CoVeriTeam

On-Demand Composition of Cooperative Verification Systems

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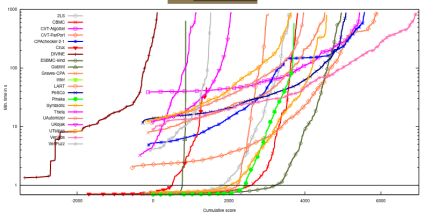
CPA

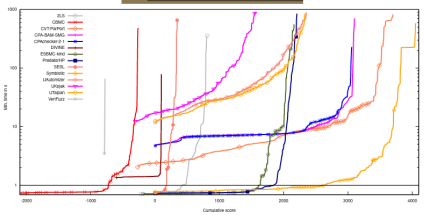
SoSy-Lab Software Systems

Many Verifiers with Different Strengths

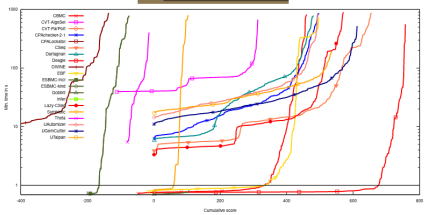
ReachSafety
1. VeriAbs
2. CPAchecker 2.1
3. PeSCo



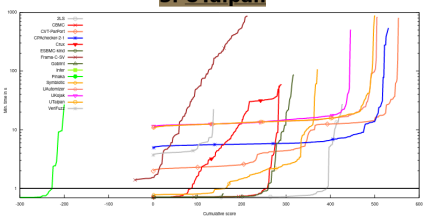
MemSafety
1. Symbiotic
2. CPA-BAM-SMG
3. CPAchecker 2.1



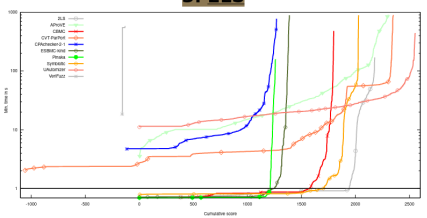
ConcurrencySafety
1. Deagle
2. CSeq
3. UGemCutter



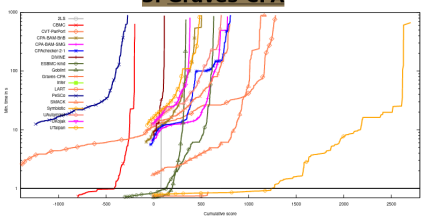
NoOverflows
1. CPAchecker 2.1
2. UAutomizer
3. UTaipan



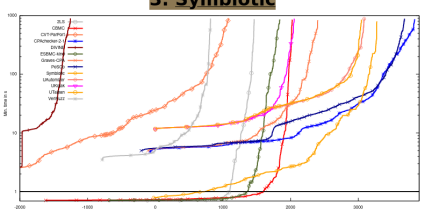
Termination
1. UAutomizer
2. AProVE
3. 2LS



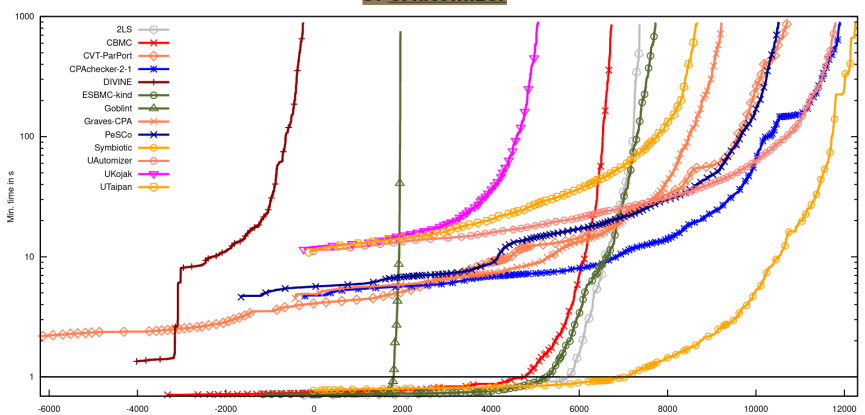
SoftwareSystems
1. Symbiotic
2. CPAchecker 2.1
3. Graves-CPA



