

# Using synthetic agents in the teaching of algorithms: a behavioral analysis

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## ABSTRACT

This article aims to discuss concepts of Artificial Intelligence in Intelligent Tutoring Systems. The concepts of agents, bots and chatterbots are discussed, as well as synthetic agents and aspects required to present a coherent behavior. The Naive Bayes algorithm is also explained, as it was used in the Chatterbot System with Human Aspects for representing emotions. The system features are shown as well as the final considerations, scoring some results from the interaction with users.

## KEYWORDS

Chatterbot, Education, Emotion, Behavior.

## AGENTS, BOTS AND CHATTERBOTS

Several definitions are assigned to agents. Wooldridge & Jennings [14] believe that the answer to the question “What is an agent?” is as inaccurate as to the answer to “what is intelligence?” since in both cases, at the computational scenario, there is no definition for the subject that is universally accepted. However, agents can be understood as individual objects [12] that simulate a human relationship by doing something that someone else could do for you [10]. And may be referred to as integrated processes of reasoning [7], structured in the form of hardware or (more common) software that have autonomy, social ability and reactivity [14]. Autonomy in the sense of those agents operates without direct human intervention, as well as has some kind of control for their actions and internal state. These agents Interact with others agents – and possibly with humans – for some kind of communication language for agents to promote social skills in their behavior. Sociability can only be conquered by reactivity, in which the agents perceive the environment that they are inserted and they respond in a timely manner the changes that occur in it. However, proactivity is also essential, since agents cannot simply act in response to the environment, they need to be able to exhibit goal-directed behavior by talking the initiative on the environment [14].

Thinking about these goals that the agents also need to be event driven and can handle complex tasks, making decisions that can lead to split these tasks into smaller activities, as well as the order to execute them.

A type of intelligent agent widely used in the games is the bot. This name is an abbreviation for robot, and some researchers also call of softbot. It can be understood as an agent that interacts with an environment through commands and it is able to interpret the feedback from the environment. [3] In the context of software is a utility that performs routines tasks, such as being an opponent in a computer game, a bot to manage broken links on a website, detect and remove malicious programs, among other assignments. A bot must have sensors and enforcement mechanisms – are based on routines “stimulus-response” – in order to notice changes in context that is inserted in order to carry out commands previously established. These commands must follow a set of rules listed below:

- Security: the bot should not destructively alter the world;
- Feed: the bot should leave the world exactly as he found them;
- Savings: the bot should limit your consumption of scarce resources;
- Surveillance: the bot should not allow unexpected results of the actions of the client [2].

Now, the chatterbots, a specific type of bot, consisting of a computer program that attempts to simulate a human being in conversation with people. For some authors [5], they are one of the most prominent examples of “weak” AI, whose objective is the simulation conversation with a human, using a database of answer to the various entries inserted by the interlocutor. Despite all the efforts, these systems still have problems in both its construction and its performance in talks with users. Chatterbots can be understood as applications of Natural Language Processing (NLP), suffering, therefore, problems common to these systems, such as lexical and semantic ambiguity [1]. There are other problems that are more specific, for example, the control of the overall progress of a conversation, the control of the same information, the treatment of unknown sentences. Such problems require an adequate treatment in order to reach the chatterbots performance near human interlocutors [8].

## CREDIBILITY IN SYNTHETIC AGENTS

The SA – Synthetic Agents – are oriented to human behavior, i.e. they usually are for the training and they may need to represent part of human behavior by means of virtual characters [11].

Therefore, it is interesting that this character is credible because it will allow students involved in this exchange of information to obtain data that are not necessarily passed with a simple textual transmission. The message in the process is laden with symbols that will complement the context and the channel where it is conveyed. For the credibility of the agent is reached, it is necessary that the synthetic agent to look for ways that the public suspend their disbelief about it and that SA offers a compelling portrait of the behavior the public expects or will wait [6].

The credibility of the agent is also attributed to its growth and change, i.e. its ability to evolve, according to the context where it operates, as well as being able to make decisions in accordance with the changing environment. This is one of the biggest challenges in this area due to the fact that is difficult to guarantee, as the autonomic character, he will grow independently, but without the variance with his true personality. However, achieving this requirement means that people will informally interact with the agent to assign credibility to him [6].

Likewise, the social interactions of the characters are of paramount importance. After all, in almost all forms of art based on characters, the characters interact with other characters and these interactions are influenced by all the relationships that the characters have with each other, and the interactions may influence the relationships [13].

