Program Synthesis

http://d3s.mff.cuni.cz

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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


- 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

  - generating programs (Scala code) from logical constraints (specifications) based on decision procedures (SMT)

  - 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