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Special Issue on Innovative Artificial Intelligence Solutions for Crisis Management

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Special Issue on Innovative Artificial Intelligence Solutions for Crisis Management

In order to respond to disasters and crises, decision-makers have to act quickly, coordinate actions and make decisions that cover large areas affected by a multitude of different factors and aspects. During a crisis, decision makers are working in conditions of “*ill-defined goals and ill-structured tasks, uncertainty, shifting and competing goals, dynamic and continually changing conditions, action-feedback loops (real-time reactions), time stress, high stakes, multiple players, organizational goals and norms*” (Klein et al., 2010). One of the major challenges practitioners face in the preparation for, and response to a crisis is hence to handle complexity and uncertainty. In an increasingly dynamic environment, the traditional paradigms of decision theory are challenged: information stems from heterogeneous sources and actors and is fraught with uncertainty – or might not be available at all; the implications of a decision need to be assessed across organizations and actors with shifting preferences and aims; the time and capacity to collect information and make decisions are limited; those who are accountable for a decision do not necessarily have the expertise and information to make it.

Today, more information than ever before is available, and one of its many promises is the improvement of crisis and disaster management, enabling rapid information sharing and self-organization, or, in more general terms, making the best possible decision at the right time. At the same time, interlaced critical infrastructures and globalized networks have led to cascading and rippling effects that make it difficult to predict the consequences of any intervention. To manage this new complexity, Artificial Intelligence (AI) approaches are indisputably good candidates, as they have already proven successful in other information-intensive, knowledge-critical domains including business, engineering or medicine.

This Special Issue aims to align the latest innovations and case studies with academic standards and theories. It includes the latest research results and efforts at different levels including simulation systems, knowledge-based approaches, risk analysis or operational research models, hoping to stress the role of emerging AI technologies in managing emergency response activities.

Six papers were selected after a strict peer review process (acceptance rate: 24%). All these papers were revised and improved in accordance with the remarks and recommendations from the reviewers. They address topical concepts and applications of AI technologies in crisis management context. Usually, crisis management is divided into four successive phases: mitigation, preparedness, response and recovery. In this issue, the

authors propose valuable contributions regarding the three first ones.

Miguel Ramirez de la Huerga, Victor A. Bañuls Silvera and Murray Turoff have studied the mitigation phase by analyzing complex cascading effects in Operational Risk Management in an industrial environment. Their proposal consists in applying a combination of HAZOP and the Risk Consequence Matrix plus Cross Impact Analysis and Interpretative Structural Modeling methods. Their contribution allows improving the prior knowledge of an organization in terms of Risk Maps, thus offering the possibility of generating predictions that help the organization to be more resilient and to prepare for outliers not covered in standard risk management schemes.

The preparedness phase is clearly the one that inspired most researchers: four papers of the featured issue are dedicated to this phase and propose complementary ways to improve disaster preparedness.

“*Learning from the past*”: In their paper, Stella Moehrle and Wolfgang Raskob propose a case- and scenario-based approach to support the management of nuclear accidents. Their contribution is structured through case-based reasoning techniques for knowledge representation, storage of previous events and scenarios, as well as approaches for retrieval. This work is embedded in a decision support method for nuclear emergencies.

“*People training*”: Jaziar Radianti, Mehdi Ben Lazreg and Ole-Christoffer Granmo have developed and implemented a fire simulation-based adaptation of SmartRescue App for serious gaming. A Bayesian network has been used to model the fire dynamics. In this paper, they present both the design and the setup of their AI tool. They also discuss the results from an experiment conducted during the Information Systems for Crisis Response and Management (ISCRAM) Summer School 2014.

“*Resources location*”: Here, Jorge Vargas-Florez, Matthieu Lauras, Uche Okongwu and Lionel Dupont propose a decision-making support model in AI capable of designing a coherent humanitarian supply network that is able to adequately support the response to a disaster despite failures or inadequacies of infrastructure and potential resources (following an earthquake for instance). This contribution is defined through a Stochastic Multi-Scenario Program as a core and a set of extensions. A real application case based on the design of a humanitarian supply chain in Peru is developed.

“*Resource allocation*”: Glenn I. Hawe, Graham Coates, Duncan T. Wilson and Roger S. Crouch focus on multi-site crisis management. If the resources of the emergency services are limited, decisions

must be made to allocate emergency management teams to the multiple sites to best serve the objectives at each site. They demonstrate their approach by a hypothetical two-site major incident case. The agent-based simulation they have developed determines the allocation of resources to minimize the latest hospital arrival times for critical injuries.

The last paper is about the response phase. The research of Nady Slam, Wenjun Wang, Guixiang Xue and Pei Wang starts by analyzing existing literature on decision-support systems for crisis management. Based on this, they propose an intelligent decision-support system for crisis management able to develop concrete reasoning capabilities. Using the Non-Axiomatic Logic, they structure a framework and demonstrate the reasoning and learning mechanisms through an application in urban firefighting.

The published contributions cover topical developments regarding the use of AI technologies for crisis management. They elaborate and refine many of the existing challenges and confirm, together, that AI technologies are useful in this domain and that researchers can develop valuable proposals. Nevertheless, the majority of crisis management research (not only this Special Issue, but in general manner) is dedicated to the preparedness phase. More efforts should be dedicated to the other phases of the crisis management cycle phases, particularly to the response and recovery phases.

Although the potential for technological innovation has been confirmed widely by practice, for instance in the 2013 Red Cross World Disaster Report, many approaches and tools for crisis and humanitarian disaster management tend to be ineffective and in many cases have actually been abandoned. Although a plethora of research has been published on the subject during the last decade, a real gap exists between the scientific proposals and their application in the field; the rigor and relevance of the research. This is particularly true for quantitative approaches, such as AI techniques. The authors of this Special Issue took care of avoiding this trap, by developing contributions in collaboration with practitioners. However, this effort must be reinforced in the future.

It is hard to draw precise conclusions and trends across the papers included in this Special Issue, but there is no doubt that the papers elaborate and refine many of the existing challenges in

crisis management. As guest editors, we are very satisfied both with the quality of the papers presented in this issue, and with the relevance on the themes we hoped to put focus on via this Special Issue.

Acknowledgments

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Finally, we would like to thank all reviewers for providing in-depth comments and constructive criticisms, and the authors for contributing their high-quality manuscripts. We hope you will enjoy the result of the efforts.

Reference

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