Verification of Parallel C++ with DIVINE

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Introduction

- Why should we care about verification of (parallel) programs?
- What is DIVINE and how it can help?
- What is my work?

Is Testing Sufficient?

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however, testing has its downsides

- it cannot proof absence of bugs
- **not very efficient in problem discovery for parallel programs**

Parallel Programs

parallel programs are much harder to think about and debug

- the timing of the execution can influence results
  - *two threads writing to the same memory location*
- results for the same input can differ
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$\Rightarrow$ testing is not deterministic

- might not discover a bug
- test cannot be repeated with guarantee of the same results
- hard to debug from failed test

Explicit State Model Checking

a technique useful for verification of parallel programs

- explores all meaningful interleavings of the program
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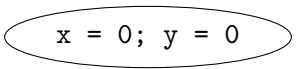

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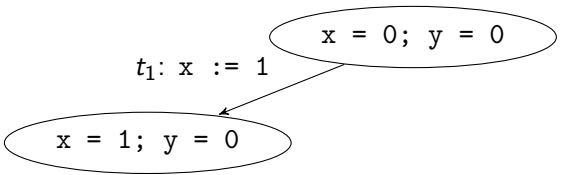

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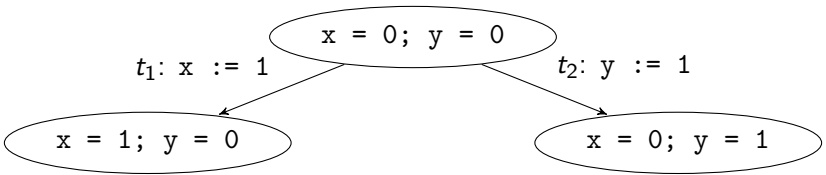

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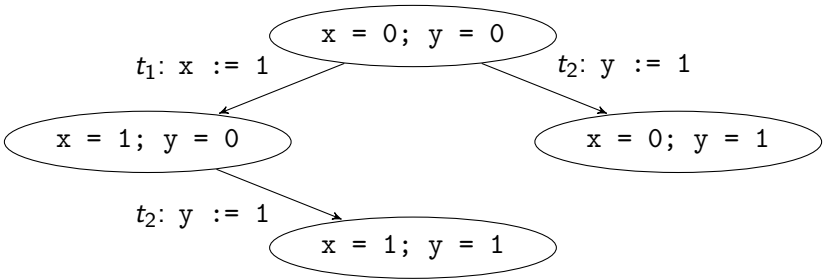

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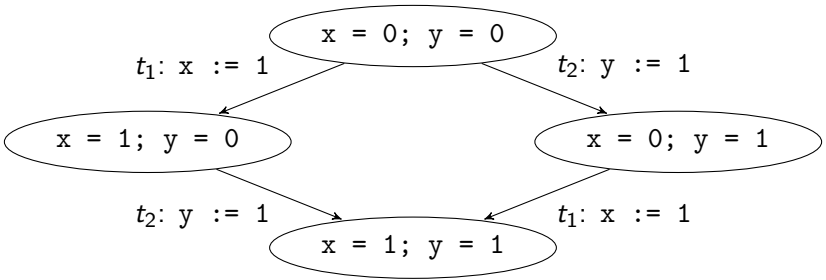

Model Checking in Practice?

traditionally, the program has to be translated to a modelling language

- extra effort (usually manual translation)
- not everything can be translated exactly
- translation can introduce or hide errors
- still useful in critical systems (modelling before development)

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solution: verify code in some programming language directly!

- program is verified directly, no need to model it
- should not limit the programmer to a subset of the language
- even more computationally expensive

- full support for C and C++ language features
- supports most of the standard C/C++ library and the `pthread` threading library
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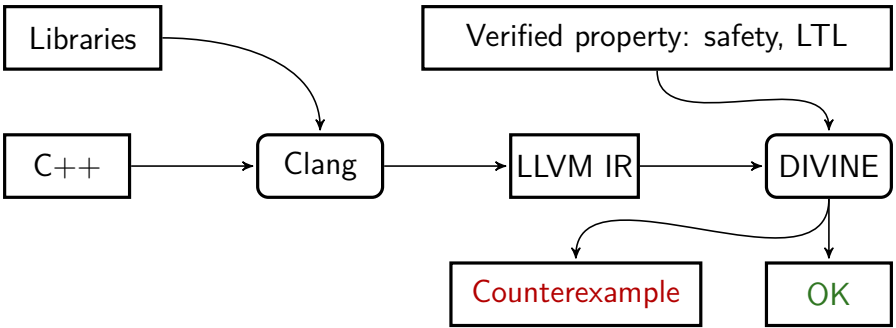
we aim at

- practical usability for unit testing of parallel programs
- and therefore adoption by programmers
- in future also support for programs with inputs

DIVINE Verification Workflow



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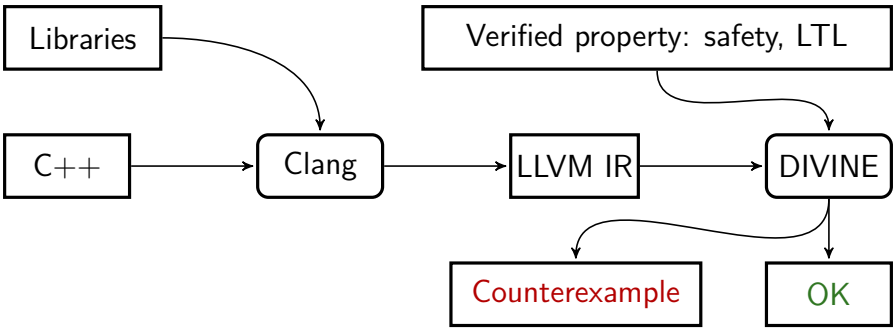

safety property: assertion safety, memory safety (dereference, array bounds, memory leaks), use of uninitialized memory, deadlocks, ...

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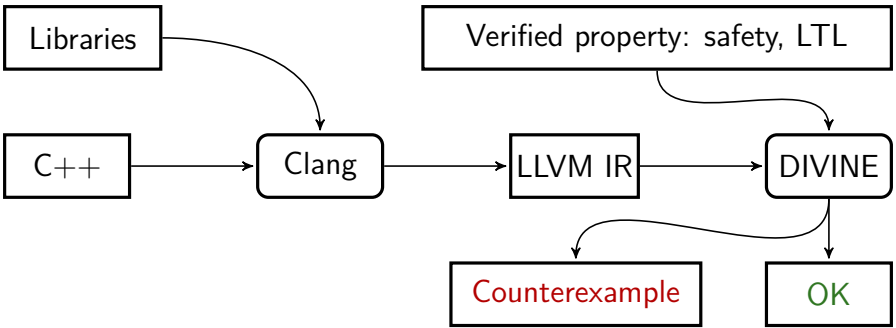

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LTL property: changes in time, i.e.: "after action A occurs, B must happen repeatedly"

My Work on DIVINE

during bachelor & masters studies

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- verification with relaxed memory models
- general maintenance

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Ph.D. research topic

- optimizations and transformations of the LLVM intermediate representation
  - to allow faster and more efficient verification
  - to be able to verify more properties
- general usability of DIVINE

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Thank you!