MyUBot: Towards an artificial intelligence agent system chat-bot for well-being and mental health

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Abstract. We propose the design of an architectural framework for a reasoning logic-based intelligent agent system chatbot for dialogue composition named MyUBot. This framework is applied in the well-being mental health domain for the well-being development of first-year university students. A particular aspect of our framework's capabilities is the handling of poetry and silence mild therapies. A machine language code defined in this work is used to describe and interpret micro-scripts that are used as atomic pieces for dialogue composition for the intelligent agent system chatbot. The use of logic programming to provide reasoning skills to MyUBot is proposed within the architectural framework. Logic Programming theories, as a tool of knowledge representation are used to reason, plan and optimally solve the Dialogue-Session Composition Problem.

1 INTRODUCTION

Stress is the world mental health disease of the 21st century [16] and may be the trigger for depression and even suicide if it is not treated correctly. The World Health Organization (WHO) estimates that, in the world, suicide is the second cause of death in the group of 15 to 29 years of age and that more than 800,000 people die due to suicide every year [41]. Mental illnesses generate high economic losses since sick people and those who care for them reduce their productivity both at home and at work [38, 40, 19]. WHO projected that for this year 2020, depression would be the second disease that will cause the greater damage in society [39].

The mind has the ability to reeducate due to neuroplasticity, which refers to the ability of neurons to regenerate and form new connections, and to make the students overcome problems they face. Over the years, science has shown that the brain and the mind work synergistically, that is why the brain can be reorganized by forming new nerve connections or paths when learning to control the mind through therapies [2]. These therapies could help persons to reach a *flow state* [11] and *being in your own element* [34]. A flow state corresponds to the operating mental state in which a person is completely immersed in the activity that he/she executes, it is characterized by a feeling of total involvement with the task, and the success in carrying out the activity. This sensation is perceived while the activity is ongoing and it is called being in your own element, that is, doing something that feels so completely natural to you and makes you feel that this is who you really are. Currently there are different therapies to support a person in overcoming their psychological difficulties such as: *Mindfulness* [6, 21, 15] and *Cognitive Behaviour Therapy (CBT)* [2] or *Poetry Therapy* [23].

Jon Kabat-Zinn defines *Mindfulness* as "Pay attention intentionally to the present moment, without judging" [21]. This type of attention allows us to detect a direct relationship with what is happening in our life, here and now, in the present moment. It is a way of becoming aware of our reality, giving us the opportunity to work consciously with our stress, pain, illness, loss or in general the problems of our life. Even more, over the past twenty years, the amount of published scientific research on the effectiveness of stress reduction training based on mindfulness has been greatly increased to improve function in a broad list of both physical and psychological processes [35, 15].

CBT was initially developed by J. Beck as a treatment for distorted thinking and brief depression by evaluation of negative thoughts influencing the behaviours. CBT is a psychotherapy that proposes modification of the thought to produce effective health improvement as has been shown in over 2,000 research studies [18].

It is worth to mention that authors of [37, 36] indicate that mindfulness involves cultivating an observer of consciousness, trying to maintain reflective awareness of each moment. In contrast, flow involves losing the inner observer within an altered state of consciousness in which the moment blurs into a continuous stream of activity. However, there is way to combine them and take advantage of both sates of mind. From a self-regulatory perspective, an optimal sequence might entail first mindfully surveying the situation and one's reactions to it in order to decide what to do, then going into a flow state in service of one´s selected actions, then going into a mindful state in order to observe the results of those actions, then going into another flow state to best accomplish the next actions, and so on.

According to [31, 22, 8], therapists practicing standard CBT are encouraged to adapt some changes to CBT practice such as an increased use of smiling, silence, imagery, metaphors and interview practices. These changes are due to the fact that language is considered as a field of energy in practice and catharsis exercise to help psychological development. In this sense, *Poetry Therapy* can be considered a beneficial option for those people who enjoy writing or reading poetry [23].

The term *well-being* (meaning having no anxiety, depression or stress) has recently gained attention as a term that covers our general happiness and even more concrete good conditions in our lives, such as physical, psychological, and social wellness [25]. Even economists and governments are starting to focus on well-being and "Gross National Happiness" as a new metric for measuring the statuses of the nations [25]. Based on research of Richard Davison [13]

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well-being is a skill to be learned.

