

From **C**onfigurable Towards Self-configuring **P**rogram **A**nalysis

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Paderborn University

5th International Workshop on CPAchecker

September 28th/29th, 2020

Configurable Program Analysis

Concolic Execution

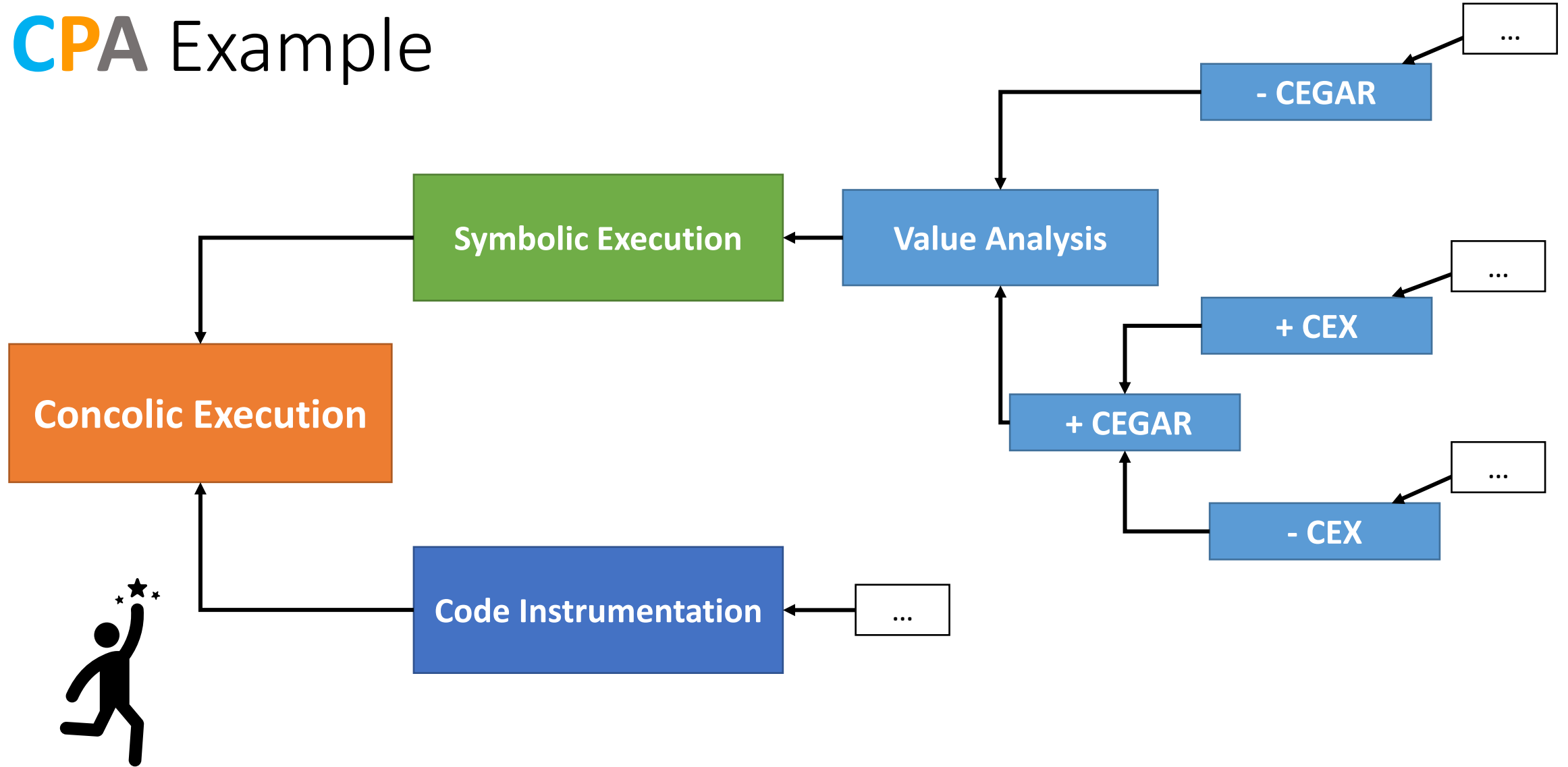


CPA ✓



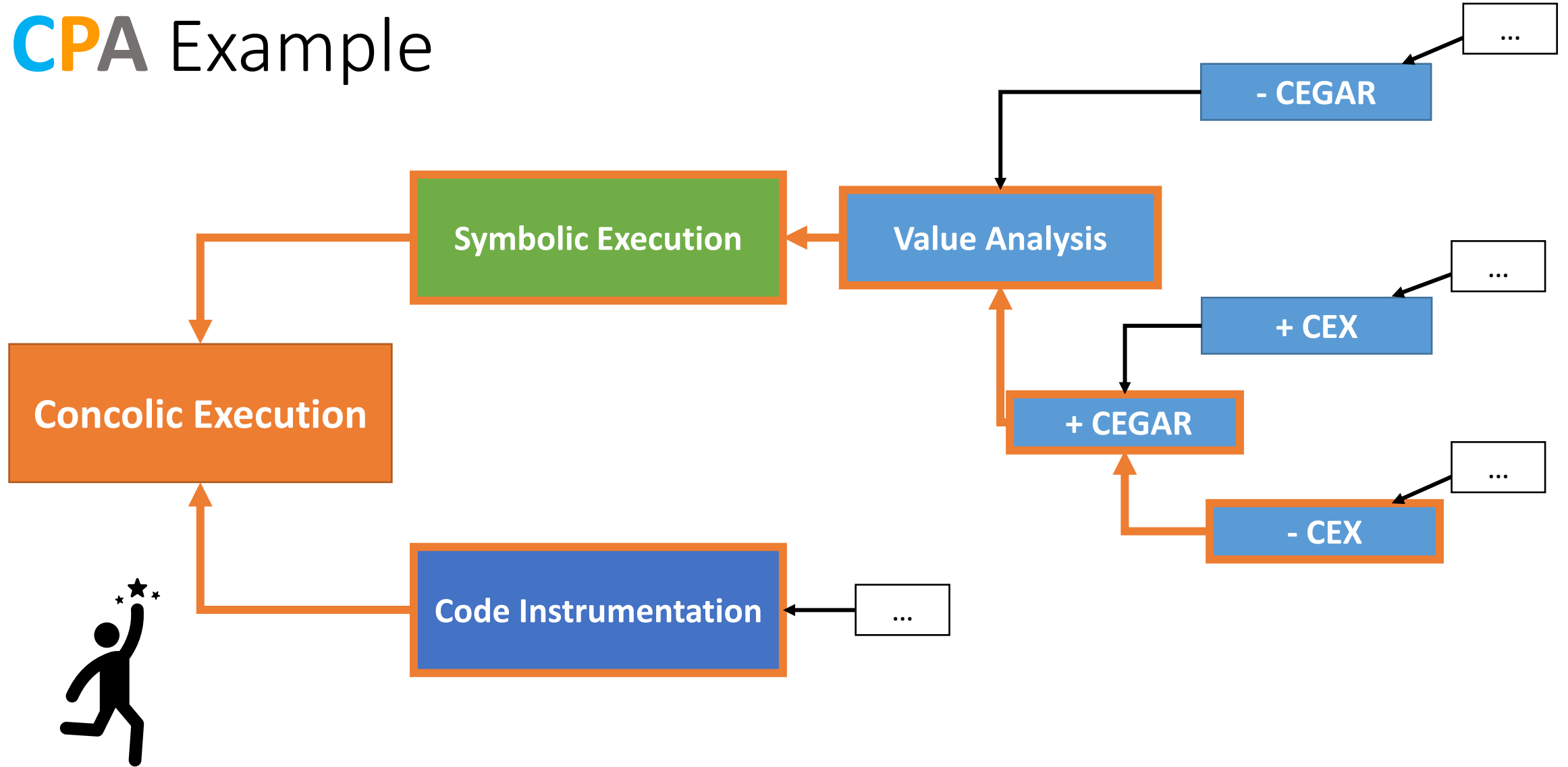
CPA Developer

CPA Example



CPA Developer

CPA Example



CPA Developer

CPA Example

Concolic Execution



Benchmark
(SV-COMP)

