversations drift from one topic to another and do not follow any set pattern;
- ALICE has a very short-term memory and will not remember conversations that have taken place in the recent past;
- When a specific category is not found in the AIML set, ALICE randomly chooses a default category to keep the conversation going; and,
- The need for very large AIML sets for ALICE to successfully hold a conversation consistently.

Table 1 provides a summative comparison of the advantages and disadvantages of NLI's and RBS.

TABLE I
ADVANTAGES AND DISADVANTAGES OF NLIS AND RBSS.

Natural Language Interface (ALICE)	Rule Based Expert System (IVR)
✓ Users can use natural language to state their queries.	✗ Users input are restricted to menu options.
✗ Input can be ambiguous as user input is unlimited.	✓ Ambiguity is not a problem as user input is restricted.
✗ Short term memory poses a problem for users.	✓ Has a long term memory ✗ Users have to remember menu options.
✓ NLIs allow for a more natural interaction with the system.	✗ System does not feel natural as input is restricted.
✓ Advantage	✗ Disadvantage

III. DATA GATHERING

The related work identified that RBS and NLIs require knowledge bases in order to function. Data for this research was gathered through case studies which were given to users to act upon. The participants for this data gathering process

had various levels of computer knowledge in particular to computer hardware, were of different ages and had a variety of native languages (Fig. 3) and were chosen randomly as it would simulate a heterogeneous sample which are the same diverse group of clients who a contact centre deals with on a daily basis.

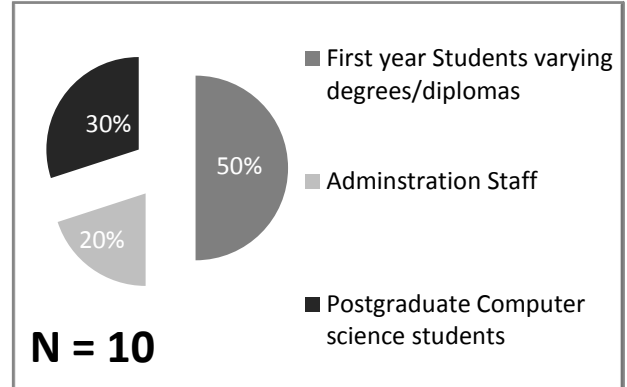


Fig. 3. Data gathering sample breakdown

The case studies addressed particular problems that could be encountered when using printers, and catered for the following scenarios: No Paper, Paper Jam, Printer Off and Toner Problems. Data was gathered using an instant messenger. A Google Talk username and password was set for each participant that was not in possession of one. A Nelson Mandela Metropolitan Helpdesk contact was created on Google Talk as this was the contact that participants conversed with. The Google Talk IM was chosen because it allowed for chats to be stored for later use (Fig. 4). Participants were advised to chat without hindrance - they could state the problem in the manner they wished.

```

bassoncj: hi i was busy printing a document, and about 20 pages in it just
stopped all together and now has a light flashing
what can i do?
me: Are u sure you have paper in your printer
11:49 AM bassoncj: im not 100% sure, how would i check?
me: Look for the Labels on the front of the printer e.g 1 & 2 can u see it
11:50 AM bassoncj: ok i see them, but what am i supposed to be doing
with them?
me: I need you to look to the left of 2 and pull out the tray gently. can you
do that?
11:51 AM bassoncj: the tray?

```

Fig. 4. Chat History with data gathering participant

IV. IMPLEMENTATION

For the purposes of this study two prototypes were implemented: a rule based expert system that resembled an IVR and an NLI which used pattern matching (ALICE). The reason was to compare the advantages and disadvantages of these systems with respect to user satisfaction and compare this to the literature stated in section II.

The chat histories (Fig. 4) gathered were converted to AIML using a converter which was written in C#. The inclusion of wild cards and was done manually using a text editor.

Once the AIML sets were completed, an interpreter for the AIML was acquired through a GNU public licence. A user interface was created to resemble an instant messenger style (Fig. 5). The system was then tested by the authors against the AIML sets to determine whether the system ran smoothly.

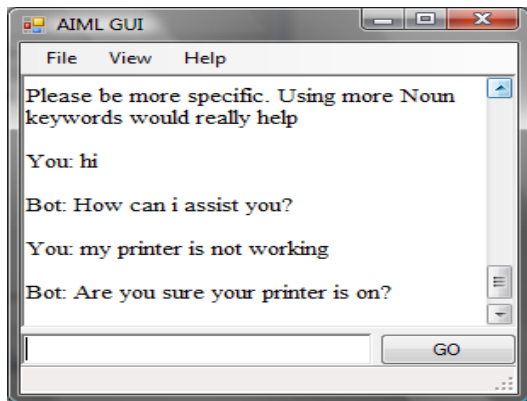


Fig. 5. Pattern matching system using an IM Metaphor

The same data that was collected in the data gathering process was used in the implementation of the RBS prototype. It was written using a forward chaining expert system shell known as CLIPS. The system followed an IVR type format and therefore involved the user giving input in the form of a number to be queried posted to them.

