

Conversational System based on Socratic Dialectics in a Virtual Educational Environment

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Abstract. In this work, a conversational system is presented through a credible socio-emotional agent with the role of a coach. Which involves dialectics as a self-learning process for the coachee, using the types of questions that characterize the technique of the dialectic for the selection of their sentences. The personality type of the coach will be based on the personality of the coachee, which influences the preferences of how it wants to perceive the information within the dialogue and the impact criteria of the information associated with the importance and relevance of the sentences in a Socratic dialogue. In this paper, the ELECTRE III overclassification method is proposed as a strategy to obtain the direct powerful question closest to the agent's preferences, which are associated simultaneously with the coachee's answers. A conversational system with these characteristics can contribute to the development of serious games, modeling virtual entities with the ability to guide users through consistent dialogue, making users find solutions to their problems based on their cognitive possibilities.

Keywords: Conversational educational system, Socratic dialectic, socio-emotional agent with personality, virtual coach.

1 Introduction

In education, various teaching-learning models can include reflection methodologies such as the one based on thinking. This methodology makes use of inductive and deductive methods to carry out learning [1]. In the deductive method, concepts or clues are transmitted to determine an answer within a set of possibilities. The inductive method establishes clear and specific examples or questions for the adviser to identify and reflect on globally until reaching their conclusion [2].

To obtain self-knowledge through inductive learning, the technique of dialectics can be used, which is a rhetorical technique to reason and argue through a dialogue between two individuals. In this type of Socratic dialogue, the coach (advised) uses powerful direct questions based on maieutics or irony. One of the application areas where Socratic dialectics is used as a teaching-learning technique is in coaching processes [3].

Currently, it is possible to emulate coaching processes through a conversational agent based on dialectics, which will allow the creation of a virtual coach, simulating events that in this conversational process could offer the user (coachee) possible solutions to make decisions and solve the problems raised [4].

To give realism to the behavior of the virtual coach based on dialectics, it is necessary to incorporate artificial intelligence techniques that support the behavioral purposes of the coach within the coaching processes, these behaviors can be divided into motivated by emotions [5] and motivated by belief or reasoning [6].

In this case, the modeling of functions that integrate emotions, personality traits, preferences, and motivations, take on great relevance in the selection of powerful questions based on Socratic dialectics.

This research work proposes a conversational system that integrates the technique of dialectics as a strategy for the design of a virtual coach. To incorporate the characteristics of dialectics, it is proposed to ask rhetorical questions in the function of the mirror so that the coachee can reach their solutions, it is proposed that the personality of the coach reflects the personality of the coachee.

That is, the personality of the coachee will define what the personality of the coach will be. Its influence on the selection of questions will be based on the profile of this personality, reflecting a relaxed or strict coach.

2 Related Works

This section presents a brief description of some works related to intelligent virtual agents that use personality traits to give realism and credibility to their sentences through their dialogue management system. These agents are developed based on expert knowledge according to the context of the application area for which their use is intended.

In the educational context the work of Gómez-Róspide [7], which focuses on developing an intelligent virtual agent to help with learning. This agent is intended to resolve academic doubts about a subject through a conversation with a human, being able to understand the questions asked by the student and prepare an answer according to what was questioned.

However, its vocabulary is based on a single context, for example, a topic-specific vocabulary related to the topic of linear algebra. This represents a limitation for the agent if the student questions issue not specified in the context of algebra.

In [8] and [9] a socio-emotional tutor agent is created, that is, through the dialogue they try to guide the user through dialogues that express emotions and personality to guide the interaction.

In the work of Morales-Rodríguez [9], an intelligent emotional character is proposed in a virtual therapy context capable of modifying their emotional state based on the evaluation of it interlocutor's actions and attitudes, that is, It could react positively or negatively to certain stimuli.

It intends to generate a feeling of immersion in the patient through the emotional expression of a virtual social presence, stimulating the patient's participation during therapy. This work involves the approach of personality traits with the FFM model (Five-Factor Model).

Another example of the selection processes that involve taking into consideration emotional characteristics in conversational agents can be seen in the work of Florencia-Juárez [10], in this project, credible dialogues are produced capable of creating real scenarios for the student in psychology and psychiatry diagnose the condition of generalized anxiety disorder simulated by the conversational agent. Florencia uses a deliberative architecture and for personality modeling.

He uses the FFM model. The works of Morales-Rodríguez [9] and Florencia-Juárez [10] present dialogues that are reactively established between the user and the agent. That is, they are previously stored in a knowledge base and selected according to the interaction with the user. This can produce a repetitive dialogue and the person does not reflect on his problem.

To give realism and credibility to each of the sentences of a socio-emotional agent using personality traits, Delgado-Hernández et al. [11] propose a sentence selection model which is responsible for choosing the most appropriate sentence in response to the perceived context within the dialogue.

