

Report on CSC'09

The 4th International Constraint Solver Competition

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- 1 Choco solver
 - Presentation
- 2 CSC'09
- 3 Results

Choco : a JAVA library for CSP



- Choco is a java library for constraint satisfaction problems (CSP), constraint programming (CP) and explanation-based constraint solving (e-CP),
- It is built on a event-based propagation mechanism with backtrackable structures,
- Choco is an open-source software, distributed under a BSD Licence and hosted by sourceforge.net.

- 1 Choco solver
- 2 CSC'09
 - Presentation
 - 2009
- 3 Results

A Constraint Solver Competition



- GOAL : improve our knowledge of what is behind the efficiency of constraint satisfaction algorithms, heuristics, solving strategies, and constraint systems
- 5 CATEGORIES :
 - 2-ARY-EXT : binary extensional constraints
 - 2-ARY-INT : binary intensional constraints
 - N-ARY-EXT : n-ary extensional constraints
 - N-ARY-INT : n-ary intensional constraints
 - GLOBAL : global constraints
 - AllDiff
 - AllDiff+Cumul+Elt+WSum
 - AllDiff+Elt+WSum
- Link to CSC'09 website

The 4th Constraint Solver Competition



The fourth CSP solver competition was held in 2009 with 9 teams and 14 solvers.

Category	Instances	Teams	Solvers
2-ARY-EXT	635	9	14
2-ARY-INT	686	8	13
N-ARY-EXT	699	9	14
N-ARY-INT	709	8	13
AllDiff	118	7	11
Alldiff+Cumul+Elt+WSum	276	5	8
Alldiff+Elt+WSum	162	4	6

1 Choco solver

2 CSC'09

3 Results

- 2-ARY-EXT
- 2-ARY-INT
- N-ARY-EXT
- N-ARY-INT
- GLOBAL
 - AllDiff
 - Alldiff+Cumul+Elt+WSum
 - Alldiff+Elt+WSum
- Best/Worst cases

2-ARY-EXT : SAT+UNSAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 635

1	Mistral	570	90%	82.20
2	Choco2.1.1b	556	88%	99.67
3	Abscon 112v4	551	87%	106.45
4	Abscon 112v4	547	86%	92.12
5	Choco2.1.1	547	86%	104.91
6	Concrete DC	504	79%	120.96
7	Concrete	503	79%	98.17
8	Sugar	466	73%	152.86
9	Sugar	438	69%	122.02
10	SAT4J CSP	421	66%	123.14
11	bpsolver	416	66%	134.74
12	pcs-restart	394	62%	117.67
13	pcs	393	62%	144.82

2-ARY-EXT : SAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 635

1	Mistral	326	51%	101.48
2	Choco2.1.1b	314	49%	102.86
3	Abscon 112v4	314	49%	116.62
4	Abscon 112v4	310	49%	97.22
5	Choco2.1.1	309	49%	117.34
6	Concrete	297	47%	110.56
7	Concrete DC	297	47%	122.18
8	Sugar	274	43%	112.34
9	Sugar	270	43%	113.35
10	SAT4J CSP	259	41%	104.82
11	bpsolver	253	40%	114.99
12	pcs-restart	241	38%	84.52
13	pcs	238	37%	114.82

2-ARY-EXT : UNSAT answers

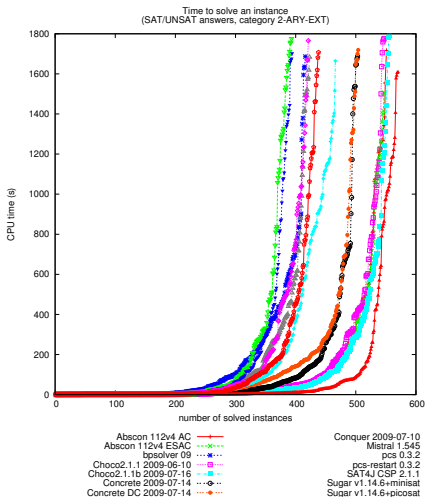


Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 635

1	Mistral	244	38%	56.46
2	Choco2.1.1b	242	38%	95.52
3	Choco2.1.1	238	37%	88.78
4	Abscon 112v4	237	37%	85.45
5	Abscon 112v4	237	37%	92.98
6	Concrete DC	207	33%	119.20
7	Concrete	206	32%	80.31
8	Sugar	192	30%	210.70
9	Sugar	168	26%	135.94
10	bpsolver	163	26%	165.40
11	SAT4J CSP	162	26%	152.44
12	pcs	155	24%	190.89
13	pcs-restart	153	24%	169.88

