

Programme	Contre-exemple	Erreurs	LocFaults (≤ 3)	BugAssist
AbsMinusKO	$\{i = 0, j = 1\}$	17	{17}	{17}
AbsMinusKO2	$\{i = 0, j = 1\}$	11	{11}, {17}	{17, 20, 16}
AbsMinusKO3	$\{i = 0, j = 1\}$	14	{20}, {16(Else)}, {14}, {12}	{16, 20}
AbsMinusV2KO	$\{i = 0, j = 1\}$	13	{13}	{13}
AbsMinusV2KO2	$\{i = 0, j = 1\}$	11	{11}, {13}	{13, 16, 12}
MinmaxKO	$\{in_1 = 2, in_2 = 1, in_3 = 3\}$	19	{10}, {19}, {18(If)}, {10}	{14, 19, 30}
MidKO	$\{a = 2, b = 1, c = 3\}$	19	{19}, {14(If)}, 23(If), 26(Else)}	{14, 19, 30}
Maxmin6varKO	$\{a = 1, b = -4, c = -3, d = -1, e = 0, f = -4\}$	27	{28}, {15(Else)}, {27(If)}	{15, 12, 27, 31, 166}
Maxmin6varKO2	$\{a = 1, b = -3, c = 0, d = -2, e = -1, f = -2\}$	12	{65}, {12(Else)}	{12, 64, 166}
Maxmin6varKO3	$\{a = 1, b = -3, c = 0, d = -2, e = -1, f = -2\}$	12, 15	{65}, {12(Else)}, 15(Else)}	{12, 15, 64, 166}
Maxmin6varKO4	$\{a = 1, b = -3, c = -4, d = -2, e = -1, f = -2\}$	12, 15, 19	{116}, {12(Else)}, 15(If), 19(Else)}	{12, 166}
TritypeKO	$\{i = 2, j = 3, k = 2\}$	54	{54}, {26(Else)}, {48(Else)}, {30}, {25}, {29(If)}, 32(Else)}, {53(If)}, 57(Else)}, {30}, {25}	{26, 27, 32, 33, 36, 48, 57, 68}
TritypeKO2	$\{i = 2, j = 2, k = 4\}$	53	{54}, {21(Else)}, {26(If)}, {35(Else)}, {27}, {25}, {53(If)}, {27}, {25}, {29(Else)}, 57(If)}, {32(Else)}, 44(If)}	{21, 26, 27, 29, 30, 32, 33, 35, 36, 53, 68}
TritypeKO2V2	$\{i = 1, j = 2, k = 1\}$	31	{50}, {21(Else)}, {26(Else)}, {29(If)}, {36(Else)}, {31}, {25}, {49(If)}, {31}, {25}, {33(Else)}, 45(If)}	{21, 26, 27, 29, 31, 33, 34, 36, 37, 49, 68}
TritypeKO3	$\{i = 1, j = 2, k = 1\}$	53	{54}, {21(Else)}, {29(If)}, {35(Else)}, {30}, {25}, {53(If)}, {30}, {25}, {26(Else)}, 57(If)}, {32(Else)}, 44(If)}	{21, 26, 27, 29, 30, 32, 33, 35, 36, 48, 53, 68}
TritypeKO4	$\{i = 2, j = 3, k = 3\}$	45	{46}, {45(If)}, {33}, {25}, {26(Else)}, 32(If)}, {32(If)}, 35(If), 49(Else)}, {32(If)}, 35(If), 53(Else)}, {32(If)}, 35(If), 57(Else)}	{26, 27, 29, 30, 32, 33, 35, 45, 49, 68}
TritypeKO5	$\{i = 2, j = 3, k = 3\}$	32, 45	{40}, {26(Else)}, {29(Else)}, {32(Else)}, 45(If)}, {35(If)}, 49(Else)}, {25}, {35(If)}, 53(Else)}, {25}, {35(If)}, 57(Else)}, {25}	{26, 27, 29, 30, 32, 33, 35, 49, 68}
TritypeKO6	$\{i = 2, j = 3, k = 3\}$	32, 33	{40}, {26(Else)}, {29(Else)}, {35(If)}, 49(Else)}, {25}, {35(If)}, 53(Else)}, {25}, {35(If)}, 57(Else)}, {25}	{26, 27, 29, 30, 32, 33, 35, 49, 68}
