# Domain-Independent Interprocedural Program Analysis using Block-Abstraction Memoization

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# Software Verification

C Program

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void main() {
  uint a = nondet();
  uint b = nondet(a);
  uint s = sum(a, b);
  if (s != a + b) {
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}}
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Verification Tool

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specification is satisfied

FALSE

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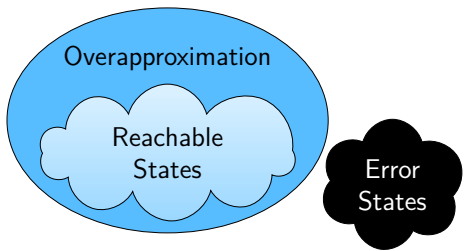
General method:
Create an overapproximation of the program states /
compute program invariants



# Example of an Analysis

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7    }
8  }
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10 uint sum(uint n, uint m) {
11   if (n == 0) {
12     return m;
13   } else {
14     uint tmp = sum(n - 1, m + 1);
15     return tmp;
16   }
17 }
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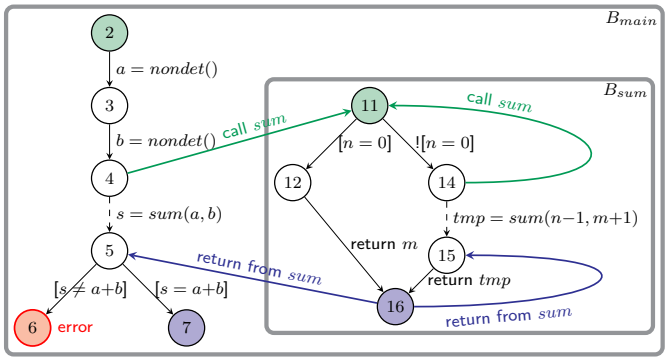


control-flow automaton

# Configurable Program Analysis (CPA)

[1, Beyer/Henzinger/Théoduloz, 2007]

CPA algorithm explores the abstract state space and defines operators for each specific domain

- *transfer*: successor computation
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- *stop*: coverage of abstract states

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X Not using block summaries: one analysis for the whole program

# Block-Abstraction Memoization (BAM)

[2, Wonisch/Wehrheim, 2012]

- split large verification task into smaller problems and solve them separately
- use CPA algorithm for a domain-specific analysis
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x Not interprocedural:
  - context relevant for block abstractions
  - colliding variable names from different procedure scopes

# Interprocedural Block-Abstraction Memoization

- based on BAM Intraprocedural

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Fixed-point algorithm:

- sound overapproximation of the recursive procedure

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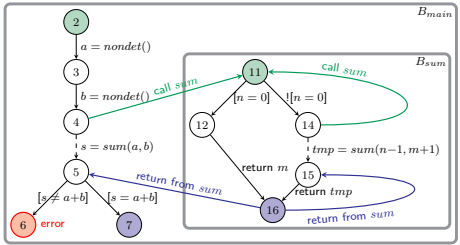


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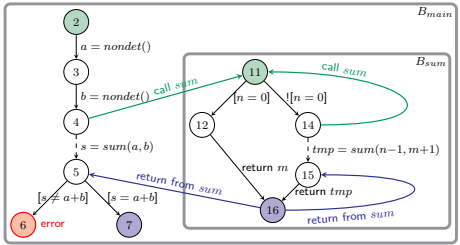


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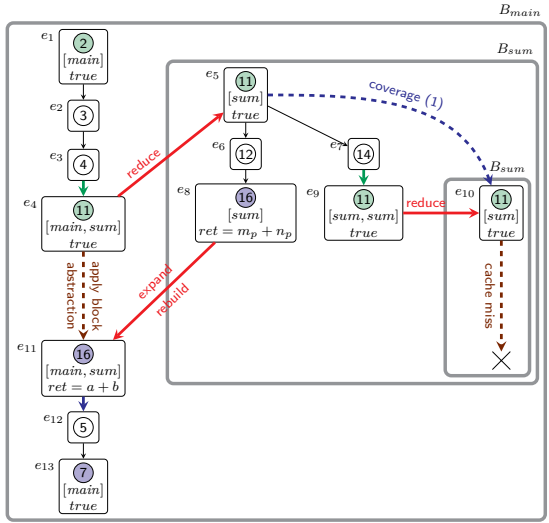


abstract reachability graph

Fixed-point algorithm
(first iteration)

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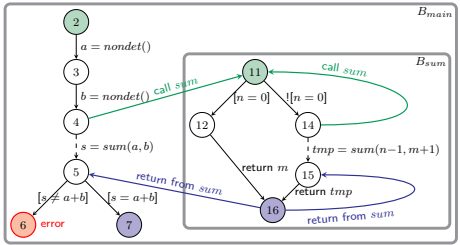


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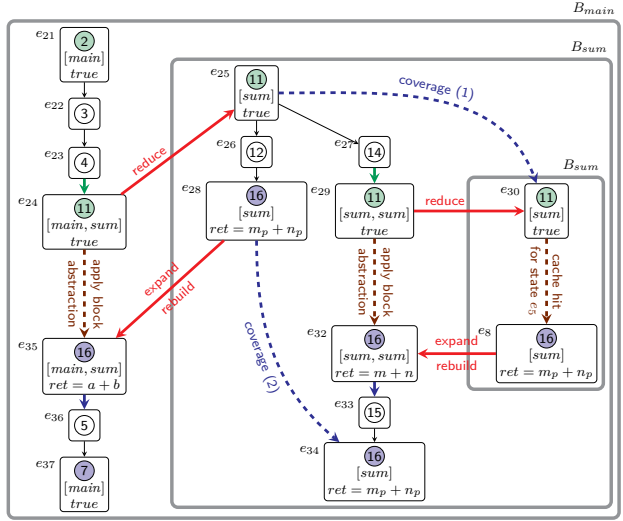


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  - witness validation
- implementation in the open-source framework CPAchecker

# Evaluation: CPAchecker vs. Tools of SV-COMP 2020

| Verifier | CPU time (s) | Proofs | Bugs |
|---|---|---|---|
| CBMC | 662 | 32 | 47 |
| CPACHECKER (Value+Predicate) | 2 180 | 37 | 46 |
| DIVINE | 1 190 | 32 | 42 |
| ESBMC | 941 | 33 | 47 |
| MAP2CHECK | 23 600 | 34 | 37 |
| PINAKA | 237 | 31 | 31 |
| SYMBIOTIC | 138 | 33 | 45 |
| UAUTOMIZER | 2 160 | 41 | 37 |
| VERIABS | 7 630 | 41 | 46 |

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- support for recursive tasks
- negligible overhead
- competitive performance on a large set of benchmarks

# References

- Domain-Independent Interprocedural Program Analysis using Block-Abstraction Memoization
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- Reproduction Package:
  doi:10.5281/zenodo.4024268


- CPAchecker
  https://cpachecker.sosy-lab.org/

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