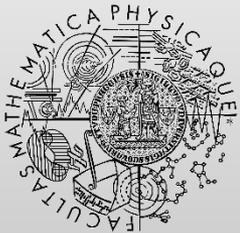# Program Synthesis

http://d3s.mff.cuni.cz

Department of
Distributed and
Dependable
Systems

D3S

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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)

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D3S

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)

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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/