TriPerimetreKO	$\{i = 2, j = 1, k = 2\}$	58	{58}, {31(If)}, {37(Else)}, {32}, {27}	{28, 29, 31, 32, 35, 37, 65, 72}
TriPerimetreKOV2	$\{i = 2, j = 3, k = 2\}$	34	{34}, {60}, {32(If)}, {40(Else)}, {33}, {27}	{28, 32, 33, 34, 36, 38, 40, 41, 52, 55, 56, 60, 64, 67, 74}
TriPerimetreKO2	$\{i = 1, j = 1, k = 2\}$	57	{58}, {22(Else)}, {28(If)}, {37(Else)}, {29}, {27}, {57(If)}, {29}, {27}, {31(Else)}, 61(If)}, {34(Else)}, 48(If)}	{22, 28, 29, 31, 32, 34, 35, 37, 38, 48, 49, 52, 53, 57, 58, 61, 72}
TriPerimetreKO2V2	$\{i = 1, j = 2, k = 1\}$	33	{54}, {22(Else)}, {28(Else)}, {31(If)}, {38(Else)}, {33}, {27}, {53(If)}, {33}, {27}, {35(Else)}, 49(If)}	{22, 28, 72, 54, 53, 39, 33, 36, 38, 29, 31, 35, 49, 50}
TriPerimetreKO3	$\{i = 2, j = 1, k = 2\}$	57	{58}, {22(Else)}, {31(If)}, {37(Else)}, {32}, {27}, {57(If)}, {32}, {27}, {28(Else)}, 61(If)}, {34(Else)}, 48(If)}	{22, 28, 29, 31, 32, 34, 35, 37, 38, 49, 52, 57, 72}

TriPerimetreKO4	$\{i = 2, j = 3, k = 3\}$	49	$\{50\}$ $\{34(If)\}$ $\{37(Else)\}, \{35\}, \{27\}$ $\{49(If)\}, \{35\}, \{27\}$	$\{37, 35, 72, 50, 49, 34, 28, 29, 32, 61, 65, 31\}$
TriPerimetreKO5	$\{i = 2, j = 2, k = 3\}$	34,49	$\{50\}$ $\{34(If)\}$ $\{37(Else)\}, \{35\}, \{27\}, \{29\}$ $\{49(If)\}, 54(Else)\}, \{35\}, \{27\}, \{29\}$	$\{37, 35, 32, 29, 72, 34, 31, 49, 53\}$
TriPerimetreKO6	$\{i = 2, j = 2, k = 3\}$	34,35	$\{50\}$ $\{34(If)\}$ $\{37(Else)\}, \{35\}, \{27\}, \{29\}$ $\{49(If)\}, 53(Else)\}, \{35\}, \{27\}, \{29\}$	$\{37, 72, 29, 32, 35, 34, 31, 49, 53\}$
TriMultPerimetreKO	$\{i = 2, j = 1, k = 2\}$	58	$\{58\}$ $\{31(If)\}$ $\{37(Else)\}, \{27\}, \{32\}$	$\{72, 37, 53, 49, 29, 35, 32, 31, 28, 65, 34, 62\}$
TriMultPerimetreKO2	$\{i = 1, j = 1, k = 2\}$	57	$\{58\}$ $\{22(Else)\}$ $\{28(If)\}$ $\{37(Else)\}, \{27\}, \{29\}$ $\{57(If)\}, \{29\}, \{27\}$ $\{31(Else), 61(If)\}$ $\{34(Else), 48(If)\}$	$\{22, 37, 72, 58, 38, 52, 57, 49, 35, 32, 29, 28, 31, 65, 34\}$
TriMultPerimetreKO2V2	$\{i = 1, j = 2, k = 1\}$	32	$\{53\}$ $\{21(Else)\}$ $\{27(Else)\}$ $\{30(If)\}$ $\{37(Else)\}, \{32\}, \{26\}$ $\{52(If)\}, \{26\}, \{32\}$ $\{34(Else), 48(If)\}$	$\{21, 27, 71, 49, 52, 38, 53, 32, 35, 37, 28, 30, 34, 48\}$
TriMultPerimetreKO3	$\{i = 1, j = 2, k = 1\}$	56	$\{57\}$ $\{21(Else)\}$ $\{30(If)\}$ $\{36(Else)\}, \{26\}, \{31\}$ $\{56(If)\}, \{31\}, \{26\}$ $\{27(Else), 60(If)\}$ $\{33(Else), 47(If)\}$	$\{21, 71, 56, 51, 37, 57, 31, 28, 36, 34, 30, 27, 33, 47\}$
