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# Prototype virtual assistant as a tool to support research activities at CORPOSUCRE

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**Abstract.** Chatbots have become widely used tools in different fields of society, such as in industry, banking, health among other sectors. Their success is mainly that they can provide assistance to people quickly and in a timely manner no matter the time or place where the user is located. This project consisted of a virtual assistant (chatbot) based on artificial intelligence more specifically in the subfield of natural language processing (NLP). Basically what was intended with this prototype is to provide remote assistance to teachers and especially to students researchers of the Antonio José de Sucre Corporation answering their questions on research-related issues, particularly to support those who start in this field and wish to clarify some aspects related to the exercise of research within the institution. The system has been developed with open source tools in its latest versions, it is also modular in nature to facilitate its maintenance and easy integration with other programs, and in addition to being a web-oriented system can be deployed on a wide variety of devices which has greatly facilitated its validation.

## 1. Introduction

Research is considered one of the fundamental processes in university centers because it basically allows to further enhance knowledge in the educated and is also a source of creation and development of new creative ideas that properly aimed set the course for the achievement of the progress of society. Antonio José de Sucre Corporación Universitaria, recognizing the importance of this activity and with the contribution of the research groups of each of his faculties, is constantly promoting the development of training research within the academic community. Different research strategies have been implemented, such as classroom projects plus illustration provided by research seedlings, which has led the way for students to have their first approaches in this area and consequently through discipline, reflection and teamwork to forge a culture towards research.

In this sense from the faculty of engineering science, different technological projects have also been proposed to facilitate and support the research process through the use of artificial intelligence as a bastion of these developed tools. In this context, the branch of AI that excels in built applications is the processing of the natural language NLP that according to [1] deals with the communication capabilities of computers with humans using their own language.

Natural language processing seeks to help computers understand, interpret, and manipulate human language by borrowing from many disciplines, including computer science and computational



linguistics, in order to bridge the gap between human communication and computer understanding [2].

NLP and artificial intelligence in general for some years has been disrupting a large number of social sectors through the application of many of its techniques and tools to address different problems of society, and education has not been the exception as the demands and challenges presented in educational institutions that justify the need to incorporate technology and innovation into their processes to provide more efficient and timely services.

In the university corporation Antonio José de Sucre has seen the need to have a web tool to provide virtual assistance, through which to answer all those questions that the research community may have. This application is designed to interact with research users in a similar way to human, being able in addition to responding to their concerns, performing some specific tasks. This purpose is fundamentally aimed at the number of concerns usually generated within the exercise of research, especially in those who start in this process within the corporation. Such questions arise mainly in processes such as drafting of undergraduate project documents, research reports and diligence of institutional formats. In this regard questions such as: What is the research group of the engineering faculty?, What are the lines of research that are handled in the engineering faculty?, What are the types of research?, Where do I radiate my undergraduate project? are some of the many doubts that the minds of the beginner students are assailed and that through the outcome of this project are intended to respond in an effective and accessible way. Although many of the aforementioned concerns can be resolved by a teacher or a collaborator of the investigative area is not always granted the necessary immediacy required by the user due mostly due to time limitations of the same working days, lack of documentation of the processes among others; therefore the need for this proposal to ensure much more timely responses to these requests for information.

Faced with this problem, the need arises the development of this web-based chatbot system through which we will seek to provide the necessary assistance for users from the reception and analysis of users' questions and giving them successful answers based on the appropriate context. Chatbots are highly responsive and interactive, they are able to establish conversations like those that humans do using artificial intelligence techniques and tools being able to solve any question at any time by means of a chat. These applications can learn from expressions in the conversation and from previous dialogs to further customize and fine-tune their responses [3].

The virtual assistant proposed in this project will bring many benefits such as: improvements in response times, permanent attention 24 hours a day, better use of time by users by reducing administrative wear and more user satisfaction, who will see in this software the ideal tool to answer their doubts quickly and accurately.

As a fundamental library for this development Rasa NLU (Natural Language Understanding) and Rasa Core were used which are very robust modules ideal for the creation of conversational systems in a simple and very efficient way. The first helps to determine the intentions and analyze the entities grammatically, while with the second we configure the domain and the stories are the way we want our robot to communicate with users [4].

