**Using Shared Mental Models and Organisational Learning to Support Safety and Security through Cyberspace: a Computational Analysis Approach**

Peter H.M.P. Roelofsma, Fakhra Jabeen, H. Rob Taal, Jan Treur (eds.)

**Part I**

**Introductory Chapters**

In this part, first an introduction chapter for the book as a whole is provided and next chapters for a global overview of the resaerch programme and results obtained.

1. Peter H.M.P. Roelofsma, Fakhra Jabeen, Rob H. Taal, Jan Treur

Introduction to the book

1. Peter H.M.P. Roelofsma, …

Overview of the research programme

1. Fakhra Jabeen, ….

Overview paper Safety Coach

**Abstract:** Ensuring patient healthcare and safety necessitates effective teamwork and collaboration, rooted in the concept of shared mental understanding or shared mental models. Different personal and professional factors among team members may influence patient diagnosis and decision-making, which can have long-lasting impact(s) on the patient (mental) wellbeing. Our work introduces the innovative concept of an Artificially Intelligent (AI) Coach, designed to enhance the shared understanding and communication among team members, to reduce the error expectancy in different medical fields (e.g., neonatology). This virtual assistant aims to cater the error related causes or factors for monitoring, so a related support can be provided to minimize these errors. The coach encompasses computational logic regarding user tasks and mental models, offering monitoring and communication to accomplish its task.

**Part II**

**Basics for the Area: Shared Mental Models, Organisational Learning, and Adaptive Network Modeling**

In this part, the basic concepts used throughout the book are explained concerning the use of shared mental models in teamwork to support safety and security, organisational learning to support ther use of shared mental models, and adaptive network modeling to model and analyse these processes computationally.

1. Laila van Ments, Jan Treur, Jan Klein, Peter H.M.P. Roelofsma

A Second-Order Adaptive Network Model for Shared Mental Models in Hospital Teamwork

Proc. of the 13th International Conference on Computational Collective Intelligence, ICCCI'21. Nguyen, N.T., et al. (eds.)Volume: Lecture Notes in AI, vol. 12876, pp. 126-140, Springer Nature.

**Abstract**. This chapter describes a second-order adaptive network model for mental processes making use of shared mental models for team performance. The chapter illustrates the value of adequate shared mental models for safe and efficient team performance and in cases of imperfections of such shared team models how this complicates the team performance. It is illustrated for a context of a medical team performing a tracheal intubation. Simulations illustrate how the adaptive network model is able to address the type of complications that can occur in realistic scenarios.

1. Gülay Canbaloğlu, Jan Treur, Peter H.M.P. Roelofsma

An Adaptive Self-Modeling Network Model for Multilevel Organizational Learning

In: Proceedings of the Seventh International Congress on Information and Communication Technology, ICICT 2022, Volume 2. Lecture Notes in Networks and Systems, vol 448, pp. 179-191. Springer Nature.

**Abstract.** Multilevel organizational learning concerns an interplay of different types of learning at individual, team, and organizational levels. These processes use complex dynamic and adaptive mechanisms. A second-order adaptive network model for this is introduced here and illustrated.

**Part III**

**Supporting Safety and Security in Medical Teamwork in the Neonatal Domain through Cyberspace**

This part focuses in particular on the use of shared mental models and organisational learning for medical teamwork in the neonatal domain and an AI Coach in cyberspace to support safety and security.

1. Yida Xu, Fakhra Jabeen, Jan Treur, H. Rob Taal, Peter H.M.P. Roelofsma

Adaptive Agent Network Models with Internal Mental Models Supporting Patient Safety

Proc. of the 15th International Conference on Social Computing and Networking, SocialCom'22. IEEE Computer Society Press (2022)

**Abstract.** In this chapter, it is shown how second-order adaptive agent-based network models can be used to model a medical team supported by a virtual AI Coach. It is illustrated for the case of a newborn baby in danger. The design of these computational agent models is based on an adaptive self-modeling network modeling approach. It also addresses how the AI Coach can play a central role in organizational learning. The agent models enable representations and processing of all actors' internal mental models and internal simulation of these mental models, adaptive changes of these mental models (learning and forgetting), and the interaction between the actors and the world.