The relationship between well-being and physical health have been studied by many Scientists. Elizabeth H. Blackburn, Carol W. Greider and Jack W. Szostak were awarded the Nobel Prize in Physiology or Medicine 2009 "for the discovery of how chromosomes are protected by telomeres and the enzyme telomerase". They show that Telomerase activity is a predictor of long-term cellular viability, which decreases with chronic psychological distress [15].

Technologies of inclusive well-being is a field of study that assumes technology has the capacity of increasing emotional, psychological, and social well-being, and that investigates how information and communication technologies empower and enhance the quality of personal experience in these areas [5]. In this sense, we consider that it could be very useful to have an intelligent agent system that could give support on managing stress, anxiety and depression to all individuals, but specially to young people in order to reduce the risk of failure in the university life due to problems in learning, health and behaviour when they face university challenges [33].

Hence, in this work, we describe a proposal about the design of an architectural framework for a reasoning logical-based intelligent agent system chatbot for dialogue composition named *MyUBot*. The goal of MyUBot is to encourage the well-being of the student by means of his/her interaction through questions and answers, and while MyUBot "learns" from him/her, it also allows the user to learn from him/her-self. Once the student discovers elements that were unnoticed by him/her, he/she can find a better way to improve when discovering her points of improvement. Thus, during sessions with MyUBot, it is intended that the students understand, accept and "become a friend of" their minds and emotions obtaining a better performance both in school and in their personal life. MyUBot is directed to every student, with particular interest in those suffering from mild symptoms of depression or anxiety, and who of course, are seeking support for this and are willing to practice constantly a mild therapy. MyUBot takes advantage of what Richard Davidson, founder of the Center for Healthy Minds at the University of Wisconsin-Madison, explains about the constituents of well-being in [12] : "The constituents of well-being are rooted in specific brain circuits that exhibit neuroplasticity, which gives people the opportunity to enhance their well-being with practice.". Davidson also explains in [12] that well-being is a skill and in order to acquire some skill a person has to practice it, in this way this person improves by allowing pro-social behavior. In other words, in this article we describe a proposal for a system whose final implementation, in a near future, can be used as a student support tool for practicing mild therapies, in order to strengthen an individual's internal resources, thus allowing the prevention of mental anxiety disorders or depression and thus to help to reach well being. The mild therapies offered by MyUBot combine the practice of two important elements: enriching talks and psychological techniques. The enriching talks is a process that is supported mainly on recommendations made by MyUBot. These recommendations are based on the psychological techniques previously mentioned in this section: Mindfulness, Cognitive Therapy, Poetry Therapy, and silent handling. It is worth specifying that the efficiency in individuals who practice them in a reasonably short period of time has been tested in different scientific ways, and very favorable results were obtained for individuals with the characteristics of a university student with mild anxiety and depression problems. MyUBot follows the basic principles of cognitive therapy [2] which were presented in [30]

MyUBot is intended to be an intelligent agent system running on a smartphone that has the capacity, through the use of a chatbot, to answer questions of university matters in order to try to create a link with the student because the system considers his/her pleasures and hobbies. MyUBot handles silence within the dialogue session in two directions: the silence from student to MyUBot, and the silence as a response of MyUBot to student answers. We also have added to MyUBot, design Poetry Therapy within dialogue session, in order to motivate the student to read and write poetically for a well-being development. The core part of our proposal in the design of the MyUBot, is the use of Logic Programming (LP) that allows to implement a system responsible for defining the behavior of MyUBot with the user. Moreover, LP is very useful to represent knowledge, and an inference mechanism is used to manipulate it. We propose to use a master-slave conceptual design for our architectural framework, following a centralized approach for the agents. Hundreds of slave agents perform a particular task dedicated to the interactions with the students and a master agent is charged to execute a plan (which is obtained by a reasoning planning system) to direct them. All the semantic knowledge of each slave agent plus a general theory of interaction among them is written in LP. The master agent corresponds to an LP program. Our proposal also considers a machine language code defined to describe and interpret micro-scripts that are used as atomic pieces for dialogue composition for the intelligent agent system chatbot. We also specify, by means of LP, the model of dialogue composition problem as an extended version of the 0-1 knapsack problem that addresses the issue of optimizing engagement, enjoyment, and smoothness for the dialogue session.

