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Innovation in Medicine and Healthcare Systems, and Multimedia

Proceedings of KES-InMed-19 and KES-IIMSS-19 Conferences

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Country	Germany - SIR Ranking of Germany
Subject Area and Category	Computer Science Computer Science (miscellaneous) Decision Sciences Decision Sciences (miscellaneous)
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Publication type	Book Series
ISSN	21903018
Coverage	2010-ongoing

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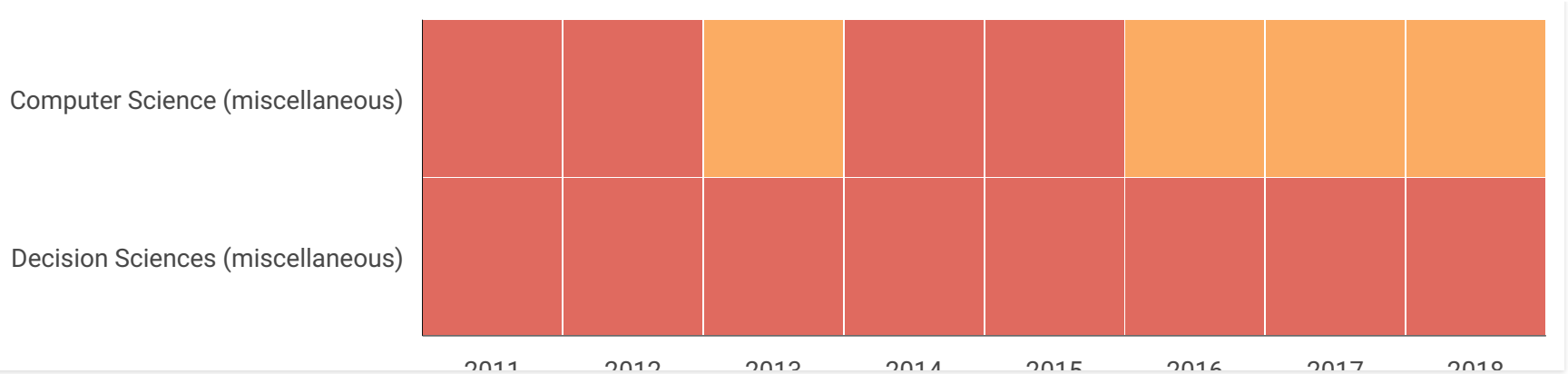

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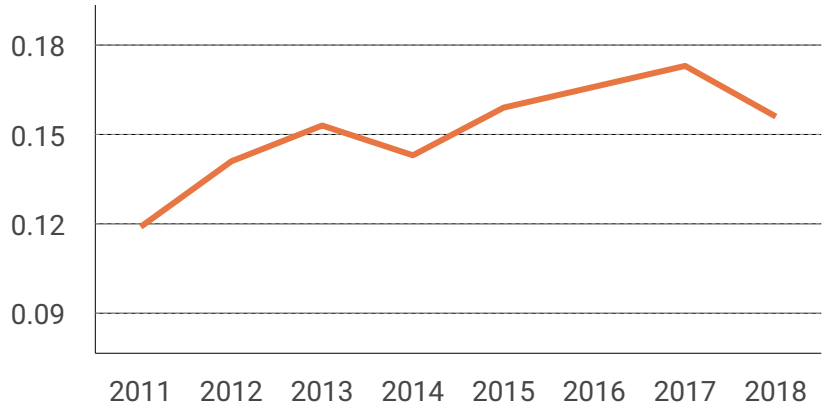

