

BinCAT

Purrfecting binary static analysis

June 16th 2017 - REcon

Philippe Biondi, Raphaël Rigo, Sarah Zennou, Xavier Mehrenberger

Plan

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Under the hood

Conclusion

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Under the hood

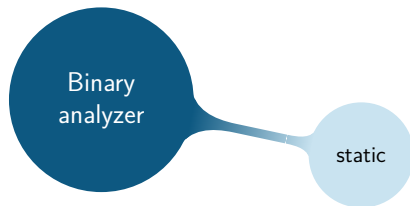
Conclusion

BinCAT (*Binary Code Analysis Toolkit*)

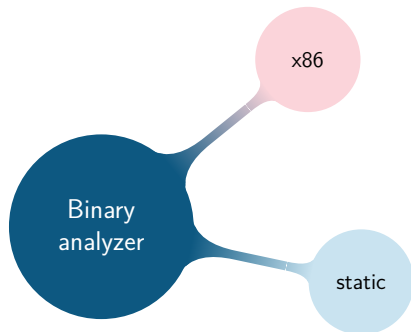


Binary
analyzer

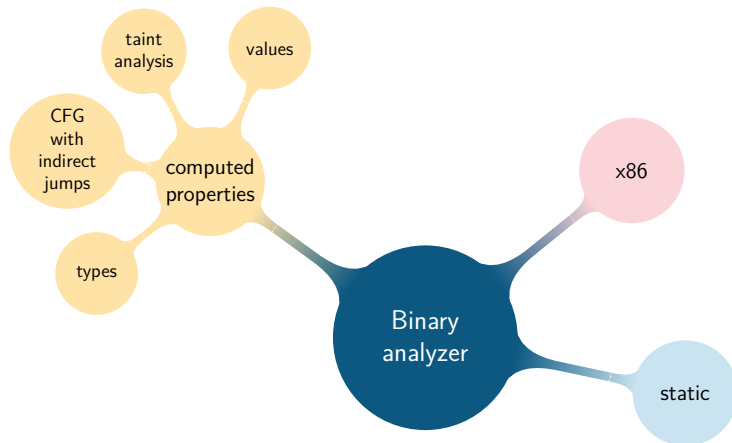
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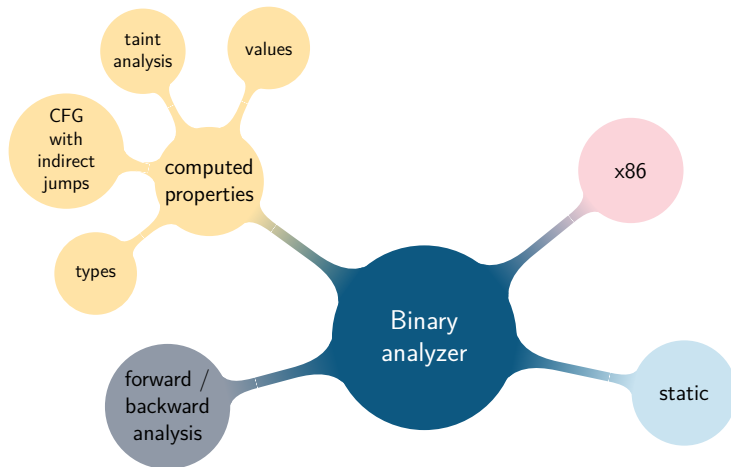
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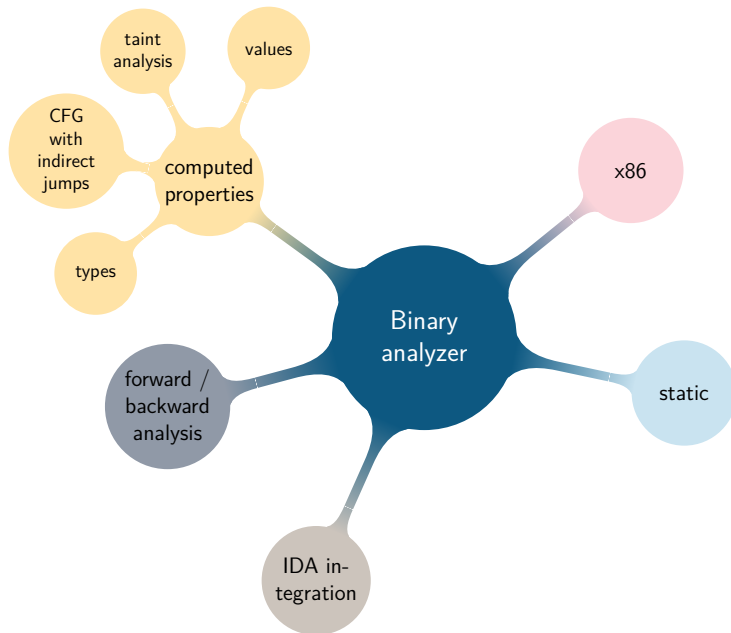