One of the advantages offered by Rasa NLU in addition to being a project with a large community of collaborators actively participating in it, is that it allows you to have full control over the chatbot allowing you to train, refine and optimize the data in the way the developer wants, as well as supports testing with different machine learning algorithms to choose the one that best fits the available data set without having to rely on a fixed algorithm [5]. The machine learning algorithm is a prediction program that learns from data in order to find patterns or trends to understand what this data tells us, and thus build a model to predict or classify elements [6].

The development of this prototype was carried out in three phases that are generally stated below but will be further described during the article:

*Planning:* At this stage a search was carried out of more used open source environments and libraries for the development of virtual assistants both in academia and industry in general. Going so

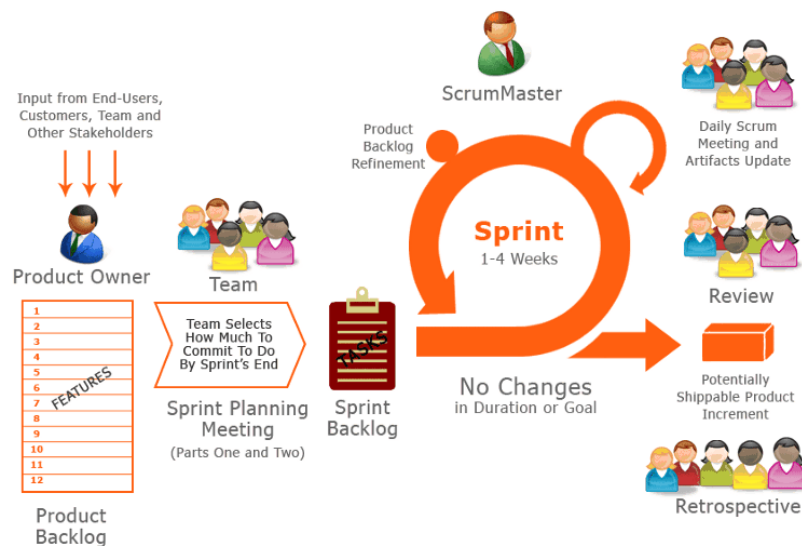
far as to choose RASA along with Python for facilitating the programming of applications with artificial intelligence due to the large amount of resources available to the programmer.

*Design and Construction:* In this phase a development architecture was defined based on the Model View Controller (MVC) pattern and the user interfaces and entity model relationship of the database were developed. The modular nature used allowed the integration of this system with other websites and applications of machine learning-based research projects that have been developed articulately with this project within the engineering faculty.

*Evaluation:* Performance of the predictive model generated with artificial intelligence was estimated using various controlled tests, assessing some assessment metrics such as *accuracy*, as well as the performance of the chatbot was deployed on a locally accessed web page to verify its operation.

## 2. Methodology

For the development of the prototype, the agile SCRUM methodology was used through which the system was built iteratively and detecting change needs so that new functionalities could be added.



**Figure 1.** Elements of the Scrum methodology.

A key aspect of these agile methodologies like Scrum is the high visibility of all events in the evolution of projects. For this reason, it is important to track and discipline the activities that generate the necessary visibility. Some: Daily Scrum, Sprint Review, Spring Retrospectives, Product Backlog and Burndown chart [7]. First, the first three help to gain an understanding of the current state of development and advancement in the Springs at all times, as well as to verify improvement actions focused on achieving better group performance. On the other hand, the Product Backlog as one of the most important assets was the reason for permanent reviews to more accurately determine the highest priority stories for each Spring, leaving those in a pending state, reflected in the Burndown Chart.

The overall process using the Scrum methodology can be described in the following 3 stages:

### 2.1. Planning

For this stage, special attention was paid to the lifting of user requirements through the implementation of user stories, as well as defining the roles and those responsible for making each user story, and also defining the dates of the deliverables of the project.

### 2.2. Springs Development

At this stage, each responsible user story was encoded using the object-oriented programming paradigm. Each story as the programmer developed marked it as finished on an online dashboard created with Jira software. The Jira Scrum board is the tool that unraies teams around unique goals and promotes iterative and incremental delivery [8].