Once implementations of the two prototypes were completed, the evaluation phase of the research was initiated. This will be discussed in the next section.

V. EVALUATION

There is a lack of evaluation metrics available to evaluate a machine conversation chatbot. The Loebner prize [23] has been used as a benchmark for testing chatbots. Sceptics, however, believe that this is an ineffective method to evaluate chatbots as it only has to fool the human and does not involve much effort since the chatbot only has to keep the user involved in a conversation. Various other mechanisms have been used to evaluate chatbots such as glass box and black box testing. These methods, however, evaluate the effectiveness and efficiency of the system and not user satisfaction.

To measure user satisfaction the following questions were used. They were initially utilised by Munteanu and Boldea [22] who evaluated dialog systems.

- Did you get all the information you wanted using the system?
- Do you think the system understood what you asked?
- How easy was it to obtain the information you wanted?
- How easy was it to reformulate your questions when you were invited to?
- Do you think you would use the system again?
- Overall, are you satisfied with the system?

The methodology used for the evaluation was the Wizard-of-Oz (WOz). This methodology was chosen in order to simulate the speech-to-text and text-to-speech components that would be found in a contact centre.

The case studies set up in the data gathering process were used again in the evaluation process. The WOz experiments ran over two weeks and involved one wizard and sixteen users. Users **were different** from those chosen in the data gathering process but had the same diverse profile: four admin staff, four first year computer science students, four non-computer science students with varying degrees/diplomas and four postgraduate students.

Users tested the NLI system first and were asked to answer the user satisfaction questionnaire upon completion.

Our main observation from the users testing the NLI is their frustration at having to rephrase some of the answers they had given the bot while it was troubleshooting their problems. As can be seen from Table II, 31% of the users had trouble with this. This is mainly due to fact that a large AIML set is needed to conduct the study successfully. The users also states that the chatbot sometimes changed conversation completely and did not solve the problem. This was brought upon the fact that ALICE has a short term memory and does not necessarily remember what she has done in the short term past. The problems noted above by the users were all mentioned in the related work.

TABLE II
TOP 3 PROBLEMS ENCOUNTERED USING NLI.

Had to rephrase questions	31%
Conversation did not make sense	25%
Did not remember my previous answers	13%

Once testing of the NLI system was completed by a user, the user was asked to complete the same case studies using the RBS which was modelled to resemble an IVR. Testing followed the same WOz experimental method used on the NLI system. Users filled answered a similar questionnaire that was given to them previously after testing the NLI system. The question which dealt with rephrasing of queries was omitted since this was not possible in the RBS. The main observation made from the users testing the rule based IVR style system was that it took them far too long to solve their problems and moreover some of their options they had to select were the last ones and they felt it unnecessary to listen to all the other options. The main reason users did not like this system (Table III) is because they found it time consuming (56% of the users mentioned this). Users also stated that they felt that too much information was directed at them and felt “lost” sometimes.

TABLE III
TOP 3 PROBLEMS ENCOUNTERED USING RBS.

Long frustrating menus	31%
Time consuming	56%
Too much information	50%

Slightly more users felt that the RBS system made it easier for them to find information (88% vs 82%) (Table IV). NLI's though, were easier to use to obtain information and were also higher rated as systems which users would use again. 69% percent of the users were more satisfied with the NLI in comparison to the RBS.

TABLE IV
COMPARISON OF NLI AND RBS.

	NLI	RBS
Users were able to find information	82%	88%
Was it easy to obtain information	90%	80%
Would you use the system again?	82%	50%
Overall Satisfaction	69%	31%

VI. CONCLUSION AND FUTURE WORK

This paper has identified the need to replace IVR as an automation technique at contact centres. A possible NLI solution was discussed and compared to current IVR automation techniques. IVR is identified as being restrictive in terms of input whereas NLI is viewed as being less restrictive since it simulates a natural dialogue. Since an

NLI system allows users to use natural language to convey their queries it could save time and money since queries would be resolved in a shorter space of time.

Users of the RBS prototype which was modelled to resemble an IVR stated that they were able to find the information that they were looking for much easier than using the NLI prototype. They also mentioned that they would prefer to use the NLI prototype over the RBS prototype as it was quicker to resolve their queries. Users were also more satisfied with the NLI prototype in comparison to the RBS option.