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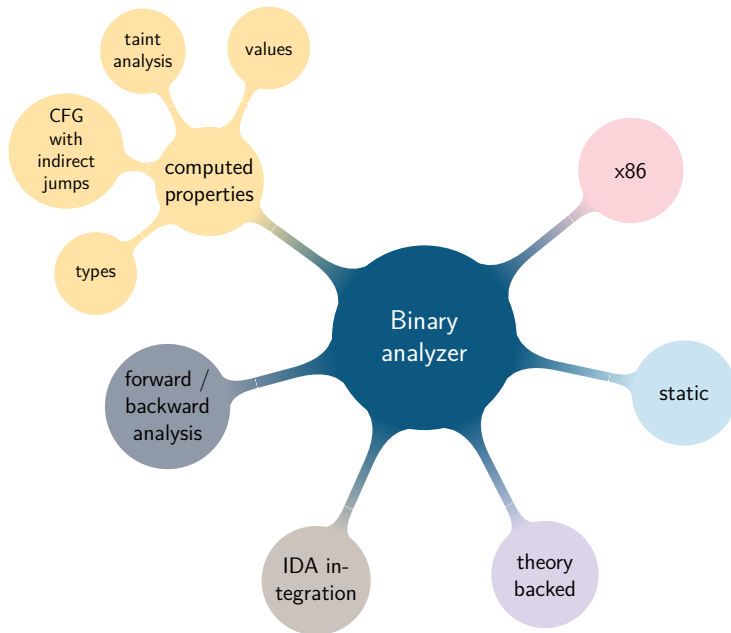
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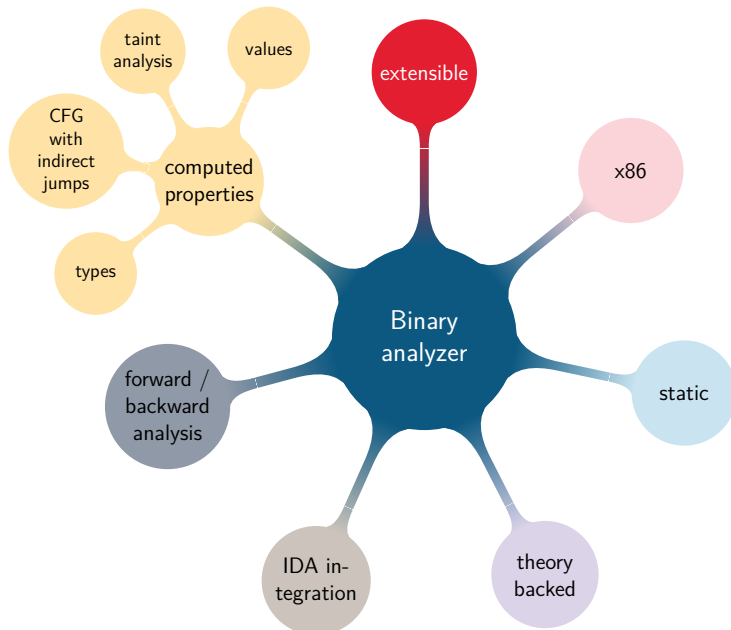
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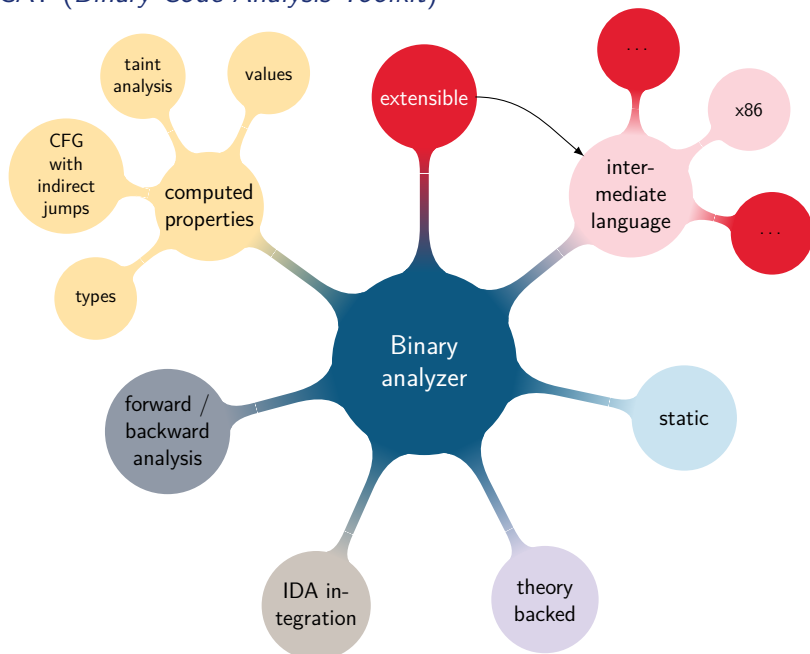
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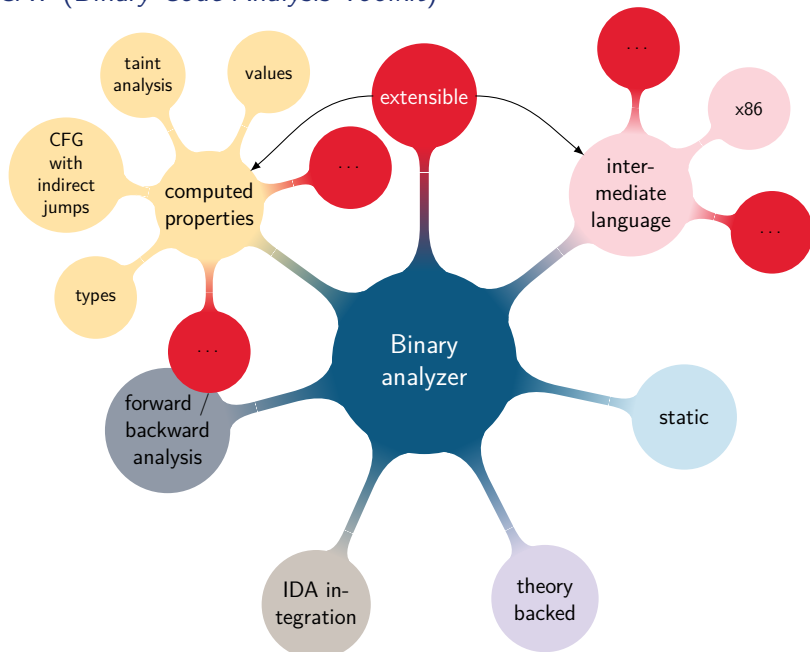
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$ ./get_key company department name 025E60CB0[...]
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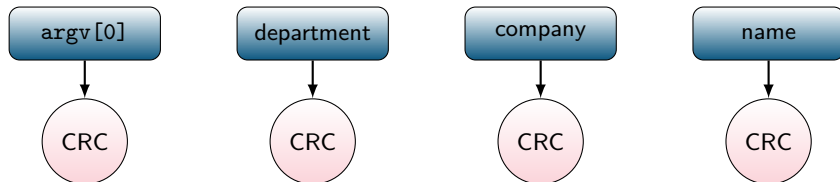
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```

