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Is Software Debloating Useful? - A Comparative Study

Sumit Lahiri, Amit Kumar Sharma

What is Program Debloating? What is Program Debloating?

Index Terms—Software Debloating, Software Engineering, Delta Debugging

I. Project Objective

Program debloating techniques. Program deblaoting techniques rogram debloating techniques. Program deblaoting techniques rogram debloating techniques. Program deblaoting techniques rogram debloating techniques rogram deblaoting techniques. Program deblaoting techniques rogram debloating techniques. Program deblaoting techniques. Program deblaoting techniques rogram debloating techniques. Program deblaoting techniques. Program deblaoting techniques. Program deblaoting techniques rogram deblaoting techniques rogram deblaoting techniques rogram deblaoting techniques. Program deblaoting techniques rogram deblaoting techniques rogram deblaoting techniques. Program deblaoting techniques rogram deblaoting techniques. Program deblaoting techniques

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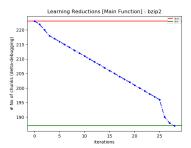


Figure 1: Learning plot for mkdir

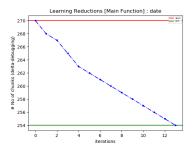


Figure 2: Learning plot for date

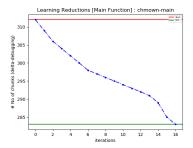


Figure 3: Learning plot for chown

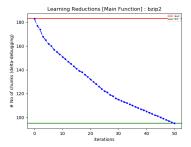


Figure 4: Learning plot for bzip2

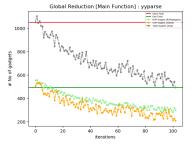


Figure 5: Gadgets plot for yyparse

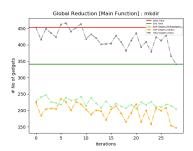


Figure 6: Gadgets plot for mkdir

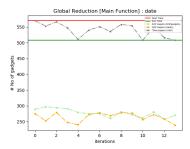


Figure 7: Gadgets plot for date

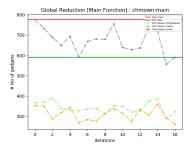


Figure 8: Gadgets plot for chown

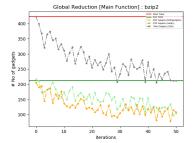


Figure 9: Gadgets plot for bzip2

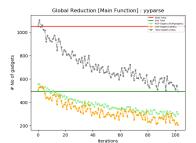


Figure 10: Gadgets plot for yyparse

II. WHAT IS SOFTWARE DEBLOATING?

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A. Software Debloating Tools

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B. Software Debloating Techniques

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III. MOTIVATING EXAMPLES

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IV. OCCAM TOOL

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A. Overview

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B. Working Procedure

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airtun_ng-airtun-ng										
Libraries/Tools	Before	None	Aggressive	DeepOCCAM Non-rec RL Model Aggressive		Only once	IPDSE/IPSCCP			
	Beiore	TVOIC	11881055140			omy once	Loop Unrolling			
Functions	4	4	3	3	3	4	3			
Basic Blocks	451	445	450	450	450	445	448			
Instructions Count	2521	2481	2523	2523	2523	2481	2523			
Direct Calls	328	327	330	330	330	327	330			
External Calls	322	321	326	326	326	321	325			
Memory Instructions	671	658	672	672	672	658	675			
Load/Store	071	050	012	012	012	000	019			

Table I: Comparison of DeepOCCAM with other OCCAM Run settings and OCCAM-T Run (Trimmer)

bzip2										
Libraries/Tools	Before	None	Aggressive	DeepOCCAM	Non-rec	Only once	IPDSE/IPSCCP			
				RL Model	RL Model Aggressive		Loop Unrolling			
Functions	61	35	54	54	54	35	54			
Basic Blocks	2776	2538	3137	3137	3137	2538	3137			
Instructions Count	24412	20540	23769	23769	23769	20540	23769			
Direct Calls	4714	621	1011	1011	1011	621	1011			
External Calls	4575	515	835	835	835	515	835			
Memory Instructions	5144	5209	5989	5989	5989	5209	5989			
Load/Store	0144	5209	5303	5369	0909	0209	0303			