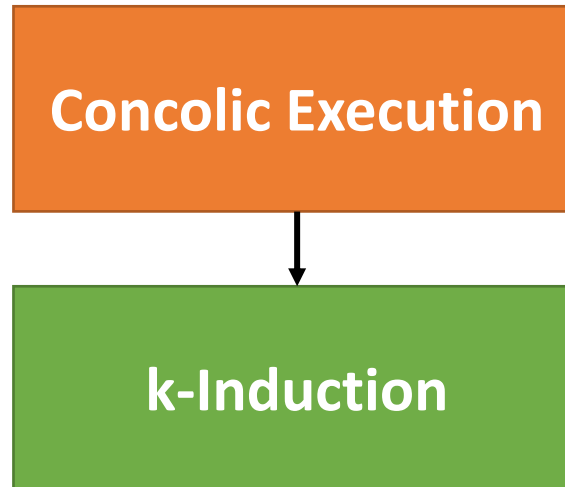


Improvements 😊
Failures ☹️



1.5 months

CPA Tinkering

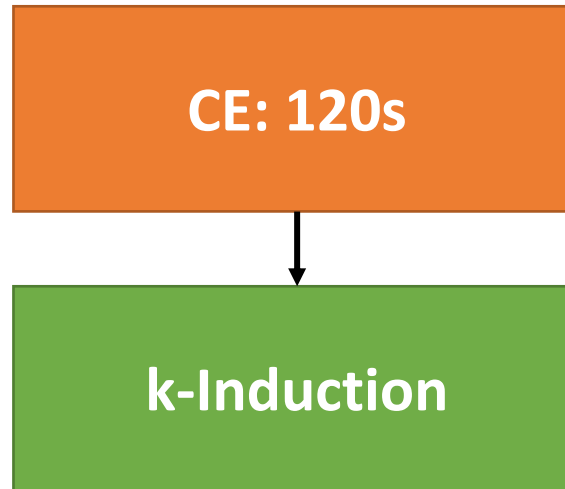


Failures:
k-Induction has not enough time



3 month

CPA Tinkering

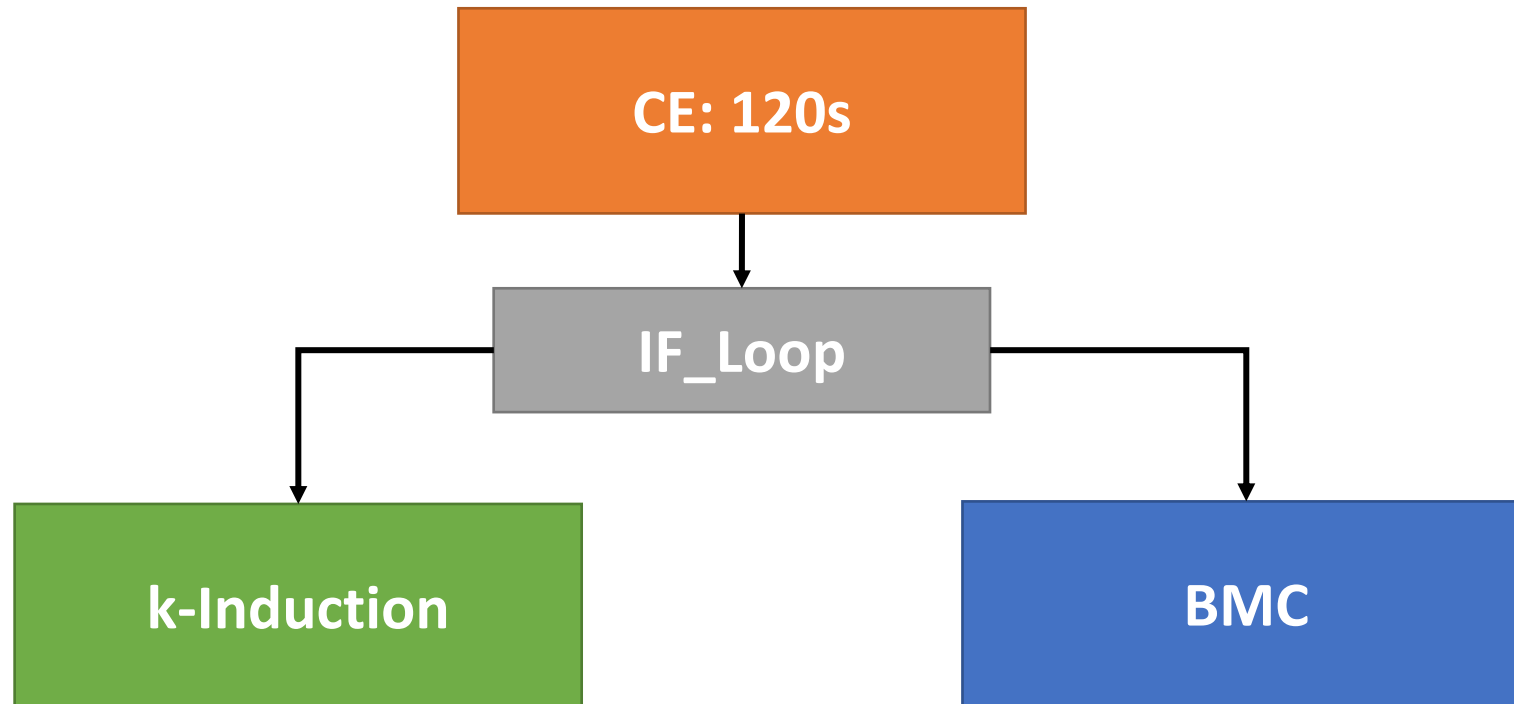


Failures:
k-Induction takes a lot of time



4.5 month

CPA Tinkering



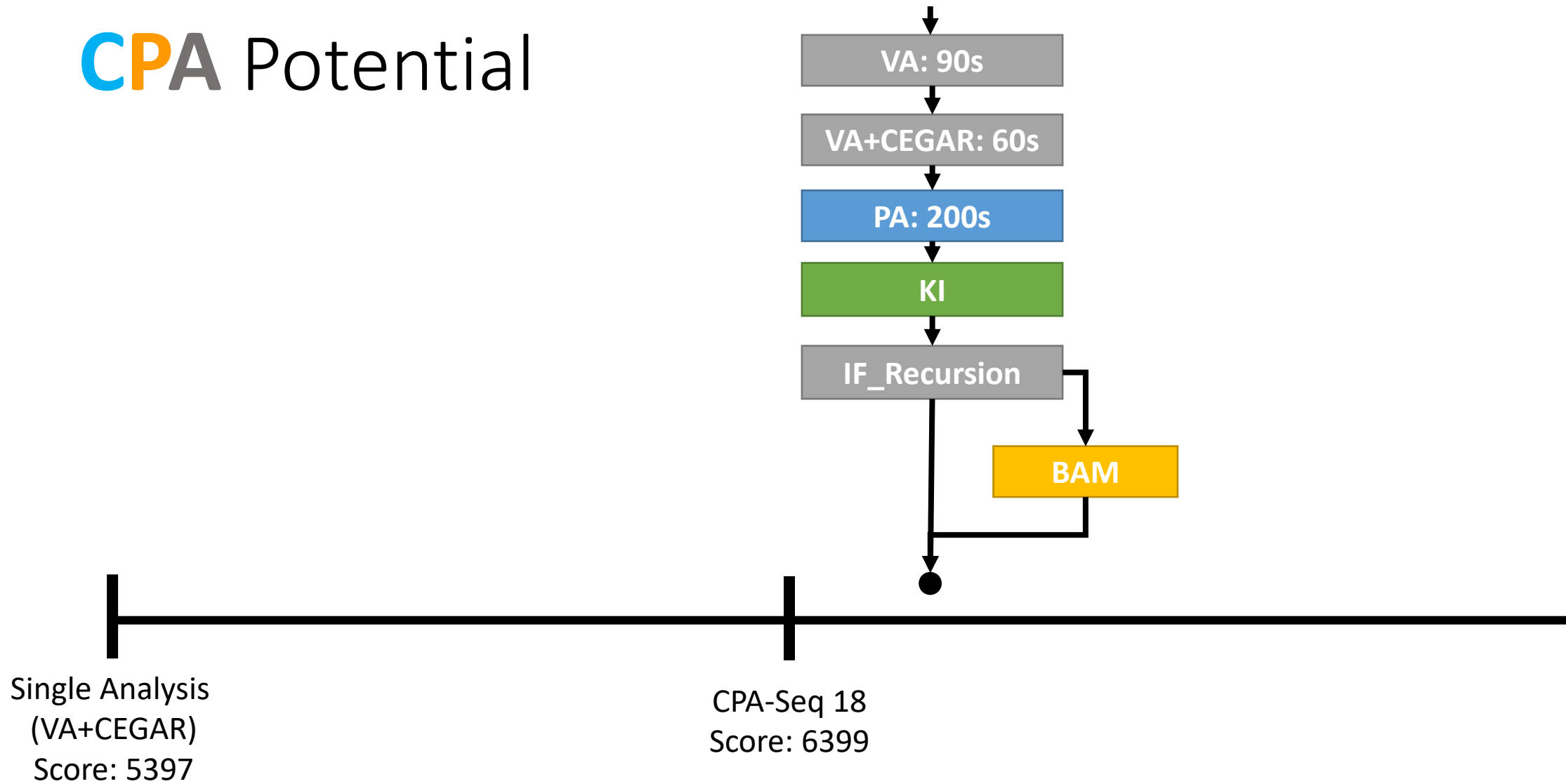
6 month

CPA Potential

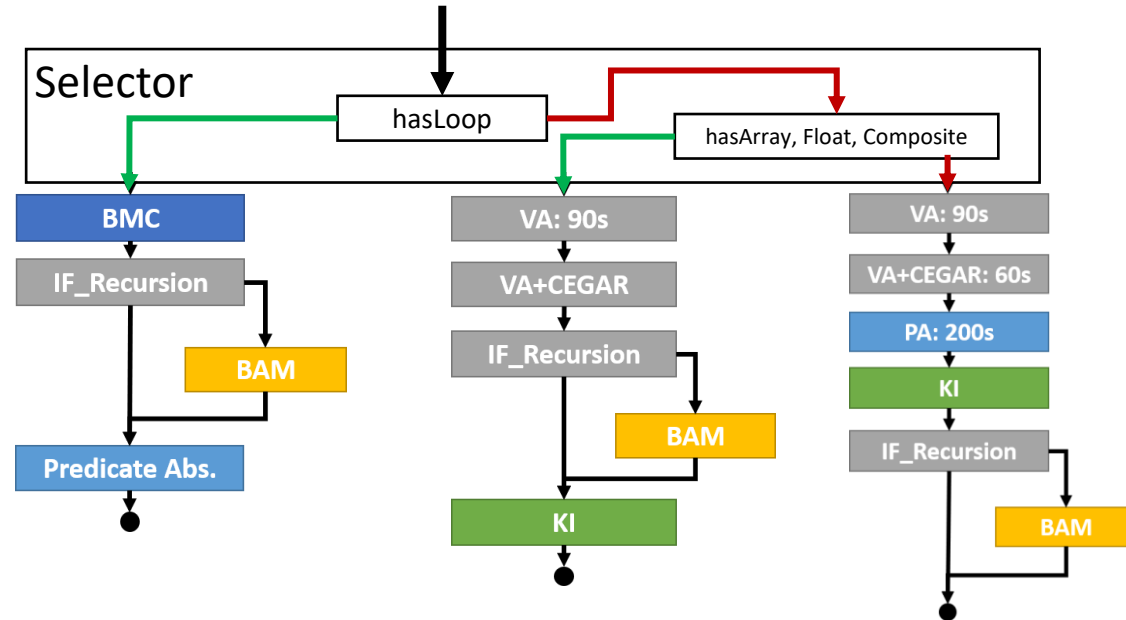
VA+CEGAR

Single Analysis
(VA+CEGAR)
Score: 5397

CPA Potential



CPA Potential

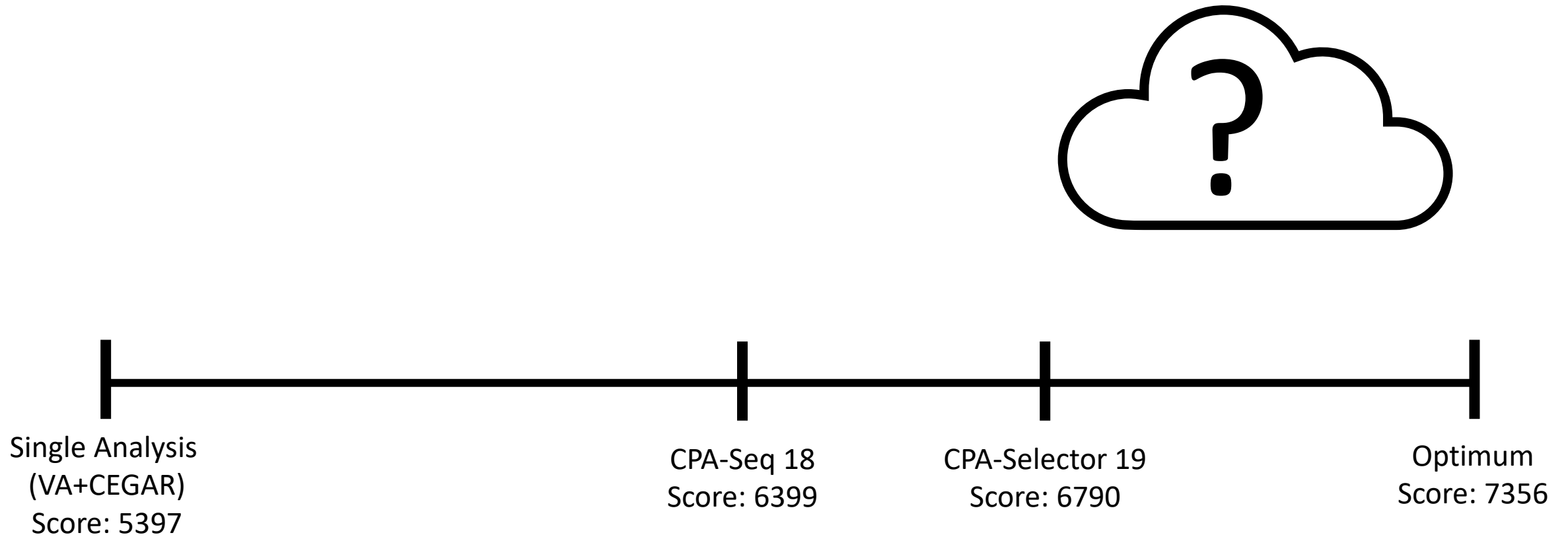