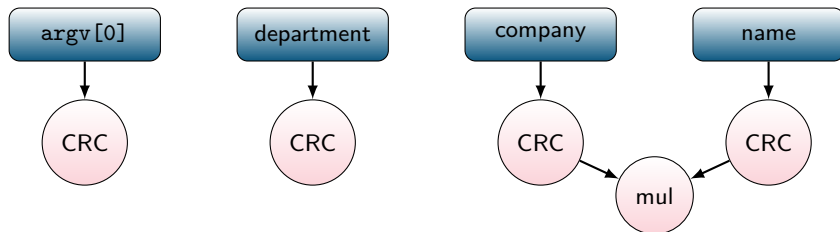
```
Licence=>[025E60CB08F00A1A23F236CC78FC819CE6590DD7]
```

```
Thank you for registering !
```

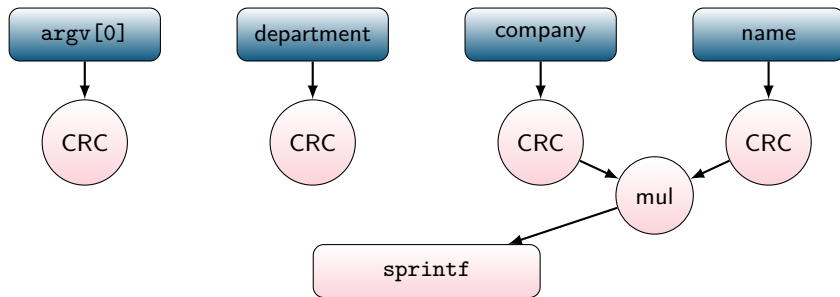
Keygenme: data flow



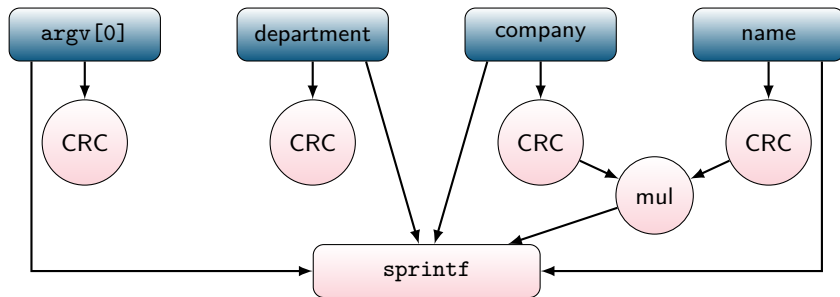
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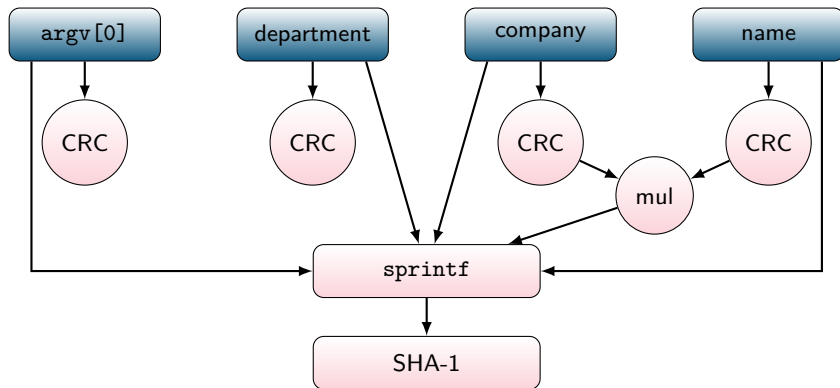
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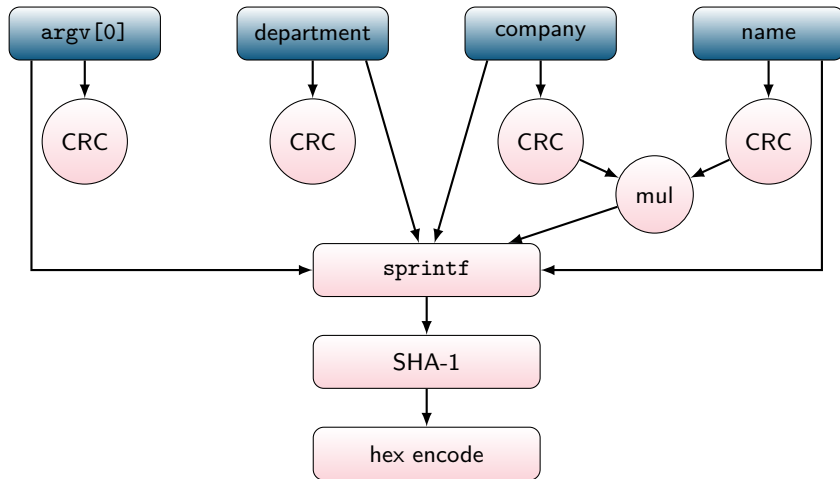