Table II: Comparison of DeepOCCAM with other OCCAM Run settings and OCCAM-T Run (Trimmer)

				curl			
Libraries/Tools	Before	None	Aggressive	DeepOCCAM	Non-rec	Only once	IPDSE/IPSCCP
Libraries/ 100is	Belore	Ttone	Aggressive	RL Model	Aggressive	Omy once	Loop Unrolling
Functions	124	59	62	62	52	59	57
Basic Blocks	2823	2764	4256	4375	3369	2764	3369
Instructions Count	11870	11777	17965	18106	14512	11777	15854
Direct Calls	1786	1696	2423	2500	2005	1696	2145
External Calls	1234	1250	1911	1911	1519	1250	1975
Memory Instructions	2503	2511	3698	3858	3048	2511	3625
Load/Store	2505	2011	2090	9090	3048	2011	3020

Table III: Comparison of DeepOCCAM with other OCCAM Run settings and OCCAM-T Run (Trimmer)

V. TRIMMER TOOL

Program debloating techniques. Program debloating techniques rogram debloating techniques. Program debloating techniques. Program debloating techniques. Program debloating techniques rogram debloating techniques rogram debloating techniques. Program debloating techniques rogram debloating techniques. Program debloating techniques. Program debloating techniques rogram debloating techniques. Program debloating techniques. Program debloating techniques. Program debloating techniques rogram debloating techniques rogram debloating techniques rogram debloating techniques. Program debloating techniques rogram debloating techniques rogram debloating techniques. Program debloating techniques rogram debloating techniques. Program debloating techniques

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A. Overview

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B. Working Procedure

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Program debloating techniques. Program debloating techniques rogram debloating techniques. Pro-

nettest_bsd										
Libraries/Tools	Before	None	Aggressive	DeepOCCAM	DeepOCCAM Non-rec		IPDSE/IPSCCP			
				RL Model	Aggressive		Loop Unrolling			
Functions	33	23	24	24	24	24	24			
Basic Blocks	979	553	573	573	573	573	573			
Instructions Count	6301	3045	3140	3140	3140	3140	3140			
Direct Calls	862	402	412	412	412	412	412			
External Calls	794	369	377	377	377	377	377			
Memory Instructions	2859	1350	1396	1396	1396	1396	1396			
Load/Store	2009	1550	1000	1990	1000	1000	1930			

Table IV: Comparison of DeepOCCAM with other OCCAM Run settings and OCCAM-T Run (Trimmer)

				httpd			
Libraries/Tools	Before	None	Aggressive	DeepOCCAM	Non-rec	Only once	IPDSE/IPSCCP
	Beiere	rvone	11881055140	RL Model	Aggressive	omy once	Loop Unrolling
Functions	1083	477	428	430	444	416	441
Basic Blocks	12943	11615	12563	13562	12999	11401	12652
Instructions Count	83238	62428	65842	66521	70773	61667	65252
Direct Calls	22603	5279	5152	5259	5932	5175	5869
External Calls	20712	4152	4563	4628	4787	4116	4625
Memory Instructions	17071	16334	18345	17056	18347	16188	17854
Load/Store	17071	10554	10040	17050	16347	10100	17654

Table V: Comparison of DeepOCCAM with other OCCAM Run settings and OCCAM-T Run (Trimmer)

	GNU Tree										
Libraries/Tools	Before	None	Aggressive	DeepOCCAM	Non-rec	Only once	IPDSE/IPSCCP				
	Beiore	TVOIC	11881055140	RL Model Aggressive		omy once	Loop Unrolling				
Functions	52	40	41	44	44	40	42				
Basic Blocks	1458	1845	1850	1891	1891	1845	1850				
Instructions Count	7442	8957	9152	9286	9286	8957	9365				
Direct Calls	1051	1257	1150	1290	1290	1257	1362				
External Calls	845	1167	1147	1200	1200	1167	1058				
Memory Instructions	1944	2362	2344	2344	2344	2222	2452				
Load/Store	1344	2002	2044	2044	2044	2222	2402				