FalsificationOverall
1. CPAchecker 2.1
2. PeSCo
3. Symbiotic



Overall
1. Symbiotic
2. CPAchecker 2.1
3. UAutomizer



https://sv-comp.sosy-lab.org/2022/results

Many Verifiers Combine Techniques

Verifier	CEGAR	Predicate Abstraction	Symbolic Execution	Bounded Model Checking	k-Induction	Property-Directed Reach.	Explicit-Value Analysis	Numeric. Interval Analysis	Shape Analysis	Separation Logic	Bit-Precise Analysis	ARG-Based Analysis	Lazy Abstraction	Interpolation	Automata-Based Analysis	Concurrency Support	Ranking Functions	Evolutionary Algorithms	Algorithm Selection	Portfolio
2LS				✓	✓			✓	✓		✓						✓			
APROVE			✓				✓	✓		✓	✓						✓			
BRICK	✓		✓	✓				✓								✓				
CBMC				✓							✓					✓				
COASTAL[∅]			✓																	
CVT-ALGOSEL[new∅]	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
CVT-PARPORT[new∅]	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓
CPA-BAM-BNB[∅]	✓	✓					✓				✓	✓	✓	✓						
CPA-BAM-SMG[new]																				
CPALOCKATOR[∅]	✓	✓					✓				✓	✓	✓	✓		✓				
CPACHECKER	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓
CRUX[new]			✓																	
CSEQ				✓							✓					✓				
DARTAGNAN				✓							✓					✓				
DEAGLE[new]																				
DIVINE[∅]			✓				✓				✓					✓			✓	✓
EBF[new]				✓																
ESBMC-INCR[∅]				✓	✓						✓					✓				
ESBMC-KIND				✓	✓			✓			✓					✓				
FRAMA-C-SV								✓												
GAZER-THETA[∅]	✓	✓		✓			✓				✓	✓	✓	✓						✓
GDART[new]			✓								✓									✓
GOBLINT								✓								✓				
GRAVES-CPA[new]	✓	✓		✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓

Competition Report [1]

https://doi.org/10.1007/978-3-030-99527-0_20

Examples of Tool Combinations from Literature

Technique	Year
Counterexample Checking [15]	2012
Conditional Model Checking [6]	2012
Precision Reuse [12]	2013
Witness Validation [3, 2]	2015, 2016
Execution-Based Validation [4]	2018
Reducer [8]	2018
CoVeriTest [7]	2019
CondTest [11]	2019
MetaVal [14]	2020

Motivation for CoVeriTeam

Tool combinations were developed *ad hoc*. We missed

- a conceptual framework for composing verification tools
- a common interface for tools
- mechanisms safeguarding from undesirable side effects of tool execution in the combinations