Every character also needs to have consistency in their expressions. Each character or agent has many ways to express themselves, depending on the environment where it is exposed, for example, an actor's facial expression, body posture, moving, voice intonation, etc. According Loyall [6], to be believable at every moment, every avenue of expression should work together to convey a unified message and is appropriate to the personality, feelings, situations, thoughts, etc. of the character. Breaking this consistency, even for a moment, there causes a disbelief in the veracity of the character.

Following all these requirements to the letter, the agents will be able to transmit credible than expected "illusion of life" because they will have the idea that they have goals, they act in parallel, they are reactive and responsive, they are situated in a context and they are well integrated and largely able. But creating these agents is not an easy task due to the technological complexity and consensus in creating AS based on these requirements. After all, the development of SA raises a number of challenges related to integration of decision-making mechanisms and modeling of the agent itself, its beliefs, intentions and goals.

## **NAIVE BAYES FOR REPRESENTING EMOTIONS**

Among the features the virtual characters need to present, is the ability to recognize human emotions. In particular, they must also be able to express their own emotions. After all, emotions are not only crucial to human reasoning, but are central to what can be called "social norms" – according to Halliday [4] – as well as to control the flow of the dialogue.

The Naive Bayes Algorithm is considered one of the simplest probabilistic classifiers. The model established by this algorithm consists of a set of probabilities, which are estimated according to the count of the constancy of each characteristic value for the instances of training data. The emergence of a new instance, the classifier considers the likelihood of this instance to be related to a specific class, based on the individual conditional probabilities product for the characteristics information of the instance. The calculation of these estimates makes use of Bayes's theorem and it is for this reason that the algorithm is called Bayes classifier. It is also nicknamed Naive, because all attributes are independent given the value of class variable. However, even with this assumption, the Naive Bayes algorithm offers good performance in many of the panoramas prediction classes. Experimental studies – as that performed by Oudeyer [9] – indicates that algorithm tends to learn more quickly and efficiently that most of the algorithms induction, and requires a small number of parameters to learn. These were the reasons that led to the choice of classifier for his study.

The Naive Bayes uses a wider range of characteristics, based on initial classification rules that exploit a probabilistic model to make decisions based on the classification obtained through combinations of its parameters. Thus, you can label a potentially larger and more diverse set of not tabulated sentences and more reliable way than rule-based classification. Thus, the system using the Naive Bayes for classification will relabel the training data that has started, and then repeat the subsequent steps.

The Naive Bayes was used in the system to train the stock phrases about the kind of emotion that each statement should present in a given context. Several statements of the stock of phrases chatterbot system explained below not undergone training with the Naive Bayes, however, emotions were assigned based on similarities with the speeches that were tested with users prior.

## **CHATTERBOT SYSTEM FOR TEACHING ALGORITHMS**

The system was developed for the web, and the need to use a server to be available over the Internet. Therefore, the Chatterbot System with Human Aspects proposes to implement a conversational agent with behavior, mood, personality and human emotions aimed at teaching algorithms. Subsequently, the system will be available for download to allow anyone access to the system source code, documentation and other files.

The system was developed from changes in the Program-O System for development of other features needed for the project. The Program-O supports the PHP language, which required that changes occur using this language. The changes enabled the Program-O was able to read additional information to the AIML.

The system consists of Five macro features: Intention, Personality, Emotion, Humor and Logging Dialogue.

The functionality of Intent is responsible for indentifying the purpose of conversation and will restrict the conversation



focused on the goals of the virtual character, which aims to teach algorithms. Soon, conversations that escape the scope of Cocorote will be redirected to assertions that fit with the main goal of the bot. Self-motivation is another item approached in this feature, since the chatterbot always tries to ask questions to direct the conversation according to your goals. For example, after the initial interactions of presentation the bot demonstrates to be happy by the interaction with the student and poses the question: “Let’s learn about algorithms?”.

Personality, Humor and Emotion are identified at the base of knowledge of the character. Personality is responsible for the remarkable characteristics (long term) that can describe the behavior of the chatterbot. The humor charts the reactions of medium-term, long-lasting affective states that have great influence on the human-cognitive functions, but generally not related to a specific event, action or object. Now, the emotion is excitement is responsible for mapping the responses of short-term decay and disappears from the focus of the bot. It is linked to a specific event, as the action of the interlocutor or other object of the conversation. The presentation of emotions is also represented in the form of facial expressions, emotions happiness, sadness, surprise, anger, disgust and fear.