TriMultPerimetreKO4	$\{i = 2, j = 3, k = 3\}$	48	$\{49\}$ $\{33(If)\}$ $\{36(Else)\}, \{26\}, \{34\}$ $\{48(If)\}, \{34\}, \{26\}$	$\{36, 34, 71, 49, 48, 33, 27, 28, 31, 53, 30, 60\}$
TriMultPerimetreKO5	$\{i = 2, j = 2, k = 3\}$	33,48	$\{49\}$ $\{33(If)\}$ $\{36(Else)\}, \{34\}, \{28\}, \{26\}$ $\{48(If)\}, 52(Else)\}, \{26\}, \{34\}, \{28\}$	$\{36, 34, 31, 28, 71, 49, 33, 30, 48, 52\}$
TriMultPerimetreKO6	$\{i = 2, j = 2, k = 3\}$	33,34	$\{48\}$ $\{33(If)\}$ $\{36(Else)\}, \{34\}, \{26\}, \{28\}$ $\{47(If)\}, 51(Else)\}, \{26\}, \{34\}, \{28\}$	$\{36, 70, 48, 28, 31, 34, 33, 30, 47, 51\}$
HeronKO	$\{i = 3, j = 4, k = 3\}$	61	$\{61\}$ $\{29(If)\}$ $\{35(Else)\}, \{30\}, \{25\}$	$\{19, 61, 79, 35, 27, 33, 30, 42, 29, 26, 71, 32, 48, 51, 54\}$
HeronKO2	$\{i = 2, j = 2, k = 4\}$	59	$\{19\}, \{62\}$ $\{26(If)\}$ $\{35(Else)\}, \{27\}, \{25\}$ $\{59(If)\}, \{27\}, \{25\}$ $\{29(Else), 65(If)\}$ $\{32(Else), 46(If)\}$	$\{62, 80, 19, 59, 36, 42, 33, 35, 30, 27, 26, 29, 68, 32, 48, 51, 54\}$
HeronV1	$\{i = 3, j = 4, k = 3\}$	61	$\{61\}$ $\{29(If)\}$ $\{35(Else)\}, \{30\}, \{25\}$	$\{79, 33, 30, 42, 35, 27, 61, 29, 26, 71, 32, 48, 36, 51\}$
HeronV2	$\{i = 2, j = 2, k = 4\}$	59	$\{62\}$ $\{26(If)\}$ $\{35(Else)\}, \{25\}, \{27\}$ $\{59(If)\}, \{27\}, \{25\}$ $\{29(Else), 65(If)\}$ $\{32(Else), 46(If)\}$	$\{62, 80, 59, 36, 42, 33, 35, 30, 27, 26, 29, 72, 32, 48, 51, 54\}$
HeronKO2V2	$\{i = 1, j = 2, k = 1\}$	31	$\{55\}$ $\{26(Else)\}$ $\{29(If)\}$ $\{36(Else)\}, \{25\}, \{31\}$ $\{52(If)\}, \{31\}, \{25\}$ $\{33(Else), 47(If)\}$	$\{26, 19, 52, 80, 55, 43, 31, 34, 36, 27, 29, 33, 47, 49\}$
HeronKO3	$\{i = 1, j = 2, k = 1\}$	59	$\{62\}$ $\{29(If)\}$ $\{35(Else)\}, \{25\}, \{30\}$ $\{59(If)\}, \{30\}, \{25\}$ $\{26(Else), 65(If)\}$ $\{32(Else), 46(If)\}$	$\{80, 42, 19, 59, 51, 62, 30, 27, 35, 33, 29, 26, 32, 46\}$
HeronKO4	$\{i = 2, j = 3, k = 3\}$	47	$\{49\}$ $\{32(If)\}$ $\{35(Else)\}, \{33\}, \{25\}$ $\{47(If)\}, \{33\}, \{25\}$	$\{35, 33, 80, 49, 47, 32, 26, 19, 27, 30, 55, 29\}$
HeronKO5	$\{i = 2, j = 2, k = 3\}$	32,47	$\{49\}$ $\{20(Else)\}$ $\{32(If)\}$ $\{35(Else)\}, \{33\}, \{25\}, \{27\}$ $\{47(If)\}, 52(Else)\}, \{25\}, \{33\}, \{27\}$	$\{20, 35, 33, 30, 27, 80, 49, 32, 29, 47, 52\}$
HeronKO6	$\{i = 2, j = 2, k = 3\}$	32,33	$\{48\}$ $\{20(Else)\}$ $\{32(If)\}$ $\{35(Else)\}, \{33\}, \{27\}, \{25\}$ $\{46(If)\}, 51(Else)\}, \{27\}, \{33\}, \{25\}$	$\{20, 35, 79, 48, 27, 30, 33, 32, 29, 46, 51\}$

