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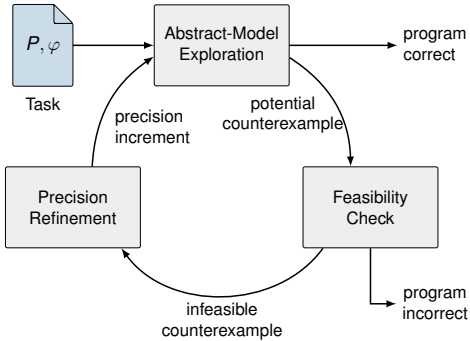
Component-based CEGAR

(under review)

Dirk Beyer, Jan Haltermann,
Thomas Lemberger, Heike Wehrheim
01.10.2021

Motivation: Classic CEGAR



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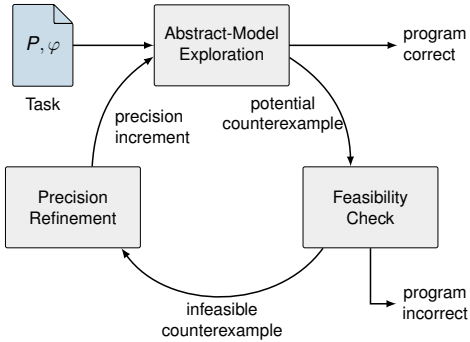
Motivation: Classic CEGAR - Problem



Problem:

- Many tools employ CEGAR (statefull)
- Common underlying schema
- New idea $\Rightarrow$ New Implementation

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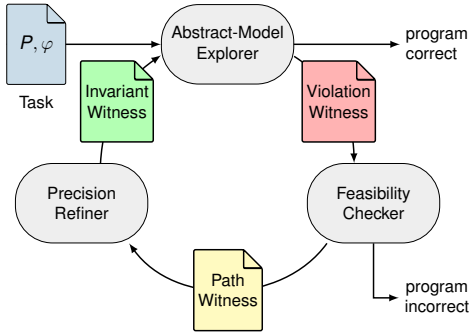
Component-based CEGAR (C-CEAR)



Defined components and interfaces:

- Components (stateless):
  - Abstract Model Explorer
  - Feasibility Checker
  - Precision Refiner
- Interfaces (existing formats):
  - Violation Witness
  - Path Witness
  - Invariant Witness
- Construction for off-the-shelf components

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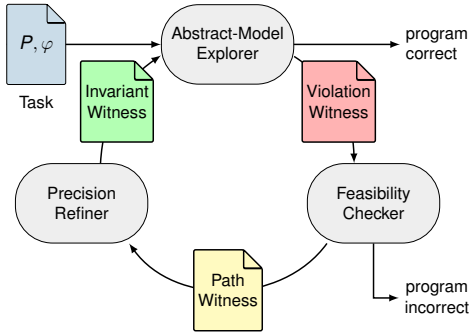
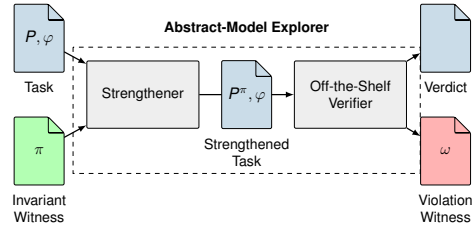
Usage of Off-the-Shelf Components - Model Explorer





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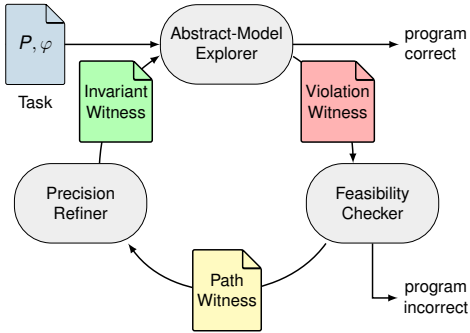
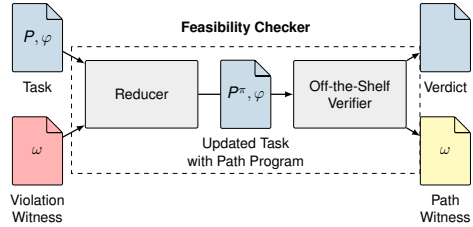
Usage of Off-the-Shelf Components - Feasibility Checker





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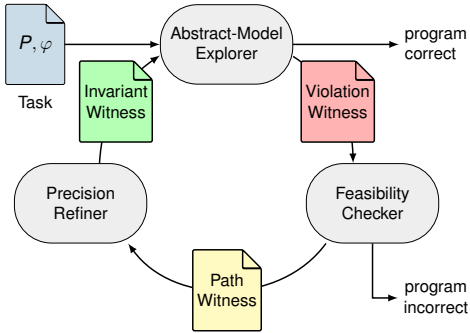
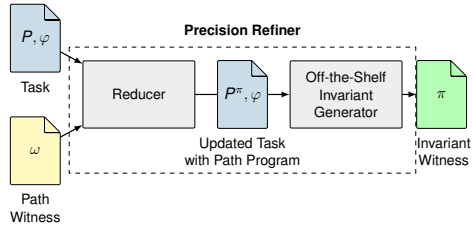
Usage of Off-the-Shelf Components - Precision Refiner





