

GUEST EDITORIAL PREFACE

Special Issue on Modeling, Simulation, and Computational Methods for Privacy and Healthcare Information

Francesco Longo, University of Calabria, Cosenza, Italy

Rafael Diaz, Eastern Virginia Medical School, Norfolk, VA, USA

Research in the field of health care seeks to improve quality, safety, efficiency, and effectiveness of health care for individuals and social groups. This research is substantially supported for well-established disciplines that include Pathophysiology, Epidemiology, and Population Health among others. As such, a substantial part of health care research focuses on generating knowledge that seeks to improve life expectancy and the facing and managing of chronic and acute diseases. However, as informational and operational technology evolves, the emergent research dimension of health care systems and delivery that involves the analysis and implementation of technical, operational, and management processes requires articulated endeavors that guide a fruitful research agenda. Thus, novel and existing paradigms applied in the health care domain can be supported by tools and approaches that are continuously reviewed and improved.

The performance of health care systems and delivery are affected by a number of aspects ranging from simple technicality to the organizational and managerial issues present in a health care institution. Hence, it is imperative to identify and manage the effects of implementations in this field that are not trivial to managers and administrators, e.g., information management, decision-making, and training. Similar to other economic systems such as production or manufacturing systems, health care systems call for considering the arrangement and management of multi-dimensional delivery complexities that maximize the system's outcomes and strives for reaching the upmost progress and well-being.

This special issue highlights the need for new approaches in health research whose complexity is multidimensional, many times intractable, and simply cannot be analyzed with deterministic or deductive methods. They require the use of effective and cutting-edge

advanced computational methods such as Modeling and Simulation (M&S) that are capable of managing and processing such complexities. To this end, M&S applications in the healthcare domain have already been debated and as a result it has been agreed on recognizing M&S as a leading methodology for training and decision-making.

Simulation systems for professional training allow trainees to learn procedures without endangering patients' life. Simulation-based training has been employed as a vehicle for the teaching of technical and non-technical skills that improves both learning efficacy and patient outcomes. However, it is a very wide research area in which many techniques converge, e.g., anesthesia, surgical operations, intensive care, laparoscopy, endoscopy etc. Interesting applications are found in Gaba and DeAnda (1988), Suwa (1992), Swank and Jahr(1992), Lussi et al. (1999), Morris et al. (2006), Daenzer and Fritzsche(2008), Semeraro et al(2008), Yoshida et al (2009) Sun et al. (2010). Murray (2011) provides a review about the use of simulation to reduce human error during the administration of anesthesia. Therefore, the use of M&S in healthcare training is fruitful and seeks to expand to new application areas and horizons.

M&S also allows the developing of predictive models that analyzes diseases spread or assesses the effects of new management policies before they are implemented. Practical advantages of M&S used as a policy making tool are discussed in Pritsker (1992), Banks (1998), Law and Kelton (2006), Pritsker (1992) can be extended in the healthcare area.

This Special Issue contains articles about experiences and challenges in the development of advanced simulation models and new computational methods pertaining to healthcare. In the following list, the papers belonging to this special issue are briefly introduced:

- **Variable Interaction Networks in Medical Data:** The aim of this paper is to generate mathematical models for medical parameters using other available parameters. Data of thousands of patients of the General Hospital (AKH) Linz, Austria, have been analyzed in order to identify mathematical models for cancer diagnoses. The authors demonstrate that is possible to identify relevant influential factors and display those in interaction networks which can be interpreted without domain knowledge in machine learning or informatics in general.
- **Developing an Ultrasonography Simulator Tool:** A real-time, dynamic prototype ultrasound simulator training tool for cardiac interrogation is presented. The authors face relevant challenges integrating the user with the physical (hardware) and cognitive (software-visualization) learning experience as well as capabilities for pathologies interpretation.
- **IFEDH - Solving Health System Problems Using Modeling and Simulation:** The Innovative Framework for Evidence-Based Decision Support in Healthcare (IFEDH) project pertaining to the field of Health Technology Assessment (HTA) is presented. A set of newly developed methods to support decision-making processes in the health system is proposed in this paper. The paper describes methods for modeling and simulation, data handling, documentation and visualization have been developed and combined to manage interdisciplinary projects and to integrate results and answers in HTA processes for efficient and credible decision support.
- **A New Hybrid Algorithm based on Watershed Method, Confidence Connected Thresholding and Region Merging as Preprocessing for Statistical Classification of General Medical Images:** An algorithm for pre-segmentation of general medical input data is presented. This algorithm is based on a watershed-segmentation strategy utilizing both original intensities and derived gradient magnitudes for region growing.
- **The Effects of Transit Corridor Developments on the Healthcare Access of Medically Fragile Vulnerable Populations:** A simulation framework based on system dynamics modeling that enables the

identification of individual factors affecting gentrification processes under transit oriented developments (TOD) initiatives is suggested while critical areas for empirical research are highlighted.