TABLE 1 – MCS identified by LocFaults [1] [2] for programs without loops : improved results. This table also shows the result of BugAssist [3].

Program	LocFaults									BugAssist	
	P	L								P	L
		= 0		≤ 1		≤ 2		≤ 3			
		V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2		
AbsMinusKO	0.719	0.024	0.021	0.024	0.026	0.021	0.028	0.027	0.033	0.01	0.02
AbsMinusKO2	0.726	0.035	0.042	0.029	0.031	0.037	0.04	0.034	0.036	0.02	0.06
AbsMinusKO3	0.708	0.02	0.026	0.032	0.069	0.092	0.045	0.059	0.05	0.02	0.07
AbsMinusV2KO	0.682	0.021	0.025	0.023	0.023	0.021	0.025	0.021	0.023	0.01	0.02
AbsMinusV2KO2	0.704	0.027	0.03	0.025	0.029	0.033	0.029	0.041	0.029	0.02	0.06
MinmaxKO	0.696	0.062	0.088	0.066	0.065	0.119	0.057	0.107	0.072	0.02	0.07
MidKO	0.695	0.027	0.022	0.023	0.029	0.021	0.022	0.028	0.037	0.02	0.10
Maxmin6varKO	0.856	0.032	0.028	0.04	0.052	0.041	0.05	0.061	0.052	0.07	1.50
Maxmin6varKO2	0.78	0.027	0.035	0.035	0.035	0.04	0.042	0.04	0.061	0.07	0.98
Maxmin6varKO3	0.791	0.027	0.037	0.03	0.036	0.046	0.045	0.049	0.056	0.07	1.79
Maxmin6varKO4	0.802	0.027	0.035	0.032	0.037	0.033	0.035	0.051	0.056	0.08	1.11
TritypeKO	0.735	0.028	0.024	0.071	0.081	0.161	0.163	0.19	0.151	0.03	0.40
TritypeKO2	0.757	0.031	0.029	0.135	0.116	0.159	0.146	0.177	0.153	0.02	0.69
TritypeKO2V2	0.743	0.011	0.014	0.061	0.062	0.129	0.096	0.275	0.102	0.03	0.80
TritypeKO3	0.735	0.025	0.024	0.1	0.11	0.169	0.148	0.234	0.18	0.03	0.77
TritypeKO4	0.739	0.028	0.028	0.069	0.058	0.085	0.063	0.188	0.17	0.02	0.37
TritypeKO5	0.74	0.022	0.022	0.042	0.034	0.161	0.157	0.153	0.158	0.02	0.39
TritypeKO6	0.752	0.023	0.028	0.038	0.039	0.182	0.163	0.187	0.146	0.03	0.34
TriPerimetreKO	0.787	0.028	0.027	0.071	0.061	0.099	0.074	0.219	0.092	0.02	0.98
TriPerimetreKOV2	0.751	0.086	0.068	0.177	0.185	0.186	0.162	0.243	0.19	0.04	1.78
TriPerimetreKO2	0.756	0.024	0.029	0.144	0.113	0.171	0.152	0.193	0.166	0.04	3.84
TriPerimetreKO2V2	0.722	0.151	0.041	0.182	0.166	0.13	0.136	0.157	0.164	0.03	2.18
TriPerimetreKO3	0.778	0.034	0.025	0.143	0.14	0.184	0.171	0.223	0.175	0.02	1.83
TriPerimetreKO4	0.786	0.023	0.025	0.117	0.127	0.122	0.092	0.172	0.122	0.04	1.12
TriPerimetreKO5	0.763	0.026	0.025	0.085	0.1	0.2	0.171	0.261	0.208	0.04	1.11
TriPerimetreKO6	0.75	0.029	0.028	0.105	0.078	0.247	0.167	0.232	0.203	0.04	0.85
