

Program Synthesis

<http://d3s.mff.cuni.cz>

Department of
Distributed and
Dependable
Systems



Pavel Parízek



FACULTY
OF MATHEMATICS
AND PHYSICS
Charles University

Introduction

- Goal: discovering executable programs that realize some task
- Motivation: simple repetitive tasks
- Selected target domains
 - Basic textbook algorithms (sorting, graphs)
 - Complex bit-vector manipulation routines
 - Simple text string manipulation programs
 - Mutual exclusion (thread synchronization)

Dimensions

- Expressing the user intent
 - few pairs of input-expected output examples
 - demonstrations of program behavior (traces)
 - logical relations between inputs and outputs
- Search space of programs
 - Restrictions: control structure, allowed operations
- Efficient search technique
 - Exhaustive brute force search (over the whole space)
 - Machine learning (probabilistic, genetic programming)
 - Logical reasoning (constraints, induction, SAT/SMT)

Literature

- S. Gulwani. **Dimensions in Program Synthesis**. Invited Talk Paper, PPDP 2010, ACM.
- S. Gulwani, W.R. Harris, and R. Singh. **Spreadsheet Data Manipulation Using Examples**. Communications of the ACM, 55(8), August 2012.
- M. Vechev, E. Yahav, and G. Yorsh. **Abstraction-Guided Synthesis of Synchronization**. POPL 2010, ACM.
- F. Logozzo and T. Ball. **Modular and Verified Automatic Program Repair**. OOPSLA 2012, ACM.

Further reading

- V. Kuncak, M. Mayer, R. Piskac, and P. Suter. **Software Synthesis Procedures**. Communications of the ACM, 55(2), February 2012.
 - generating programs (Scala code) from logical constraints (specifications) based on decision procedures (SMT)
- P.A. Abdulla, M.F. Atig, Y.-F. Chen, C. Leonardsson, and A. Rezine. **Counter-Example Guided Fence Insertion under TSO**. TACAS 2012, LNCS 7214.
 - automatic inserting fences (barriers) to concurrent programs (TSO model)
 - goal: eliminate undesired and incorrect behavior (thread interleavings)
 - barrier prevents reordering instructions under the weak memory models
- P. Hawkins, A. Aiken, K. Fisher, M. Rinard, M. Sagiv. **Data Representation Synthesis**. PLDI 2011, ACM.
 - synthesizing low-level code for data representation and processing from high-level relational specification and client program
- A. Solar-Lezama. **Program Synthesis by Sketching**. PhD thesis, 2008.
 - <http://people.csail.mit.edu/asolar/papers/thesis.pdf>
- R. Alur, R. Singh, D. Fisman, and A. Solar-Lezama. **Search-based Program Synthesis**. Communications of the ACM, December 2018.
 - <https://cacm.acm.org/magazines/2018/12/232879-search-based-program-synthesis/>