



## Edmund Melson Clarke, Jr. (1945–2020)

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This special issue of *Formal Methods in System Design* is dedicated to the memory of Edmund Melson Clarke, Jr., who sadly passed away on December 22, 2020. Ed, as he wanted to be addressed by everyone, was an exceptional scientist and an outstanding mentor of young researchers. Throughout his illustrious scientific career, Ed received many prestigious prizes including the 2007 ACM Turing Award, for which he was co-recipient with his former graduate student E. Allen Emerson and Joseph Sifakis. The Turing Award was given in recognition of Ed’s crucial contribution to the conception of model checking and its development into a verification technology, which has found worldwide industrial adoption and has generated many lines of extremely fruitful scientific research. Ed was instrumental in creating a research community in the field of formal verification. He supervised 28 Ph.D. students and 41 postdocs, many of whom have made major breakthroughs in the field. He co-founded the International Conference on Computer-Aided Verification and was a founding editor of this very journal. Ed was also generous with his time—he was always more than willing to meet his students and junior colleagues to discuss research or to give general advice for future endeavors.

The authors of the six papers included in this special issue have been at some point Ed’s students, postdocs, or close collaborators: Sagar Chaki was a PhD student with Ed; Natasha Sharygina was Ed’s close collaborator while she was based at Carnegie Mellon’s Software Engineering Institute; Armin Biere was a postdoc with Ed; Doron Peled was a co-author with Ed and Orna Grumberg, co-editor of this special issue, of the first and most popular book on model checking; Somesh Jha was a PhD student with Ed; Finally, Alessandro Cimatti was a co-developer with Ed, Biere et al., on bounded model checking and a part of the Trento-Carnegie Mellon collaboration to develop the NuSMV model checker.

The special issue includes the following six papers. The paper *Achieving High Coverage in Hardware Equivalence Checking via Concolic Verification* by Roy and Chaki is a perfect example of the impact of model checking in industry: it describes an efficient approach for checking sequential equivalence between a circuit’s high-level, programmatic description and its register-level implementation. Next, the paper *SMT-based Verification of Program Changes through Summary Repair* by Asadi, Blich, Hyvarinen, Fedyukovich,

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and Sharygina tackles the verification problem for software in the modern Continuous Integration/Continuous Delivery world: That is, how to efficiently and incrementally verify large applications that are released frequently, e.g., daily. Fleury and Biere's *Mining Definitions in Kissat with Kittens* is instead devoted to improving SAT solving, which is a workhorse of countless formal verification approaches and tools. In particular, Fleury and Biere present a new approach for simplifying SAT formulae by bounded variable elimination. The paper *On Monitoring Linear Temporal Properties* by Havelund and Peled addresses instead Runtime Verification, which is important both for the field deployment of actual devices and for the verification of exceedingly large designs that might not afford an exhaustive solution. The paper studies and classifies temporal properties according to the monitoring of a finite prefix of a system execution. Next, *Machine Learning and Logic: A New Frontier in Artificial Intelligence* by Ganesh, Seshia, and Jha gives a very interesting and up-to-date perspective on a crucially important and timely problem: the connection between machine learning and formal reasoning, and their interaction in a newly proposed unifying framework. Finally, the paper *Verification Modulo Theories* by Cimatti, Griggio, Mover, Roveri, and Tonetta uses SAT-based model checking and CounterExample-Guided Abstraction Refinement—another of Ed's seminal contributions—to frame and solve in a SMT approach the verification of fair transition systems.

We conclude by noting that the included papers span only a fraction of Ed's research contributions and interests—his long list of impactful publications witnesses the calibre of Ed's scientific legacy. We believe that Ed's works, ideas, ethics, energy, and enthusiasm for research will continue to inspire generations of researchers to come.

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