TriMultPerimetreKO	0.723	0.058	0.054	0.13	0.137	0.145	0.147	0.168	0.148	0.04	3.23
TriMultPerimetreKO2	0.708	0.044	0.055	0.217	0.253	0.269	0.233	0.264	0.25	0.06	5.21
TriMultPerimetreKO2V2	0.728	0.055	0.053	0.231	0.239	0.25	0.276	0.227	0.246	0.06	3.97
TriMultPerimetreKO3	0.714	0.045	0.063	0.164	0.255	0.251	0.271	0.286	0.255	0.06	3.96
TriMultPerimetreKO4	0.724	0.048	0.058	0.228	0.208	0.196	0.15	0.162	0.142	0.04	2.78
TriMultPerimetreKO5	0.739	0.054	0.05	0.138	0.096	0.179	0.142	0.199	0.211	0.06	3.90
TriMultPerimetreKO6	0.722	0.056	0.054	0.133	0.132	0.218	0.2	0.24	0.229	0.05	2.65
HeronKO	0.793	0.13	0.119	0.23	0.221	0.224	0.231	0.212	0.238	0.06	6.78
HeronKO2	0.737	0.053	0.082	0.232	0.243	0.275	0.209	0.295	0.263	0.08	10.05
HeronV1	0.747	0.06	0.052	0.139	0.147	0.148	0.142	0.165	0.157	0.08	11.25
HeronV2	0.748	0.059	0.064	0.243	0.249	0.255	0.271	0.271	0.275	0.08	7.04
HeronKO2V2	0.757	0.126	0.124	0.298	0.337	0.317	0.268	0.199	0.33	0.08	5.84
HeronKO3	0.677	0.117	0.08	0.3	0.332	0.325	0.23	0.359	0.325	0.09	6.02
HeronKO4	0.743	0.046	0.047	0.144	0.149	0.152	0.217	0.174	0.196	0.08	4.52
HeronKO5	0.736	0.051	0.048	0.135	0.132	0.24	0.229	0.224	0.208	0.07	6.02
HeronKO6	0.754	0.051	0.055	0.139	0.14	0.22	0.225	0.251	0.252	0.08	4.58

TABLE 2 – Computation time (in seconds). The columns V_1 and V_2 correspond to results of `LocFaults` respectively with and without marking the nodes in the CFG. With marking of nodes in `LocFaults` : at a given step, the node that detects a minimum deviation correction will be marked by the cardinal of this deviation; for to next steps, the algorithm will not allow visiting an adjacency list of this node. For `LocFaults`, we used the solver MIP of Cplex(<http://www-01.ibm.com/software/commerce/optimization/cplex-optimizer/>) for all programs in the table; except the programs with non-linear calculation, for which we used the solver IBM ILOG CP of Cplex(<http://www-01.ibm.com/software/commerce/optimization/cplex-cp-optimizer/>). For `BugAssist`, we used the Max-SAT solver MSUnCore2 [4].

Références

- [1] Bekkouche, Mohammed, Hélène Collavizza, and Michel Rueher. "Une approche CSP pour l'aide à la localisation d'erreurs." arXiv preprint arXiv :1404.6567 (2014).
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- [4] Marques-Silva, Joao. "The msuncore maxsat solver." SAT 2009 competitive events booklet : preliminary version (2009) : 151.