### 2.3. Evaluation of Springs

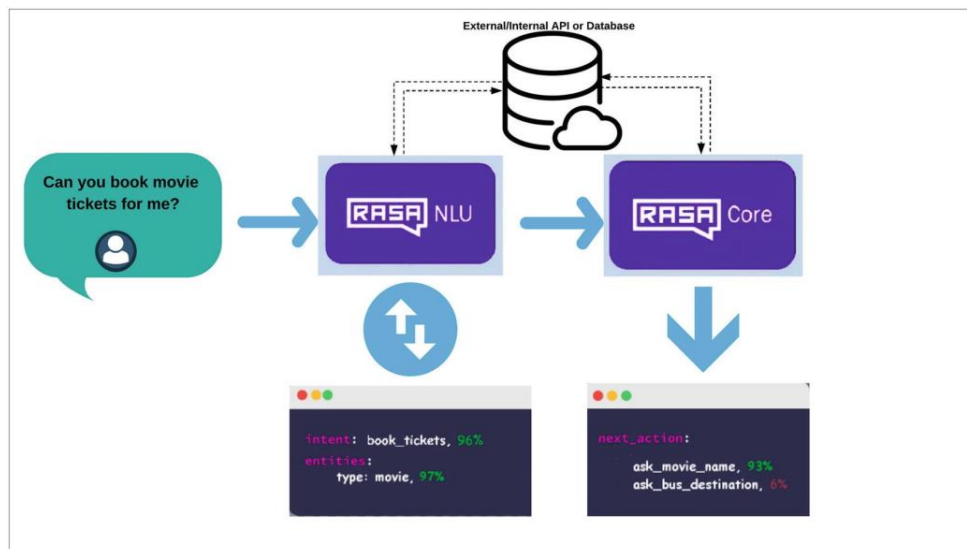
Finally, at this stage the validation of each of the Springs was carried out where the clients (commissioned teachers) reviewed that the proposed functionalities met the established requirements.

## 3. Proposed solution

For the proposed system stands out the Rasa framework which is a library based on artificial intelligence that has made it possible to create the virtual assistant. Which has two components that are: Rasa NLU (Natural Understanding of Language) which is used for the recognition of messages entered by the user and is responsible for finding a correspondence with an *intent*. The latter represent what the user can type or want and are used to describe how to categorize those messages. For example: If the user enters "Hello" or "Good morning" the intention in this case will be *greeting*. That component also extracts from the user's message keywords called *entities* with which the chatbot recognizes the structure of the sentence. Rasa Core, meanwhile, is a learning engine that uses machine learning, which defines what the next action to take based on the user's message. The input data for this engine for wizard training is defined in the stories [9].

Rasa Core specifies all the things that the chatbot can say or do, these are called *actions*. The actions defined in the proposed system were basically: greeting, farewell, FAQs and research\_concepts, the latter makes connection to the database to obtain information related to research projects such as: Research lines, participants, directors, methodologies, among others. Training data trained a probabilistic model to predict what action will be taken based on the historical conversation of the user or users [5].

Where the main component of the model is a recurring neural network (RNN) type LSTM which maps the history of raw dialogs directly to the distribution of system actions [10]. LSTM (Long short term memory) is a special type of memory-ended neural networks. Allowing them to learn from important experiences they have spent before. LSMs allow RNNs to remember their inputs for a long time, using a memory that can be considered similar to a computer's memory in the sense that a neuron in an LSTM can read, write, and erase information from its memory [6].



**Figure 2.** RASA Architecture.

To carry out the training you must clearly define intentions, entities, among others. To do this you must configure the following files: 1. `config.xml` (configuration for Rasa NLU), this basically specifies the language, the training pipeline that are a sequence of processing components that run over incoming messages and policies specifying what action to take at each point of a dialog, leaving by default MemoizationPolicy, MappingPolicy and TEDPolicy the latter with a maximum of 5 stories and a total of 100 eras or iterations. 2. `nlu.md`, here are defined the possible messages of the user that will be grouped according to an intention. 3. `domain.xml`, this is the file where you mainly define default intentions, actions and responses that the system should know and that define its scope.

To perform training with NLU based on the above files, the `rasa train` command is used, which at the end of its execution generates a compressed file in a folder called `models`. This helps the model understand what the user writes, to make it respond to the user's queries, and we must run the Rasa Core, this component helps decide the next action to execute in a conversation with the user based on previous intents, entities, and conversations. To do this work is based on stories where examples of possible conversations between a user and the chatbot were defined, those stories were written in a file called `stories.md`. Custom actions that were created are executed on the action server by using the `rasa run actions` command by making them accessible through the url "`http://localhost:5055/webhook`" which is specified in a file called `endpoints.xml`. These actions retrieve information from a database in Mysql using code written in Python by establishing the proper connection to the `mysql-connector-python` driver.