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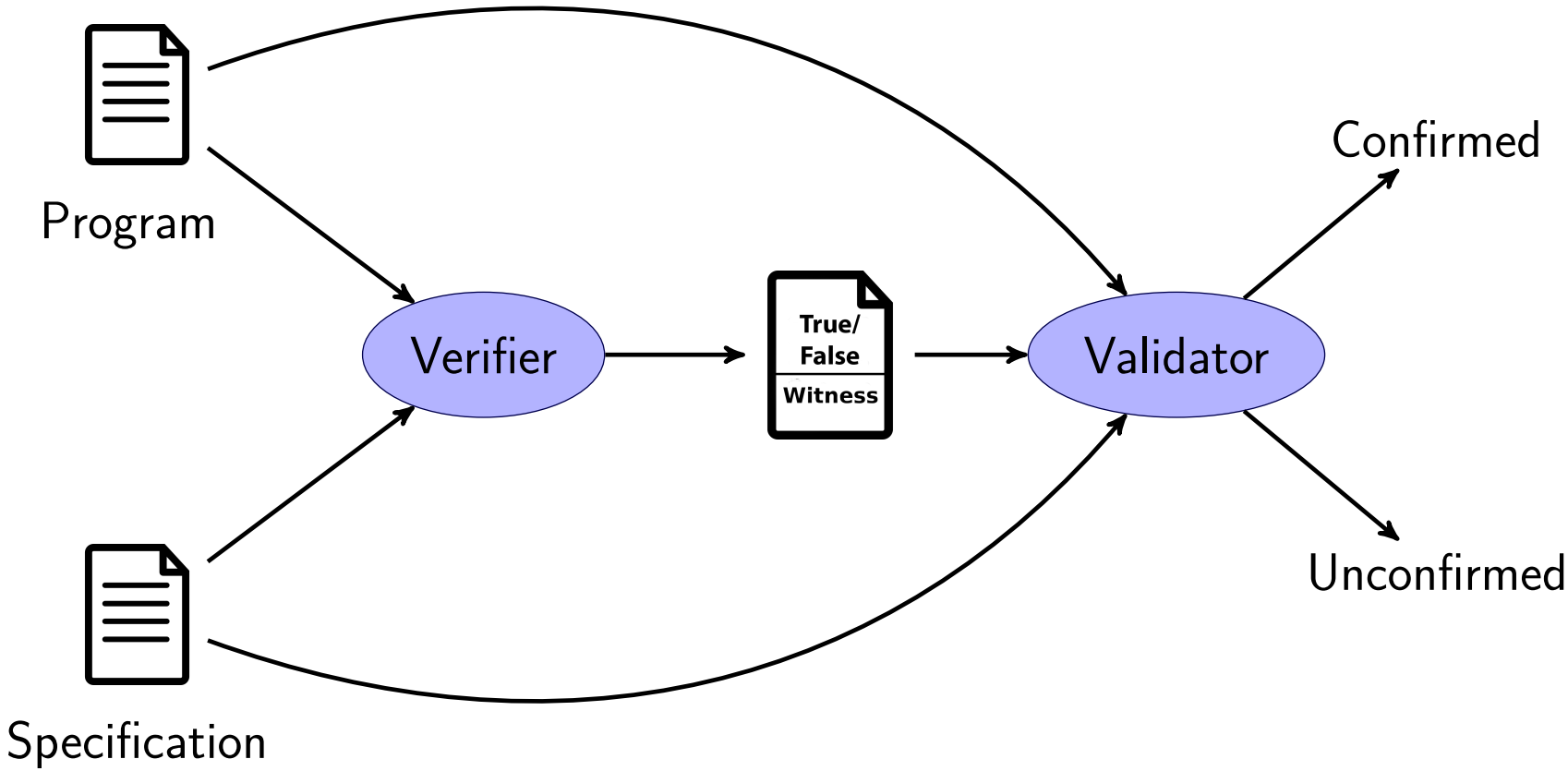
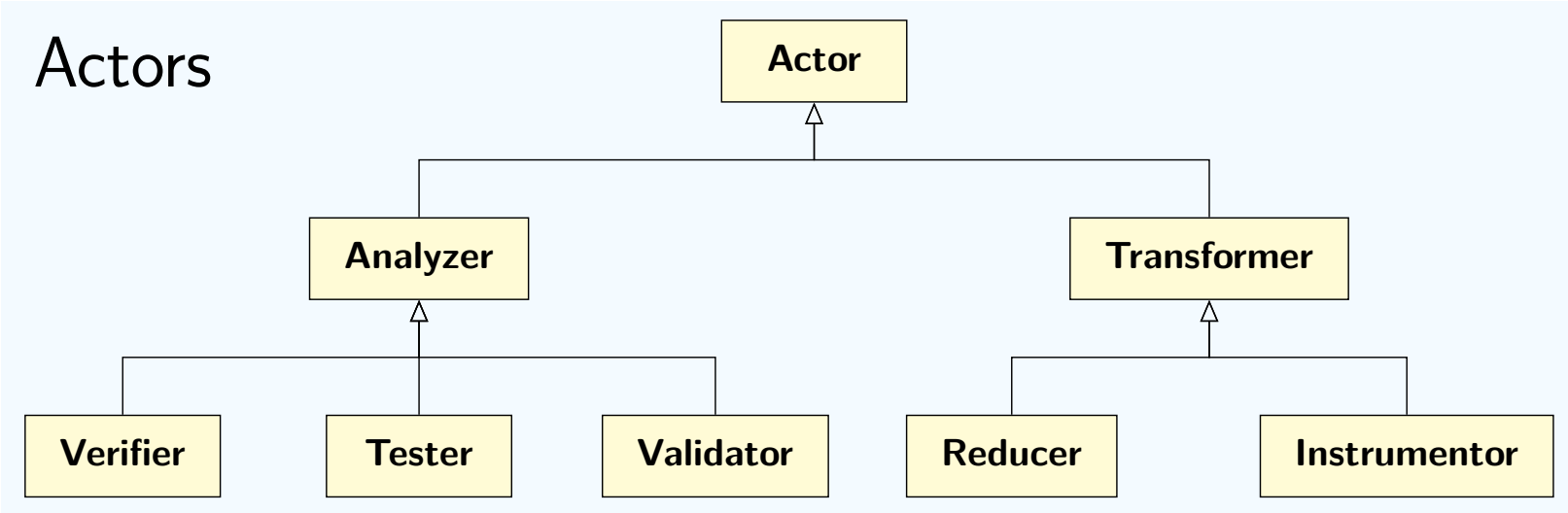
CoVeriTeam aims to make developing tool combinations systematic and easy to maintain.