Single Analysis
(VA+CEGAR)
Score: 5397

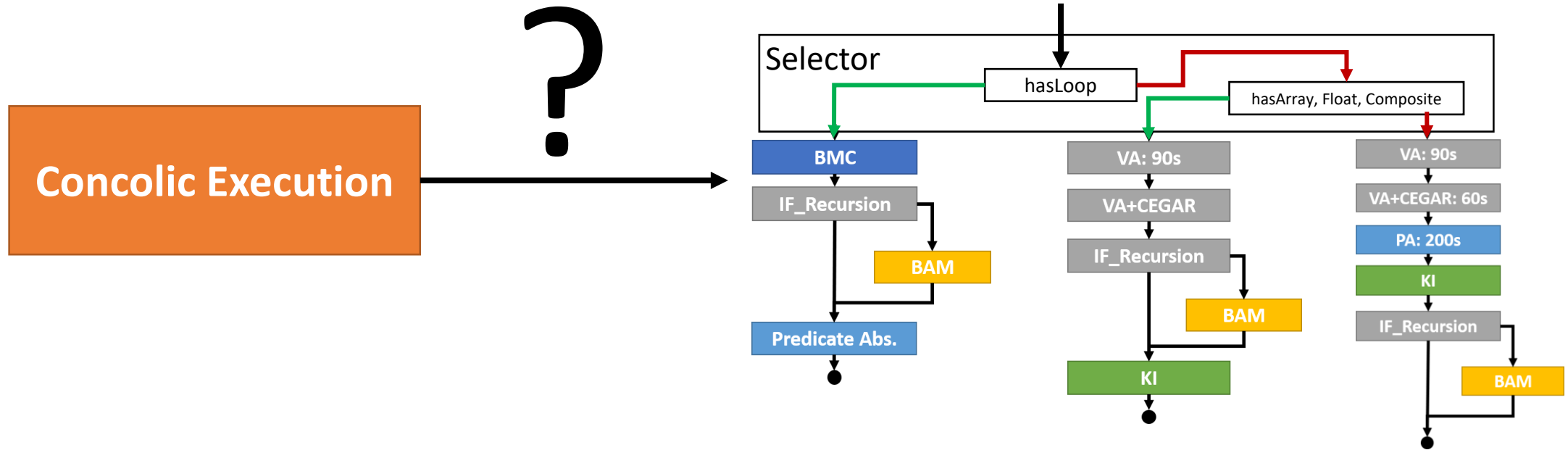
CPA-Seq 18
Score: 6399

CPA-Selector 19
Score: 6790

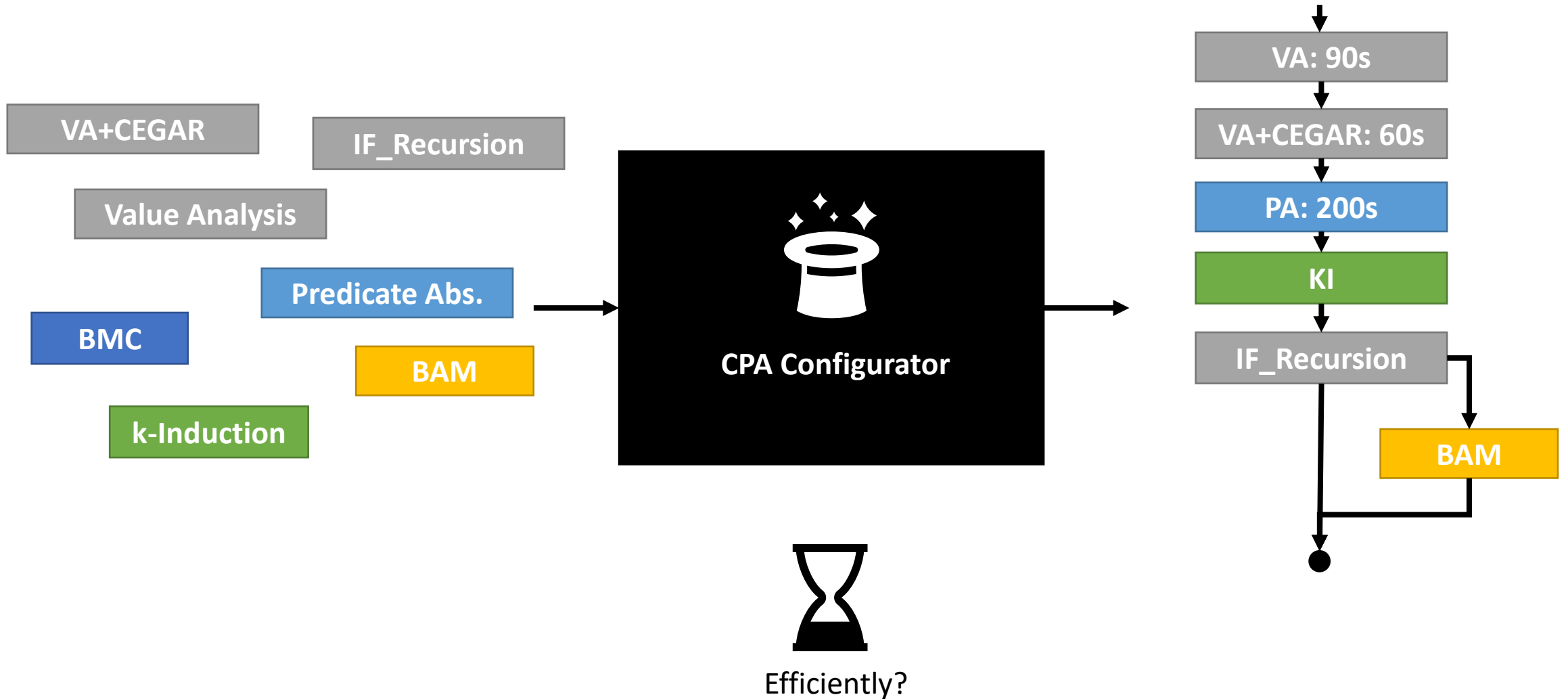
CPA Potential



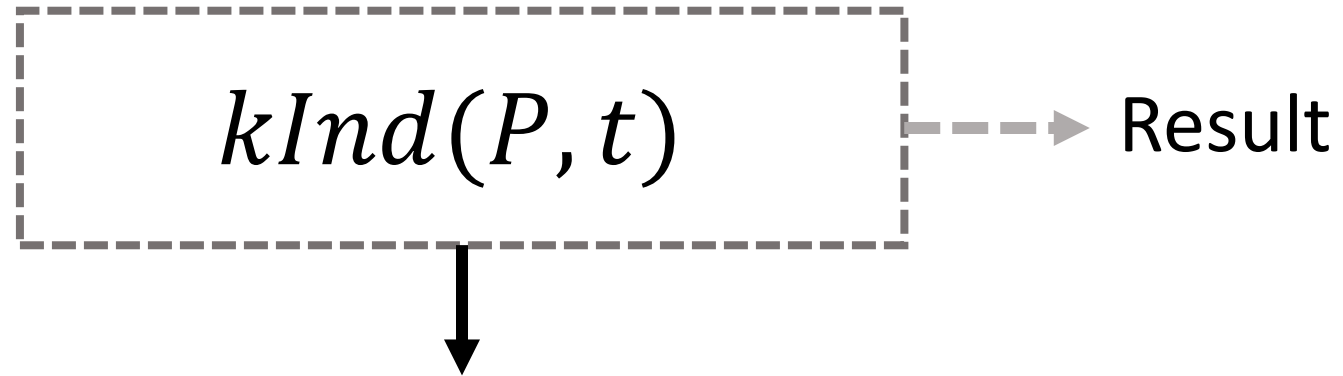
CPA Extension



CPA Self-Configuration



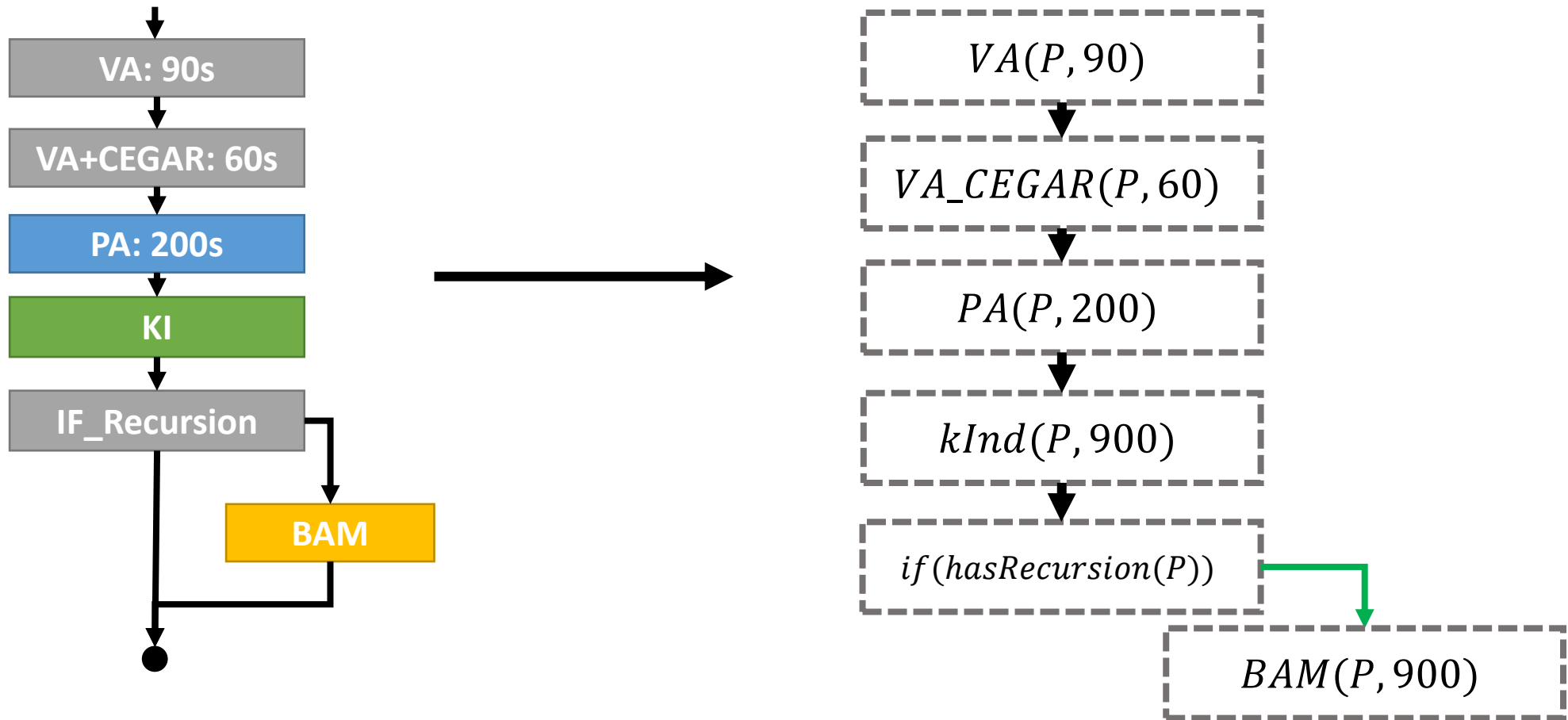
CPA Compositions as Programs



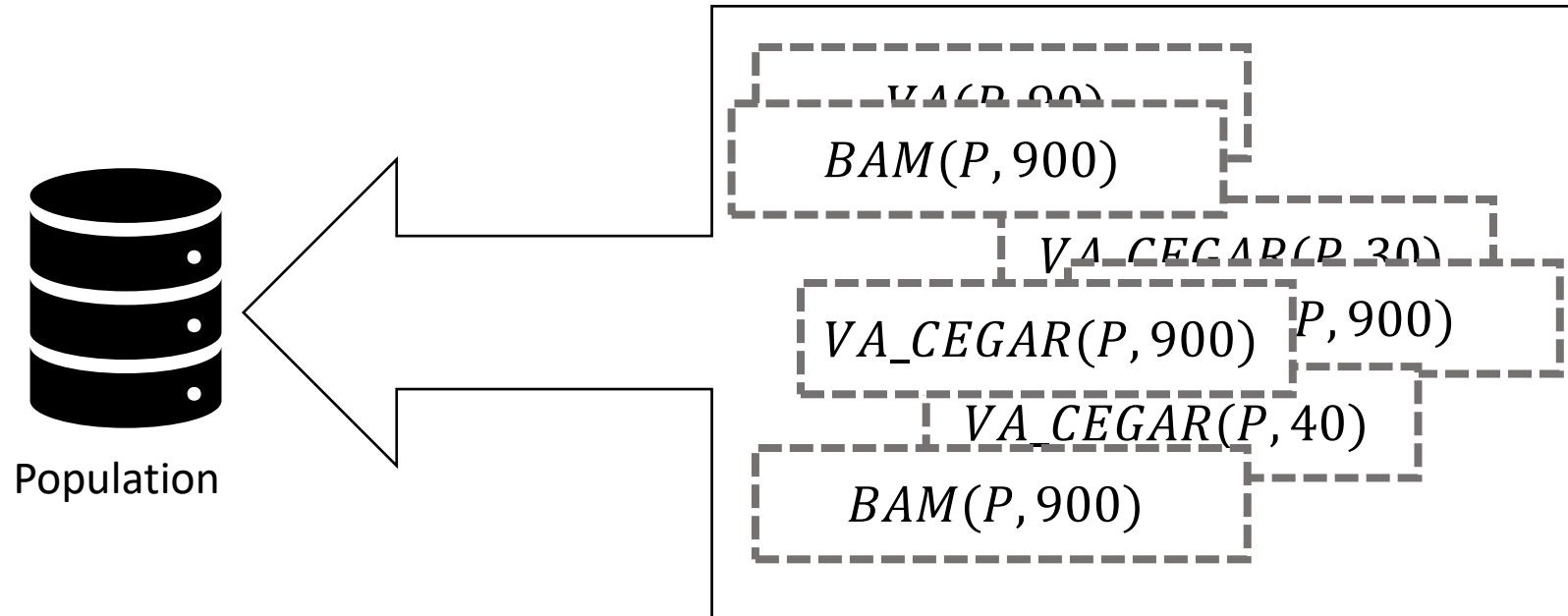
CPA Compositions as Programs



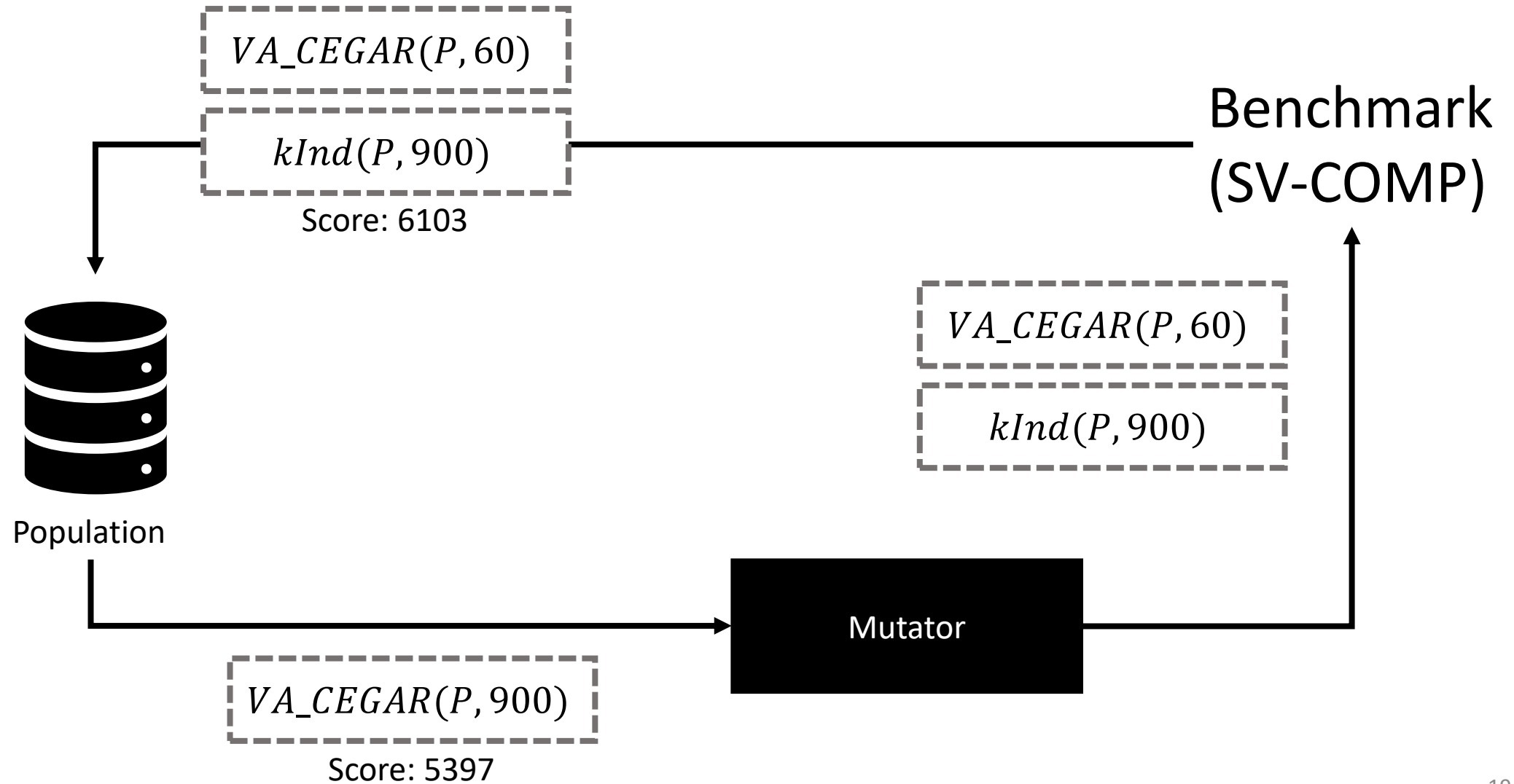
CPA Compositions as Programs



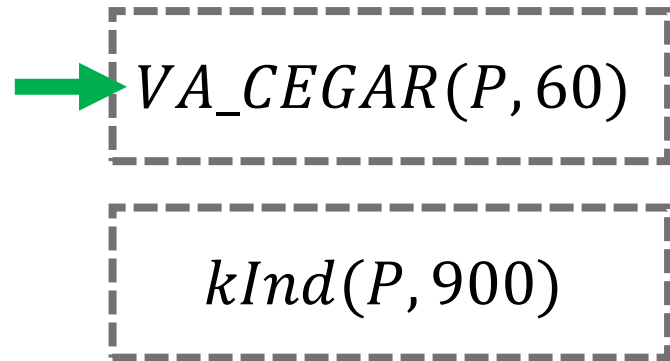
