A Computational Framework for Decision Analysis and Support in ISI: Artificial Societies, Computational Experiments, and Parallel Systems

Fei-Yue Wang

Chinese Academy of Sciences, Beijing 100080, China
University of Arizona, Tucson, Arizona 82521, USA
feiyue.wang@ia.ac.cn

In response to the September 11, 2001 terrorist attacks, many governments and citizens across the world have been mobilized at an unprecedented scale to contribute to national/international and societal security. The scientific and engineering research communities are no exception and have been called upon to play an important role in this effort. With such background, Intelligence and Security Informatics (ISI) has emerged since 2003 as a fast growing multidisciplinary field of study aimed at developing advanced information technologies, systems, algorithms, and databases for national- and homeland security-related applications, through an integrated technological, organizational, and policy-based approach [1-3].

Observation, analysis, and classification of human behaviors under various situations are among key issues in ISI research. Although huge amounts of historical data sets and vast sources of new intelligence information are available, studies of human behaviors and their social impacts still remain extremely difficult mainly due to the following two facts: 1) problems can not be reduced to simple cases and must be integrated as a whole, and 2) situations or events are not repeatable or re-constructible so that experiments are virtually impossible in many cases. While traditional approaches are not effective for addressing those problems, new concepts and methods developed in complex systems could provide a potential solution [4-8]. This consideration is the motivation for establishing a computational framework for ISI decision analysis and support based on a newly developed computational theory of complex systems using artificial societies, computational experiments, and parallel systems [9]. Specifically, our approach consists of three components:

1) ***Modeling and Specification of ISI Problems Using Artificial Societies***
We consider computers as social labs by creating artificial human and societal relationships in artificial societies using autonomous agent programming. This is a natural extension of computer simulations in the sense that we no longer take the accuracy to real systems as our only criterion for model construction. Instead, we consider "model" as an alternative to the reality and "equivalent" to a real system. Based on this concept, various artificial systems can be constructed for testing and validating in ISI research and development. This is not only useful for fast prototype studies, but also fundamental to computational experiments and parallel systems for analysis and implementation of actual ISI strategies and methods.

H. Chen et al. (Eds.): WISI 2006, LNCS 3917, pp. 183 – 184, 2006.

2) Analysis and Evaluation of ISI Methods using Computational Experiments
Computational experiments are natural applications of artificial systems. For many problems in ISI, it is very difficult and sometimes impossible to study concerned objects through active and controlled experiments in reality. Computational experiments through computers and artificial systems provide an alternative and complement to actual physical experiments. Various techniques in experiment design and statistical analysis can be applied here directly.

3) Implementation and Execution of ISI Systems Based Parallel Systems
The basic idea is to run "simulations" side by side with actual operations. A parallel system consists of a real system and an artificial system that can be linked in different modes of operations: 1) off-line for teaching and learning, 2) off/on-line for testing and evaluation, and 3) on-line for management and control in real ISI applications. Various concepts and methods developed in adaptive control can be used in operations of parallel systems.

Acknowledgments. This research was supported in part by the National Natural Science Foundation of China (60573078 and 60334020) and the National Basic Research Program (2004CB318103).

References

1. Chen, H. and Wang, F.Y.: Artificial Intelligence for Homeland Security. IEEE Intelligent Systems (2005), pp. 12-16.
2. Chen, H., Wang, F.Y., and Zeng, D: Intelligence and Security informatics for Homeland Security: Information, Communication and Transportation. IEEE Trans. Intelligent Transportation Systems (2004), pp. 329-341.
3. Kantor, p. Muresan, G. Roberts, F. Zeng, D., Wang, F.Y., Chen, H. and Merkle, R.C.: Intelligence and Security Informatics. Proceedings IEEE Conference on Intelligence and Security informatics, Atlanta, GA,USA, May 2005.
4. Fei-Yue Wang and Steve Lansing: From Artificial Life to Artificial Societies – The State of the Art of Complex Social Systems and Beyond, Journal of Complex Systems and Complexity Science (2004), Vol. 1, No. 1, pp. 33-41.
5. Fei-Yue Wang: Computational Experiments for Behavior Analysis and Decision Evaluation of Complex Systems, Journal of Systems Simulation (2004), Vol. 16, No.5, pp. 893-897.
6. Fei-Yue Wang: Parallel Systems for Management and Control of Complex Systems, Journal of Control and Decision (2004), Vol.19, No.5, pp. 485-490.
7. Fei-Yue Wang and J. Wang: Issues and Applications of Intelligence and Security Informatics, China Basic Sciences (2005), Vol.7, No.3, pp. 24-29.
8. Fei-Yue Wang: Social Computing and Dynamic Analysis of Digital and Networked Societal States, Science and Technology Review (2005).
9. Fei-Yue Wang: On a Computational Theory for Complex Systems, China Basic Science (2004), Vol. 6, No.5, pp. 3-10.