Synthesis of Reactive Systems

Bernd Finkbeiner
Universität des Saarlandes, Saarbrücken, Germany

More than fifty years after its introduction by Alonzo Church, the synthesis problem is still one of the most intriguing challenges in the theory of reactive systems. On the one hand, synthesis algorithms have found applications in many areas of systems engineering, from the construction and optimization of circuits and device drivers to the synthesis of controllers for robots and manufacturing plants. On the other hand, the logical and algorithmic foundations of the synthesis problem are still far from complete.

In this series of lectures, I will trace the developments triggered by Church's classic problem [1] from the early solutions in the 1960s [2, 3] to the practical tools [4, 5, 6] that have come out in the past few years. The lectures will give an overview on the automata- and game-theoretic foundations (cf. [7]), explore the spectrum of logics for the synthesis of reactive systems, from reduced logics with simpler synthesis problems like GR(1) [8] to advanced logics such as strategy [9] and coordination logic [10], and discuss the ideas behind efficient synthesis approaches like bounded synthesis [11].

References

[1] A. Church. *Applications of Recursive Arithmetic to the Problem of Circuit Synthesis.* In: Summaries of the Summer Institute of Symbolic Logic; vol. 1; pp. 3–50; Cornell Univ., Ithaca, NY; 1957.

[2] J. R. Büchi, L. H. Landweber. *Solving Sequential Conditions by infinite-state Strategies.* Transactions of the American Mathematical Society; vol. 138; 1969.

[3] M. O. Rabin. *Automata on Infinite Objects and Church's Problem.* American Mathematical Society, Boston, MA, USA; 1972.

[4] R. P. Bloem, H.-J. Gamauf, G. Hofferek, B. Könighofer, R. Könighofer. *Synthesizing Robust Systems with RATSY.* In: SYNT 2012 (O. P. Association, ed.); vol. 84; pp. 47–53; Electronic Proceedings in Theoretical Computer Science: 2012.

[5] A. Bohy, V. Bruyère, E. Filiot, N. Jin, J.-F. Raskin. *Acacia+, a Tool for LTL Synthesis.* In: CAV, P. Madhusudan, S. A. Seshia (eds.); LNCS 7358; pp. 652–657; Springer; 2012.

[6] R. Ehlers. *Unbeast: Symbolic Bounded Synthesis.* In: TACAS'11; P. A. Abdulla, K. R. M. Leino (eds.); LNCS 6605; pp. 272–275; Springer; 2011.

[7] E. Grädel, W. Thomas, T. Wilke (eds.). *Automata Logics, and Infinite Games: A Guide to Current Research.* New York, NY, USA; Springer; 2002.

[8] N. Piterman, A. Pnueli, Y. Sa'ar, *Synthesis of Reactive(1) Designs.* In: Verification, Model Checking, and Abstract Interpretation, E. Emerson, K. Namjoshi (eds.); LNCS 3855; pp. 364–380; Springer; 2006.

[9] K. Chatterjee, T. A. Henzinger, N. Piterman. *Strategy Logic.* Inf. Comput.; vol. 208, no. 6; pp. 677–693; 2010.

[10] B. Finkbeiner, S. Schewe. *Coordination Logic.* In: CSL, A. Dawar, H. Veith (eds.); LNCS. 6247; pp. 305–319; Springer; 2010.

[11] B. Finkbeiner, S. Schewe, *Bounded Synthesis.* International Journal on Software Tools for Tech- nology Transfer; vol. 15, no. 5-6; pp. 519–539; 2013.