CPA Genetic Programming



CPA Genetic Programming

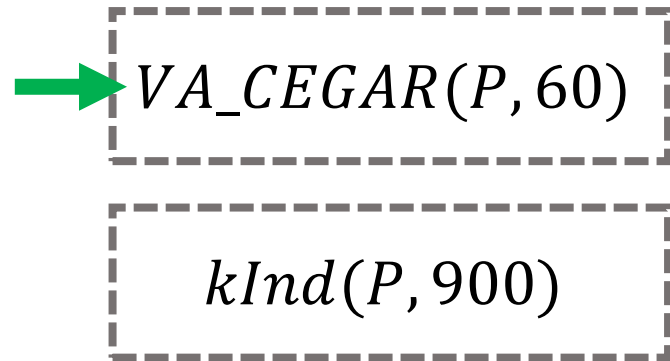


CPA Fast Benchmarking



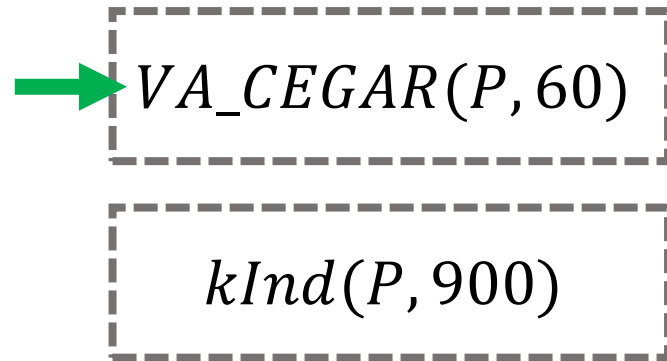
Benchmark Cache			
program1.c	VA_CEGAR	false	45.3s
program2.c	VA_CEGAR	UNKNOWN	224.5s
program3.c	VA_CEGAR	TIMEOUT	906.2s
program4.c	VA_CEGAR	true	840.8s
program5.c	VA_CEGAR	OOM	321.3s
program6.c	VA_CEGAR	ERROR	11.2s
...

CPA Fast Benchmarking



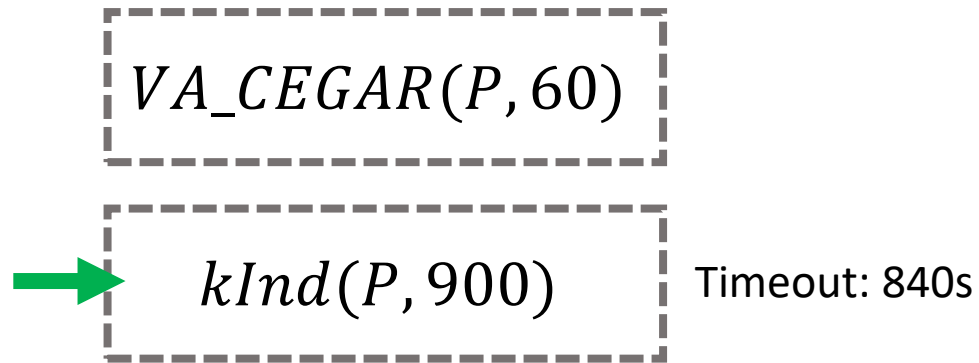
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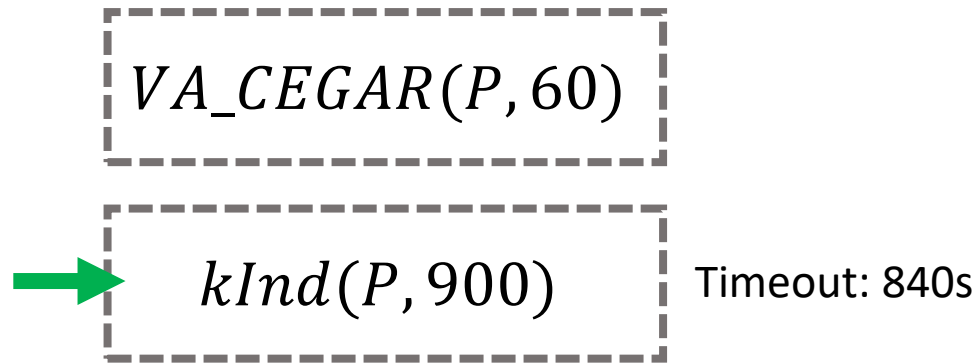
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...

CPA Fast Benchmarking



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...

CPA Fast Benchmarking



200cfgs/sec

Benchmark Cache			
program1.c	<i>VA_CEGAR</i>	false	45.3s
program2.c	<i>VA_CEGAR</i>	UNKNOWN	224.5s
program3.c	<i>VA_CEGAR</i>	TIMEOUT	906.2s
program4.c	<i>VA_CEGAR</i>	true	840.8s
program5.c	<i>VA_CEGAR</i>	OOM	321.3s
program6.c	<i>VA_CEGAR</i>	ERROR	11.2s
...
program1.c	<i>kInd</i>	false	221.4s
program2.c	<i>kInd</i>	true	431.6s
program3.c	<i>kInd</i>	TIMEOUT	905.3s
...