Finally, the generated model is deployed to the server with the `rasa run` command, making several functions available through several paths that can be reached using the GET and POST methods. For the point-in-time case of this prototype, "`http://localhost:5005/webhooks/rest/webhook`" was accessed using a request in Ajax and processing the response emanating from the server in JSON format.

```

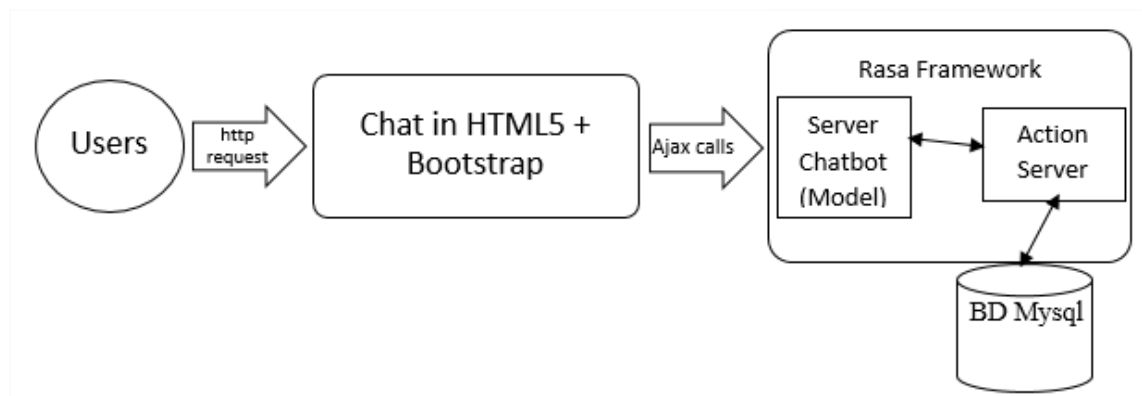
function sendMessage(textoServ)
{
    var xhttp = new XMLHttpRequest();
    xhttp.onreadystatechange = function() {
        if (this.readyState == 4 && this.status == 200) {
            var dataJson = eval(this.responseText);
            insertText("res", dataJson[0].text);
        }
    };
    xhttp.open("POST", "http://localhost:5005/webhooks/rest/webhook");
    xhttp.setRequestHeader("Content-Type", "application/json");
    xhttp.send(JSON.stringify({message:textoServ}));
}

```

**Figure 3.** Access to the model deployed on the server. Source: Own elaboration.

To perform the evaluation of the model we obtain a test data group of the original dataset using the command: *rasa data split*. This action generates a file named *conversation\_tests.md* in a folder called *tests*, with which you can run the test using the command: *rasa test -u tests-conversation\_tests.md --model models-20200815-063926.tar.gz*, after which an *accuracy* of more than 70% is achieved. Accuracy is an evaluation metric that is defined as the sum of all correct predictions divided by the total number of predictions or mathematically:  $A = (TP/TN) / (TP+TN+FP+FN)$  [11].

The communication between the different elements of the prototype is shown below:



**Figure 4.** General chatbot architecture. Source: Own elaboration.

#### 4. Results

The purpose of this project was to develop a smart assistant that would help the student researchers answer the questions that most afflict them when participating in some research activity, for which it was used to build the frontend the Html5, css and Javascript languages, thus making a page with an interactive chat so that the user can dialogue with the chatbot. For its part for the backend was used in addition to the aforementioned Rasa library, the Python programming language to program custom actions involving queries on the database in Mysql, whose model entity relationship shown below.