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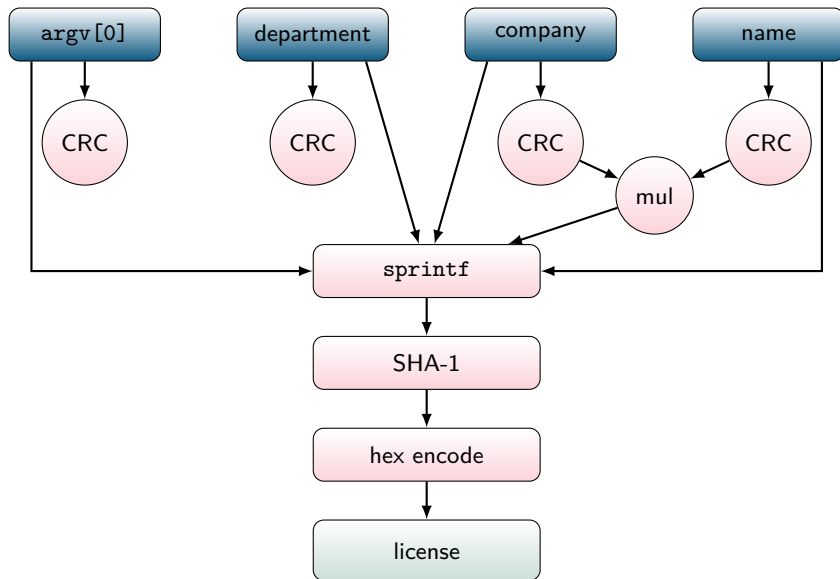
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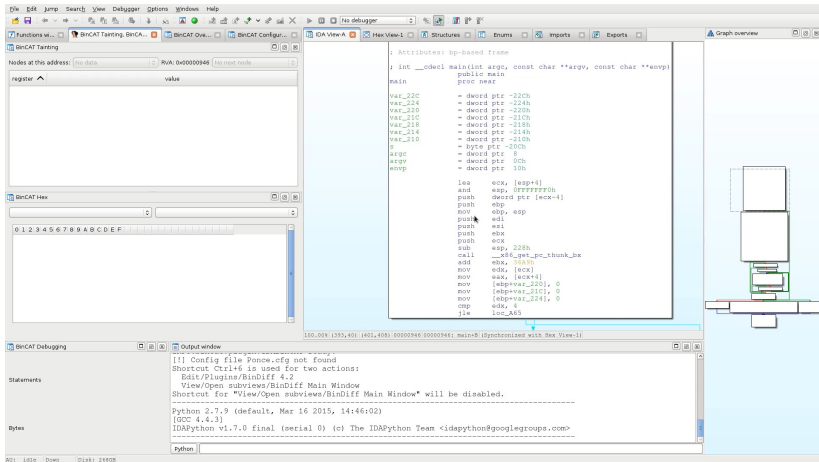
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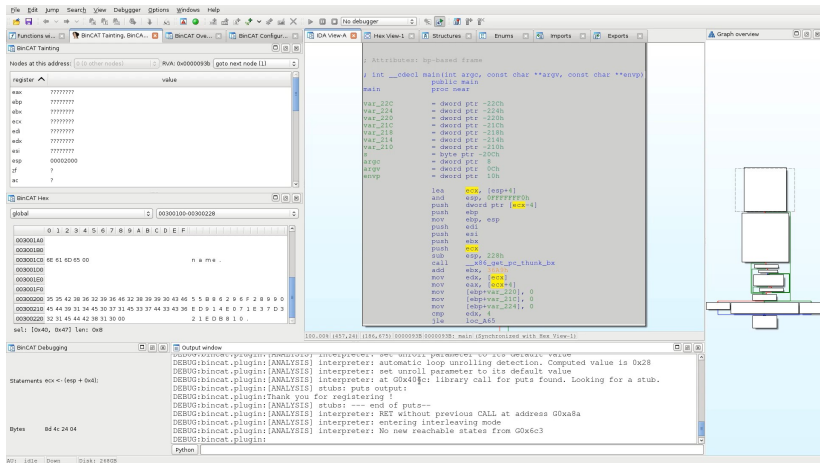
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Demo 1: BinCAT usage