Rediscover CPA-Seq

$VA_NoCEGAR(P, 900)$

$VA_NoCEGAR(P, 90)$

$VA_CEGAR(P, 900)$

$VA_CEGAR(P, 60)$

$PA(P, 900)$

$PA(P, 200)$

$kInd(P, 900)$

$BAM(P, 900)$

$if(hasArray(P))$

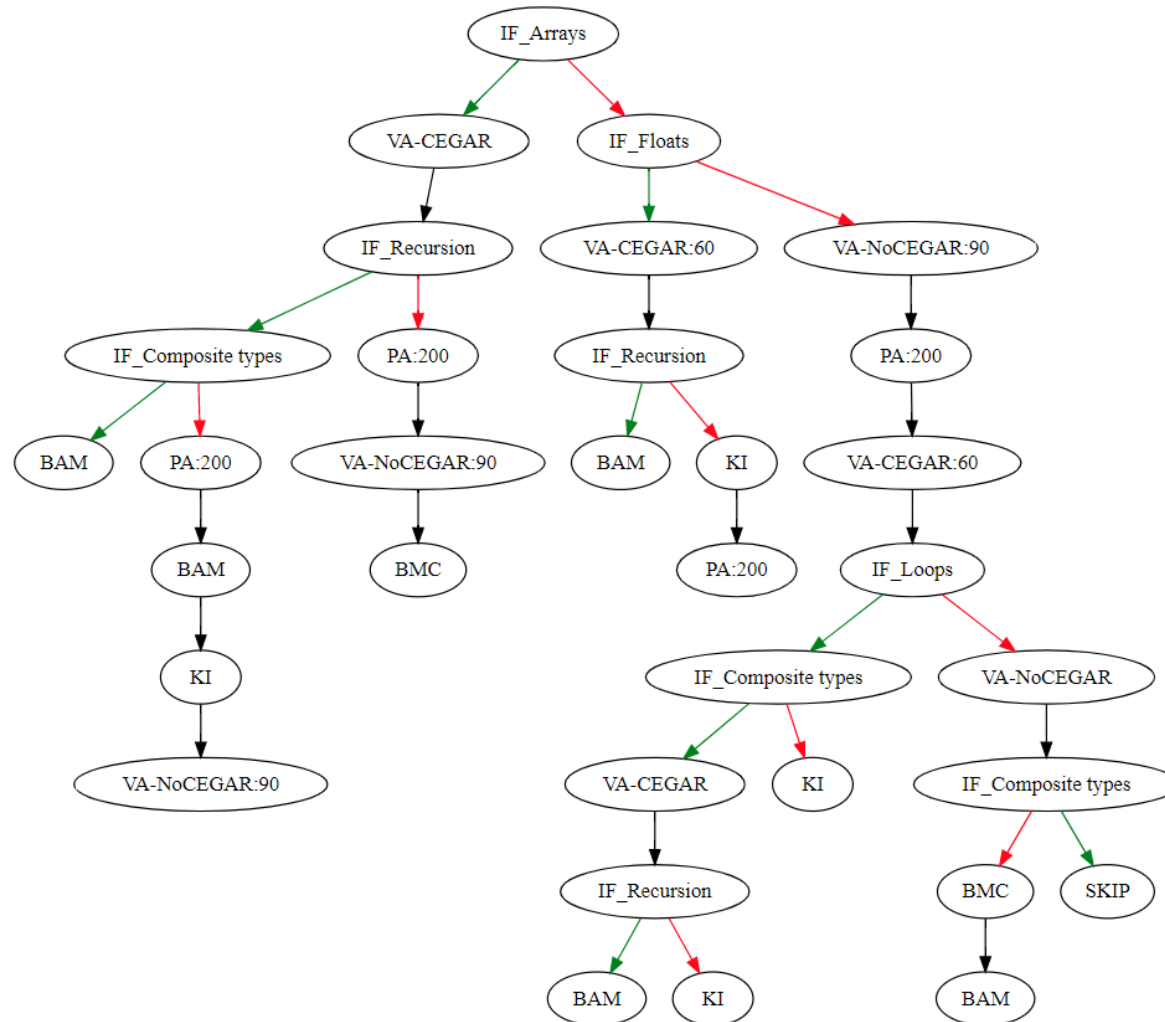
$if(hasLoops(P))$

$if(hasBool(P))$

$if(hasFloats(P))$

$if(hasComp(P))$

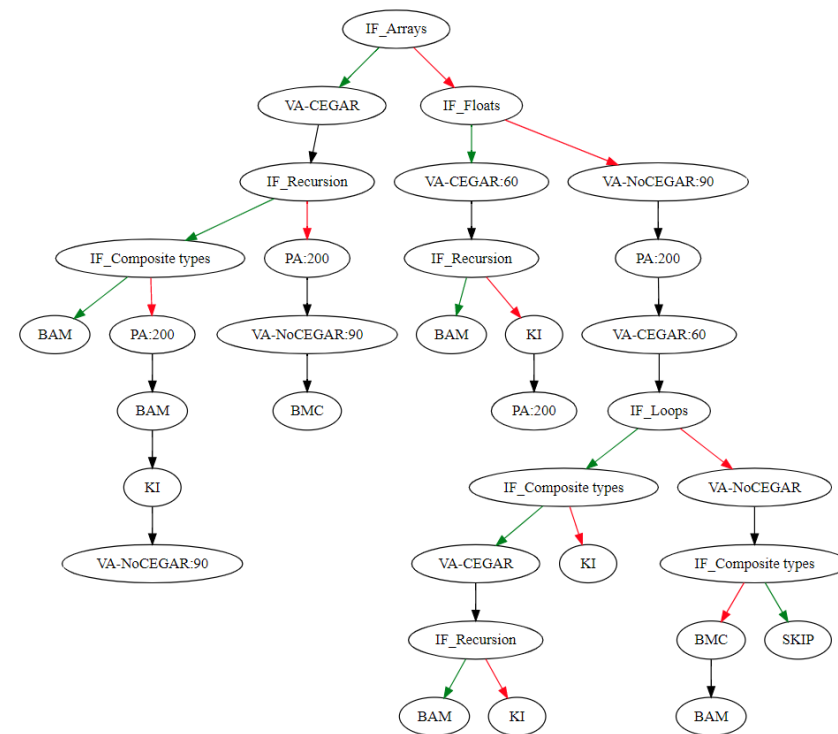
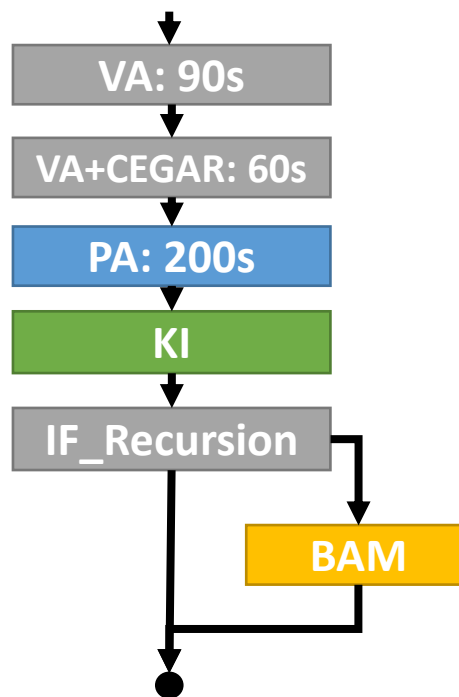
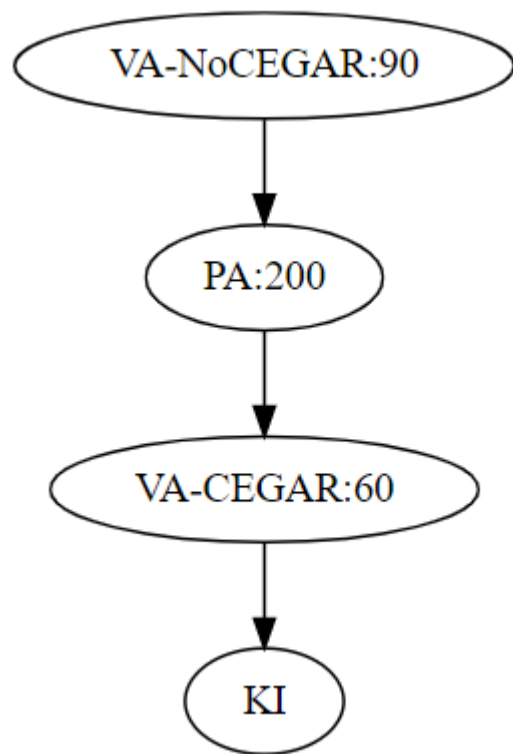
Rediscover CPA-Seq