Table VI: Comparison of DeepOCCAM with other OCCAM Run settings and OCCAM-T Run (Trimmer)

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VI. CHISEL TOOL

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B. Working Procedure

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C. State Encoding

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D. Delta Debugging

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E. 1-minimal Program

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VII. DEEPOCCAM TOOL

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B. Working Procedure

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C. State Encoding

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Bzip2 Program	Original	Chisel	OCCAM-T	DeepOCCAM	OCCAM	OCCAM
Dzipz i rogram		Tool	(Trimmer)	RL Model	Aggressive	None
ROP Gadgets	646	313	1311	1395	1336	1455
COP Gadgets	97	55	208	226	205	236
JOP Gadgets	6872	1562	3784	3722	3848	4585
Total Unique Gadgets	7374	1930	5284	5117	5185	6345
(Excluding SYS & Chain)	1314	1950	5264	5117	3163	0343

Table VII: Gadgets count comparision for Bzip2

GNU Tree	Original	Chisel	OCCAM-T	DeepOCCAM	OCCAM	OCCAM
GIVO Tree		Tool	(Trimmer)	RL Model	Aggressive	None
ROP Gadgets	567	405	483	567	713	515
COP Gadgets	50	9	19	146	39	83
JOP Gadgets	2126	775	2774	1951	1951	2564
Total Unique Gadgets	2693	0	3258	2664	2664	3162
(Excluding SYS & Chain)	2093	U	3230	2004	2004	5102

Table VIII: Gadgets count comparision for GNU Tree

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D. Inst2Vec Usage

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VIII. PROJECT AIM

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IX. IMPLEMENTATION

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X. PIPELINE SETUP

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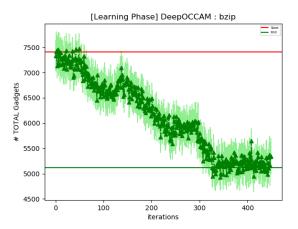


Figure 11: **DeepOCCAM Total** ${\bf 450} \ {\bf iterations} \ {\bf bzip} \ {\bf -HF}$

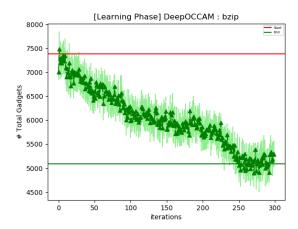


Figure 12: **DeepOCCAM Total**

300 iterations bzip - inst2vec bzip embedding

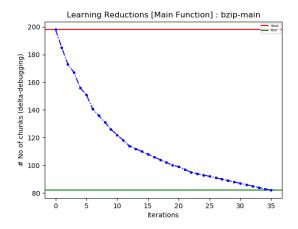


Figure 13: Chisel Learning bzip main()

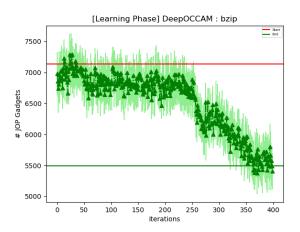


Figure 14: **DeepOCCAM JOP**400 iterations bzip - HF

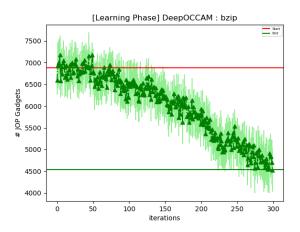


Figure 15: **DeepOCCAM JOP 300** iterations bzip - inst2vec bzip embedding

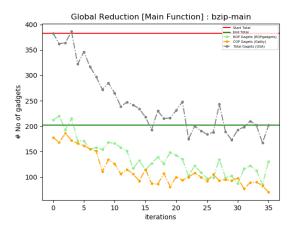


Figure 16: Chisel Gadgets Count main()

