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EDITORIAL

Special issue on contributions of computational intelligence in designing complex information systems

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During the last decades Computational Intelligence (CI) has emerged and showed its contributions in various broad research communities (computer science, engineering, finance, economic, decision making, etc.). This was done by proposing approaches and algorithms based either on turnkey techniques belonging to the large panoply of solutions offered by CI such as data mining, genetic algorithms, bio-inspired methods, Bayesian networks, machine learning, fuzzy logic, artificial neural networks, etc. or inspired by CI techniques to develop new ad-hoc algorithms for the problem under consideration.

The main objective of our special issue is not to cover the contributions of the CI in all domains, but in the particular field of computer science, which is Information Systems (IS). ISs are repositories where sensitive and crucial data are recorded to support day-to-day company applications and decision-making processes. Building such systems usually passes through several complex steps: (a) requirement analysis, (b) design, (c) implementation, (d) testing, (e) evolution and (f) tuning. Moreover, two other crucial aspects should be taken into account when building IS: (1) the big data dimension and (2) the advanced deployment platforms such as cloud that comes with

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interesting economical aspects and models. Under these situations, SI building is a time consuming process. To reduce this complexity and to propose companies and organization IS with a high quality, the incorporation of CI techniques in the life-cycle of IS may represent a key issue for researchers and industrials.

This special issue is open to researchers from both academia and industry consumer of CI. The aim of this special issue of the Computing Journal, Springer is twofold. The first one is to present new and challenging issues in the contribution of CI for designing high quality and efficient IS. The second one is to present new research and technological developments that use CI all over the life cycle of IS.

There was great response to the call for papers; we received 22 papers from 11 countries (Algeria, Austria, China, France, India, Kazakhstan, Lebanon, Luxembourg, Spain, United Arab Emirates, USA).

Due to this success and the quality of the received papers, we accept five papers for this special issue, which makes an accepting rate of 23.8 %. These papers are authored by an outstanding roster of experts in their respective fields, and tackle various issues from different angles, requirements and interests. Their topics include: modelling, meta-modelling, formal methods, advanced CI algorithms, stochastic optimization, scalability of algorithms, validation, security, etc. These topics cover several domain applications: social network, Internet-ware systems, Human Computer Interaction, etc. One of the particularities of our this special is the presence two survey papers about two hot topics related to the use of the CI techniques in recommender systems and formal methods in security of model-based systems.

The five selected papers are summarized as follows:

The paper, entitled; *A Survey on Context-aware Recommender Systems Based on Computational Intelligence Techniques*, by Assad Abbas, Limin Zhang, and Samee U. Khan, presents a rich overview of context-aware recommender systems using Computational Intelligence (CI) approaches. The survey discusses the recommendation approaches, such as (1) collaborative filtering, (2) content based filtering, and (3) hybrid filtering employed in contemporary recommender systems. This survey categorizes the studied papers (70 papers are cited) in five categories according to the used CI techniques namely: (1) fuzzy set theory, (2) artificial neural networks, (3) evolutionary computing, (4) swarm intelligence, and (5) artificial immune systems. For each category a description of several context-aware recommender systems (approximately 5–6 systems by category) is given and a comparison table summarizing their ability to deal with the following challenges is described: (i) sparsity, (ii) cold start, and (iii) scalability. This paper could be a nice introduction for students and researchers working on recommender systems.

The paper, entitled, *Specification, Verification, and Quantification of Security in Model-based Systems*, by Samir Ouchani and Mourad Debbabi, a state of the art review on the way security requirements can be integrated in model-based systems which is a hot topic for information systems designers as the security requirements have to be integrated in earlier stage of the design. A particular attention is given to UML and SySML system descriptions, security requirements, attack scenarios, verification and validation. An interesting classification of the existing verification and validation approaches for validating and verifying security policies (UML based, standards and policies, formal approaches) is given.

The paper, entitled, *A Formal Model for Output Multi-modal HCI. An Event-B Formalization*, by Linda Mohand Oussaid, Idir Ait-Sadoune, Yamine Aït Ameur, and Mohamed Ahmed-Nacer provides an innovative approach for the formal design of multi-modal Humancomputer interaction (HCI). One of the particularities of these interfaces is that they combine different modalities, both in input or output communication with the machine. This paper proposes a generic approach handling the design of output multi-modal human computer interfaces, and proposes a stepwise refinement involving models for (i) semantic fission dedicated to decompose the information (produced by the functional core) into elementary information and for (ii) allocation of modalities and media to the obtained composite information. An Event-B formalization of the proposed is given. It enables developers to achieve the formal properties validation and verification based on proof and refinement.

The paper, entitled, *Enhancing Firefly Algorithm using Generalized Opposition-based Learning*, by Shuhao Yu, Shenglong Zhu, Yan Ma and Demei Mao, presents a detailed study of a variant of the firefly algorithm using generalized opposition-based learning. Firefly algorithm is a robust stochastic optimization and population-based technique inspired from flashing lights of fireflies in nature. In some context it outperforms traditional algorithms such as genetic algorithms. The proposed algorithm is tested against the traditional firefly algorithm by considering 16 standard benchmark functions. The obtained results show the effectiveness and the efficiencies of the proposal.

The paper, entitled, *A Pre-distribution Algorithm of Component Reliability in Internetware System*, by Jing Zhang and Hang Lei presents a method to compute and distribute reliability to components of Internetware systems. In particular, the authors show the steps to derive a Markov chain representation of the architecture from design artifacts (e.g., UML sequence diagrams), then computing the reliability based on the structure, and allocating reliability to components through an optimization model (in the design phase), by using a cost function as objective to minimize. Numerical illustration is used on three-components example. This work is sponsored by the national science and technology support plan of Ministry of Science and Technology of Sichuan Education Department, China.

We hope readers will find the content of this special issue interesting and will inspire them to look further into the challenges that are still ahead before designing advanced information systems using Computational Intelligence. We would like to thank all the authors who submitted their papers to this special issue. In addition, we are grateful for the support of various reviews that ensured the high quality of this special issue. Last but not least, we would like to thank Professor Schahram Dustdar, Editor-In-Chief of Computing, for accepting our proposal of a special issue focused on *Contributions of Computational Intelligence in Designing Complex Information Systems*, and for assisting us whenever required. We would like to thank very much Priya Balamurugan and Christine Kamper for their endless help and support. The complete International Program Committee of this special issue is listed next.

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