Running Example

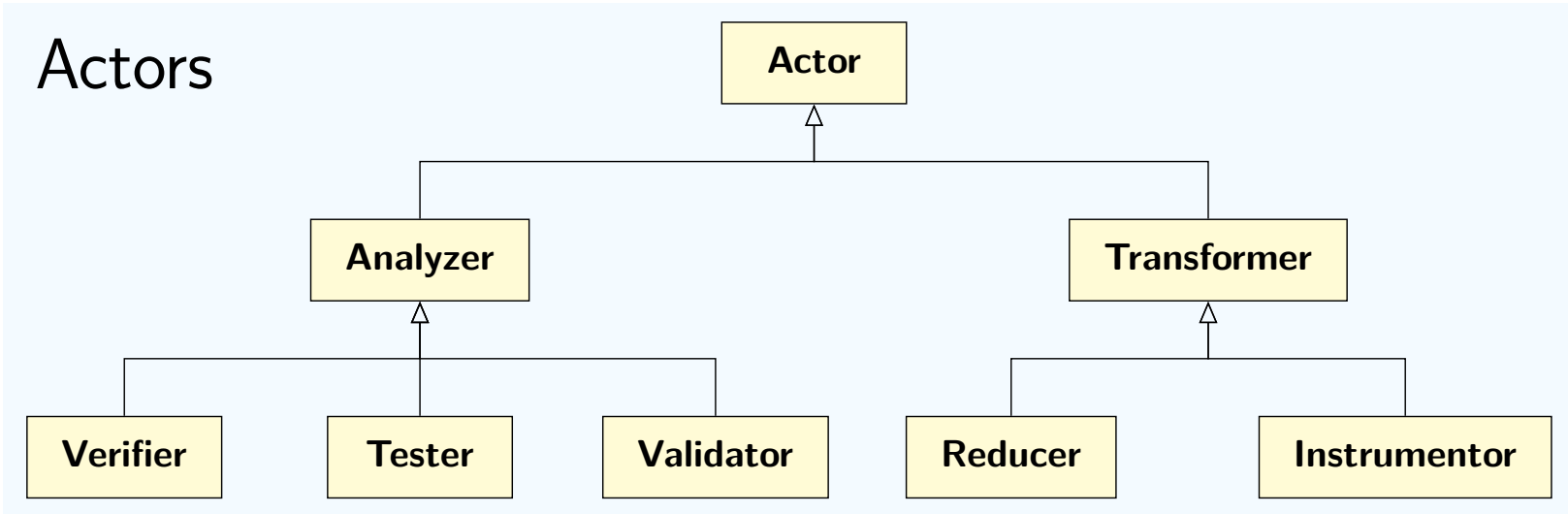


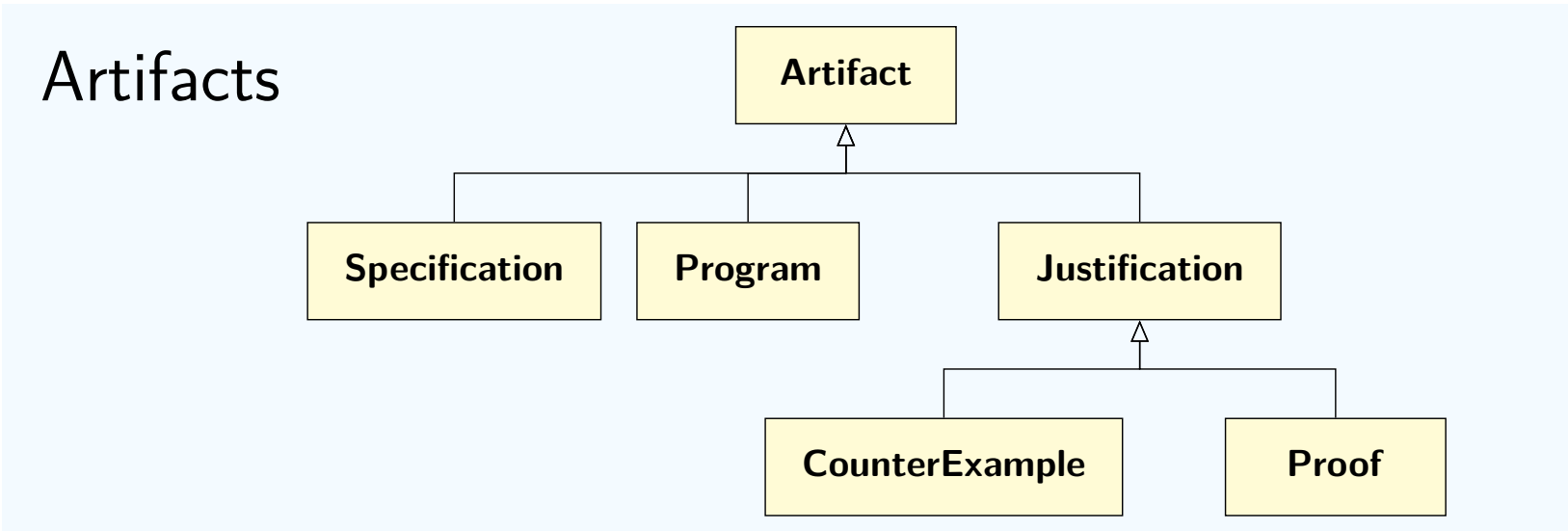
Witness validation

Simplified Domain Model

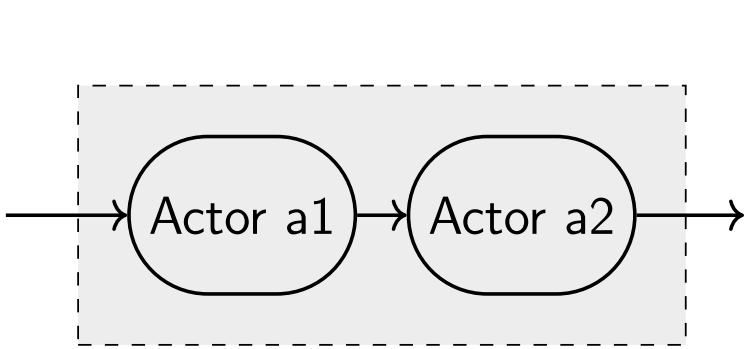


Simplified Domain Model

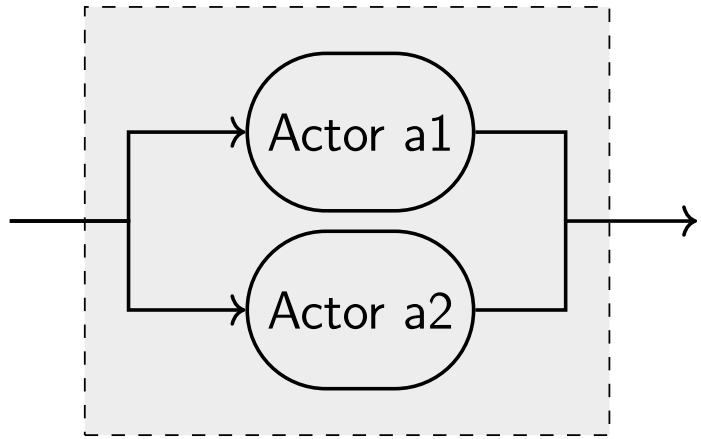




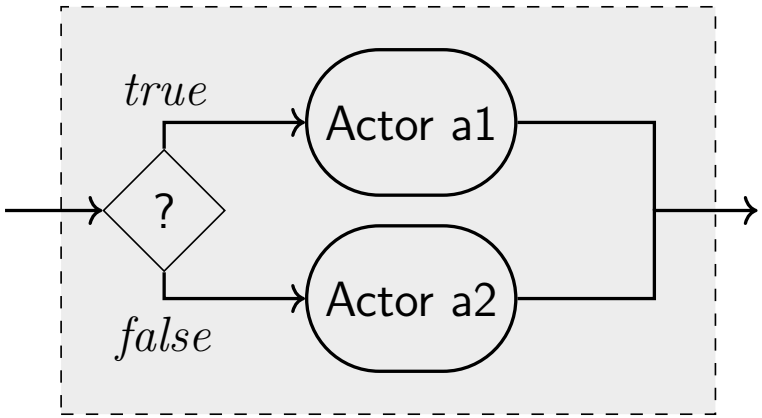
Compositions



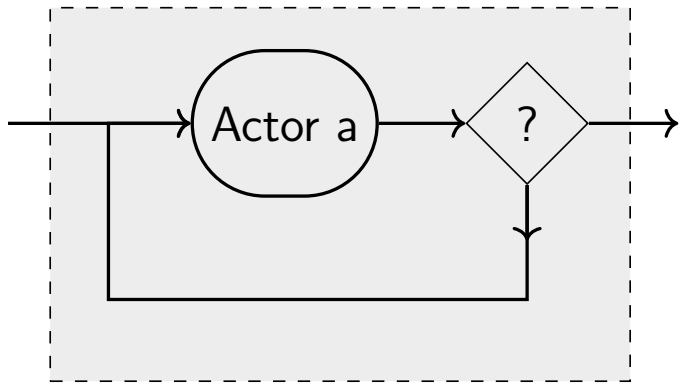
(a) SEQUENCE



(b) PARALLEL