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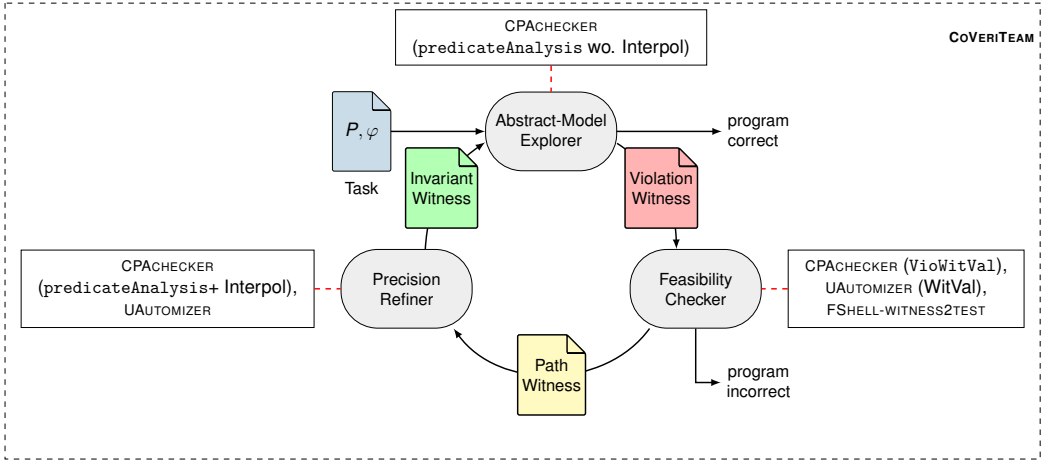
Implementation



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Evaluation

Reasearch Questions:

- RQ1: Overhead of a component-based approach (with predmap)
- RQ2: Cost using existing formats
- RQ3: Use of off-the-shelf components

Dataset: SV-BENCHMARKS (4510 tasks), SV-COMP setting

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RQ1: Overhead of component based design

		correct		incorrect	
	overall	**proof**	**alarm**	**proof**	**alarm**
Pred	2 183	1 343	840	0	7
C-Pred	2 105	1 297	808	0	2

(Using predmap as exchange format)

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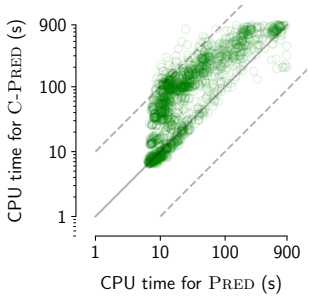
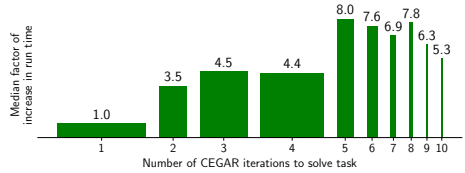
RQ1: Overhead of component based design



Comparison of CPU time for Pred and C-Pred



Median factor of run-time increase by C-Pred compared to Pred.
Overall median increase is 3.2

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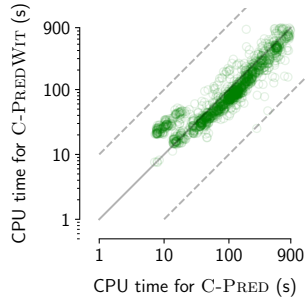
RQ2: Cost of Standardized Formats

	overall	correct proof	alarm
C-Pred	2 105	1 297	808
C-PredWit	1 573	978	595

- Effectiveness reduces by 25%
- Reasons:
  - Not all predicates discovered are exported
  - No loop unrollings in witness



Comparison of CPU time for C-Pred and C-PredWit

RQ3: C-Cegar using different components

RQ 3.1: C-PredWit + different feasibility checker (with precision refiner CPACHECKER)

		correct			
	overall	**proof**	unique	**alarm**	unique
CPACHECKER	1 573	978	61	595	317
FSHELL-WITNESS2TEST	612	515	0	97	56
UAUTOMIZER	1 225	918	1	307	20

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RQ3: C-Cegar using different components

RQ 3.2: C-PredWit + different precision refiner (with feasibility checker CPACHECKER)

	overall	**proof**	unique	**correct alarm**	unique
CPACHECKER	1 573	978	301	595	303
UAUTOMIZER	1 016	716	41	300	6

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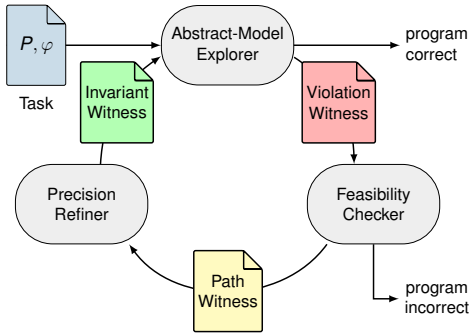
Summary - C-CEGAR



- Clear defined components and interfaces
- Implementation in CoVeriTeam
- Evaluation show advantages:
  - Same expressiveness (with lower efficiency (3.2))
  - Existing formats can be used
  - Usage of existing off-the-shelf components
- Starting point for further development

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