Demo 2: Tainting



Plan

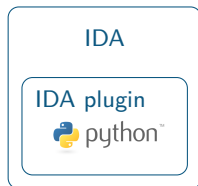
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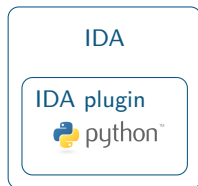
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Architecture



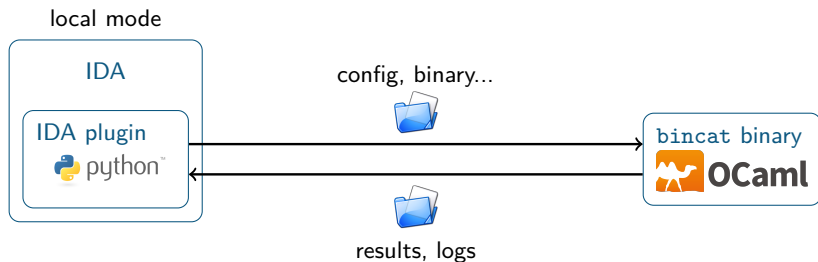
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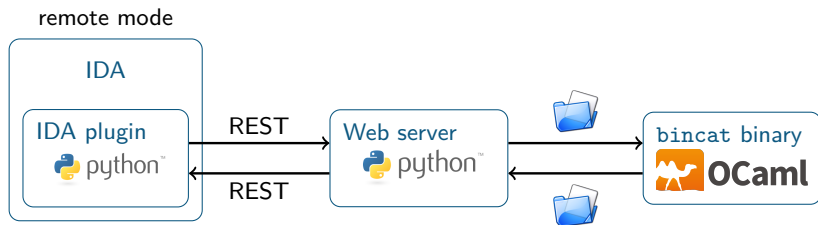
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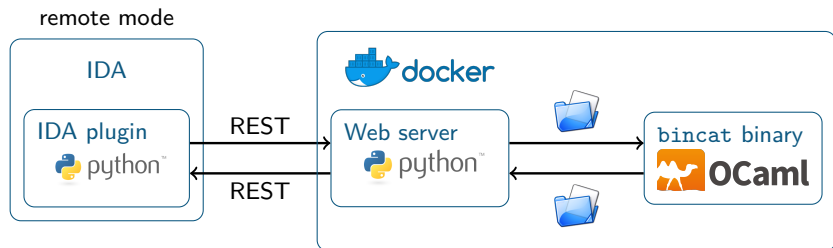
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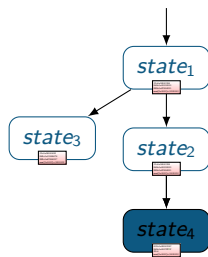
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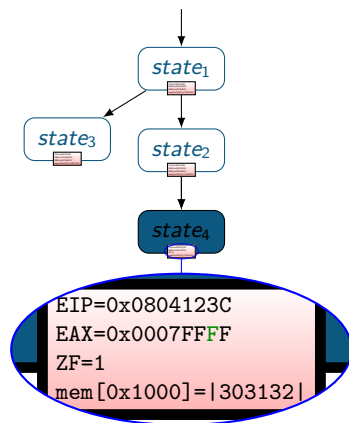
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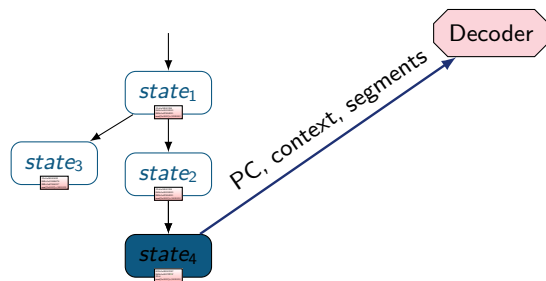
Control flow graph reconstruction