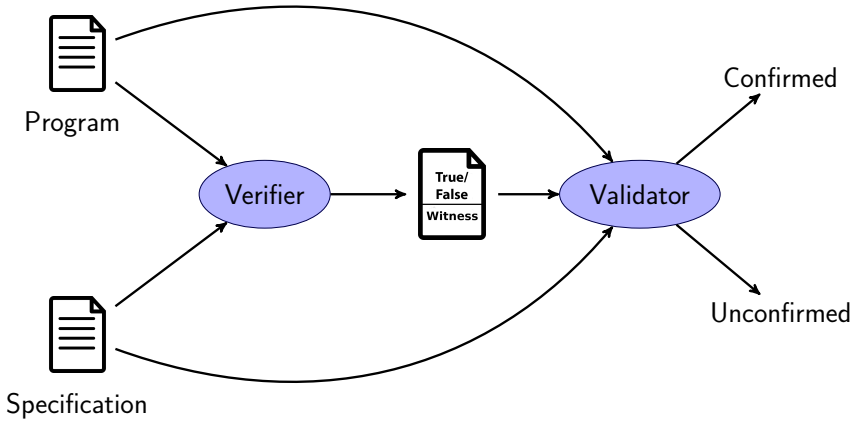
(c) ITE

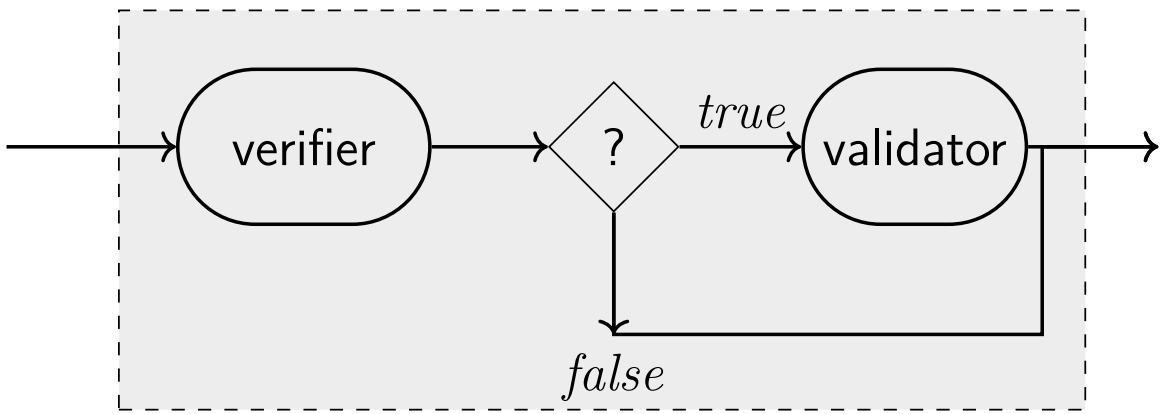


(d) REPEAT

Compositions in CoVeriTeam

Running Example





Running Example in CoVeriTeam

```
// Create actors
verifier = ...
validator = ...

// Prepare inputs
prog = ...
spec = ...
inputs = {'program':prog, 'spec':spec};

// Use validator if verdict is true or false
condition = ELEMENTOF(verdict, {TRUE, FALSE});
second_component = ITE(condition, validator);
// Verifier and second component to be executed in sequence
validating_verifier = SEQUENCE(verifier, second_component);

// Execute the new component on the inputs
res = execute(validating_verifier, inputs);
print(res);
```

Running Example in CoVeriTeam Language

Actor Execution

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Reusing features from BenchExec [13],