2-ARY-EXT : Time vs Number of solved instances



2-ARY-EXT : Comparison



3 top solvers

Series	#	Mistral	Abscon	Choco
Hanoi	5	5	5	5
Langford	4	4	4	4
BQWH	20	20	20	20
Black Hole	37	37	37	37
Graph Coloring	22	22	22	22
QCP/QWH	100	77	73	97
Quasi Random CSP	75	75	75	70
Random CSP	365	323	308	294
Driver	7	7	7	7
Total	635	570	551	556

2-ARY-INT : SAT+UNSAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 686

1	Abscon 112v4	517	75%	33.07
2	Abscon 112v4	513	75%	42.42
3	Mistral	511	74%	53.73
4	Choco2.1.1b	510	74%	70.28
5	Choco2.1.1	508	74%	64.06
6	Sugar	479	70%	75.66
7	Sugar	470	69%	59.17
8	Concrete	428	62%	79.68
9	pcs-restart	419	61%	52.12
10	pcs	419	61%	57.26
11	Concrete DC	372	54%	179.27
12	bpsolver	349	51%	103.69
13	SAT4J CSP	306	45%	58.61

2-ARY-INT : SAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 686

1	Sugar	263	38%	61.54
2	Abscon 112v4	259	38%	31.14
3	Abscon 112v4	258	38%	43.20
4	Sugar	254	37%	51.21
5	Mistral	242	35%	37.71
6	Choco2.1.1b	240	35%	68.88
7	Concrete	237	35%	34.37
8	Choco2.1.1	236	34%	60.98
9	pcs-restart	211	31%	31.92
10	pcs	210	31%	55.04
11	Concrete DC	179	26%	189.26
12	bpsolver	178	26%	135.84
13	SAT4J CSP	177	26%	51.97

2-ARY-INT : UNSAT answers

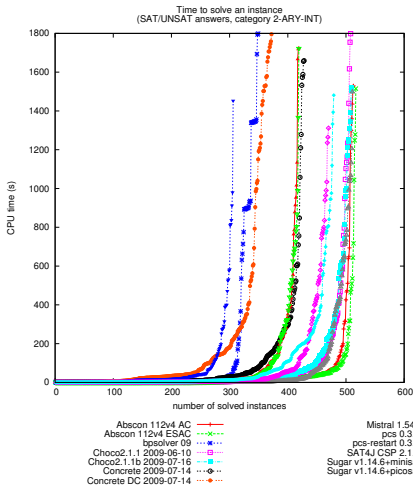


Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 686

1	Choco2.1.1	272	40%	66.73
2	Choco2.1.1b	270	39%	71.53
3	Mistral	269	39%	68.14
4	Abscon 112v4	258	38%	35.00
5	Abscon 112v4	255	37%	41.62
6	Sugar	216	31%	68.52
7	Sugar	216	31%	92.86
8	pcs	209	30%	59.50
9	pcs-restart	208	30%	72.61
10	Concrete DC	193	28%	170.00
11	Concrete	191	28%	135.91
12	bpsolver	171	25%	70.23
13	SAT4J CSP	129	19%	67.72

2-ARY-INT : Time vs Number of solved instances



2-ARY-INT : Comparison



3 top solvers

Series	#	Abscon	Mistral	Choco
Domino	10	10	10	10
Knights	10	8	7	4
Langford	43	27	30	29
NengFa	3	3	3	3
Pigeons	10	10	10	10
Queen Attacking	10	3	4	4
Queens	15	11	10	12
Queens-Knights	10	9	8	5
Pseudo-Boolean	1	1	1	1
Graph Coloring	141	119	121	118
Haystacks	15	6	3	6
Job-Shop	76	45	49	62
Open-Shop	75	47	70	75
Super-solutions	85	40	52	49
Crossword	3	3	3	3
FAPP	120	116	73	63
RLFAP	59	59	57	56
Total	686	517	511	510

N-ARY-EXT : SAT+UNSAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 699

1	Mistral	585	84%	85.67
2	Abscon 112v4	545	78%	75.78
3	Concrete	544	78%	210.85
4	Abscon 112v4	543	78%	77.52
5	Conquer	532	76%	88.26
6	Choco2.1.1	532	76%	158.46
7	Concrete DC	532	76%	318.55
8	Choco2.1.1b	528	76%	143.80
9	pcs	497	71%	166.89
10	pcs-restart	496	71%	165.04
11	bpsolver	394	56%	108.39
12	Sugar	374	54%	194.24
13	Sugar	350	50%	172.23
14	SAT4J CSP	209	30%	144.31