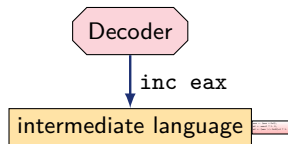
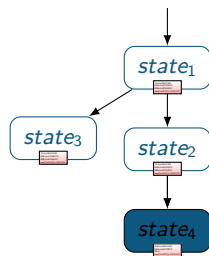
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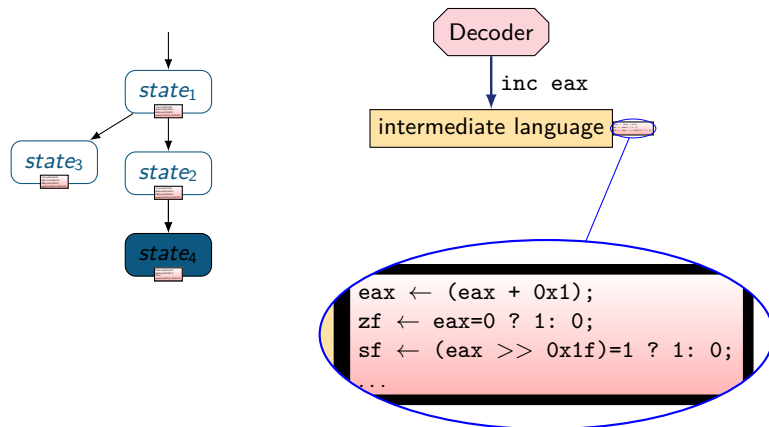
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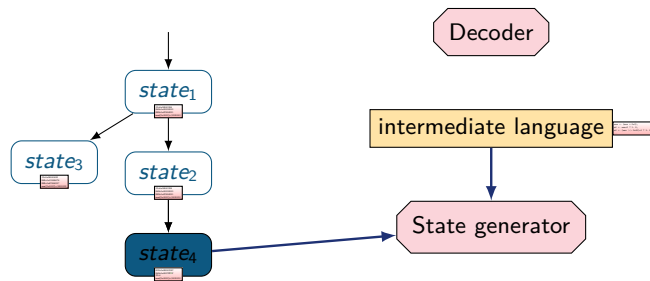
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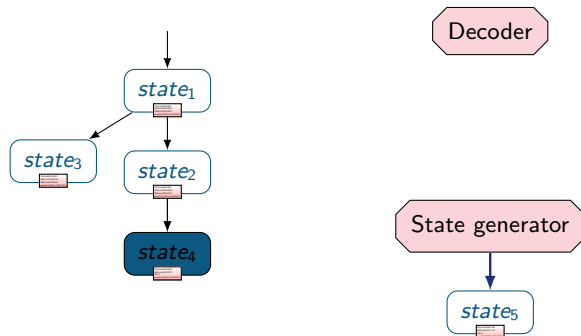
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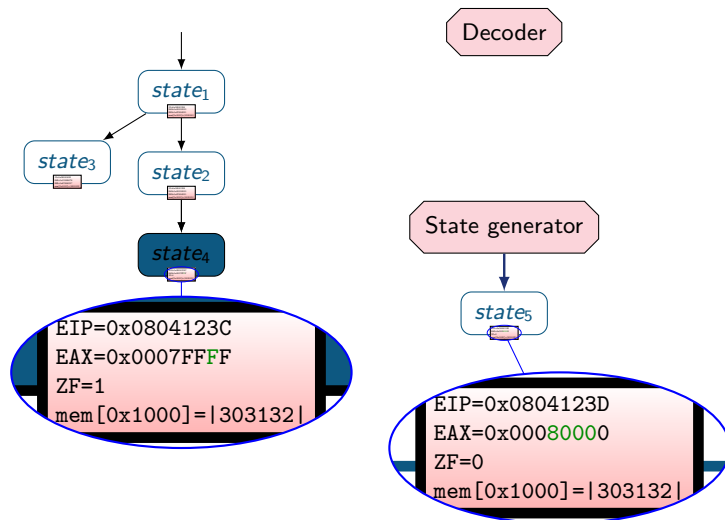
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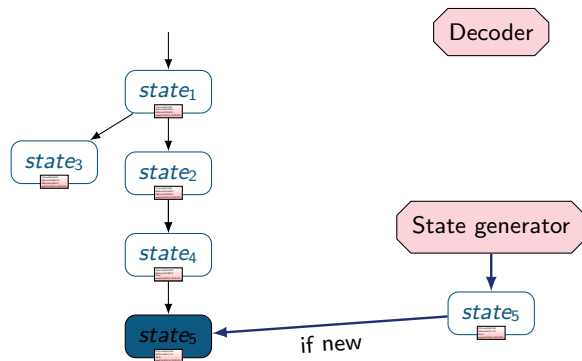
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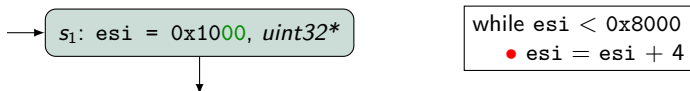