This model requires as input the corpus and the context characterized according to the personality profile of the agent. The author uses the MBTI model (Myers-Briggs Type Indicator) and the values of the individual's preference thresholds that are integrated into an overclassification strategy called ELECTRE. This work is the closest to the work proposed in this document.

However, the dialogues are characterized manually and are characterized according to the vocabulary of the authors. Therefore, it cannot answer questions that are not stored in its knowledge base, nor can it use more than one personality and preferences profile.

Following the line of investigation of personality models that can be used in socio-emotional agents to show congruent dialogues related to the preferences of how information is intended to be perceived in a particular context, is the Castro-Rivera model [12].

This personality model is known as MPBCD (Decision Context Personality Model) and its decision profiles are: optimistic/relaxed, collaborative, inquiring, and strict. These personality profiles can reflect a relaxed or strict coach according to the perception of information received from the coach.

This work does not contain the construction of dialogs to guide the user. It is worth mentioning that the MPBCD personality model is useful to guide the process of selecting an answer in the Socratic dialogue through the influence of personality on preferences in decision processes.

The works presented in this Section involve conversational social-emotional virtual agents with personality. However, they present limitations in the way in which the dialogue between the user and the agent is carried out. This article proposes a response dialogue generated from a user's phrase, which is displayed as a direct question based on Socratic dialectic.

These dialogues are not stored in a knowledge base, that is, they are automatically generated through the perception of characteristics related to speech acts and Socratic dialectic. In addition, the selection of the answer or question is carried out using the ELECTRE-III strategy, which uses preferential thresholds influenced by personality.

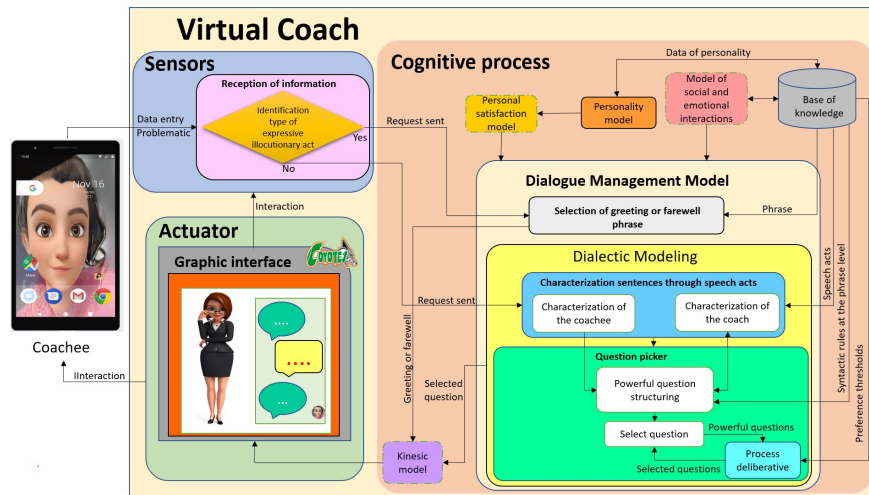


Fig. 1. Proposed architecture of a virtual coach based on dialectics.

These thresholds have been taken up from the work of Castro-Rivera [12], as well as from personality profiles. These profiles will allow the selection of the direct answer or question to be adapted based on the user's personality detected in their sentence through speech acts.

3 Influence of Personality on the Selection of Questions based on Dialectics in Credible Socio-Emotional Agents

To understand how to give certainty to the behavior of a virtual entity based on the Socratic dialectic, and the influence on the selection of powerful questions through a personality profile, it is necessary to know some concepts related to intelligent virtual agents and the mechanism they use to make decisions based on emotions, personality traits and preferences under a decision context using the overclassification strategy known as ELECTRE III.

3.1 Deliberative Conversational Agent

A virtual agent that emulates human behavior is a deliberative conversational agent. This type of agent incorporates in its architecture the basic principles of most intelligent systems. These are reactivity, internal state, principles, and goals, autonomy, sociability, and reasoning [13]. These principles are related to the symbology of the real world, through beliefs, desires, and intentions.

Where beliefs are related to personality, that is, the agent knows who he is and the context or environment in which he operates. The desires are related to the objectives that pursue the agent, in this case, it is the formulation of questions based on the dialectic influenced by the personality.

The intention is to deliver a suggestion as a question to the coachee to create a reflective environment that allows them to create their solution to their problem. The

Table 1. Example of the phrases said in a Socratic dialogue.

