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Abstract

Managing Viability Zone Dynamics for the Assurance of Self-Adaptive Systems

We define the viability zone of a self-adaptive software (SAS) system as the set of possible states in which the system operation is not compromised, that is, the set of states where the system's requirements and desired properties (i.e., adaptation goals) are satisfied. Viability zones can be characterized in terms of relevant context attributes and corresponding desired values. These context attributes correspond to either measurements of internal variables of the target system or the adaptation mechanism, or environmental variables whose variations can take the system outside its viability zone. Viability zones are N-dimensional. Therefore, a particular SAS system may have more than one associated viability zone (e.g., one for each adaptation goal). The global viability zone of a system thus results from the composition of these partial viability zones. Moreover, existing viability zones can be added, replaced or adjusted by adding or removing variables of interest at runtime.

Viability zones can change with context changes, as opposed to the solution space concept, which is assumed to be fixed. In effect, the viability zone of a target system under adaptation constantly varies along adaptation dimensions. These variations take place every time the adaptation operation modifies either the target system architecture (e.g., adding or removing components and connectors) or the controller itself (e.g., modifying its parameters or replacing the control algorithm), thus introducing new, or removing existing variables and associated domain types. To extend the V&V coverage of the expanded viability zone, runtime models are required for the incremental derivation of software artifacts for V&V monitoring and checking. Therefore, not only are runtime V&V methods required to cope with the viability zone dynamics problem, but these V&V methods also need to be automatically generated according to the modifications that result from dynamic adaptation to keep the adaptive system inside its viability zone. We believe that managing viability zones at runtime is crucial for the assurance of self-adaptive systems.

Bibliography

N. M. Villegas, “Context Management and Self-Adaptivity for Situation-Aware Smart Software Systems,” Ph.D. dissertation, University of Victoria, Canada, February 2013.

G. Tamura, “QoS-CARE: A Reliable System for Preserving QoS Contracts through Dynamic Reconfiguration,” Ph.D. dissertation, University of Lille 1 - Science and Technology, and Universidad de Los Andes, 2012.

G. Tamura, N. M. Villegas, H. A. Müller, J. P. Sousa, B. Becker, M. Pezzè, G. Karsai, S. Mankovskii, W. Schäfer, L. Tahvildari, and K. Wong. “Towards Practical Runtime Verification and Validation of Self-Adaptive Software Systems,” volume 7475 of LNCS, pages 108-132. Springer, 2013.

N. M. Villegas and H. A. Müller. “Runtime Evolution of Highly Dynamic Software,” in Evolving Software Systems, Mens, Serebrenik, Cleve (eds.), LNCS, pages 229-264. Springer, 2014 (In Press).

J. Aubin, A. Bayen, and P. Saint-Pierre. “Viability Theory: New Directions.” Springer, Heidelberg, 2011.

S. Balasubramanian, R. Desmarais, H. A. Müller, U. Stege, and S. Venkatesh. “Characterizing Problems for Realizing Policies in Self-Adaptive and Self-Managing Systems.” In Proceedings 6th International Symposium on Software Engineering for Adaptive and Self-Managing Systems (SEAMS 2011), pages 70{79, New York, NY, USA, 2011. ACM.

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