



## Spring 2017 Colloquium

### Department of Computer and Information Sciences

#### *Syntax-Guided Synthesis*

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**Abstract:** The classical synthesis problem is to find a program or a system that meets a correctness specification given as a logical formula. Recent work on synthesis and optimization illustrates many potential benefits of allowing the user to supplement the logical specification with a syntactic template that constrains the space of allowed implementations. The formulation of the syntax-guided synthesis problem (SyGuS) is aimed at standardizing the core computational problem common to these proposals in a logical framework. The input to the SyGuS problem consists of a background theory, a semantic correctness specification for the desired program given by a logical formula, and a syntactic set of candidate implementations given by a grammar. The computational problem then is to find an implementation from the set of candidate expressions so that it satisfies the specification in the given theory.

In this talk, we first describe how a wide range of problems such as automatic synthesis of loop invariants, program optimization, program repair to defend against timing-based attacks, and learning programs from examples can be formalized as SyGuS instances. We then describe the counterexample-guided-inductive-synthesis (CEGIS) strategy for solving the SyGuS problem. Finally we discuss our efforts over the past three years on defining the standardized interchange format built on top of SMT-LIB, repository of benchmarks from diverse applications, organization of the annual competition, SyGuS-COMP, of solvers, and experimental evaluation of solution strategies.

**Bio:** Rajeev Alur is Zisman Family Professor of Computer and Information Science at University of Pennsylvania. He obtained his bachelor's degree in computer science from IIT Kanpur in 1987 and PhD in computer science from Stanford University in 1991. Before joining Penn in 1997, he was with Computing Science Research Center at Bell Labs. His research is focused on formal methods for system design, and spans theoretical computer science, software verification and synthesis, and cyber-physical systems. He is a Fellow of the AAAS, a Fellow of the ACM, a Fellow of the IEEE, an Alfred P. Sloan Faculty Fellow, and a Simons Investigator. He was awarded the inaugural CAV (Computer-Aided Verification) award in 2008, ACM/IEEE Logic in Computer Science (LICS) Test-of-Time award in 2010 and the inaugural Alonzo Church award by ACM SIGLOG / EATCS / EACSL in 2016 for his work on timed automata. Prof. Alur has served as the chair of ACM SIGBED, is the author of the textbook Principles of Cyber-Physical Systems (MIT Press, 2015), and is currently the lead PI of the NSF Expeditions in Computing center ExCAPE (Expeditions in Computer Augmented Program Engineering).