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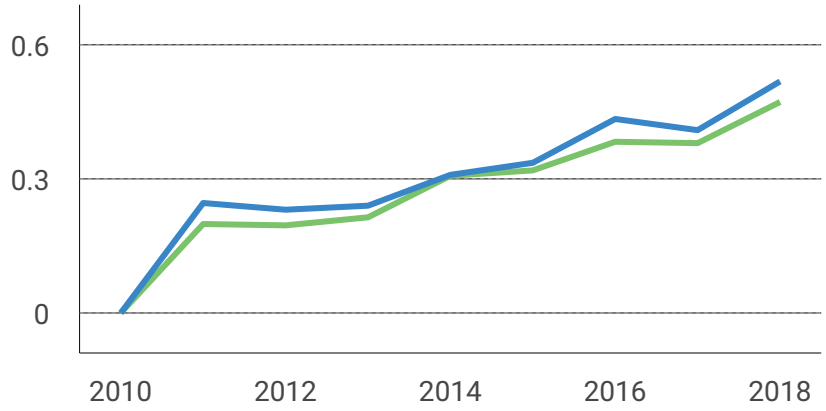

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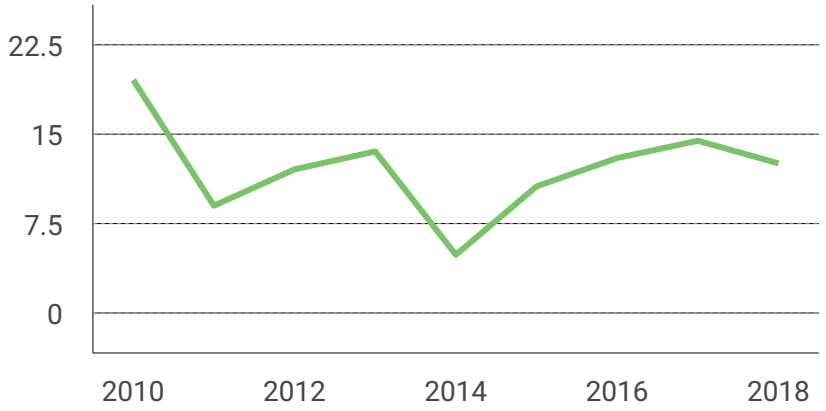

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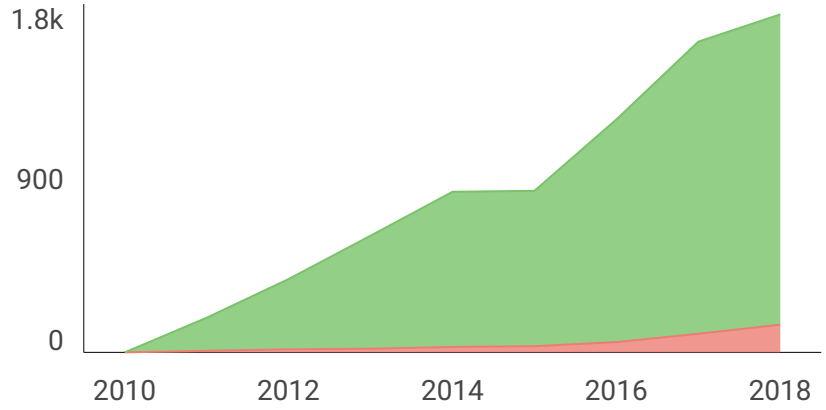

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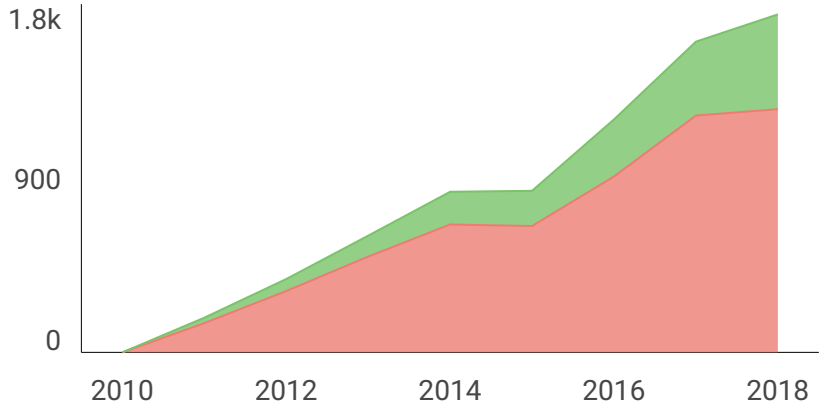