N-ARY-EXT : SAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 699

1	Mistral	293	42%	104.59
2	Choco2.1.1	267	38%	160.50
3	Concrete	267	38%	190.25
4	Concrete DC	265	38%	289.44
5	Choco2.1.1b	262	37%	121.41
6	Conquer	261	37%	97.08
7	Abscon 112v4	250	36%	84.75
8	Abscon 112v4	249	36%	83.22
9	pcs	225	32%	198.98
10	pcs-restart	223	32%	188.17
11	bpsolver	196	28%	134.88
12	Sugar	184	26%	188.11
13	Sugar	183	26%	180.24
14	SAT4J CSP	119	17%	221.57

N-ARY-EXT : UNSAT answers

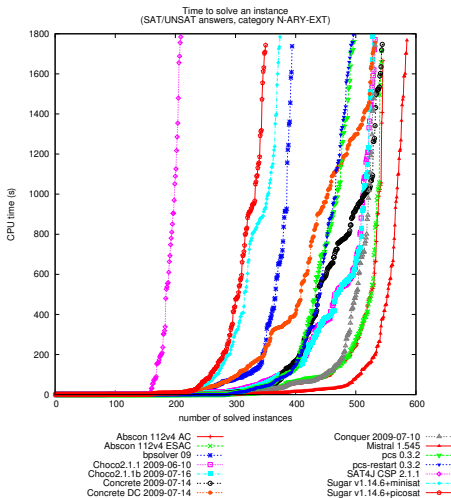


Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 699

1	Abscon 112v4	295	42%	68.19
2	Abscon 112v4	294	42%	72.69
3	Mistral	292	42%	66.67
4	Concrete	277	40%	230.70
5	pcs-restart	273	39%	146.15
6	pcs	272	39%	140.36
7	Conquer	271	39%	79.77
8	Concrete DC	267	38%	347.45
9	Choco2.1.1b	266	38%	165.85
10	Choco2.1.1	265	38%	156.40
11	bpsolver	198	28%	82.17
12	Sugar	190	27%	200.19
13	Sugar	167	24%	163.46
14	SAT4J CSP	90	13%	42.15

N-ARY-EXT : Time vs Number of solved instances



N-ARY-EXT : Comparison



3 top solvers and Choco

Series	#	Mistral	Abscon	Concrete	Choco
Dimacs	158	157	156	143	144
TSP	30	30	30	30	29
Quasi Random CSP	100	86	88	92	78
Random CSP	199	136	91	108	111
Crossword	170	134	138	129	130
Renault	42	42	42	42	42
Total	699	585	545	544	534

N-ARY-INT : SAT+UNSAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 709

1	Mistral	572	81%	31.18
2	Choco2.1.1	560	79%	49.53
3	Choco2.1.1b	548	77%	58.24
4	pcs-restart	546	77%	41.12
5	pcs	542	76%	39.47
6	bpsolver	513	72%	180.47
7	Abscon 112v4	489	69%	78.68
8	Abscon 112v4	481	68%	59.56
9	Sugar	481	68%	69.50
10	Sugar	478	67%	51.32
11	Concrete	439	62%	187.29
12	Concrete DC	342	48%	249.94
13	SAT4J CSP	171	24%	111.07

N-ARY-INT : SAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 709

1	Mistral	494	70%	30.19
2	Choco2.1.1	482	68%	48.23
3	Choco2.1.1b	469	66%	55.52
4	pcs-restart	461	65%	38.60
5	pcs	457	64%	40.55
6	bpsolver	442	62%	184.93
7	Abscon 112v4	426	60%	74.95
8	Abscon 112v4	418	59%	51.54
9	Sugar	397	56%	71.68
10	Sugar	396	56%	54.57
11	Concrete	379	53%	177.29
12	Concrete DC	290	41%	249.96
13	SAT4J CSP	133	19%	103.70

N-ARY-INT : UNSAT answers

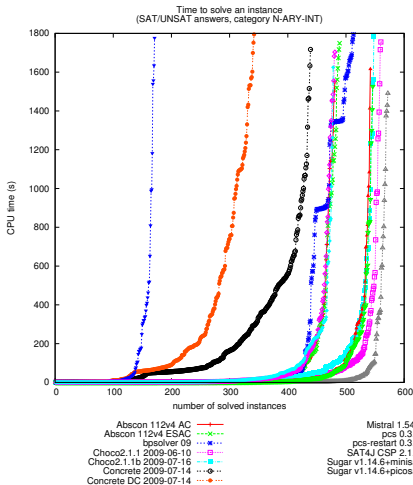


Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 709

1	pcs	85	12%	33.64
2	pcs-restart	85	12%	54.76
3	Sugar	84	12%	59.22
4	Sugar	82	12%	35.62
5	Choco2.1.1b	79	11%	74.41
6	Mistral	78	11%	37.51
7	Choco2.1.1	78	11%	57.53
8	bpsolver	71	10%	152.65
9	Abscon 112v4	63	9%	103.87
10	Abscon 112v4	63	9%	112.74
11	Concrete	60	8%	250.47
12	Concrete DC	52	7%	249.84
13	SAT4J CSP	38	5%	136.88