1. Nisrine Mokadem, Fakhra Jabeen, Jan Treur, H. Rob Taal, Peter H.M.P. Roelofsma

An Adaptive Network Model for AI-Assisted Monitoring and Management of Neonatal Respiratory Distress

Proc. of the 14th International Conference on Brain-Inspired Cognitive Architectures for Artificial Intelligence, BICA\*AI'23 (2023)

**Abstract.** This chapter presents the use of second-order adaptive network models of hospital teams consisting of doctors and nurses, interacting together. A variety of scenarios are modelled and simulated, in relation with respiratory distress of a neonate, along with the integration of an AI-Coach for monitoring and support of such teams and of organizational learning. The research highlights the benefits of introducing a virtual AI-Coach in a hospital setting. The practical application setting revolves around a medical team responsible for managing neonates with respiratory distress. In this setting an AI-Coach act as an additional team member, to ensure correct execution of medical procedure. Through simulation experiments, the adaptive network models demonstrate the progression of the scenarios and highlight how the diverse challenges that may arise throughout the processes are handled.

1. Raghav Chawla, Fakhra Jabeen, Jan Treur, H. Rob Taal, Peter H.M.P. Roelofsma

An Adaptive Network Model Simulating the Effects of an AI Coach on Supporting Safety In Hospitals Through Inducing Adherence to Guidelines In Neonatal Medical Protocols (2023)

**Abstract.** In this chapter, it is shown how second-order adaptive agent-based network models can be used to support a medical team in healthcare institutions to adhere to specific neonatal hypoglycemia and neonatal hyperbilirubinemia treatment guidelines through the integration of an Artificial Intelligence (AI) Virtual Coach. The proposed AI Coach is designed to provide timely interventions and correct deviations when lapses in the health care practitioner’s internal mental states occur. Through simulating three different scenarios, the internal dynamics of these mental models, adaptive changes of these mental models (learning and forgetting),

and the interaction between health care practitioners and the world is shown when; (1) There is perfect adherence to guidelines, (2) There is imperfect adherence to guidelines and (3) There is imperfect adherence to guidelines with the intervention of the AI coach.

1. chapter Yassine (2023)

**Part IV**

**Supporting Safety and Security for Communication with Patients and Colleagues through Cyberspace**

The focus of this part is in particular on the use of an AI Coach in cyberspace to support safety and security in the neotal domain concerning communication between colleagues and with patients.

1. Linn Weigl, Fakhra Jabeen, Jan Treur, H. Rob Taal, Peter H.M.P. Roelofsma

Modelling learning for a better safety culture within an organization using avirtual safety coach: Reducing the risk of postpartum depression viaimproved communication with parents

Cognitive Systems Research 80, 1-36 (2023)

**Abstract.** This chapter describes an extension of a safety culture within hospital organizations providing more transparency and acknowledgement of all actors, and in particular the parents. It contributes a model architecture to support a hospital to develop such an extended safety culture. It is illustrated for prevention of postpartum depression. Postpartum depression is a commonly known consequence of childbirth for both mothers and fathers. In this research, we computationally analyze the risk factors and lack of support received by fathers. Therefore, we use shared mental models to model the effects of poor and additional communication by healthcare practitioners to mitigate the development of postpartum depression in both the mother and the father. Both individual mental models and shared mental models are considered in the design of the computational model. The chapter illustrates the benefits of simple support in terms of communication during childbirth, which has lasting effects, even outside the hospital. For the impact of additional communication, a Virtual Safety Coach is designed that intervenes when necessary to provide support, i.e., when a health care practitioner doesn’t. Moreover, organizational learning is also modelled to improve the mental models of both the Safety Coach and the Health Care Practitioner.

1. Shaney Doornkamp, Fakhra Jabeen, Jan Treur, H. Rob Taal, Peter H.M.P. Roelofsma

A Controlled Adaptive Computational Network Model of a Virtual Coach Supporting Speaking Up by Healthcare Professionals to Optimise Patient Safety

Cognitive Systems Research 81, 37-49 (2023)