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ISSN 2190-3018 ISSN 2190-3026 (electronic)
Smart Innovation, Systems and Technologies
ISBN 978-981-13-8565-0 ISBN 978-981-13-8566-7 (eBook)
https://doi.org/10.1007/978-981-13-8566-7

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The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

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Formalization of the Agent-Based Model for the Detection of Behavior Patterns in Older Adults Who Start Using ICT

Consuelo Salgado Soto, Ricardo Rosales Cisneros, Nora del Carmen Osuna Millan and Maricela Sevilla Caro

Abstract The purpose of this article is to present the formalization of the agent-based model, which will detect the patterns that shape the behavior of older adults influenced by the use of new information and communication technologies. This model aims to achieve the identification of possible risk factors that adults can present, to minimize them and to increase the protective factors that allow mental activation and active aging through the correlation between energy and motivation. In addition, the model could help create behavioral simulations that could be presented by adults through the four agents contemplated: adult agent, detection agent, content agent, and agent activity, and after formalization, similar capabilities will be imitated human beings that can have as beliefs, desires, and intentions and that will allow them to communicate and interact with the exchange of information to allow guide the behavior of adults and active and physical health and positive mental health.

Keywords Agent-based model · Protective and risk factors · Mental activation

1 Introduction

If we analyze in detail all the technology that surrounds us, we can conclude that artificial intelligence is present in most of it. Gradually, these smart technologies are forcing people and organizations to interact with them to the point that they become

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Y.-W. Chen et al. (eds.), *Innovation in Medicine and Healthcare Systems, and Multimedia*, Smart Innovation, Systems and Technologies 145,
https://doi.org/10.1007/978-981-13-8566-7_23

a necessity to be adopted. The progress in this area is so great that the health area has become the center for the development of systems that support the activities of diagnosis of diseases, patient monitoring, among others.

Mental health should also be considered in this area for its study, especially that of a sector of the population that is affected positively or negatively by technology and major advances, we refer to that of the elderly. By using the benefits offered by artificial intelligence and a simulated environment, you can identify possible risk factors to minimize them and increase the protective factors that allow mental activation and active aging.

In the proposal of the model based on agents for the detection of patterns in older adults who start with the use of information and communication technologies, the objective was to find solutions that allow the detection of an action based on certain rules and parameters to achieve the prediction of their behavior.

This model contains the interactions between the agents, the knowledge base, the database, and the constant feedback of the state of the environment to allow guiding the behavior of the elderly. With the future development, the attitudes and the possible risk factors will be identified to minimize them and the protection factors that allow the physical and mental activation derived from the correlation between energy and motivation will be increased, guiding the behavior of the older adult toward a better integration with society, an improvement in health.

The update through the courses, in this case, designed for older adults, allow the participants to know the information and communication technologies, besides focusing on establishing a communication link with the current society and allowing mental activation and the increase of a positive attitude.

1.1 Older Adult

During the normal aging process, learning speed, and memory decrease; it is a deterioration that can be caused by disuse, disease, behavioral factors, psychological factors, and social factors, rather than by aging itself [1].

Technological advances have caused a radical change in the forms of production, dissemination, and acquisition of knowledge [2] even, the forms of communication have changed influenced by these advances and they are part of the social environment that surrounds older adults and that has changed aggressively in recent decades.

There are studies that reveal that a large percentage of this population needs help to carry out processes that were born to simplify and not complicate, and in the absence of someone to support them, are isolated by society [3] may be affected in terms of physical and mental health.