N-ARY-INT : Time vs Number of solved instances



N-ARY-INT : Comparison



3 top solvers

Series	#	Mistral	Pcs-r	Choco
All Interval Series	15	12	15	11
Chessboard Coloration	15	12	11	10
Golomb Ruler	28	21	23	23
NengFa	4	3	4	3
Ramsey	16	10	5	10
Schurr's Lemma	10	8	8	7
Social Golfers	10	6	5	5
Pseudo-Boolean	262	190	179	180
2D Strip Packing	20	5	3	3
Fischer	25	13	17	15
Multi Knapsack	6	5	4	6
Primes	76	70	57	70
Rader Surveillance	65	65	65	65
BMC	15	15	15	15
Crossword	142	137	135	137
Total	709	572	546	560

Alldiff : SAT+UNSAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 118

1	Sugar	104	88%	58.18
2	Mistral	98	83%	54.47
3	Sugar	88	75%	130.77
4	Abscon 112v4	78	66%	138.73
5	Abscon 112v4	77	65%	109.14
6	Concrete	73	62%	73.83
7	Choco2.1.1	72	61%	88.07
8	Choco2.1.1b	71	60%	51.97
9	Concrete DC	68	58%	144.49
10	SAT4J CSP	65	55%	181.88
11	bpsolver	60	51%	29.46

AllDiff : SAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 118

1	Sugar	77	65%	78.35
2	Mistral	75	64%	71.17
3	Sugar	61	52%	188.39
4	Abscon 112v4	54	46%	186.64
5	Abscon 112v4	53	45%	145.53
6	SAT4J CSP	53	45%	200.36
7	Concrete	50	42%	107.40
8	Choco2.1.1	49	42%	129.23
9	Choco2.1.1b	48	41%	76.69
10	Concrete DC	45	38%	217.89
11	bpsolver	37	31%	47.75

Alldiff : UNSAT answers

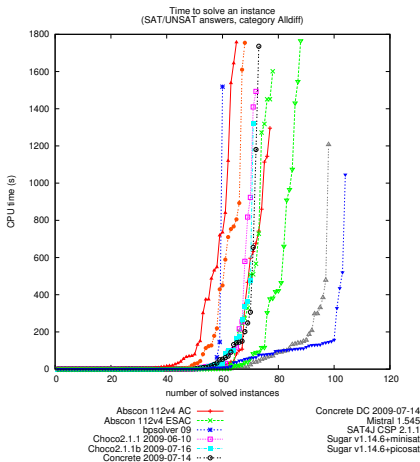


Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 118

1	Sugar	27	23%	0.59
2	Sugar	27	23%	0.66
3	Abscon 112v4	24	20%	28.79
4	Abscon 112v4	24	20%	30.94
5	Mistral	23	19%	0.01
6	bpsolver	23	19%	0.03
7	Choco2.1.1	23	19%	0.39
8	Choco2.1.1b	23	19%	0.39
9	Concrete	23	19%	0.84
10	Concrete DC	23	19%	0.87
11	SAT4J CSP	12	10%	100.26

AllDiff : Time vs Number of solved instances



AllDiff : Comparison



3 top solvers and Choco

Series	#	Sugar	Mistral	Abscon	Choco
CostasArrays	11	11	10	11	11
LatinSquare	10	10	5	10	6
nengfa	3	3	3	3	3
ortholatin	9	8	7	9	8
pigeons	19	19	19	19	19
regular pattern	20	20	20	20	20
PATAT	46	42	39	19	14
Total	118	113	103	91	81

Alldiff+Cumul+Elt+WSum : SAT+UNSAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 162

1	Sugar	136	84%	30.85
2	Sugar	135	83%	22.49
3	Choco2.1.1	125	77%	87.51
4	Choco2.1.1b	122	75%	62.69
5	Mistral	120	74%	21.24
6	bpsolver	111	69%	251.25

Alldiff+Cumul+Elt+WSum : SAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 162