Expected Score:
6823

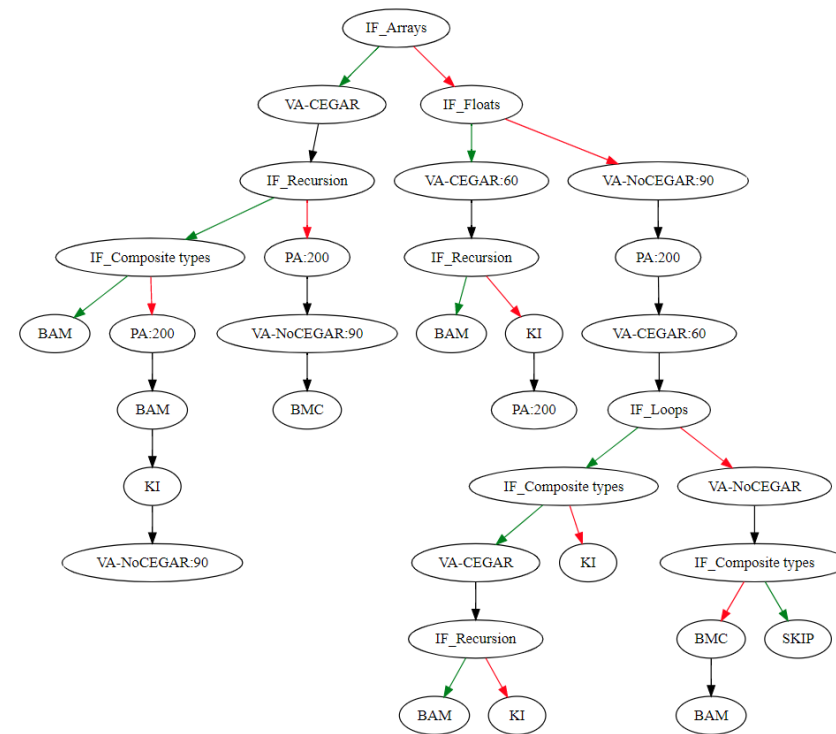
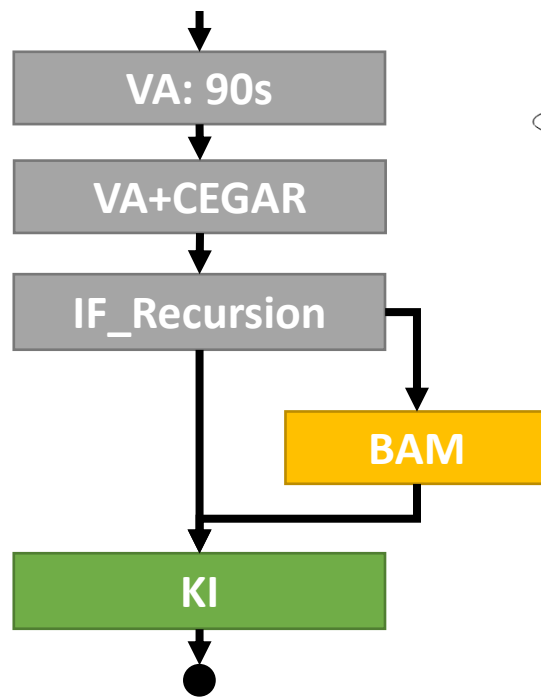
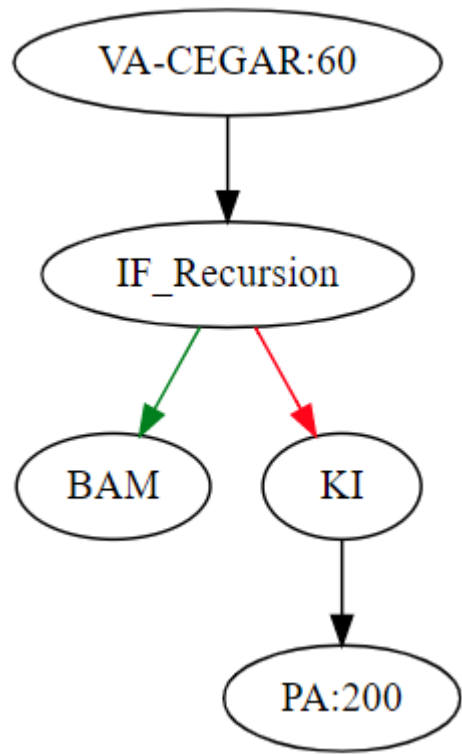
Rediscover CPA-Seq

Loops, no Arrays, no Floats, no Composite



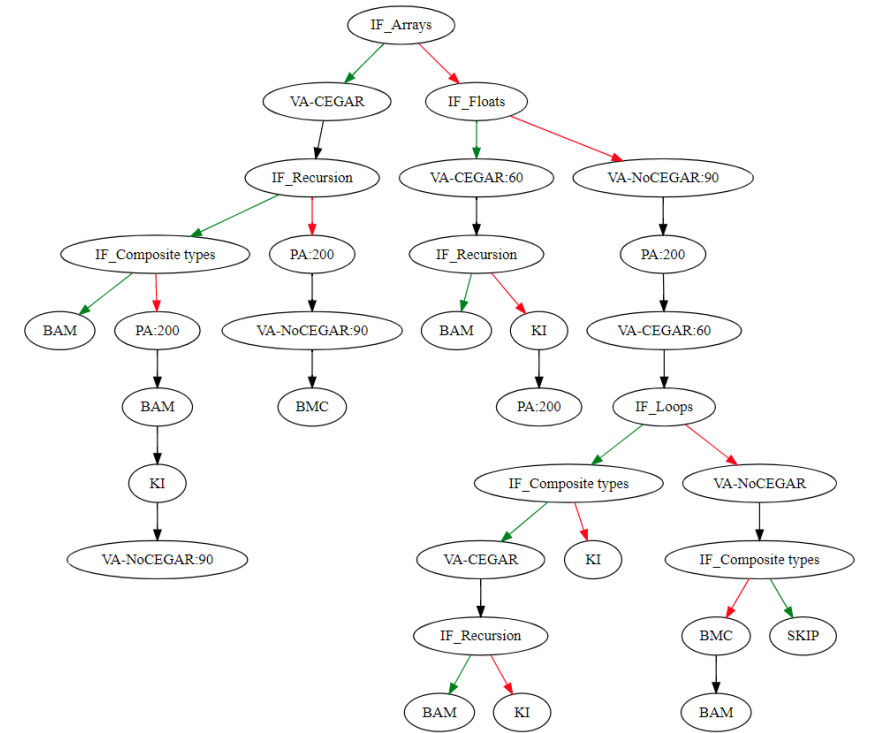
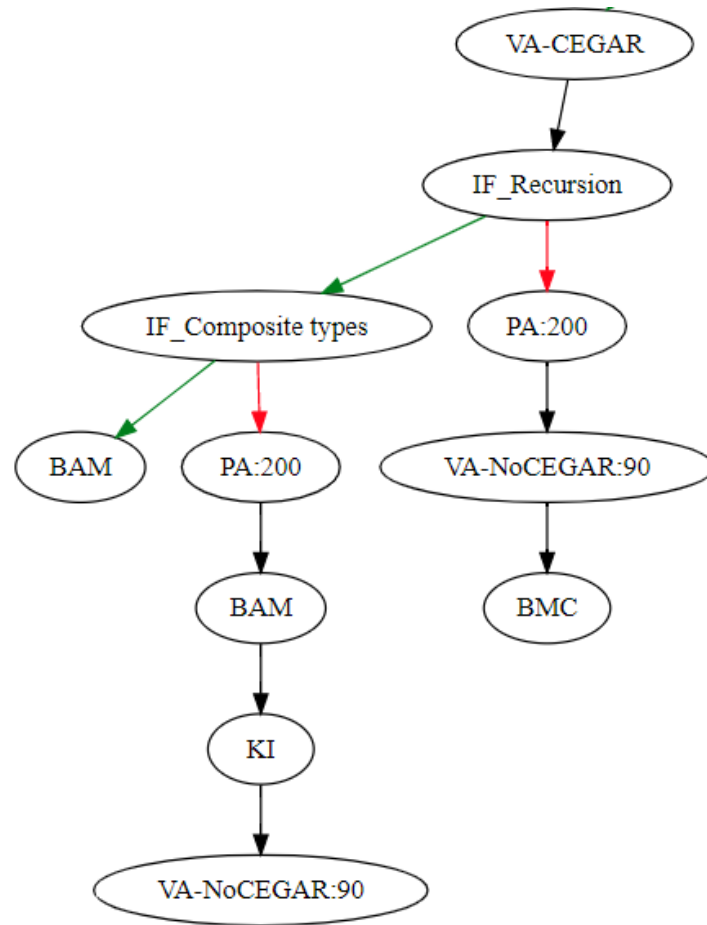
Rediscover CPA-Seq