Formal correctness: static analysis by abstract interpretation

- operations on values/taint/types are done on *abstract* objects which represent sets of values/taint/types
ex: $0 \equiv \{0\}$, $? \equiv \{\text{integers}\}$, $\text{Struct} \equiv \{\text{C structs}\}$
- abstract computations are always an *overapproximation* of actual ones
- approximation example: loop widening (∇)

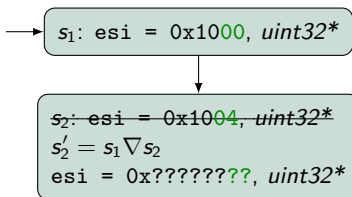
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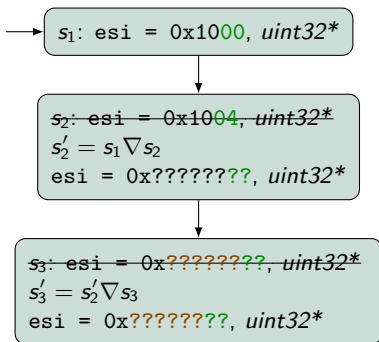


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  • esi = esi + 4
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 - what is **stable** is **kept**
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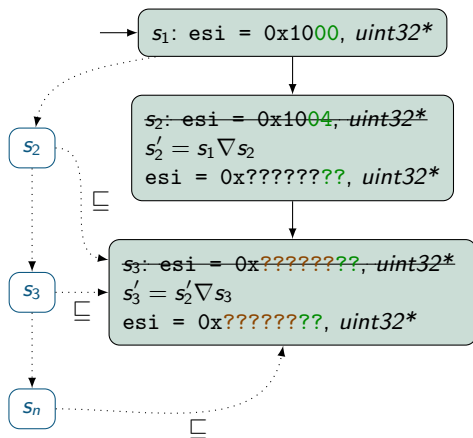


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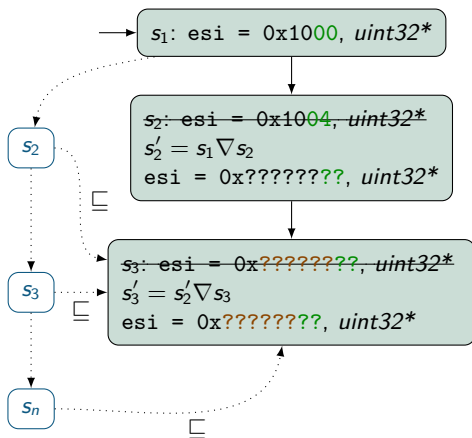


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- some techniques allow for precision recovery

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Analyzer's performance

Example: keygenme

- 6407 instructions analyzed
- RAM usage: 90 MiB
- running time: 6s
- average: $\simeq 1060$ insn/s

QEMU tests:

- 209 120 instructions analyzed
- RAM usage: 2.3 GiB
- running time: 23 min 30 s
- average: $\simeq 150$ insn/s

