Towards a Model of Empathic Pedagogical Agent for Educating Children and Teenagers on Good Practices in the Use of Social Networks

Joaquín Taverner[a], Emilio Vivancos[b] and Vicente Botti[c]

Valencian Research Institute for Artificial Intelligence (VRAIN). Universitat Politècnica de València, Valencia, Spain

Abstract: Social networks have been a revolution for our society. The rapid expansion of these networks results in more and more children and teenagers using them regularly. However, despite the fact that most social networks have privacy control systems, most young people do not use these controls because teenagers are usually unaware of the privacy risks that exist in the Internet. This inadequate use of social media can lead to different social problems such as cyber-bullying, grooming, or sexting. The best way to prevent these risks is through education. In this paper we propose an empathic pedagogical agent model for education on good practices in the use of social networks. The agent interacts empathetically with users through the social network. The user's emotion is recognized through a camera and is processed in real time to obtain the emotion. The agent analyzes the recognized emotion and the users' actions and looks for the best strategy to advice and educate the teenager in the correct use of the social network.

1 INTRODUCTION

Today's society is increasingly moving towards virtual environments. Video calls, instant messaging, and social networks have transformed the way we communicate and relate to others. The incorporation of these new technologies into our daily lives, has been accelerated this year by the pandemic produced by COVID-19. People find several advantages such as instant communication, the search for lost old friends, the improvement of the prospects of finding a job, or the communication in times of confinement. The democratisation of the use of the Internet is resulting in more and more children and teenagers using them. In fact, today the young people are the biggest consumers of technology and social networks (García-Peñalvo and Kearney, 2016). However, young people are often not aware of the privacy risk they are exposed to when using the Web (Alemany et al., 2019). An inappropriate use of social networks can have negative personal, professional, and emotional consequences (Machimbarrena et al., 2018). These consequences are aggravated when they occur in children and teenagers, as they do not have sufficient emotional capacity to deal with certain situations that may arise from the inappropriate use of

social networks. Therefore, for a social transition towards virtualised environments to be effective, it is necessary to design educational models focused on teaching the correct use of the Internet. An appropriate use of the web can turn it into a pedagogical tool that allows a great dissemination of knowledge (Karal et al., 2017). Artificial intelligence can help in this educational task through the use of intelligent agents acting as tutors in the use of social networks. Intelligent agents have already been used in education with good results (Obaid et al., 2018; Serholt and Barendregt, 2016). In particular, agents with empathic abilities, capable of recognising and showing emotions, have been successfully used in educational tasks by increasing the sociability and participation of young people (Rodrigues et al., 2015). Furthermore, empathic intelligent agents are perceived as much more reliable than traditional agents by children and teenagers. This advantage makes empathic agents more suitable for tutoring (Paiva et al., 2017). In this paper we propose a model of empathic pedagogical agent to be used as a tutor to train young people in the correct use of a social network.

The rest of this paper is organized as follow. In section 2, we discuss the problem of privacy risk in the Internet and the most important proposals regarding pedagogy with agents and education in the use of social networks. Section 3 introduces a empathetic pedagogical agent model for education on social networks. The agent will interact with students in an af-

[a] https://orcid.org/0000-0002-5163-5335
[b] https://orcid.org/0000-0002-0213-0234
[c] https://orcid.org/0000-0002-6507-2756

fective way by recognizing and expressing emotions. Finally, the main conclusions and future works are presented in Section 4.

2 RELATED WORK

Social networks have revolutionised various aspects of society. They have not only transformed the way we communicate and relate to others, but have also affected other aspects such as politics, business, culture, or the way we perceive reality. Social networks also allow us to meet new people and share our ideas. However, not everything is an advantage in social networks. These networks have become a perfect medium for the dissemination of fake news and disinformation campaigns. Fake news try to give a biased view of many events in order to manipulate people's opinion.

Given the high level of social exposure to which users of social networks are subjected, there is a risk of losing privacy. In addition, an inappropriate comment or an unfortunate photo can harm our personal image and damage us socially and emotionally. In fact, the privacy risk has become one of the main concerns of users of this type of network (Alemany et al., 2019). Currently, most social networks have privacy management systems that allow users to control the audience of their publication. However, these systems are often ignored by users, both because they are not aware of the potential risks of exposure of a specific publication and because users are not concerned about privacy. This fact is further aggravated when young people are involved since they do not have sufficient social and emotional skills to deal with certain situations that may arise when using social networks (Micheli, 2016).