- tool-info modules
  - prepare the command for the tool
  - parse tool output

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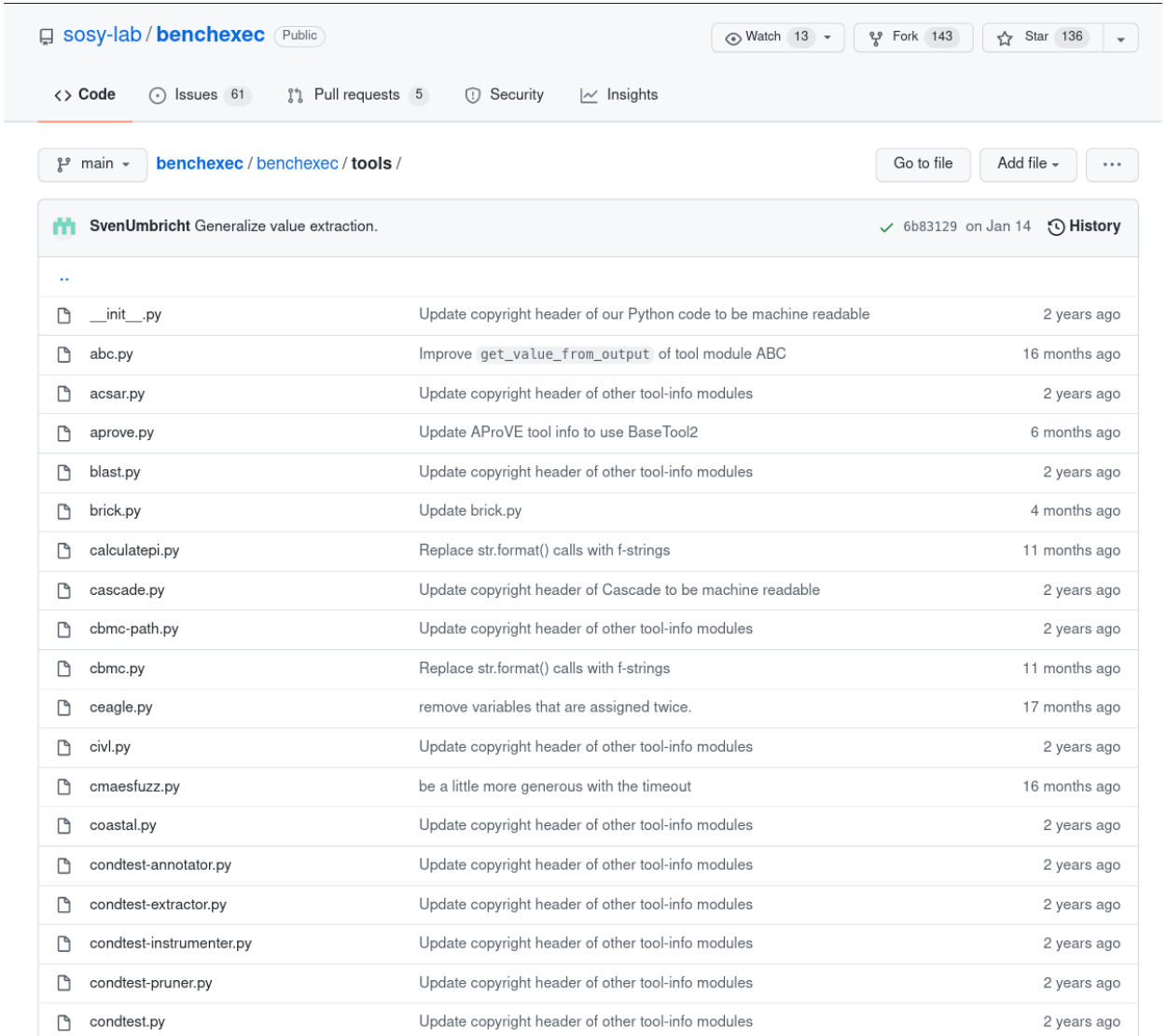
Reusing features from BenchExec [13],

- tool-info modules
  - prepare the command for the tool
  - parse tool output
- RunExec
  - execute tools in isolation
  - measure resource consumption
  - enforce resource limits

Tool-info Module



sosy-lab / **benchexec** Public

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Code | Issues 61 | Pull requests 5 | Security | Insights

main | **benchexec** / benchexec / **tools** / | Go to file | Add file | ...

SvenUmbricht Generalize value extraction. 6b83129 on Jan 14 **History**

..		
__init__.py	Update copyright header of our Python code to be machine readable	2 years ago
abc.py	Improve `get_value_from_output` of tool module ABC	16 months ago
acsar.py	Update copyright header of other tool-info modules	2 years ago
aprove.py	Update AProVE tool info to use BaseTool2	6 months ago
blast.py	Update copyright header of other tool-info modules	2 years ago
brick.py	Update brick.py	4 months ago
calculatepi.py	Replace str.format() calls with f-strings	11 months ago
cascade.py	Update copyright header of Cascade to be machine readable	2 years ago
cbmc-path.py	Update copyright header of other tool-info modules	2 years ago
cbmc.py	Replace str.format() calls with f-strings	11 months ago
ceagle.py	remove variables that are assigned twice.	17 months ago
civl.py	Update copyright header of other tool-info modules	2 years ago
cmaesfuzz.py	be a little more generous with the timeout	16 months ago
coastal.py	Update copyright header of other tool-info modules	2 years ago
condtest-annotator.py	Update copyright header of other tool-info modules	2 years ago
condtest-extractor.py	Update copyright header of other tool-info modules	2 years ago
condtest-instrumenter.py	Update copyright header of other tool-info modules	2 years ago
condtest-pruner.py	Update copyright header of other tool-info modules	2 years ago
condtest.py	Update copyright header of other tool-info modules	2 years ago

Using tool-info modules gives us integration with many well known verification tools without any effort.