An important disadvantage of NLI systems remains the fact that it has a very short memory. This limitation could be addressed by a system that utilises rule based and natural language (especially pattern matching) techniques.

A thorough statistical analysis should be conducted to compare the NLI and the RBS to theory. Due to time constraints, this could not be achieved for report in this publication.

Upon completion of the hybrid system, the three systems will be evaluated and a statistical analysis will then be conducted to determine whether the results are significant.

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REFERENCES

- [1] Australian National Audit Office, (1996). *Telephone call centres* [online]. Available: <http://www.anao.gov.au/website.nsf/publications/4A25^AE90015F69B4A2569120006FCD1>
- [2] N.Gans, G.Koole, and A.Mandelbaum (2003). Commissioned Paper – *telephone call centres: Tutorial, Review and Research Prospects*. Manufacturing & Service operations management, vol.5, no.2, pp. 79-141.
- [3] A. Singh, (2007). *An IUI model for contact centre operations*. Dissertation, Department of Computer Science and Information Systems, Nelson Mandela Metropolitan University, 2007.
- [4] S. Kaish, (2004). Challenges for customer care centre – Enhancing services and reducing costs with Cosmocall Universe [online]. Available: <http://www.cosmocom.com/whitepapers/whitepaper-telecustomecare.htm>
- [5] A.Steel (2003). Understanding and Enhancing Call Centre Computer-Human-Human Interaction. *Proceedings on human factors in computing systems*. Florida. New York, NY, ACM Press.
- [6] A. Mandelbaum and G. Koole, (2001). *Queuing Models of Call Centres: An Introduction*. [online]. Available: <http://www.cs.vu.nl/obp.callcentres>
- [7] M.G. Frants, (2006). The Evolution of the IT Helpdesk to the Service Desk. CompuCom. Available: <http://www.compucom.com/wwwimages/Corp/Images/CompuComServiceDeskWhitePaper0106.pdf>
- [8] A.S. Saluja, (2006). A Wake up call for your IVR.
- [9] J.Preece, J.Rogers, and H.Sharp, (2002). *Interaction Design: Beyond Human – Computer Interaction*. Wiley. ISBN: 9780471492788
- [10] B.Long, (1994). Natural Language as an Interface style.[online]. Available: <http://www.dgp.toronto.edu/people/byron/papers/nli.html>
- [11] Ascent, (2006). Improving IVR Self-Service. Ascent Group INC.
- [12] D.Fum, G.Guida and C.Tasso, (1998). A Distributed Multi-Agent Architecture for Natural Language Processing.
- [13] P.R.Cohen, (1992). The Role of Natural Languages in a Multimodal interface. *ACM*.
- [14] J.Y. Chai, Z.Prasov, J.Blaim, and R.Jin (2005). Linguistic Theories in efficient multimodal reference resolution: An empirical investigation. *ACM*. 43-50.
- [15] Dimension Data, (2006). *Merchants Global Contact Centre Benchmarking Report 2006*. Dimension Data: Pages 1 -120.
- [16] J.Lin, D.Quan, V.Sinha, K.Bakshi, D.Huynh, B.Katz, and D.R. Karger. (2003). What makes a good answer? The Role of Context in Question Answering. *MIT AI library*. Cambridge, MA 02138, USA.
- [17] B.A. Shawar, and E. Atwell (2007). Different Measurement metrics to evaluate a chatbot system. *Academic and Industrial Research in Dialog Technologies Workshop Proceedings*. Association for Computational Linguistics. Pages 89-96.
- [18] R.S. Wallace, (2005). *Be your own botmaster: The step by step guide to creating, hosting and selling your own A.I. chatbot on Pandorabots*. ALICE A.I. Foundation.
- [19] J. Giarrantano and G.Riley, (1989). *Expert systems: Principles and Programming*. Thomson Information/Publishing Group. USA.
- [20] F. Hayes-Roth, (1985). Rule-Based Expert Systems. *Communications of ACM*. ACM.
- [21] A.Abraham, (2005). Rule-Based Expert Systems. *Handbook of measuring system design*. Oklahoma state University, Stillwater, OK, USA.
- [22] C. Munteanu and M. Boldea, (2000). MDWOZ: A Wizard of OZ Environment for Dialog Systems Development. In *proceedings of LREC*.
- [23] Loebner Prize, (2008). *Loebner Prize for Artificial Intelligence*. [Online]. Available: <http://www.loebner.net/Prize/loebner-prize.html>

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