Nowadays, the younger population is becoming the main users of social networks. The European General Data Protection Regulation (GDPR) (Jasmontaite and De Hert, 2015) allows young people over 16 to transfer their personal data to be processed by social network providers without the consent or the authorization of the parental responsibility holder. In addition, this regulation allows EU members to reduce this age to 13 years. Consequently, children and teenagers spend several hours a day using their smartphones. During this time, they receive hundreds of advertisements and messages that, frequently are hoaxes and fake news. This misinformation is often spread to create a negative view of everything that is different: religious belief, political ideas, sexual tendency, immigrants, people with disabilities,... This misinterpretation and manipulation of real events can

affect the emotional development of teenagers and children, because they have less critical thinking and tools to analyse and protect themselves of fake news. Moreover, during pandemic confinement, young people have spent many hours connected to the Internet, often without parental supervision (Gómez-Galán et al., 2020). How can they filter all the messages that receive? Ballesteros and Pizaco (Ballesteros and Picazo, 2018) estimated that only 22% of teenagers between 14 and 16 years old have received training on how to filter the information they find on the Internet.

On the other hand, many young people use social networks as a social showcase in which they look for group acceptance: the greater the number of followers and friends, the better their perception of their status on the social network. However, most young people do not know how to handle their privacy in social network environments (Silva et al., 2017). Therefore, when making a publication they do not consider the risk that sharing this information may suppose. This is because they do not have the necessary skills to determine what kind of information poses a risk when disseminating it. This level of public exhibition can have negative consequences. Recent studies show that the abusive and inappropriate use of social networks can lead to negative effects such as addiction, cyberbullying, grooming, sexting, and paradoxically, social isolation (Machimbarrena et al., 2018; Primack et al., 2019).

2.1 Pesedia: A Pedagogical Social Network

In recent years, some proposals for assessing privacy on social networks have been made (Acquisti et al., 2017; Alemany et al., 2020; Botti-Cebriá et al., 2020). Most of these proposals involve the definition of metrics and mechanisms to improve trust and avoid the vulnerability of privacy in social networks (Ruiz-Dolz et al., 2019; Taverner et al., 2018b). One of these proposals is found in (Argente et al., 2017) in which *Pesedia*, a social network designed specifically to educate in the correct use of social networks, is presented. *Pesedia* offers an interface that is very similar to the interfaces of current social networks like Facebook. Young people have their own wall where they can create and share publications. They can also send private messages or establish groups. The network also allows to establish friendship relationships and trust levels in order to teach the appropriate privacy measures by providing the appropriate level of privacy for the publications. *Pesedia* allows the addition of plugins to increase its functionality. For example, in (Alemany et al., 2019) two mechanisms were

included to assist in the decision-making process of selecting the privacy level of a publication. The aim of these mechanisms was to alert users about the visibility of publications in order to make them aware of the privacy risk involved when posting. These mechanisms were based on the model of soft-paternalism, in which specific interventions are made in the actions performed by the student without affecting his/her freedom of choice.

2.2 Pedagogical Intelligent Agents

While the establishment of metrics and mechanisms has proven to be effective in educating about good practices in social networks, they lack the interactive experience that an intelligent agent can offer. Intelligent agents are capable of reasoning and reacting proactively to a perceived change in the environment. Therefore, they are able to interact with the user by reacting to his/her actions. Intelligent agents have been used in recent years to perform tutoring tasks in educational environments improving the motivation, socialization, understanding, and attitudes of students (Rodrigues et al., 2015). For example, an educational pedagogical agent model for tutoring children on the autism spectrum is proposed in (Grawemeyer et al., 2012). Similarly, in (Barrón-Estrada et al., 2012) an educational pedagogical agent model for helping in homework is presented. That agent was developed to operate in a social network in which students perform their homework while participating in a common social experience.

