Using Chatbots for Network Management Training through Problem -based Oriented Education

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Abstract

This work presents an investigation of the use of ChatBots as a tool for network management training, through the use of the Problem-based Oriented (PBO) approach. Network management can be defined as the act of initializing, monitoring and modifying the operation of the functions that directly support the user requirements. Managing the current heterogeneous networks requires the collection of large quantities of data from the network; data that must then be analyzed before a management activity is initiated. Due to this fact, this domain represents an opportunity for using the PBO approach in education. In our approach, we have created Dorothy, a network management-aware ChatBot that is able to interact not only with the user, but also with the managed network via management protocols.

1. Introduction

One of the key aspects in network management is that, in case of a problem, a solution has to be quickly found. The fault has to be diagnosed and automatically fixed or a human operator needs to be informed and advised about the proper sequence of actions. This work addresses the above issue through the investigation of the use of ChatBots as a network management training tool that is used to teach less experienced users. A ChatBot (also referred in this paper as bot) is a program that attempts to simulate typed conversation, with the aim of, at least temporarily, fooling a human into thinking the human is talking to another person. In our approach, we have created network management-aware ChatBot, Dorothy, that is able to interact not only with the network administrator, but also with the managed network via management protocols such as SNMP [2].

The SNMP network management architecture contains four key elements: Network Management Station (NMS), managed elements, Management Information Base (MIB), and the protocol used to exchange messages. Managed objects are devices such as computers, routers, and terminal servers. To be able to manage these elements, agents are necessary. Agents are software modules that reside in network elements. They collect and store management information such as the number of error packets received by a network element. The MIB is basically a database of managed objects that resides on the agent. A Network management Station hosts the network management application. It contains one or more processes that communicate with the agents in the network by sending commands and getting responses.

The goal of this research is to provide a more feasible and effective tool to act between the less experienced administrator and the managed network because the unexperienced administrator does not need to know all the management protocol details to manage the underlying network. Moreover, this model suggests a tutoring approach centered in the user, making possible the application of the knowledge acquired in real problems and also the growth of the comprehension of the user by using the PBO approach (also know as troubleshooting). Troubleshooting is predominately a cognitive task that includes the search for causes of faults through a problem space of possible causes [8].

The remainder of this paper is organized as follows: section 2 presents the related research; section 3 presents the ChatBot we have developed in our investigation. Finally, in section 4 we discuss the effectiveness of our approach and present some concluding remarks.

2. Related Research

Athanasou and Cornford's [3] research point to the fact that the ways in wich expert workers differ from novices is principally in the amount of specific skills that they posess and how they organize their knowledge. Also, they present the formal classification for different levels of expertise in people. Even though (in this work) we are not interested in the formal classification of the levels of skills and knowledge of network administrators, we can consider the fact that the tool proposed in this work helps the transition between these levels because it helps to develop user expertise by applying the PBO approach through problem solving methods and troubleshooting.

The ability to solve problems requires a lot of knowledge and capacities from people who needs to deal with a complete range of information to be able to increase expertise to diagnose and take correct actions dealing with problems. Jonassen and Hung's research [4] presents troubleshooting as a common form of problem solving. They propose an architecture for learning environments for troubleshooting (TLEs) composed of three parts: system model, simulator, and

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case library. The system model is composed of a set of knowledge representing functional purposes and abstract or physical functions needed to diagnose a system, allowing learners to view how the system works so they can make diagnoses. The simulation provides feedback from the system, allowing users to learn in practice. The case library represents historical information about problems. This third component is very important and such importance is confirmed in Konradt's work [6], in which the author says that experience is the most common determinant of expertise and the recall of historical information is the most frequent strategy for failure diagnosis and, consequently, problem solving.

The previously presented researches indicate that approaches in which expertise is developed through experience and case knowledge related to real-life examples represent superior learning methods. Thus, they contribute to motivate learning, enhance the acquisition of problem solving, and develop reasoning and experience.

The use of ChatBots as the chosen technology in this project can be justified through recent results published. ALICE [9] is an example of a current widely used chatBot, mainly because it is an open-source system maintained by an active community. ALICE is a chatBot system composed of two parts: the engine and the knowledge base itself. The ALICE knowledge base is built using Artificial Intelligence Markup Language (AIML), which is a XML compliant language that describes a class of data objects called AIML objects, and partially describes the behavior of computer programs that process them. The AIML is based on the user's input questions, output answers and context, called categories. The user inputs are called patterns. A sentence written by a user is compared (using the engine) to the described patterns in the language and based on this process the answers, or templates, are selected. The AIML knowledge base is based on manual authoring and this enables ALICE to be used as the starting point of some projects [1, 5].

3. The Dorothy ChatBot

Figure 1 shows a detailed diagram of Dorothy´s architecture. The ChatBot used as base in this solution is ALICE. Although ALICE can only simulate natural language processing and is unable to fully understand people's questions to the depth of any other human being, the goal within the scope of this project is to show how artificial intelligence tools can be successfully used in network management training through problem-based oriented education, not to research techniques of natural language processing itself.