Some of the characteristics that generate greater vulnerability in individuals, being potentially influential and/or favorable to provoke a behavior, are called risk factors; on the other hand, there are characteristics that counteract the effects of risk factors, discouraging or preventing the appearance of problems, which have been called protection factors [4]. For the model, social isolation, fear, passivity, depression, low

self-esteem, and cognitive deterioration is seen as risk factors. Protective factors that can support the change in the physical and mental health of older people include motivation, better communication, greater social contact, mental activation, sense of belonging, and feeling useful.

1.2 Modeling Based on Agents

Modeling and simulation are known as artificial societies or agent-based modeling such as [5, 6]. From the point of view of the sciences of complexity, focuses on addressing the emergence of properties from the interaction between a wide number of agents [5] where most of the advances of these systems are focused in mathematics and computing. The agent-based models belong to a movement of social simulation, which constitutes an artificial society [7] and is composed of autonomous decision-making entities, known as agents [8], which act self-sufficiency in their environment to comply with the objectives of its design [9].

Agent-based models are identified by their autonomy, independence, obey, or follow simple rules, and they are adaptive [10]. In the health scenario, these models can have different roles to improve the physical and mental state of patients [11], due to their ability to react to situations detected in their environment.

1.3 Capabilities of the Agents

The use of agents has increased remarkably to give solution or attention to complex situations; these agents must be designed in such a way that they can choose what to do and execute what they decide. This decision is made through the capacities of beliefs, goals, and intentions to achieve the goal, which enriches the agent-based model so that commitments can be assumed to achieve the objectives, that is, that the appropriate guidelines to address the reasoned behavior that identifies and recognizes in other agents [12].

2 Related Works

The field of application of systems based on agents is very broad and tends to grow more, given their interest to simulate and model environments and patterns that allow searches, generate new knowledge, and define new patterns.

An example of the above is the case in which the complexity of people with multimorbid mental and physical health problems is modeled in a social context, where those characteristics, among others, prevent the complete integration of a person socially.

This area of artificial intelligence was applied to explore the underlying mechanisms that explain the medical/surgical outcomes of the hospital for individuals with mental and physical illnesses [13]. Other examples of agent-based simulation focused on mental health where the introduction of coordination capabilities of care in a complex system of care for patients with severe and persistent mental illness was modeled. This model describes the commitment between patients and medical, social, and criminal justice services with those who interact in the care ecosystem and provide preliminary results of the application of the simulation [14].

3 Case Study

This project focuses on the older adult who is in a social environment that has changed aggressively in recent decades. This environment has been influenced by technological advances that have caused a radical change in the forms of production, dissemination, communication, and acquisition of knowledge [2]. In addition, they need help to carry out processes that were born in order to simplify and not complicate; in the absence of someone to support them they are isolated in society [3], so they can be affected by various factors that impair physical and mental health.

With this project, we want to simulate a school environment through a model based on agents that allows supporting motivation, communication and a better adaptation of older adults to new technologies and the current digital society.

The school environment is based on the elderly who attend a course directed to them, where the activities are focused on knowing the information and communication technologies, the general concepts of computing, practicing with different Windows accessories, using the internet to make inquiries and communicate through email.

4 Modeling the Pattern of Behavior in Older Adults

Represent the real world through a model, simulate an artificial environment based on rules to obtain results and define actions, and in this case, through modeling and simulation of a school environment is intended to achieve the detection of behavior patterns in older adults to detect risk factors and protective factors.

4.1 Formalization of the Agents of the Model

The formalization of the agent model allows understanding its properties and its behavior. The agents of this model simulate reasoning in a similar way to a human through the inclusion of the elements beliefs, desires, and intentions.