Intel Core i7-6700K CPU @ 4,00GHz

Plan

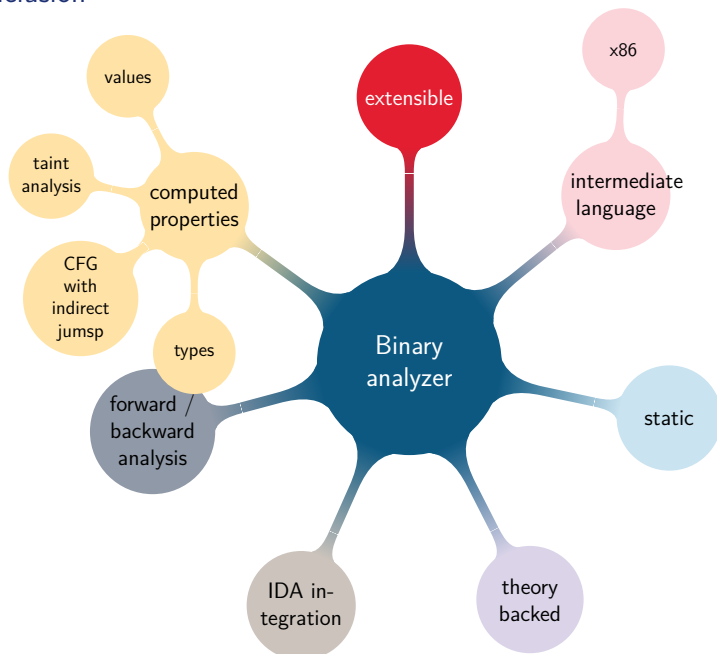
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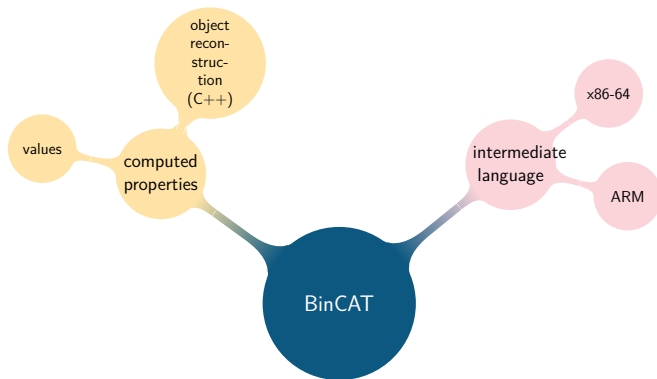
Under the hood

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Future features



- finer approximations in values computation by using intervals
- complex objects reconstruction (C++)
- x86-64 and ARM decoders

Thanks!

Full paper (link in README):

https://www.sstic.org/media/SSTIC2017/SSTIC-actes/bincat_purrfecting_binary_static_analysis/SSTIC2017-Article-bincat_purrfecting_binary_static_analysis-biondi_rigo_zennou_mehrenberger.pdf

- project was partially financed by DGA-MI
- Get it! (AGPL licence)

<https://github.com/airbus-seclab/bincat>

`docker run -p 5000:5000 airbusseclab/bincat`

tutorial in `doc/tutorial.md`

x86 coverage

ADD			PUSH ES		POP ES		OR			PUSH CS		2 bytes																			
ADC			PUSH SS		POP SS		SBB			PUSH DS		POP DS																			
AND			ES:		DAA		SUB			CS:		DAS																			
XOR			SS:		AAA		CMP			DS:		AAS																			
INC			DEC																												
PUSH			POP																												
PUSHA		POPA		BOUND		ARPL		FS:		GS:		OPSIZE:		ADSIZE:		PUSH		IMUL		PUSH		IMUL		INSB		INSW		OUTSB		OUTSW	
JNO		JNO		JB		JNB		JZ		JNZ		JBE		JA		JS		JNS		JP		JNP		JL		JNL		JLE		JNLE	
Grp1		Grp1		Grp1		TEST		XCHG		MOV			LEA		MOV		POP														
NOP		XCHG			EAX			CWD		CDQ		CALL		WAIT		PUSHF		POPF		SAHF		LAHF									
MOV			EAX		MOVS		CMPS		TEST		STOS		LODS		SCAS																
MOV			MOV																												
SHIFT		RETN		LES		LDS		MOV		ENTER		LEAVE		RETF		INT3		INT		INTO		IRETD									
Grp2			AAM		AAD		SALC		XLAT		FPU																				
LOOPNZ		LOOPZ		LOOP		JCXZ		IN		OUT		CALL		JMP		JMPF		JMPS		IN		OUT									
LOCK:		INT1		REPNE:		REP:		HLT		CMC		Grp3		CLC		STC		CLI		STI		CLD		STD		Grp4		Grp5			

x86 coverage - Second table

Grp6	Grp7	LAR	LSL		CLTS		INVD	WBINVD		UD2		NOP				
SSE				E	Prefetch SSE1	HINT			NOP							
MOV CR DR							SSE				E					
WRMSR	RDTSC	RDMSR	RDPIC	SYSENTER	SYSEXIT		GETSEC SHX	MOVBE		SSE						
CMOV																
SSE				SSE		E										
MMX				SSE				E								
MMX				SSE				VMX		MMX						
SSE				VMX					MMX							
JNO	JNO	JB	JNB	JZ	JNZ	JBE	JA	JS	JNS	JP	JNP	JL	JNL	JLE	JNLE	
SETNO	SETNO	SETB	SETNB	SETZ	SETNZ	SETBE	SETA	SETS	SETNS	SETP	SETNP	SETL	SETNL	SETLE	SETNLE	
PUSH FS	POP FS	CPUID	BT	SHLD				PUSH GS	POP GS	RSM	BTS	SHRD	FENCE	IMUL		
CMPXCHG	LSS	BTR	LFS	LGS	MOVZX	POPCNT	UD	BTx	BTC	BSF	BSR	MOVXS				
XADD	SSE				CMPXCHG	BSWAP										
MMX				SSE				E								
MMX				SSE				E								
MMX				SSE				E								

Currently implemented lattices