Many proposals made in the field of affective computing focus on the study of empathy as a mechanism to improve the human-machine interaction (Paiva et al., 2017). Empathy is a construct used in different domains such as ethology, philosophy, psychology, or neuroscience to explain different social behaviours. These behaviours are generally focused on the ability to understand and share emotions, moods, and mental states of others, as well as the behaviours derived from this understanding, such as prosocial behaviour or altruism (Cuff et al., 2016; Stueber, 2013). Empathy encourages the development of emotional bonds, allowing human beings to constitute themselves as social and moral beings (Kauppinen, 2014). In fact, recent neuroscientific studies relate some social disorders, such as autism spectrum disorder or psychopathy, with a deficit in the brain areas involved in empathic processes (Blair, 2008). One of the most recurrent definitions of empathy is the one proposed by M. L. Hoffman (Hoffman, 2001), in which empathy is defined as a psychological process that makes a person have feelings more simi-

lar or congruent with the other person's situation than with his/her own situation. Therefore, it is not necessary for empathic responses to be identical or approximate to the mood of the other, but according to Hoffman any emotional reaction compatible with the mood of the other can be considered empathy. According to Hoffman's definition, to simulate the processes inherent within empathy, software agents must be able to perceive and recognize emotions or moods and react accordingly by simulating a behavior appropriated to the perceived emotion or mood.

The area of artificial intelligence has evolved by developing models of agents with different affective and empathic abilities (Alfonso et al., 2015; Alfonso et al., 2017; Taverner et al., 2018a; Yalçın, 2020). Most of these models use a dimensional representation for emotions and mood (Taverner et al., 2020). One of the most widely used dimensional representation is the *Circumplex Model of Affect* that uses two dimensions to represent emotions: pleasure and arousal (Russell, 1980). The use of this dimensional model allows the representation and simulation of affective processes such as emotion elicitation, emotional contagion, or empathy.

Empathic agents have been used in different contexts and have proved to be more reliable and more credible, thus reducing the stress and frustration of human users and improving human-machine interaction (Paiva et al., 2017). The development of agents with empathy has also been useful in the educational field. For example, the research performed in (Rodrigues et al., 2015) used empathic agents to prevent bullying. In this experiment it was found that agents with empathic skills increased the sociability and involvement of young users. The participants played a game in which the agents recognized and showed emotions. During the game, a series of social situations were presented in which an agent was bullied by other agents with the intention of driving the students' behaviour through empathy. Empathic agents have also been used for tutoring in educational environments. For example, in (Obaid et al., 2018) a robot tutor with empathic skills was proposed. The study showed that the empathic agent improved the predisposition of young people to participate in learning experiences. In the same way, in (Serholt and Barendregt, 2016) a model of a robot tutor with empathy is presented. This model is able to recognize children's emotions and interact with them through a touch screen. The results of experiments show that the empathic robot tutor was able to elicit and maintain the social engagement of the students.

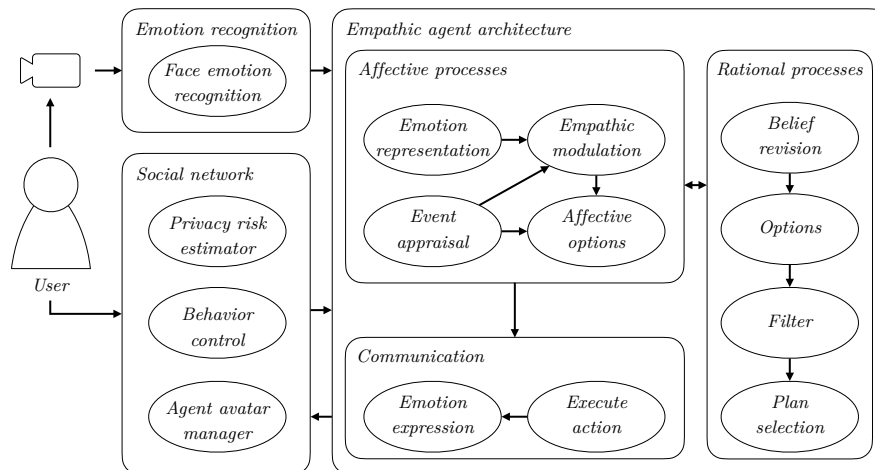Considering the promising results of previous works, where was shown that empathy increases trust

Figure 1: The proposed model for a empathic pedagogical agent in a social network.

and engagement, we propose to employ an empathic agent to increase the efficiency of the learning process of young people in the correct use of social networks.