**Abstract.** Previous studies show that a substantial proportion of (near) medical errors in the operating theatre is attributable to ineffective communication between healthcare professionals. Speaking up about observed medical errors is a safety behaviour which promotes effective communication between health care professionals, consequently optimising patient care by reducing medical error risk. Speaking up by healthcare professionals (e.g., nurses, residents) remains difficult to execute in practice despite increasing awareness of its importance. Therefore, this chapter exploreres a computational model concerning the mechanisms known from psychological, observational, and medical literature which underlie the speaking up behaviour of a health care professional. It also addresses how a doctor may respond to the communicated message. Through several scenarios we illustrate what pattern of factors causes a healthcare professional to speak up when witnessing a (near) medical error. We moreover demonstrate how introducing an observant agent can facilitate effective communication and help to ensure patient safety through speaking up when a nurse can not. In conclusion, the current chapter introduces an adaptive computational model which predicts speaking up behaviour from the perspective of the speaker and receiver, with the addition of a virtual coach to further optimise patient safety when a patient could be in harm’s way.

**Part V**

**Organisational Learning for Safety and Security through Cyberspace**

This part addresses in particular the role of mistakes and learning from them and how an organisation-wide strategy can ber followed to support safety and security.

1. Mojgan Hosseini, Jan Treur, Wioleta Kucharska

An Adaptive Network Model for a Double Bias Perspective on Learning from Mistakes within Organizations

**Abstract.** Although making mistakes is a crucial part of learning, it is still often being avoided in companies as it is considered as a shameful incident. This goes hand in hand with a mindset of a boss who dominantly believes that mistakes usually have negative consequences and therefore avoids them by only accepting simple tasks. Thus, there is no mechanism to learn from mistakes. Employees working for and being influenced by such a boss also strongly believe that mistakes usually have negative consequences but in addition they believe that the boss never makes mistakes, it is often believed that only those who never make mistakes can be bosses and hold power. That's the problem, such kinds of bosses do not learn. So, on the one hand, we have bosses who select simple tasks to be always seen as perfect. Therefore, also they believe they should avoid mistakes. On the other hand, there exists a mindset of a boss who is not limited to simple tasks, he/she accepts more complex tasks and therefore in the end has better general performance by learning from mistakes. This then also affects the mindset and actions of employees in the same direction. This chapter exposes the consequences of both attitudes for the organizations.

1. Nick van den Hurk, Jan Treur, Peter H.M.P. Roelofsma

Adaptive Modelling of the Implementation of Environment Health and Safety Standards

Proc. of the 15th International Conference on Social Computing and Networking, SocialCom'22. IEEE Computer Society Press (2022)

**Abstract.** This chapter focusses on using a self-modelling network modeling approach to analyse and predict the behavior of people within organizations, specifically on the implementation of EHS standards. The study focusses on a real-world scenario in which EHS standards are implemented in a multi-level organizational learning scenario. To ensure the health and safety of employees worldwide, the company provides standards for every EHS aspect of activities. The standards are fed by state-of-the-art technologies and science. They require local implementation at every site, also incorporating legislation for the country where it is based. The technique used in this study is dynamic computational modelling wielding the self-modelling network modeling approach. In the base scenario, the organization started with the implementation in a pilot phase. After a while the organization acknowledges it needs to take the lessons learned in the pilot and apply them to all other standards, enabling feed-forward and feedback learning within the organisation. Subsequently five alternative scenarios are described in which the organization is challenged with issues complicating the implementation process. The study shows the possibility of using a self-modelling social network in the execution of EHS activities. It demonstrates the importance of cooperation and open communication between the system owner, EHS expert and department. This is needed tobe able to learn about processes and efficiently safeguard the organization and its members.

**Part VI**

**Results and Discussion**

This part summarizes the obtained results and points out what can be put on a future research agenda.

1. Fakhra Jabeen, …

**Chapter Title:** Designing and Evaluating AI Coach

**Abstract:** In this chapter we explain how the coach interaction was designed using AI Coach System. A graphical interface is provided to input the computational models, which were modelled and simulated in Part II - V . These models encapsulate, how user task(s) can be done through user-coach interaction monitoring the information from the (mental) models of users. During evaluation, our developer study indicates that participants, although having no prior knowledge of complex systems, were able to successfully design the computational models which can be designed for user-coach interaction. Moreover, it was observed that user-coach interaction could be helpful in monitoring different causal factors and its related effects.

1. Peter H.M.P. Roelofsma, Fakhra Jabeen, Rob H. Taal, Jan Treur

Discussion