We currently have an initial MyUBot prototype that is still under development and therefore we still do not consider it relevant to test with users. This prototype still lacks: a suitable interface; a balance between natural language and other communication alternatives; mindfulness options, poetry therapy, etc.; among other things. We would also like to do more research on the above points and receive feedback in this regard before testing the system. In other words, we have first been concerned with architecture and content. But much remains to be improved in "the form".

Our paper is structured as follows: in section 2 we discuss chatbots applied for mental health well-being, the major claim here is that they are definitely useful and there is an opportunity to improve them, this is very important in order to ensure engagement of the users in using these tools. In Section 3 we present our design of MyUBot: An intelligent chatbot system, one point to emphasize is that we present an extended version of the well known 0-1 Knapsack problem as the key ingredient to express our problem. Finally in section 4 we present our conclusions and future work.

2 RELATED WORK ABOUT APPLIED CHATBOTS FOR MENTAL HEALTH WELL-BEING

Chatbots in health care may have the potential to provide patients with access to immediate medical information, recommend diagnoses at the first sign of illness, or connect patients with suitable health care providers across their community [32]. Theoretically, in some instances, chatbots may be better suited to help patient needs than a human physician because they have no biological gender, age, or race and elicit no bias toward patient demographics [32]. "Chatbots do not get tired, fatigued, or sick, and they do not need to sleep; they are cost-effective to operate and can run 24 hours a day, which is especially useful for patients who may have medical concerns outside of their doctor's operating hours. Chatbots can also communicate in multiple different languages to better suit the needs of indi-

vidual patients."[32].

Early research [32] has demonstrated the benefits of using health care chatbots in many aspects, with accuracy comparable to that of human physicians. Patients may also feel that chatbots are safer interaction partners than human physicians and, are willing to disclose more medical information and report more symptoms to chatbots. Psychological Internet interventions have frequently been evaluated and are viewed as a medium independent of time and place. They might be able to help reduce treatment barriers and expand the availability of care. Numerous studies [4] have shown that these interventions, often using cognitive-behavioral techniques, are comparable in their effectiveness to classical face-to-face psychotherapy. Psychological problems such as anxiety and depression are already being effectively addressed in this way. An example of this is Woebot, which is a template-based chatbot delivering basic CBT, that has demonstrated limited but positive clinical outcomes in students suffering from symptoms of depression [3].

In related work [1], the authors explore how an intelligent digital companion(agent) can support persons with stress-related exhaustion to manage daily activities. [1] presents a multipurpose goal model for personalized digital coaching, which is a dialogue system that enables a human to engage in dialogue with a software agent to reason about health-related issues in a home environment. Also the cognitive architecture of an agent for human-agent dialogues is presented.

In [20], an empathy-driven, conversational artificial intelligence agent, called Wysa, for digital mental well-being that is using mindfulness as mild therapy in combination with transfer to psychologist whenever the user ask for it, is presented.

In [14], the author presents the development of a mindfulness-based mobile application to learn emotional self-regulation. A state of the art in mindfulness-based mobile applications and the design of a mindfulness mobile application to help emotional self-regulation in people suffering stressful situations are also shown. We invite the reader to check [1] where a comparison of Applied Agents implemented for improving mental health and well-being is carried on.

We now discuss some drawbacks of current applied well-being chatbots. Despite their advantages, there are undeniable drawbacks-limitations of them. Several studies have investigated the clinical efficacy of remote-, internet- and chatbot-based therapy, but there are other factors, such as enjoyment and smoothness, that are important in a good therapy session. A comparative study found evidence that suggests that when compared against a human therapist control, participants find chatbot-provided therapy less useful, less enjoyable, and their conversations less smooth (a key dimension of a positively regarded therapy session) [3]. Health care chatbots technology is usually associated with poor adoption by physicians and poor adherence by patients. A study [32] suggest this may be because of the perceived lack of quality or accountability that is characterized by computerized chatbots as opposed to traditional face-to-face interactions with human physicians. The work in [4] suggests that when comparing the effectiveness of classical psychotherapy with Internet- and mobile-based interventions, one should consider that inter-individual differences.