Actor Definition

```yaml
actor_name: uautomizer
toolinfo_module: "ultimateautomizer.py"
archives:
  - version: default
    location: "https://.../uautomizer.zip"
  - version: svcomp22
    doi: "10.5281/zenodo.5898989"
options: ['--full-output']
resourcelimits:
  memlimit: "8 GB"
  timelimit: "2 min"
format_version: '1.2'
```

YAML configuration for an atomic actor

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Running Example in CoVeriTeam

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2  verifier = ActorFactory.create(ProgramVerifier,
       "actors/uautomizer.yml");
3  validator = ActorFactory.create(ProgramValidator,
       "actors/cpa-validate-violation-witnesses.yml");
4
5  // Prepare inputs
6  prog = ArtifactFactory.create(CProgram, prog_path);
7  spec = ArtifactFactory.create(BehaviorSpecification, spec_path);
8  inputs = {'program':prog, 'spec':spec};
9
10 // Use validator if verdict is true or false
11 condition = ELEMENTOF(verdict, {TRUE, FALSE});
12 second_component = ITE(condition, validator);
13 // Verifier and second component to be executed in sequence
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Running Example in CoVeriTeam Language

Evaluation Through Case Studies

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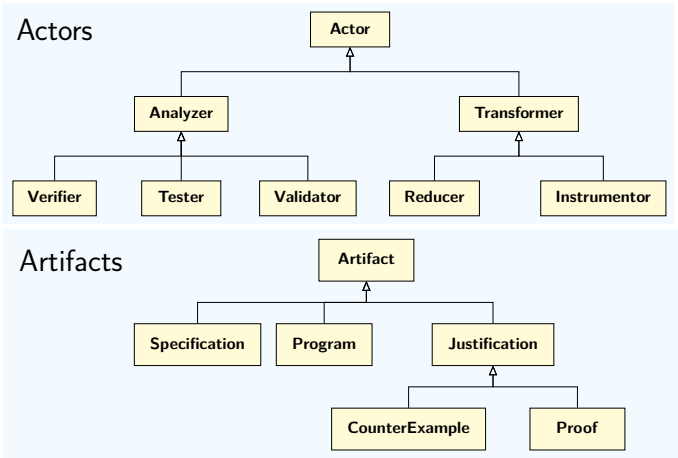
Execution-Based Validation [4]	2018	✓	
Reducer [8]	2018	✓	
CoVeriTest [7]	2019		
CondTest [11]	2019	✓	
MetaVal [14]	2020	✓	

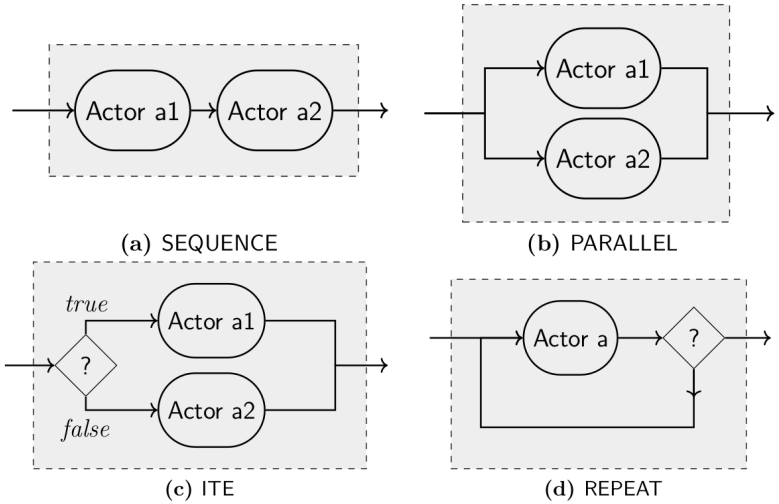
Impact

CoVeriTeam was used in:

- scientific research
  - *Construction of Verifier Combinations Based on Off-the-Shelf Verifiers* at FASE '22 [10]
  - *Decomposing Software Verification into Off-the-Shelf Components: An Application to CEGAR* at ICSE '22 [5]
- part of the workflow of software-verification competitions for last two years [1]

Conclusion



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Reducer [8]	2018	✓	
CoVeriTest [7]	2019		
CondTest [11]	2019	✓	
MetaVal [14]	2020	✓	

GitLab

https://gitlab.com/sosy-lab/software/coveriteam/

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