no Arrays, Floats

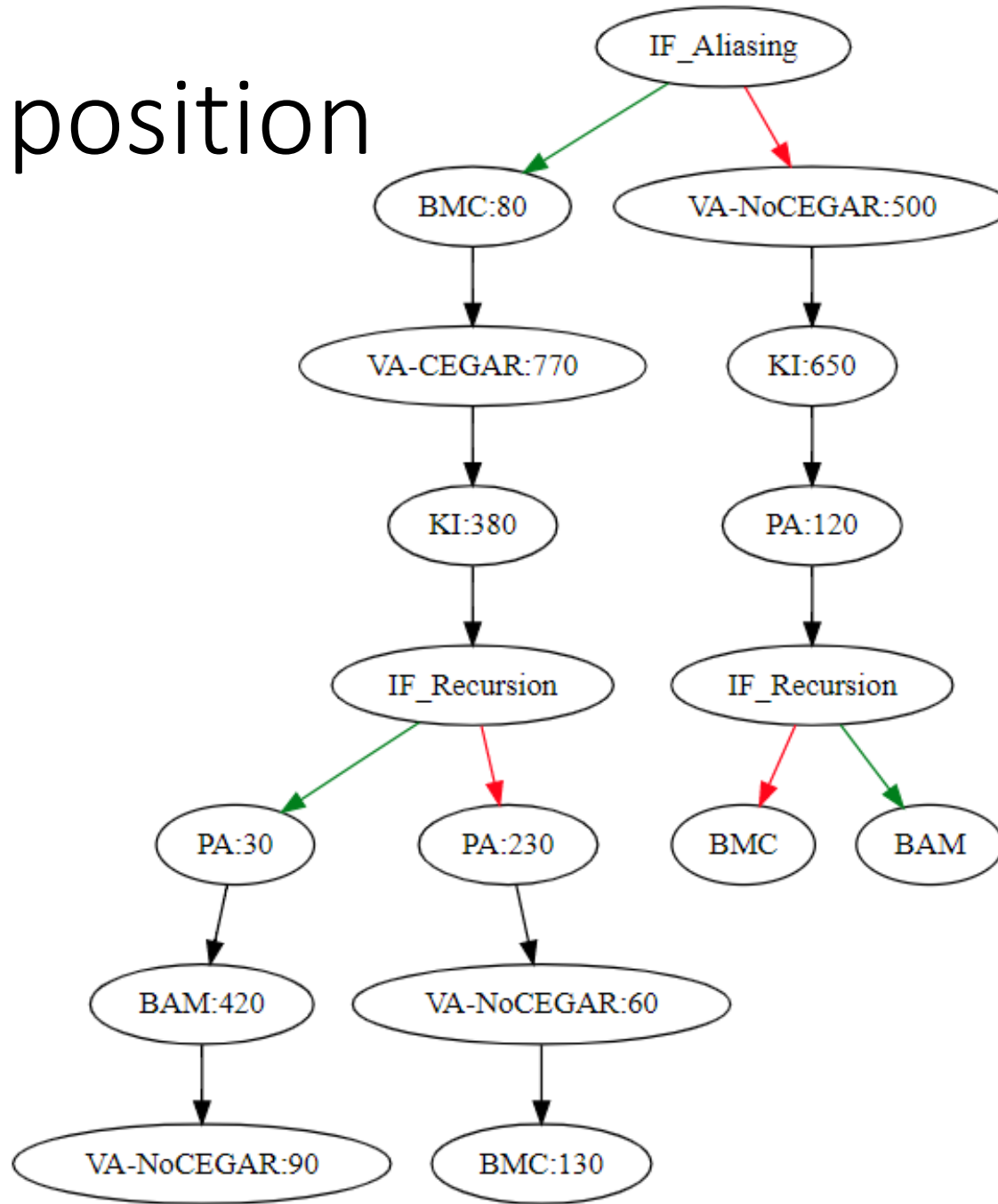


Rediscover CPA-Seq

Arrays



Novel Composition

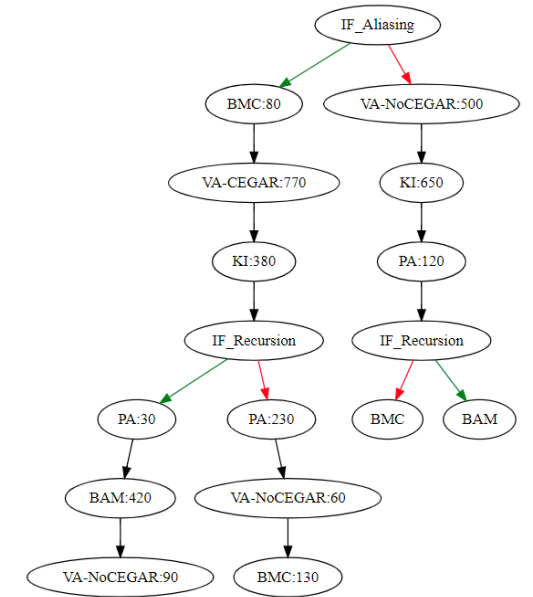


Expected Score:

6850

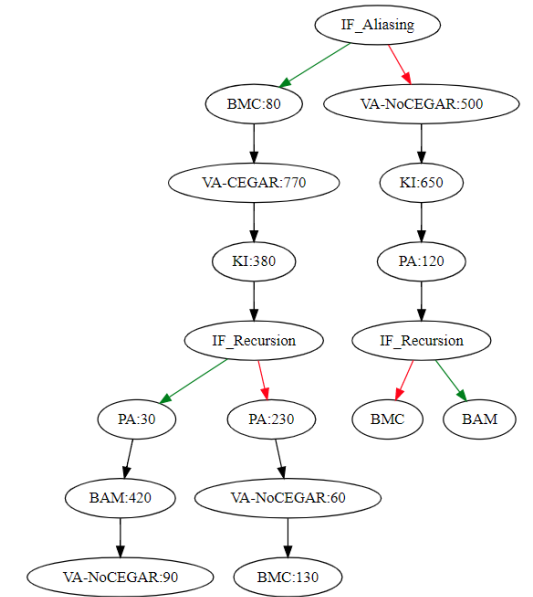
Novel Composition

Approach	CPA-Seq	BMC-BAM-PA	VA-BAM-KI	Model-Based CPA 1.7.0	NC CPA 1.9.2
Score	6399	2612	6442	6790	6284
Correct results	3740	1840	3740	3932	3922
Correct proofs	2691	804	2734	2922	2810
Correct alarms	1049	1036	1006	1010	1112
Wrong proofs	0	0	0	0	0
Wrong alarms	2	2	2	4	28
Timeouts	1715	3385	1879	1486	-
OOM	194	406	26	224	-
Other	36	54	40	41	-



Novel Composition

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Score	6399	2612	6442	6790	6284
Correct results	3740	1840	3740	3932	3922
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Correct alarms	1049	1036	1006	1010	1112
Wrong proofs	0	0	0	0	0
Wrong alarms	2	2	2	4	28
Timeouts	1715	3385	1879	1486	-
OOM	194	406	26	224	-
Other	36	54	40	41	-



Novel Composition

./sv-benchmarks/c/	status	cputime (s)	walltime (s)	memUsage
floats-esbmc-regression/digits_for_true-unreach-call.i	false(unreach-call)	657	330	1823461376
floats-esbmc-regression/digits_while_true-unreach-call.i	false(unreach-call)	657	330	1500983296
heap-manipulation/dll_of_dll_true-unreach-call_true-valid-memsafety.i	false(unreach-call)	11.3	6.20	352415744
seq-mthreaded/pals_lcr-var-start-time.5_true-unreach-call.ufo.UNBOUNDED.pals.c	false(unreach-call)	842	636	3348762624
seq-mthreaded/pals_lcr-var-start-time.6_true-unreach-call.ufo.BOUNDED-12.pals_true-termination.c	false(unreach-call)	865	658	3270615040
seq-mthreaded/pals_lcr-var-start-time.6_true-unreach-call.ufo.UNBOUNDED.pals.c	false(unreach-call)	883	675	3975770112
seq-mthreaded/pals_lcr.7_true-unreach-call.ufo.BOUNDED-14.pals_true-termination.c	false(unreach-call)	838	631	2828464128
seq-mthreaded/pals_lcr.7_true-unreach-call.ufo.UNBOUNDED.pals.c	false(unreach-call)	838	633	2956992512
seq-mthreaded/pals_lcr.8_true-unreach-call.ufo.BOUNDED-16.pals_true-termination.c	false(unreach-call)	841	633	3058118656
seq-mthreaded/pals_lcr.8_true-unreach-call.ufo.UNBOUNDED.pals.c	false(unreach-call)	844	637	3571355648
seq-pthread/cs_dekker_true-unreach-call.i	false(unreach-call)	839	751	2199674880
seq-pthread/cs_lamport_true-unreach-call.i	false(unreach-call)	837	753	2704113664
seq-pthread/cs_peterson_true-unreach-call.i	false(unreach-call)	834	775	2413658112
seq-pthread/cs_read_write_lock_true-unreach-call.i	false(unreach-call)	838	636	4142780416
seq-pthread/cs_stack_true-unreach-call.i	false(unreach-call)	858	636	5578747904
seq-pthread/cs_stateful_true-unreach-call.i	false(unreach-call)	835	671	3614429184
seq-pthread/cs_sync_true-unreach-call.i	false(unreach-call)	860	637	4665368576
seq-pthread/cs_szymanski_true-unreach-call.i	false(unreach-call)	836	771	2440540160
seq-pthread/cs_time_var_mutex_true-unreach-call.i	false(unreach-call)	839	734	3221032960
ldv-commit-tester/m0_true-unreach-call_drivers-usb-gadget-g_printer-ko--106_1a--2b9ec6c.c	false(unreach-call)	415	354	4830048256
ldv-linux-4.2-rc1/linux-4.2-rc1.tar.xz-08_1a-drivers--rapidio--rapidio.ko-entry_point_true-unreach-call.cil.out.c	false(unreach-call)	890	665	9780019200
ldv-linux-4.2-rc1/linux-4.2-rc1.tar.xz-32_7a-drivers--media--pci--ttpci--dvb-ttpci.ko-entry_point_true-unreach-call.cil.out.c	false(unreach-call)	898	652	11179134976
ldv-linux-4.2-rc1/linux-4.2-rc1.tar.xz-32_7a-drivers--media--usb--ttusb-budget--dvb-ttusb-budget.ko-entry_point_true-unreach-call.cil.out.c	false(unreach-call)	405	352	4762144768
ldv-challenges/linux-3.14__complex_emg_linux-kernel-locking-mutex__drivers-media-common-saa7146-saa7146_vv_true-unreach-call.cil.c	false(unreach-call)	659	556	5397241856
ldv-challenges/linux-3.14__linux-kernel-locking-spinlock__drivers-net-ethernet-sun-cassini_true-unreach-call.cil.c	false(unreach-call)	556	454	5782003712
ldv-challenges/linux-3.14__linux-usb-dev__drivers-media-usb-em28xx-em28xx_true-unreach-call.cil.c	false(unreach-call)	444	365	4732755968
ldv-challenges/linux-3.14__linux-usb-dev__drivers-media-usb-hdpvr-hdpvr_true-unreach-call.cil.c	false(unreach-call)	411	325	4764311552
ldv-challenges/linux-3.14__linux-usb-dev__drivers-media-usb-tm6000-tm6000_true-unreach-call.cil.c	false(unreach-call)	427	356	4962041856

Overview