For recognition of emotions, was used the inclusion of metadata on the AIML for each chatterbot response, indicating what kind of emotion it should have present given a statement. Also to assist in the whole “marriage” of the interaction, the That tag was crucial because each bot’s response, depending on your humor at that moment, your emotions would vary different. This means that, for the same answer, depending on the history of conversation occurred between bot and human, the bot could be happy or sad. The That tag checks, then, which was posted earlier assertion to thereby determine what will be said soon after.

The metadata is stored in AIML knowledge base in form: “!@emotion?%\*”. Is output to the end user, this metadata is extracted and displayed as a visual expression of the system.

The AIML provided effective means to implement most of the macro features of the system, requiring fewer changes in the Program-O that was expected. The table below represents all AIML tags and metadata used in this prototype, as well as how it was used for this study.

Purpose	Statement
THAT	Identifies previous conversations in order to direct the conversation human-bot.
SET	Creates a variable during the interaction.
THINK	Stores information in the brain of the bot.
TEMPLATE	Bot answer given category.
CATEGORY	User input.
GET	Retrieves information from a variable.
SRAI	Randomly chooses a statement given a set of sentences.
HAPPINESS	Metadata to identify the bot should have the emotion of happiness.
SADNESS	Metadata to identify the bot should have the emotion of sadness.
FEAR	Metadata to identify the bot should have the

ANGER	Metadata to identify the bot should have the emotion of anger
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The Program-O also has in its model-database the table botpersonality that stores bot information as date of birth, age, and other data that are of paramount importance in behavioral plausibility of the character, according to the first survey, need to present have human characteristics and beliefs. This information, once questioned by the recipient, will be drawn from this space.

Now, the Logging Dialogue stored in a table conversation\_log of database is able to archive conversations with users so that their context can be analyzed more effectively. The figure below illustrates the system and the features described.

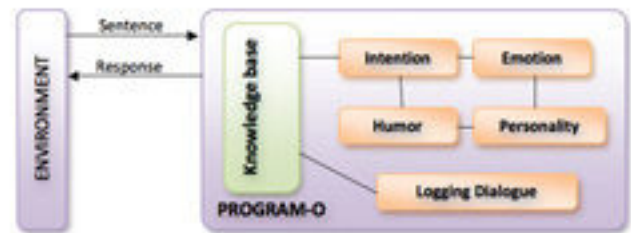


Figure 1. System Architecture.

Finally, the environment is the space of interaction and human-bot where meta information is handled and displayed in a manner transparent to the end user. The Knowledge Base represents all the AIML that is filed with the MySQL database prototype, with representations of Personality, Humor, Emotion and Intention of the system. While the Logging Dialogue stores all interaction occurred assigning an identification number to the user, the system time that the interaction occurred, as well as the input and output text.

## ASSESSMENT OF THE PROTOTYPE

Between the days June 20TH and August 3rd, 2011, the prototype was assessed by final users to verify if all the characters previously discussed as necessary for a coherent behavior in the system were properly implemented. The questionnaire used was the same as the first research (appendix 4) and was realized with ten people aged 23 to 29 years, between them 6 males and 4 females. In relation to education, seven of the interviewees have already completed graduation and three completed high school. Already their respective professional activities have been diversified in functions: teacher, student, journalist, administrative assistant, technician in telecommunications and network analyst.

About the characteristics that the interviewees would attribute to the character, there were many answers. The positive adjectives were given to the character: smart, didactic, thoughtful, helpful, interesting and emotional, totaling 80.7% of the replicates collected. In general, among the reasons cited by the positive characterization is due to the character of a variation of expression, openness and consistency in statements to the users answered. 19.3% Already encompassed the negative

characteristics: apathetic, boring and not very smart, where some of the interviewees claimed that the character did not show movement or animations and some of the messages changed seemed mechanical.

In relation to what led the user to realize that the character conveyed “illusion of life” the answers were as expected: seven of the replicas were related to coherence in the answers and 5 to the coherent character’s emotions.



Figure 2. Moments when the bot showed “illusion of life”.

While the moments where the character did not show “illusion of life” were: when the character looked forward ready-made phrases (6 answers), did not understand the statements’ accentuation (2 answers) presented expressions unexpected by the user (2 answers) and was repetitive (1 answer).