3 PROPOSAL

As mentioned in the previous sections, irresponsible use of social networks can compromise the user's privacy. Therefore, it is necessary to develop tools that allow young users to understand the risks to which they are exposed and to learn good practices in the use of social networks with the aim of maintaining their privacy. In this paper we present an educational pedagogical agent model with empathetic abilities. Our agent interacts with the user through the social network. The agent will monitor the user's actions on the network to analyse his/her behaviour. When the user prepares a publication, the agent analyses the privacy risk associated with the publication and recommends the best strategy for avoiding privacy risks. Following a soft-paternalism strategy, the user will be free to decide how to carry out the publication. Once the publication has been made, the agent will react according to whether the user has followed its advice or not.

In order to improve the interaction with the user, the agent must have certain social and emotional capacities to react with an appropriate behaviour. One of the best approaches to generating this social behaviour is through agents that simulate empathy. Our proposed agent uses empathy as a tool to build trust with the user improving its educational task. Through empathy, our agent is able to react appropriately according to the emotion or mood of its young interlocutor. Following the definition of empathy proposed by

Hoffman, our agent will be able to recognize the emotion in the teenager and to produce a behavior according to that emotion. The model that we propose in this paper uses a real-time facial emotion recognition system. Once the emotion is recognised, the agent represents the emotion internally using a multidimensional representation model (Taverner et al., 2020) and generates an empathic response in accordance with the perceived emotion. In addition, the agent will have a proactive emotional behaviour depending on the actions performed by the user in the social network.

Figure 1 shows the model for the interaction between the young user and the agent in the social network. The framework proposed in this work consists of three main components: the social network based on *Pesedia*, the emotion recognition system, and the empathic intelligent agent.

3.1 Pesedia

Our proposed framework uses three plugins of the *Pesedia* social network: the *privacy risk estimator*, the *behavior control*, and the *agent avatar manager*. On the one hand, the *privacy risk estimator* is responsible for estimating the potential audience for a publication. This estimation is obtained by measuring the number of potential users that can access to the publication according to the degree of privacy that the user has selected (Alemany et al., 2018). On the other hand, the *behavior control* is used to capture the interactions that the user makes within the social network, for example, when pushing a "like" button or when posting an item. Finally, the *agent avatar manager* displays the agent's facial expressions and messages on the social network window. Figure 2 shows a screenshot of *Pesedia* with the agent avatar inter-

face on the right. When the young user makes a comment, the privacy risk estimator warns the user of the risk involved in such publication. In the example in Figure 2, the user has provided a location that could lead to a high privacy risk. The agent warns the user that the publication has a high risk and recommends to modify the audience. The final decision belongs to the user: the teenager can continue with the publication or modify the audience. Depending on his/her decision, the agent will adapt its behaviour by using different messages and emotional expressions.

3.2 The Emotion Recognition System

The emotion recognition system consists of a video camera and a classifier based on convolutional neural networks that is locally installed in the device used by the teenager. This system captures the image in real-time and through a cascade classifier (Sharifara et al., 2014) obtains the position of the user's face. Then the face image is sent to a convolutional neural network installed in the computer used by the user. This convolutional neural network obtains the most likely emotion according to the user's facial expression (Fuentes et al., 2020). To avoid micro-expressions the system performs a controlled analysis using a multiple frame analysis. It is important to remark that the empathic agent can only be as good as the accuracy of the recognised emotion.

3.3 Empathic Intelligent Agent

Experts recommend improving the critical thinking of young people. This process involves detecting and analysing all the messages and information that the teenager receives, but frequently young people navigate the Internet without the supervision of any adult. In this kind of scenarios, an intelligent agent supervising all the teenager's activity on the Internet can provide the advice and emotional support that absent adults cannot give. Our proposal of architecture for this intelligent agent is composed of three modules: the *rational processes* module, the *affective processes* module, and the *communication* module.

Intelligent agents must be able to reason and establish plans. In our proposal the *rational processes* module is based on the BDI architecture model. A BDI agent is composed of a set of beliefs, desires, and intentions. The beliefs represent the information that the agent has about the state of the environment in which it is located, in this case the social network. The desires are objectives that the agent wants to achieve. In our model, the objectives are a set of pedagogical actions such as persuading the user to

change the privacy of a message. Finally, the intentions are the objectives that the agent selects to execute them.

