Editorial

Architecting for a Sustainable Digital Society

1. Introduction

Recent events, in particular the COVID-19 pandemic, have demonstrated the need for digital tools allowing people to meet, interact, and collaborate. Software-enabled systems must facilitate not only collaborative work, but also humanitarian needs like healthcare, online learning from kindergarten to postgraduate levels, and social networking. Such systems must be developed considering personal needs, the diversity of the population, their privacy needs, and physical safety. Moreover, this new generation of software-enabled systems must provide us a more sustainable world, from smart homes to industries and cities. All these challenges highlight critical considerations on what software-enabled systems to develop in the coming years, and especially on how to design these systems to offer a more Sustainable Digital Society.

The software engineering community is facing these challenges when developing solutions, in contemporary areas such as Cyber Physical Systems, Internet of Things, and Cloud/Edge-computing. Evidence shows that one of the most critical success factors for the design and development of these systems has been raising the level of abstraction by focusing on their software architecture. The architecture of a software system describes its static and dynamic structures in terms of its software components, their inter-connection and properties as well as the rationale explaining its design and evolution. A prescriptive architecture can be an artifact devised by an architect to make a decision about what design to choose among alternatives, as well as an artifact dynamically composed by a running system that uses it to make decisions about selecting alternative configurations to deal with runtime change.

This special issue aims at establishing a step forward to architecting the software systems demanded by a Sustainable Digital Society. Among others, this special issue aims at contributing with theories, methods, techniques, and tools that software architects and engineers need in order to ensure that the architectures of these software-enabled systems demanded by our digital society will be understandable, verifiable, adaptable, and evolvable to meet their even changing functional and quality requirements. Contributions present evidence highlighting how they pursue and contribute to a Sustainable Digital Society. Moreover, case studies compiling both success and failure experiences contribute to this Special Issue for exploitation in future research.

2. Overview of the special issue

The call for papers elicited high-quality papers describing innovative research about different topics related to how Software Architecture may help in developing the next Digital Society. The call attracted 16 submissions, including extended papers from the 15th European Conference on Software Architecture (ECSA 2021) (Biffl et al., 2021). After a thorough review process, three high-quality research papers were selected for this special issue. We summarize these three accepted papers.

The paper "ExTrA: Explaining Architectural Design Tradeoff Spaces via Dimensionality Reduction" (Cámara et al., 2023), by Camara et al. presents ExTrA (Explaining Tradeoffs of software Architecture design spaces), an approach to analyzing architectural design spaces aiming at satisfying quality properties of systems that operate under uncertainty. The approach employs dimensionality reduction techniques employed in machine learning pipelines like Principal Component Analysis (PCA) and Decision Tree Learning (DTL), enabling architects to understand how design decisions contribute to the satisfaction of properties across the design space. The approach is validated using a Tele-assistance system and a network architecture.

The paper "A component framework for the runtime enforcement of safety properties" (Bonfanti et al., 2023) of Bonfanti et al. presents an approach to enforce safety of software systems at runtime. The approach leverages the MAPE-K feedback model and uses a state machine as runtime model to specify safety assertions that are used by the feedback loop to ensure correct system behavior. The approach is illustrated in two cases from the health-care domain.

Finally, the paper "A Compositional Approach to Architecture Frameworks for distributed AI Systems" (Heyn et al., 2023) by Heyn et al. proposes an extension to architecture frameworks by providing a mathematical model for system architectures, which is scalable and supports co-evolution of different aspects of an AI system. Leveraging principles of Design Science Research and category theory, the authors provide guidelines based on a mathematical formulation on how a consistent framework can be built with existing, or newly created, viewpoints. The rules are applied to derive an architectural framework for the EU Horizon 2020 project "Very efficient deep learning in the IoT".

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Biffl, S., Navarro, E., Löwe, W., Sirjani, M., Mirandola, R., Weyns, D., 2021. Proceedings of the 15th European Conference Software Architecture. ECSA 2021, Virtual Event, Sweden, September 13-17, 2021, Springer, http://dx.doi.org/10.1007/978-3-030-86044-8.

Bonfanti, S., Riccobene, E., Scandurra, P., 2023. A component framework for the runtime enforcement of safety properties. J. Syst. Softw. 111605.

Cámara, J., Wohlrab, R., Garlan, D., Schmerl, B., 2023. ExTrA: Explaining architectural design tradeoff spaces via dimensionality reduction. J. Syst. Softw. 198, 111578.

Heyn, H.-M., Knauss, E., Pelliccione, P., 2023. A compositional approach to creating architecture frameworks with an application to distributed AI systems. J. Syst. Softw. 111604.

Stefan Biffl [a]
Elena Navarro [b,*]
Raffaela Mirandola [c]
Danny Weyns [d,e]
[a] *Technical University of Vienna, Favoritenstr. 9/194, Vienna, 1040, Austria*
[b] *University of Castilla-La Mancha, Avda. España s/n, Albacete, 02071, Spain*
[c] *Politecnico di Milano, Via Golgi 42, Milano, 20133, Italy*
[d] *KU Leuven, Celestijnenlaan 200A, Leuven, 3001, Belgium*
[e] *Linnaeus University, Vaxjo, Sweden*
E-mail addresses: Stefan.Biffl@tuwien.ac.at (S. Biffl), Elena.Navarro@uclm.es (E. Navarro), raffaela.mirandola@polimi.it (R. Mirandola), danny.weyns@kuleuven.be (D. Weyns).

* Corresponding author.