Phrases			
I	Coachee	Virtual coach	TIA
1	Hi good morning. I have problems with a student in the subject of integral calculus	Hello, good day. What do you think is the reason why you have problems with a student in the subject of integral calculus?	Assertive
2	Possibly a lack of attention in the classroom	How do I possibly think of the lack of attention in the classroom?	Expressive, Commitment

selection of powerful questions in this virtual agent is based on an overclassification method called ELECTRE III.

3.2 ELECTRE III

The ELECTRE model (Elimination and (et) Choice Translating Algorithm) is the best known among the methods developed for multi-criteria attendance problems and is used as a procedure to reduce the size of the set of efficient solutions [13]. ELECTRE III orders different solution alternatives, for which different criteria are generated with a certain weighting [14].

It works with pairs of alternatives and in these, there is a measure of agreement and disagreement to produce the degree of overclassification, this model aims to combine the credibility index that validates the decision-making process when choosing one alternative over another in a problem [13].

To work with the ELECTRE method, the development of a performance matrix is needed. In this matrix, the linguistic variable and the weight of importance must be indicated. After establishing the values of these variables, a matrix must be made to compare the values of the alternatives against the criteria that were previously established for the problem, and to conclude in the selection, the level of agreement between the variables must be taken into consideration [14].

3.3 Personality

In this work, it is proposed to integrate the Castro-Rivera personality model [12] that calculates the parameters that will reflect the behavior and preferences of the virtual coach, which will influence the formulation of the questions based on the Socratic dialectic using the four profiles of decisions proposed in this model. Personality is commonly seen as the set of behaviors that constitute a person's individuality and is used to describe and classify attitude.

Attitude is defined by two inseparable aspects, the affective aspect, and the cognitive aspect. Attitude is defined as the degree of positive or negative effect consistently associated with a person's response [15]. There are two major theories of personality on human behavior, these are the trait-based theory, The Five-Factor Model of personality (FFM-OCEAN), and the type-based theory, Myers-Briggs Type Indicator (MBTI), which are very recurrent in the modeling of behavior in virtual agents [16].

4 Conversational System for a Virtual Coach Focused on Socratic Dialectics

The modeling of a virtual coach requires an architecture supported by agent theory, due to the complexity of the elements involved in its operation, such as the dialogue management model, decision making, and the personality model. The architecture of this work has the function of representing virtual humans with the possibility of performing various roles in education. Figure 1 shows the general architecture of a virtual coach based on Socratic dialectics, which is generally composed of three main components: sensors, actuators, and cognitive process.

The information reception module is located in the sensor component. In actuator components, there is the graphical user interface module and in the cognitive process component, there is the deliberative process associated with the dialogue management model, which is made up of dialectic modeling.

The information reception module receives the problem, that is, the user's sentence. From the problem, it is possible to identify the intention and the type of illocutionary class of this, as well as the phase of the dialogue.

If the type of illocutionary class is of the expressive type, the answer is taken from the knowledge base obtaining phrases of greetings or farewells. Otherwise, a dialectic-based sentence must be determined which will be a powerful question in response to the coachee. The knowledge base module contains the welcome or greeting phrases for the user, the grammar rules at the phrase level, information criteria, and preference thresholds of the virtual agent.

In the modeling of the dialectic, there are the speech and question selector modules. The latter is responsible for generating a reflective conversational environment influenced by the preferences and personality of a virtual agent through direct questions.

The sentence characterization module through speech acts characterizes the sentence of the user (problematic) and the virtual coach through the theory of speech acts. Through this theory, the intention of the sentence is established and the personality type of the coachee is determined. In this way, it generates a powerful question as a response from the coachee, which is structured under the same personality profile.

The question selector module structures powerful questions at the level of phrases analyzing the problems derived from speech acts. Through the phrases and the user's problems, it generates a set of powerful questions.

The powerful questions were born given to the deliberative process so that they select those questions that are closest to the interests of the coach according to their preferences. According to the personality profile of the coach, it is possible to choose from the knowledge base the preferential parameters that guide the deliberative process to select the powerful questions. That is, if the personality is of the optimistic type, the preference parameters or thresholds correspond to an optimistic person.

It is worth mentioning that these preference thresholds are influenced by personality. The calculation of these thresholds is based on the work of Castro-Rivera [12].

Table 2. Comparison of 8 interactions in a Socratic dialogue under the influence of personality.

I	Coachee			Virtual coach			Real coach		
	TIA	TDQ	PP	PN	TDQ	PP	PN	TDQ	PP
1	Assertive	M	E	How?	M	E	Which?	M	E
2	Expressive, Commitment	M	O	How?	M	O	Why?	I	O
3	Commitment, assertive	M	C	How?	M	C	¿What?	I	C
4	Expressive, Commitment, Assertive	M	O	How?	M	O	Which?	M	O
5	Assertive	M	E	Which?	M	E	¿What?	I	E
6	Assertive	M	C	How?	M	C	¿What?	I	C
7	Assertive	I	E	What?	I	E	¿What?	I	E
8	Assertive	I	E	Why?	I	E	Which?	M	E

In the deliberative process module, the questions provided by the question selector module are provided, as well as the preferential thresholds influenced by the personality of the coach. In this module, the preference-based solution strategy corresponds to the ELECTRE III method.