Finally, regarding experimental chatbots, such as the one presented in this work, and which may be useful for specialist therapists, not for end users, we mention the following works: [7] presents an experimental chatbot for a virtual company at the time of COVID-19, it is based on a vector and closest neighbor approach to model the problem. In [28] a logical-based AI agent system chatbot for emotional well-being and mental health is described, it is characterized by the implementation of a module that makes the system detect when the student tries to "deceive" the system. It also proposes the use of a module to detect student emotions following the idea of OCC (model of emotions). In [29] a chatbot is described as a virtual companion system to give support during confinement; it aims to achieve well being. In [30] an experimental chatbot is described to support university students based on psychological techniques such as mindfullnes and cognitive therapy, it uses Answer Set Programming.

3 DESIGN OF ARCHITECTURAL FRAMEWORK

As far as we know, literature of related work does not include reasoning logical based architecture for dialogue composition. In this sense, a contribution of this work is to propose the design of an architectural framework for a reasoning logical based intelligent agent system chatbot for dialogue composition. The general design of our intelligent agent system is presented in this section. The 'user model' is defined in similarity to the work related in [1] but adjusted to the instantiated mental health domain for students well-being. Below, the user is referred as to student. The prototype of MyUBot can be requested by e-mail to the authors.

Remember that the tool is suggested for any student and we are not considering severe cases of anxiety-depression. However, if this is the case and MyUBot detects a serious case of anxiety-depression, then it is proposed that the system transfers student to a human expert therapist (situation that is normally possible in a university institution). Even more, the student could press an emergency button[4] available in MyUBot that provides resources for getting immediate human experts help.

Regarding the silence technique, a button can be implemented to help so that a long silence on the part of the user may prompt him/her to activate the button; otherwise a silence on the part of MyUBot may by activated automatically in case the user is relentlessly talking, for example.

3.1 A master-slave AI design

We propose a master-slave conceptual design for our architectural framework, following a centralized approach for the agents. Namely, we create hundreds of slave-agents (at least one thousand) such that each of them can perform a very concrete task and all of them are coordinated by a distinguished slave agent. All the tasks correspond to interactions with the student. Each interaction is specified as atomic micro-dialogue. An example of a task could be the congratulation of a student for a particular reason, then in order to establish this interaction, a micro-dialog about the congratulation should be specified. Another example about a more complex task could be to teach the student how to try a meditation exercise.

Each task performed by a slave-agent is programmed in the ***Basic Script/Resources Language (BSR-language)***. This is a low level language (to describe automaton) invented for this purpose (it could be as well, a small AI-ML script). Some of these slave-agents can be created by humans and some other can be constructed semi-automatically[5]. Associated to each slave-agent we have its semantic knowledge. For instance, slave-agent named $E3$ could correspond to an exercise of sound-mindfulness. Furthermore, the intelligent agent system has an explicit logical default rule saying that this type of exercise normally helps to reduces anxiety, and so on. Note that these

[4] A functionality learned from Woebot[17] chat-bot GUI.

[5] We do not consider this issue in this paper.

default rules are very useful in this context and can naturally be expressed in Logic Programming(LP) such as Answer Set Programming [10].

All the semantic knowledge of each agent-slave plus a general theory of interaction among them is written in a LP language. The LP theory corresponds to the ***Master-Agent Artificial Intelligent Composer (MAIC)***. The main goal of the MAIC is the definition of a sequence of few tasks that correspond to a *plan*. This plan is performed by the slave agents and coordinated by the distinguished slave agent, a program interpreter of BSR-language in Python.

One of the most important goals of the coordinating agent corresponds to the collection of feedback of the student about his/her profile at the end of each session with him/her. This allows updating the knowledge about the student profile, since MyUBot "learns" about him/her in each session, so this allows to offer a personalized support by means of recommendations for student difficulties according to his preferences in future interactions. The coordinating agent corresponds to a LP program because we are taking advantage on the fact that logic is used to represent knowledge and inference is used to manipulate it. LP program uses different extensional knowledge bases to represent knowledge, and to make inferences. One of the most important knowledge basis is that used to represent the profile of the student, which is updated in each session with the student, others are the knowledge base to represent microdialogs, emotional status or history record, and another is about the answered questions where also the questions made to the student are recorded.