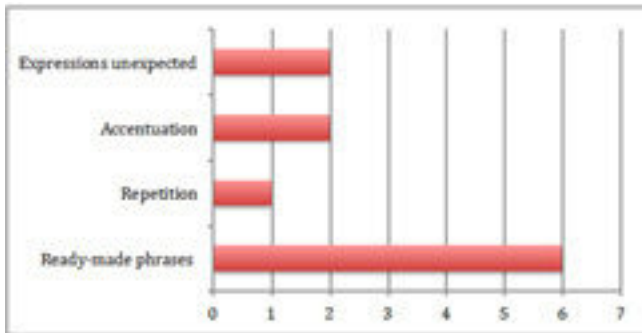


Figure 3. Moments when the bot showed “illusion of life”.

Soon after it was asked, in general, when the user thought the character showed a behavior that give “illusion of life.” Six interviewees mentioned that most of the times it happened, one claimed that it rarely happened, two said they sometimes could realize this behavior and one all the time.

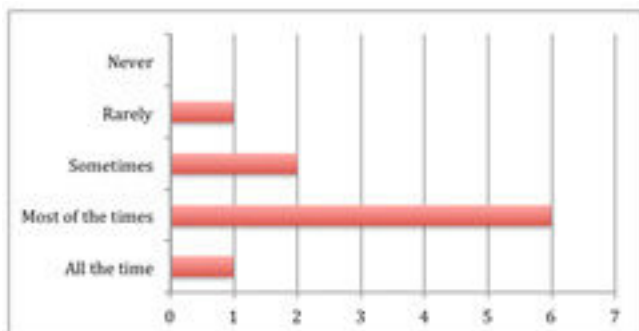


Figure 4. “Illusion of Life” from the bot.

Finally, interviewees were asked to rank the factors they identified in the character identified as: visual representation, representation of emotions, clear objective, consistency in the conversation and memory. All respondents were able to identify that the character had visual representation. Nine interviewees claimed that the bot’s ability to represent emotions and their consistency in the conversation helped plausible behavior, while a user was indifferent to these aspects. The character has a clear objective was a point that helped in the behavior of the bot to eight users, while two of them were indifferent. Lastly, in relation to the memory of the character, two of the interviewees did not realize this aspect of the prototype, one was indifferent and seven claimed that this feature was important for the behavior.

Among the answers given, may be established that the bot have shown a visual representation, coherent answers and emotions consistent points were highlighted for their plausible behavior. Also realize that there was an inefficiency in relation to memory of the character, that can inspire in a reformulation of this functionality implemented.

## FINAL CONCLUSIONS

According to the information collected in the questionnaire prior to virtual characters existing on the web and theoretical studies in the area, it was found that a chatterbot need to interact using colloquial language and coherent, display emotions, beliefs and human aspects, has memory and be able to identify double meaning in user statements to submit a behavior that can be considered consistent. Thinking about all these aspects is that the prototype Cocorote – virtual tutor for teaching algorithms – was developed, however, for purposes of implementation, the ability to realize the bot more than one meaning in conversation was ignored at first, but can be future work in finding a conversational plausibility, since it was one of the items highlighted in the first survey that conveyed an “illusion of life”.

For the evaluation after the implementation of the prototype with users, can be seen that the chatterbot requires a knowledge base more extensive in order to provide less repetition in assertive and different interpretations of the bot, as well as a restructuring is needed in the component that represents the memory of the character, since some respondents did not perceive this aspect in the prototype. However, many of the responses were favorable to the visual representation of the bot, the expressions of emotion, consistent responses and the interaction as a whole, even with the variety of profiles of users who performed the tests. Although note some users noted that facial expressions represented were unexpected, the results used to train the algorithm Naive Bayes were, in most cases, positive.

Using the tool, the user – usually a teacher, tutor, coordinator, or the system administrator – can enter the classroom the character will be able to, from the information posted on the environment (forums, labels, news, and others) (using tools, knowledge base), provides information if requests by the student or other user who has access to the environment. In addition, you can change,

remove, and query the chatterbots have created in virtual rooms that have access, as well as reports of interactions held with users. The evaluation tests of learning can be applied, for example, in a distance learning course in the subject of algorithms, using the more robust and integrated solution into the virtual classroom. As well as evaluating whether this new solution is in fact being used satisfactorily in the repertoire of the teacher in the classroom.

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