In the context of older adults in the classroom, the proposed model is composed of four agents, where the general formalization of agents is represented on their capacities as follows:

AdultAgent (AdAg) represents the Elderly, who has different attitudes identified as protective factors and risk factors, required to determine the action to be followed. The BDI elements that represent AdAg are the following:

- Beliefs (α): they are represented by the finite set to learn new technologies to adapt in the current digital society.
- Desires (β): they are represented by the finite set of enroll in courses of new technologies.
- Intentions (χ): they are represented by the finite set of intentions to receive the appropriate content of the course.

Then, the definition of the agent ActivityAgent as a tuple of three elements is as follows:

$$\boldsymbol{\omega} =< \alpha, \beta, \chi > \tag{1}$$

DetectorAgent, (DeAg) this expert agent personifies the Instructor, whose activity consists of detecting the risk factors and protective factors to assign the appropriate content, generating the one that will be stored in their knowledge base. The BDI elements that represent DeAg are the following:

- Beliefs (δ): they are represented by the finite set of detection of risk factors and protective factors in AdAg.
- Desires (ε): they are represented by the search for the appropriate content or activities based on the beliefs of AdAg.
- Intentions (ϕ): they are represented by the analysis made in the knowledge base to search for the best content and activities or to request CAAg content or AcAg appropriate activities to positively activate your mental health DeAg.

Then, the definition of the agent DetectorAgent Agent as a tuple of three elements is as follows:

$$\boldsymbol{\Xi} =< \delta, \varepsilon, \phi > \tag{2}$$

ContentActivitiesAgent, (CaAg), represents the Content and Activities agent that is responsible for receiving the content request, and performs the search in the content and activities database to deliver it to the DetectorAgent. The BDI elements that represent CaAg are the following:

- Beliefs (γ): they are represented by the finite set of DeAg content requests.
- Desires (η): they are represented by the finite set of searches of the appropriate content.
- Intentions (ι): they are represented by the analysis in the content database to find the best content.

Then, the definition of the agent ContentActivitiesAgent as a tuple of three elements is as follows:

$$\boldsymbol{\xi} =< \boldsymbol{\gamma}, \boldsymbol{\eta}, \boldsymbol{\iota} > \tag{3}$$

ActivityAgent (AcAg), receives is responsible for obtaining the requests and sending them to ContentActivitiesAgent, also, of these continually verifying the status of the environment. The BDI elements that represented AcAg are the following:

- Beliefs (φ): they are represented by the finite set of CAAg activity requests.
- Desires (κ): they are represented by the finite set of searches of the appropriate activities are represented.
- Intentions (λ): they are represented by the analysis in the database of activities to find the best activity.

Then, the definition of the agent ActivityAgent as a tuple of three elements is as follows:

$$\boldsymbol{\zeta} =< \boldsymbol{0}, \boldsymbol{\kappa}, \boldsymbol{\lambda} > \tag{4}$$

In this model, with the formalization, it is described that from the detection of behavior patterns of older adults, who have been influenced by the use of ICT, an action will be taken through the agents.

5 Conclusions

An agent-based model where an artificial environment is modeled and simulated can be a tool for predicting, achieving learning and constant feedback; and so find solutions through the detection of an action based on rules and parameters to achieve the prediction of certain behavior.

The proposed agent-based model formalized the agents that act in the school environment, and is based on the capacities they can have as beliefs, desires, and intentions and that will allow them to communicate and interact between the agents to allow them to guide the behavior of the elderly and activate positive physical and mental health.

With the formalization of the agent-based model to detect patterns of behavior and provide effective solutions based on the behavior of older adults who begin to use information technologies, the aim is to identify attitudes, behaviors, and possible risk factors to minimize them. Increase the protection that allows physical and mental activation derived from the correlation between energy and motivation, guiding the behavior of the elderly to achieve the best integration with society.

6 Future Works

Future work will focus on implementing the knowledge base based on fuzzy logic and define the rules of fuzzy inference, and be programmed in such a way that they represent older adults to throw the best activities and contents that allow adapting to the new society simulated in the agent-based model.

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