3.2 MyUBot intelligent agent system chatbot

Since MAIC is charged to generate the plans, it is based on a reasoning planning system that consists on the generation and execution of a cycle of 4 sequential processes-modules described below. The implementation of this reasoning planning system defines our MyUBot intelligent agent system chatbot.

I. Abstract script dialogue session (ASDS) is a composition of slave agent tasks sequence to be performed by MyUBot as a single dialogue session to establish an interaction with the student. Each slave agent interaction task (AI-task) with the student is described in BSR-language and is named; for example $E3$ could be a name of an AI-task for a enriching talk mindfulness exercise. Also each AI-Task is associated to semantic knowledge described in an enriching talks theories knowledge base denoted as ***ETalks-KB*** and implemented as a theory in LP.

The composition of slave agent tasks sequence to be performed by MyUBot basically is obtained in two levels, each of them is implemented as a module of knowledge base reasoning represented and specified via LP. The lowest level consists of a logical theory that generates a set of recommendations that are represented as a graph. The highest level consists of an LP program that proposes the slave agent tasks sequence to be performed by MyUBot in order to solve an specific problem based in the constructed graph. The formal specification of this second level is in terms of an optimization problem, named ***the Dialogue-Session Composition Problem (DCP)***. The DCP optimal solution can be computed specifying the problem using Integer Programming but also logic programming paradigms. In particular, we propose to use Partial-Order Logic Programming [27] which is suitable to describe DCP in a concise and straight forward declarative language to compute the optimal solution with efficiency by a APOL solver [26]. For each dialog-session we propose the solution to an optimization problem: We select from 5 to 7 objects (questions/activities) according to the student´s needs. This is done by solving an extended version of the 0-1 knapsack optimization problem, but we associate a profit to the order of the objects by considering engagement, enjoyment, and smoothness for the session. The cost of each object corresponds to the expected time it takes during the activity, and the profit is an emotional benefit estimated according to the student's profile. The capacity is the time allowed for the session (20 minutes)[6].

MAIC architecture design is independent of applied domain, in our case we have applied MyUBot architecture to Mental Health Well-being. MAIC optimizes in DCP the Mental Health of student with an optimal coherent, enjoyable and smoothable session.

II. Concrete dialogue script generation translates the ASDS list to a single BRS languaje program. The idea behind the BSR-language code (to describe automaton) is to define a basic programming language such that any program AI-task of our library is a highly malleable object where one could define and apply operators (mutation, crossover composition, selection, specialization, generalization). Two basic examples are the following: A "greeting" BSR-language code could be mutated for erasing or including an emoji-icon set; another operator could eliminate some "production rules" for deactivating some particular answer in the BSR-language. Here, we are not talking about the rationality of why to do it. For example a reason to apply these mutations can be concluded by a learning process that find outs that it is more suitable to do it so for a particular student.

III. Dialogue interpreter chatbot corresponds to the main process charged to execute the composed dialogue session as interactions of AI-task with the student.

IV. Feedback module is an extraction process of relevant information and knowledge. This module filters a student conversation record to obtain the ***student profile state (SPS)***. The SPS is used to provide feedback and to update the Extensional Knowledge Bases of the proposed Intelligent Agent System. The updates made in Extensional Knowledge Bases using the SPS could be about student profile, emotional status or history record, among others. This module also updates the answered questions Knowledge Base where also the questions made to the student are recorded.

4 CONCLUSIONS AND FUTURE WORK

One contribution of this work is to propose the design of an architectural framework for a reasoning logical based intelligent agent system chatbot for dialogue composition. Another contribution is to specify the model of the DCP as an extended version of 0-1 knapsack problem addressing the problem of optimizing engagement, enjoyment and smoothness for a dialogue session. Another contribution is to include and handle Poetry mild therapies for well-being development to provide enriching talks within the composed dialogue sessions. Finally, the applicability of this architectural framework in well-being mental health domain.

As future work we consider the following ideas: Our proposed work can be applied as a smart infotainment system to improve psychological skills in any context. The use of machine-learning algorithms combining reasoning and logic generated in the feedback model can be explored to complement the knowledge base of the students profile for the MyUBot reasoning. Finally, we propose to consider alternative logic programming semantics as well as extension-based argumentation semantics following ideas from [24, 9].

[6] In this work, we do not have enough space to formalize this problem and the solution.

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