A. Chisel Pipeline

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B. OCCAM Pipeline

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C. DeepOCCAM Pipeline

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XI. Analysis Metrics

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A. Static Analysis

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B. Dynamic Analysis

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C. Gadgets

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XII. COMPARISION METRICS

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A. Static Analysis

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	NET UUID Program									
Libraries/Tools	Before	None	Aggressive	Machine Non-rec		Only once	IPDSE/IPSSCP			
Libraries/ 100is	Delore	TVOILE	Aggressive	Learning	Aggressive	Omy once	Loop Unrolling			
Functions	10	9	9	9	9	9	9			
Basic Blocks	38	34	34	34	34	34	34			
Instructions Count	349	304	304	304	304	304	304			
Direct Calls	23	20	20	20	20	20	20			
External Calls	12	9	9	9	9	9	9			
Memory Instructions	141	128	128	128	128	128	128			
Load/Store	141	120	120	120	120	120	120			

Table IX: Comparison of DeepOCCAM with other OCCAM Run settings and OCCAM-T Run (Trimmer)

netsh Program Program											
Libraries/Tools	Before	None	Aggressive	Machine	Non-rec	Only once	IPDSE/IPSSCP				
				Learning	Aggressive	Omy once	Loop Unrolling				
Functions	12	11	13	13	13	11	11				
Basic Blocks	313	312	332	332	332	312	312				
Instructions Count	1319	1315	1417	1417	1417	1315	1315				
Direct Calls	195	194	196	196	196	194	194				
External Calls	172	171	173	173	173	171	171				
Memory Instructions	433	431	481	481	481	431	431				
Load/Store							491				

Table X: Comparison of DeepOCCAM with other OCCAM Run settings and OCCAM-T Run (Trimmer)

Chisel Tool (Final)	bzip		date		mkdir		rm		tree	
Binary Metrics	Before	After								
ROP Gadgets	646	313	408	166	210	84	485	111	567	405
COP Gadgets	97	55	39	8	7	5	44	5	50	9
JOP Gadgets	6728	1562	5214	877	2282	176	4476	190	2126	775
Total Unique Gadgets	7374	1930	5626	1046	2492	260	4965	301	2693	1187
(Excluding SYS & Chain)	1314	1930	3020	1040	2492	200	4905	301	2093	1101

Table XI: Dynamic Binary Analysis results for Chisel for Gadgets Count

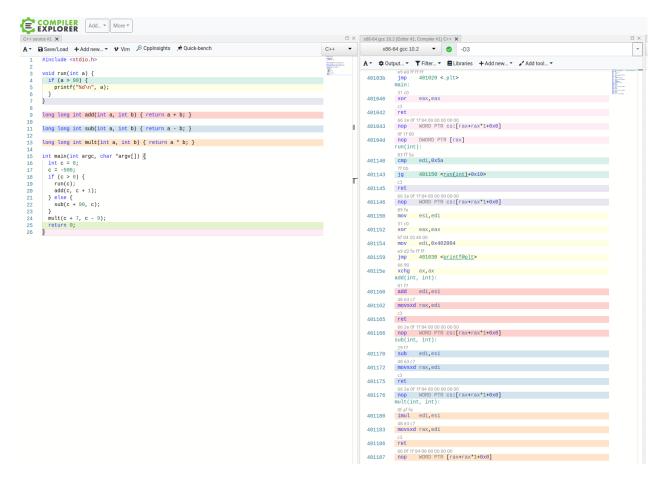


Figure 17: C Code Example before Chisel tool processing

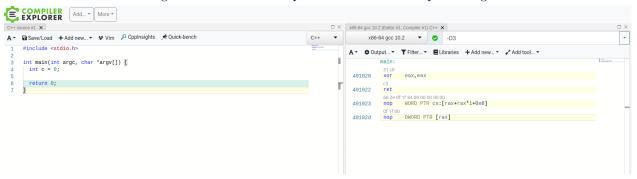


Figure 18: C Code Example after Chisel tool processing

B. Comparision: Dynamic Analysis

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XIII. Observations

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A. Insights

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XIV. CONCLUSION

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A. But finally, Who Won?

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XV. Other Tools

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XVI. PROJECT ASSETS

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A. Docker Images

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B. GitHub Repositories

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