Since ALICE and AIML have to work together with Dorothy in order to get information from a network in a precise moment, we integrate ALICE with Dorothy by generating a set of parameters. We have defined 5 parameters: topic, address, operation, time, and situation. The "topic" is a value that defines what the question is about. The "address" defines the ip of the device the user wants to query. The "operation" defines what kind of operation in SNMP must be done to get the information. The "time" is used when a question involves the behavior of the network in recent days and the "situation" receives information about a specific word in the question, like average, maximum or minimum.

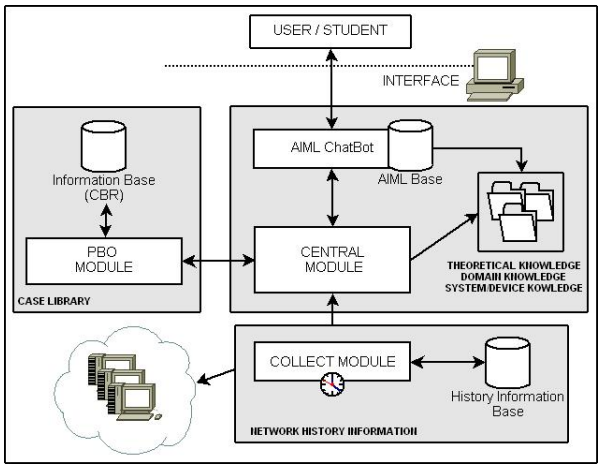

Figure 1. System Architecture

Our ChatBot implements the central module, the PBO module, and the network history Information module. We begin by discussing the central module which is responsible for receiving all the information generated by ALICE and process the information in order to enrich the answers in a practical way. Thus, it is also responsible for relating all information collected from other modules. Moreover, this module is also responsible for getting all parameters and applying correct analysis rules for each input combination. Input combinations are the combination of parameters that are effectively passed to the central module.

The network history information module consists of the following elements: collect module and history information base. The collect module is responsible for collecting information of the network and storing in the history information database. Using SNMP and MIB, the values of objects can be captured with the goal of assisting in the management of the network. This module is capable of performing SNMP queries in the managed devices to add dynamic answers in the static knowledge provided by the ChatBot.

The History Information Base is used to store measurements of the network that are collected between intervals. The interval can vary for each object and is stored together with the information of the object inside of the database. The values of each object in the history information database are updated by the collect module. This module is programmed to verify the database each minute and look for the last time the value of an object was collected. If the time of the last collection is longer that the interval, then the collect module is launched in order to get the new value of the object.

The PBO module is based on CBR (Case-Based Reasoning) and problem oriented solving. In the CBR approach, a case-based reasoner recalls a similar past case and its solution. The reasoner then adapts the successful solution of the recalled case to adjust for any differences between the current case and the recalled case. Finally, the CBR stores the solution to the current case along with feedback about the outcome so that it

can be used in solving future problems. Dorothy's PBO module works similarly. This module is responsible for retrieving past problems and solutions previosly inserted in the database and presenting to users in order to provide guidance and encourage user thinking and more information searching.

Considering the goals of this work, the PBO module works in two ways : (i) helping users to find solution for problems they already figured in the network (while using Dorothy for other questions or explanations) and (ii) presenting problems and solutions possibilities by retrieving them directly from the CBR database. In the first case, the user can ask questions like "Why is my network so slow?" that can lead to many topics of investigation that can be retrieved in through the case library in order to present possible problems and solutions that can lead to the causes presented by the user. In the second case problems are presented to users in a reformulated way, providing lessons to users in order to help solving the current problems. In this case, Dorothy is programmed to teach the users how to proceed to find the information about the problem through the use of other resources, tools or systems that may be available. It is also programmed to explain the theoretical, domain, and system concepts and knowledge and supply the current state of the network in the aspects related to the problem presented. A great amount of problems in Dorothy's case library were based in DUMBO system [7]. Dumbo is a system that uses Case-Based Reasoning paradigm applied to a Trouble Ticket System to suggest solutions for network management problems. The system provides aid diagnosis and resolution stages of network management problems.

At the end of the process, all the information generated by all modules is processed by the central module and returns to the user through ALICE. Dorothy formulates an answer based on the objects that were consulted and the characteristics of the input question or problem presented.

4. Discussion and Concluding Remarks

We presented in this paper a ChatBot designed and adapted to help less trained professionals to acquire knowledge to learn how to manage a network using SNMP. Since the ChatBot actually uses SNMP to retrieve information about the network, it can also act as a real network management tool. The advantage of using such a resource relies in the fact that the user does not need to have previous knowledge to use the system and to interact with the network he is working with. In addition, we described the architecture of the developed ChatBot. By making use of previously cited Jonassen and Hung's TLEs architecture and concepts as initial point in our work, we created a tool that enables users to enhance knowledge and improve network management capacities.

Although the ChatBot can still be improved, the use of such technology allows the apprentice to build his own knowledge since he can use the meanings already absorbed to catch the meaning of the new educational materials.

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