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SPECIAL ISSUE ON IMMUNITY-BASED SYSTEMS: SYSTEMS SCIENCES FOR ROBUST AND RESILIENT ENGINEERING

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In the course of studying complex systems inspired by biological systems (such as the immune system) and attempting to mimic the robustness, resilience, and adaptation of these systems, several fundamental sciences such as systems sciences, dynamic systems, game theory, and network science have attracted considerable attention. Immune systems, in particular, have led to the development of distributed, adaptive, and self-maintenance systems (adaptation to the internal *self* as well as to the external *environment*), which can be used in information systems whose survival is critical for reducing the damages caused by large-scale natural disasters.

After the recent gigantic natural disasters, we have realized that resilient systems should deal with various situations including the following:

- **Unavailable Information**: Most information that is readily available for daily use may not be available because of the chaotic situations caused by a natural disaster.
- **Unavailable Immediate Response**: Most situations are assumed for routine tasks and may not be valid because of the drastic environmental changes caused by the disaster, implying that prompt organized rescues are unavailable.
- **Unavailable Infrastructure**: Although infrastructure including transportation, communication, and information systems is critical for the survival of the people, it is not only unavailable but is also difficult to fix and recover after the disaster.

Coping with the abovementioned situations is considerably difficult and challenging for a single field of science and technology, and hence many fields should be involved and should be studied both on a long-term and on a short-term basis. This special issue, aiming at bringing together researchers working across fields such as sensor networks, information security and systems sciences, calls for papers on Systems Sciences and Technologies for Robust and Resilient Engineering based on the features of the immune systems: robustness, resilience and adaptation.

For innovations such as achieving robustness while seeking optimization, conventional methods may be enhanced with a completely distinct method. Angeline Vijula Dhanraj and Devarajan Nanjundappan used the *particle swarm* optimization for designing a PI controller in the multi-input–multi-output (MIMO) process. In contrast to a conventional optimization approach, Masahiro Tokumitsu proposed adaptive strategies, with which he claimed that a system would exhibit a high performance on average in a dynamic environment. A dynamic environment imposes plays with many types of adversaries. An optimized but fixed strategy can exhibit the best performance with a specific type of adversary but may not perform well on average with many other types of adversaries. He also posed some open problems for the development of the concept of adaptive strategies.

An important principle inspired by the immune system is *self/nonself discrimination*. Tao Shang, Hengli Pei, and Jianwei Liu introduced a lattice theory to construct a secure signature scheme based on *self/nonself discrimination*. They proposed a scheme with a stronger unforgeability for the natural property of lattices than traditional signature schemes. An ad-hoc network also plays a crucial role in establishing resilient communications that recover even when base stations are destructed. Ajay Guleria, Narottam Chand, and Lalit Kumar proposed a new data dissemination scheduling strategy for on-demand broadcasting of information from a roadside unit to support the differentiated levels of services in vehicular ad-hoc networks. Although their goal was to increase road safety, the model can lead to resilient networking. We know that chaotic conditions after a disaster may cause imbalances in the inventory level at each storage location or shelter. Nur Budi Mulyono developed a resilient logistics method to ensure an even level of inventory among shelters, introducing a new model based on probabilistic cellular automata.

The immune system can also inspire innovative modelling. One such innovation is to remove the formal distinction between data and a function on cellular automata. Kouji Harada devised a model in which a function and the corresponding data determine each other in contrast to conventional models where a function determines data as an output. The model also demonstrates that the mutation allows a transition between dynamical orbits and creates a meta-attractor attracting most orbits. Another aspect of the immune system is that it arms itself with a *double-edged sword*. I have also reported a self-repairing network, which is a probabilistic cellular automaton, to deal with the problem of cleaning a contaminated network by mutual-copying and self-copying. Repairing by copying among agents is the *double-edged sword* that can spread contamination unless it is appropriately used. We focused on dynamics rather than the static aspects by incorporating several phase diagrams to visualize the transient states.

In an attempt to frame the immune system of humans and the Earth, we investigate asymmetric interactions between humans and the Earth (environmental problems such as global warming, climate change, and pollution) and those between the Earth and humans (natural disasters such as earthquakes and tsunamis). A new perspective for the reconciliation of humans and nature, as obtained from the immune system, may be shaped around the concepts of diversity, adaptation, and resilience. This special issue is just a small step toward resilient systems; however, adaptive systems in diversified domains, techniques, approaches, and modelling may have been already recognized.

We regret that many important papers could not be included in this special issue; however, we presume that many similar special issues, books, and projects will emerge from many fields hopefully before the next human-threatening disaster. We are grateful to all the reviewers for the papers included in this special issue and for those not included in this special issue. Special thanks go to the Executive Editor of IJICIC, Prof. Yan Shi, who supported the entire publication process, including reviewing and editing, for this special issue.

Ittai Abraham School of Computer Science and Engineering. The Hebrew University of Jerusalem Jerusalem, Israel. ittaia@cs.huji.ac.il. Danny Dolev. âˆ—. School of Computer Science and Engineering.Â reaching agreement in asynchronous systems, which also shows that no bounded implementation exists. However, we use quite different proof techniques than FLP. Byzantine Agreement and Game Theory: We give the rst rigorous connection between Byzantine agreement lower bounds and lower bounds on implementation.Â There are still a few gaps in our theorems, as well as other related issues to explore. We list some of them here. â€¢ In Theorem 1(c), we get only an -implementation for some > 0. Can we take = 0 here? Special issue on immunity-based systems: Systems sciences for robust and resilient engineering. February 2014. Y. Ishida.Â [Show full abstract] Incorporation of a sphere-to-cone interaction between the sealing surfaces dramatically improves connector's sealing robustness. Sphere-to-cone based connectors are resilient to the tube and seat axes misalignment. Correspondingly, sphere-to-cone based connectors have less variation of the securing torque and virtually no propensity to locked misalignment occurrence. The article analyzes another fundamental advantage of a sphere-to-cone mating over the conventional cone-to-cone one. Engineering and Science collectively played a major role in the lives we live in the 21st century. In todayâ€™s technology-driven world, engineering is the cornerstone and driver of innovation of the devices we utilize daily to improve our quality of life. The latter driver, namely the new ideas, is actually elements of research in engineering.Â This special section deals with the general topic of long term innovative topics for research in Engineering and Sciences. The peer-reviewed articles will showcase potentially high impact research topics or directions.Â Publishing an article in Advances in Science, Technology and Engineering Systems Journal requires Article Processing Charges that will be billed by submitting author following the acceptance of an article for publication. Knowledge-based Systems is an international and interdisciplinary journal in the field of artificial intelligenceâ€¦Â M. Bramer November 1998|Volume Vol. 11, no. 5/6. Interactions between Software Engineering and Knowledge Engineering. N. Juristo October 1998|Volume Vol. 11, no. 2. Cumulative Indexes. The CPSS systems engineering framework uses a hierarchical approach from traditional systems engineering for captur- ing and designing in accordance with User requirements. Fig. 1 Notional network CPS The framework will also use a design scorecard approach to measure the CPSS residual risk (Patil et al.Â (2013a, b) de- more robust, resilient system that protects our critical in- veloped an approach to generate resilience metrics for sys- frastructure. Taking a systems engineering based view of tems. This approach couples the four actions described by CPS security is the first step toward this goal. NAS (plan/prepare, absorb, recover, adapt) with the four Cyber physical system security is a multi-scale issue, domains to create a 4 9 4 matrix.