This method obtains the solution alternatives, that is, the powerful questions closest to the preferences of the virtual tutor. A powerful question can use maieutics or Socratic irony according to the perception of the coachee's personality type and the existing relationship with his illocutionary act.

To structure powerful questions at the level of phrases, a previous study of each of the phrases must be carried out to make a list of all the rules that can be formed as a result of what the coachee said, that is, all the possible combinations that can be built through syntactic trees by structuring questions with the four proposed interrogative pronouns (What? How? Which? and Why?), which define the type of question-based on dialectics. Next, algorithm 1 shows the general procedure of the architecture of a dialectic-based virtual coach.

Algorithm1. General procedure of the virtual coach based on dialectics.

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1: function COACH (phrase)
2:   greeting_farewell=es_Greeting_Farewell (Perception(phrase))
3:   if greeting_farewell==null
4:     questions_characterized_dialectic=Speech_Acts(phrase)
5:     personality=Get_Personality(questions_characterized_dialectic)
6:     thresholds=select_preference_thresholds_ELECTRE_III(personality)
7:     return select_phrase(questions_characterized_dialectic, thresholds)
8:   else:
9:     return greeting_farewell
10: end function

```

5 Evaluation Results of the Selected Sentences in a Socratic Dialogue

The result of the agent's execution will generate powerful questions based on Socratic dialectics. To contrast the effectiveness of the simulation process, a comparison is made between the result of the simulation and that of the interaction of a real coach in a Socratic dialogue focused on the problems of a teacher with a student due to the lack of interest in his class. Table 1 shows the first two sentences of the interaction and its associated illocutionary act (TIA).

Next, a brief description of the results obtained through the simulation of the coaching processes is presented. The experimentation seeks to compare whether the responses of a virtual coach correspond to the responses of a real context under the same decision profile in the argumentation phase of the proposed Socratic dialogue.

Table 2 shows the comparison between the response of the virtual coach using the ELECTRE III method and the response of each of the phrases according to each personality profile of the coach. A total of 8 interactions belonging to the argumentation phase are observed. The evaluation validates if the type of dialectical question (TDQ), that is, maieutics and irony, corresponds to the one selected by the real coach.

The characteristics considered in this table are the type of illocutionary act (TIA), TDQ, personality profile (PP), and interrogative pronouns (PN). The PP is defined in terms of the TIA, that is, if the TIA is Assertive, then the coach's PP is assumed to be of type Strict (E). If the TIA is Commitment, the PP will be Collaborative (C). If the TIA is Directive, the PP will be Inquiring (Id) and if the TIA is Expressive or Declarative, the PP will be Optimistic (O).

Based on the type of TIA, the TDQ can be defined, which are Maieutics (M) and Irony (I). These are defined by the PN, those that correspond to M are How? and Which? and for I What? and Why? The final definition for each TDQ is given randomly.

The first aspect to be evaluated is the results in the choice of the TDQ, in which a total of 100% correspondence is obtained between the TDQ of the phrases selected by the virtual coach concerning that expressed by the coachee, which corresponds to the dialectic methodology.

On the other hand, the results of the evaluation of the TDQ selected between the virtual coach and the real coach differ by 50%, the difference percentage may be because the real person does not have adequate preparation to use dialectics in an appropriate way professional.

6 Conclusions and Future Work

In this article, a conversational system based on Socratic dialectics was presented, which uses the overclassification method called ELECTRE III for the selection of the phrase closest to the coach's preferences within the coaching process.

For the selection of the type of question-based on dialectics, preference thresholds were used according to the type of personality profile of the coachee perceived in the characterization phase.

This is to emulate the characteristics exposed in the literature related to the Socratic dialectic, where it is observed that the coach performs the function of a mirror, thus achieving that the coachee can reflect on their cognitive scenarios through their responses.

In future works, the integration of more grammatical rules exposed in the Spanish language is expected so that the agent can have greater reasoning not only limited to the rules within the possible phrases that can be developed from a sentence.

Another aspect that can be improved is the assignation of the interrogative pronoun associated with the type of powerful question since currently the selection of the pronoun is randomly assigned among the possible values of pronouns related to perlocutionary verbs.

It is expected that the phrases selected with this strategy contribute to inductive advice based on Socratic dialectics so that the coachee can find and improve the integration of their skills in their work environment, finding solutions to their problems through reflection on their behavior.

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