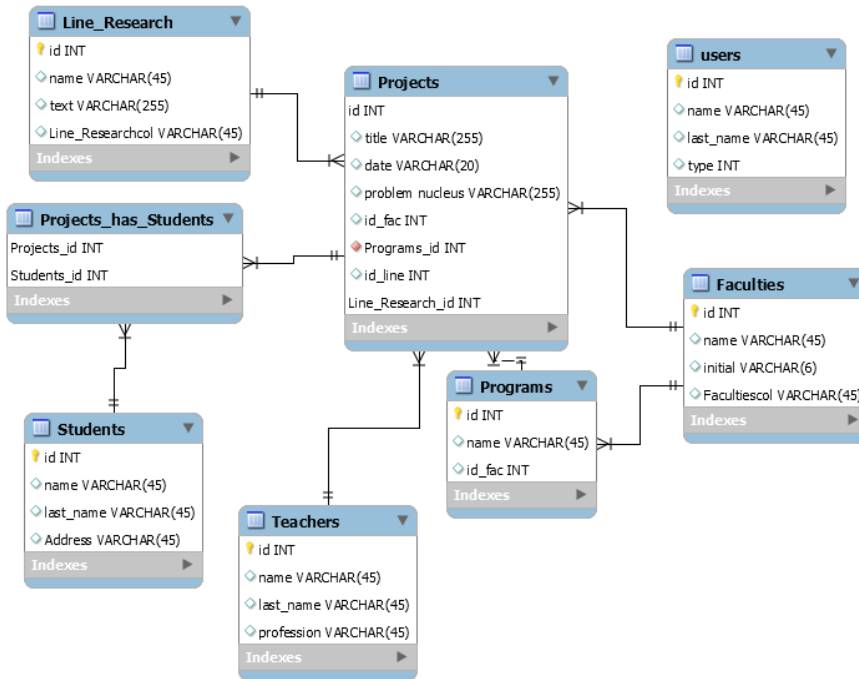


Figure 5. Relationship entity model. Source: Own elaboration.

The working wizard deployed in the web browser is also presented in the following figure.

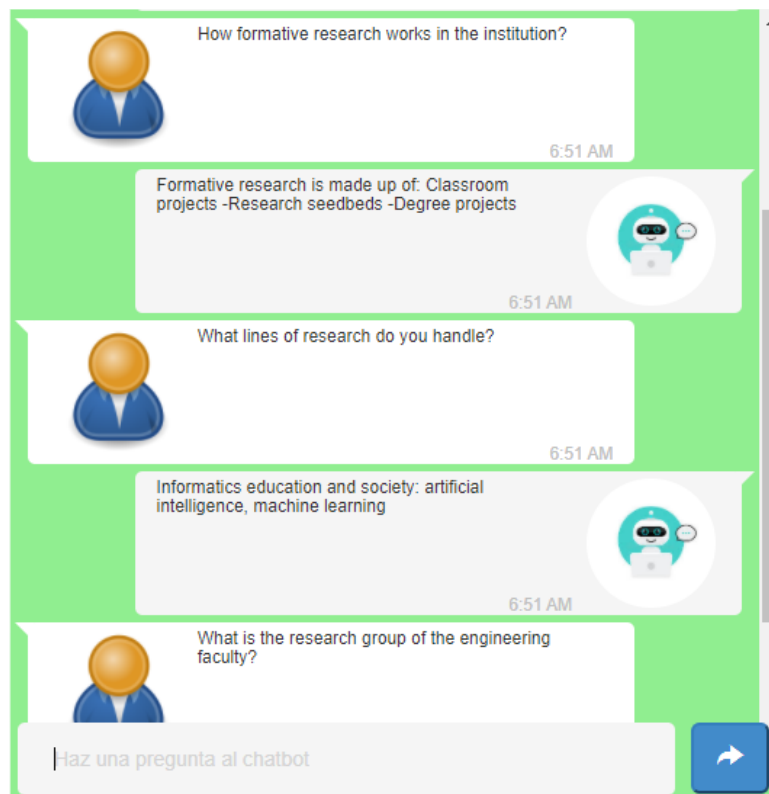


Figure 6. Chatbot in operation: Own elaboration.



## 5. Conclusions

Based on the objectives of the previous research work, the following can be concluded:

The needs presented in the students of the Faculty of Engineering were identified at the time of carrying out some activity related to research and from the collection, analysis and selection of useful information, the current situation of the faculty and the institution could be further understood by proposing an effective and efficient solution that responds to the concerns of these actors in an optimal way improving their satisfaction.

The use of an agile Scrum programming methodology has allowed to maintain a permanent communication between all those involved in the project including of course the clients, thus guaranteeing a better control and monitoring of it since the master tools of the team have been used to visualize and have a balance of the outstanding, developing and resolute tasks of Spring each and also the acceptance tests have been carried out at the end each one of these periods of development.

As a main recommendation, it is highlighted, first of all increasing the number of examples of dialogues in the stories, so that the machine learning model can have a greater repertoire and have better performance in conversations with users. Similarly, more tests should be performed based on different validation metrics to improve the accuracy of the results obtained.

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