The *affective processes* module is composed of four processes: the *appraisal* process, the *emotion representation* process, the *empathic modulation* process, and the *selection of affective options* process. The *appraisal process* appraises any action of the young users and determines the emotion. Appraisal theories hold that when a stimulus is procured, a set of processes are triggered to evaluate that stimulus (Taverner et al., 2020). As a result of these processes an emotion is generated. In our model, when the agent perceives an action of the user in the social network, the agent evaluates this action according to its beliefs and its desires and, as result, an emotion is triggered. This emotion is represented in a two dimensional space based on the dimensions of pleasure and arousal by the *emotion representation* process. Then, the *empathic modulation* process uses the dimensional representation to approximate the emotion elicited by the appraisal process to the emotion recognized in the user's face. As a result of this process, an empathic emotion that will be more in line with the user's emotional state is generated. Finally, this empathic emotion is used by the *selection of affective options* process to identify the applicable plans.

The last component is the *communication module*. This component is responsible for transmitting the actions that must be performed to the agent event manager. It is composed of two processes: the *execute action process* and the *emotion expression process*. The first one is in charge of executing the plans that have been selected by the plan selection process from the plans generated in the affective options and the filter processes. These plans may contain educational actions, privacy recommendations, or affective expressions. Finally, the emotion-expression process selects the facial expression that the agent must show, and sends it to the agent avatar manager (see Fig 2).

4 CONCLUSIONS AND FUTURE WORK

Today, social networks are an essential part of many young people's lives. However, using social networks without the necessary skills represents a privacy risk. The best tool to fight the privacy risk is education. In this work we have proposed a model of a pedagogical empathic agent for education in the use of social networks. The agent interacts with young users warning them about privacy when a publication is made. The agent interacts with the user through the social net-
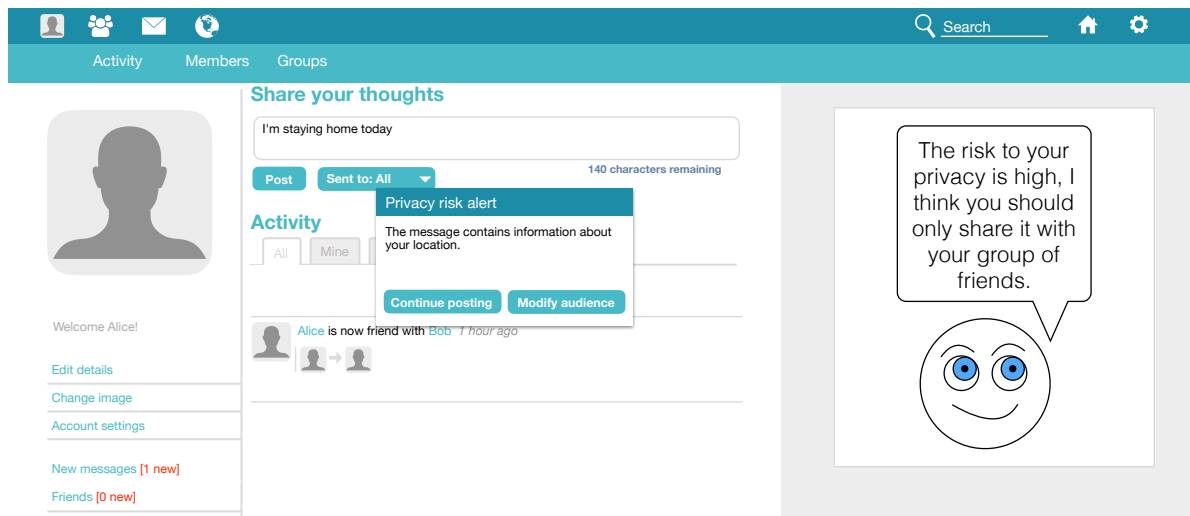
Figure 2: Screenshot of the *Pesedia* social network with the agent avatar interface on the right side.

work. To make this interaction as natural as possible we have proposed the use of empathy that has been used before in teaching tasks obtaining good results.

Our empathic pedagogical agent model will be tested on *Pesedia* social network to determine if it improves the perception of the risk of privacy of young people. Further experiments will be performed to test whether the agent is able to provide young people with the necessary skills to manage privacy risk in social networks.

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