1	Sugar	74	46%	49.02
2	Sugar	73	45%	35.24
3	Mistral	62	38%	14.88
4	Choco2.1.1	59	36%	96.85
5	bpsolver	58	36%	211.24
6	Choco2.1.1b	57	35%	48.88

Alldiff+Cumul+Elt+WSum : UNSAT answers

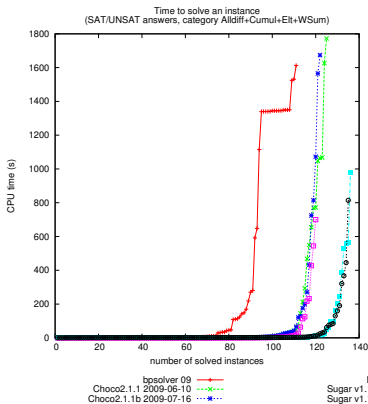


Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
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Total number of instances in the category : 162

1	Choco2.1.1	66	41%	79.16
2	Choco2.1.1b	65	40%	74.79
3	Sugar	62	38%	17349
4	Sugar	62	38%	43344
5	Mistral	58	36%	39961
6	bpsolver	53	33%	295.02

Alldiff+Cumul+Elt+WSum : Time vs Number of solved instances



Alldiff+Cumul+Elt+WSum : Comparison



3 top solvers

Series	#	Sugar	Mistral	Choco
All squares	74	54	40	47
CJSS	10	4	2	1
RCPSP	78	78	78	77
Total	162	136	120	125

Alldiff+Elt+WSum : SAT+UNSAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
Total number of instances in the category : 276				
1	Sugar	229	83%	47.44
2	Sugar	222	80%	61.73
3	Mistral	217	79%	46.60
4	Choco2.1.1	194	70%	53.48
5	Choco2.1.1b	193	70%	97.28
6	bpsolver	186	67%	110.98
7	Abscon 112v4	113	41%	279.07
8	Abscon 112v4	95	34%	293.66

Alldiff+Elt+WSum : SAT answers



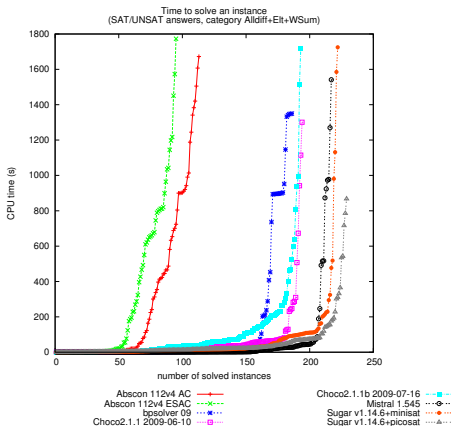
Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
Total number of instances in the category : 276				
1	Mistral	148	54%	24.51
2	Sugar	146	53%	28.97
3	Sugar	137	50%	49.79
4	Choco2.1.1	129	47%	56.65
5	Choco2.1.1b	129	47%	87.63
6	bpsolver	109	39%	173.10
7	Abscon 112v4	69	25%	124.01
8	Abscon 112v4	54	20%	205.73

Alldiff+Elt+WSum : UNSAT answers



Rank	Solver	# Solved	%VBS	$\langle CPUtime \rangle$
Total number of instances in the category : 276				
1	Sugar	85	31%	80.98
2	Sugar	83	30%	79.93
3	bpsolver	77	28%	39926
4	Mistral	69	25%	93.98
5	Choco2.1.1	65	24%	47.20
6	Choco2.1.1b	64	23%	116.72
7	Abscon 112v4	44	16%	522.25
8	Abscon 112v4	41	15%	409.46

Alldiff+Elt+WSum : Time vs Number of solved inst



Alldiff+Elt+WSum : Comparison



3 top solvers

Series	#	Sugar	Mistral	Choco
CabinetStart1	40	40	40	40
Pseudo GLB	100	75	59	53
BIBD	83	77	76	58
Magic square	18	8	13	15
QG	35	30	29	28
Total	276	230	217	194

Best and worst cases



Choco's best cases

Series	#	Mistral	Abscon	Choco
QCP/QWH	100	77	73	97
Job-Shop	76	49	45	62
Open-Shop	75	70	47	75

Choco's worst cases

Series	#	Mistral	Abscon	Sugar	Concrete	Choco
FAPP	120	73	116	—	—	63
Random CSP	199	136	91	—	108	111
PATAT	46	39	19	42	—	14
All squares	74	40	—	54	—	47
CJSS	10	2	—	4	—	1
Pseudo GLB	100	59	—	75	—	53