- **Three-Dimensional Numerical Simulations of the Aortic Flow in Presence of a Left Ventricle Assist Device with Two Outflow Graft Placements:** This paper develops a computational fluid dynamics model of the aorta with the purpose of analyzing the hemodynamic effects of a continuous flow LVAD, evaluated in three different working conditions while considering the outflow-graft anastomosis in two different locations: the descending and ascending aorta.
- **Obesity Epidemic Simulation Based On Behavioral Models and Intelligent Agents:** A simulation model based on Intelligent Agents is proposed. The intent of the model is to reproduce human behavior influence over the evolution and impact of obesity epidemics thanks to a Library including Intelligent Agents for Computer Generated Forces that allows reproducing complex scenarios with particular attention to non-conventional frameworks on the progression of obesity epidemics.
- **Transformation of Markov Models for Cost-Effectiveness Analysis into the System Dynamics Methodology: Analysis and Case Study:** The transformation of Markov cohort models into system dynamics models is dealt with. Such approach is demonstrated though an exemplary cost-effective analysis for a smoking cessation intervention for chronic obstructive pulmonary disease (COPD) where it is possible to ascertain that both the Markov model and the system dynamics model lead to nearly identical results.
- **An Innovative Serious Games for Education and Training in Health Care:** The proposed research work introduces an innovative framework based on Serious Games and agent-driven models for supporting

and renewing educational processes in Health Care. The proposed solution, called MARIA (Model for Advanced and Realistic patient simulation driven by Intelligent Agents), includes new models of virtual humans driven by intelligent agents to be used as patients in a distributed simulation game together with students. In order to teach concepts related to the continuous care of patients so as to create a strong relationship among medical doctor, students and their set of personal virtual patients.

The papers that are part of this Special Issue are extended versions of the best papers selected from the Proceedings of the International Multidisciplinary Modeling and Simulation Multiconference (I3M 2012). This Special Issue has to be regarded as the final result of a joint effort carried out by authors, reviewers, and Journal managers. Therefore, we would like to take this opportunity to thank all the authors and reviewers since their continuous efforts have improved the quality and the relevance of the articles presented in this Special Issue. Our gratitude goes also to Editor-in-Chief, Prof. Muaz A. Niazi, as well as to his staff for the valuable support they have provided during all the Special Issue phases along the last year.

*Francesco Longo
Rafael Diaz
Guest Editors
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REFERENCES

- Banks, J. (Ed.). (1998). *Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice*. New York: John Wiley & Sons, Inc. doi:10.1002/9780470172445
- Daenzer, S., & Fritzsche, K. (2008). A simulator for surgery training: optimal sensory stimuli in a bone pinning simulation. *Proceedings of the Society for Photo-Instrumentation Engineers*. doi:10.1117/12.770726

- Gaba, D. M., & DeAnda, A. (1988). A comprehensive anesthesia simulation environment: re-creating the operating room for research and training. *Anesthesiology*, 69(3), 387–394. doi:10.1097/0000542-198809000-00017 PMID:3415018
- Law, A. M., & Kelton, W. D. (2006). *Simulation, Modeling, and Analysis* (4th ed.). New York: McGraw - Hill, Inc.
- Lussi, C., Grapengeter, M., & Schüttler, J. (1999). Simulator training in anesthesia. Applications and value. *Der Anaesthetist*, 48(7), 433–438. doi:10.1007/s001010050726 PMID:10467475
- Morris, D., Sewell, C., Barbagli, F., Salisbury, K., Blevins, N., & Girod, S. (2006). Visuo-haptic simulation of bone surgery for training and evaluation. *IEEE Computer Graphics and Applications*, 26(6), 48–57. doi:10.1109/MCG.2006.140 PMID:17120913
- Murray, D. J. (2011). Current trends in simulation training in anesthesia: a review. *Minerva Anesthesiologica*, 77(5), 528–533. PMID:21540808
- Pritsker, A. (1992). Simulation: The Premier Technique of Industrial Engineering. *Industrial Engineering (American Institute of Industrial Engineers)*, (July): 25–26.
- Semeraro F., Bergamasco M, Frisoli A, Holtzer M, Cerchiari E.L. (2008) Virtual reality prototype in healthcare simulation training, Resuscitation, Vo. 77, No. Supplement 1, pp S60-S61
- Sokolowski, J.A., Banks, C. M., Principles of Modeling and Simulation A Multidisciplinary Approach, Wiley.
- Sun, J., Ci, S., Chien, J. H., Park, S. H., Suh, I. H., Oleynikov, D., & Siu, K. S. (2010), Innovative effector design for simulation training in robotic surgery, Conference on Biomedical Engineering and Informatics BMEI, Vo. 4, pp. 1755–1759
- Suwa K (1992), Simulation in anesthesia, Masui The Japanese journal of anaesthesiology, Vo. 41, No. 10, pp. 1658-1663.
- Swank, K. M., & Jahr, J. S. (1999). The uses of simulation in anesthesiology training: a review of the current literature. *The Journal of the Louisiana State Medical Society*, 144(11), 523–527. PMID:1431485
- Yoshida, Y., Yamaguchi, S., Wakabayashi, K., Nagashima, T., Takeshige, F., & Kawamoto, Y. et al. (2009). Virtual reality simulation training for dental surgery. *Studies In Health Technology And Informatics*, Vo, 142, 435–437. PMID:19377202