Latest Benchmark Results

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Services we provide

- Guide to Software: **"Decision Tree"**
- http://plato.asu.edu/guide.html
- Software Archive
- Software Evaluation: **"Benchmarks"**
- Archive of Testproblems
- Web-based Solvers **(1/3 of NEOS)**

We maintain the following NEOS solvers in 9 categories

```
Combinatorial Optimization  * CONCORDE [TSP Input]
Global Optimization         * ICOS [AMPL Input]
  * scip [AMPL Input][LP Input][MPS Input][OSIL Input][ZIMPL Input]
Linear Programming
  * bpmpd [AMPL Input][LP Input][MPS Input][QPS Input]
  * SoPlex80bit [LP Input][MPS Input]
Mixed Integer Linear Programming
  * feaspump [AMPL Input][LP Input][MPS Input]
  * proxy [LP Input][MPS Input]
  * qsopt_ex [AMPL Input][LP Input][MPS Input]
  * scip [AMPL Input][LP Input][MPS Input] [ZIMPL Input][OSIL Input]
Nondifferentiable Optimization   * condor [AMPL Input]
Semi-infinite Optimization       * nsips [AMPL Input]
```

Mixed Integer Nonlinearly Constrained Optimization

* scip [AMPL Input][LP Input][MPS Input][OSIL Input][ZIMPL Input]

Semidefinite (and SOCP) Programming (also discrete)

* csdp [MATLAB_BINARY Input][SPARSE_SDPA Input]
* mosek [MATLAB_BINARY Input][SPARSE_SDPA Input]
* penbmi [MATLAB Input][MATLAB_BINARY Input][YALMIP Input]
* pensdp [MATLAB_BINARY Input][SPARSE_SDPA Input]
* scipsdp [SPARSE_SDPA Input]
* sdpa [MATLAB_BINARY Input][SPARSE_SDPA Input]
* sdplr [MATLAB_BINARY Input][SDPLR Input][SPARSE_SDPA Input]
* sdpt3 [MATLAB_BINARY Input][SPARSE_SDPA Input]
* sedumi [MATLAB_BINARY Input][SPARSE_SDPA Input]

Stochastic Linear Programming

* bnbs [SMPS Input]
* DDSIP [LP Input][MPS Input]
* SD [SMPS Input]

Usage of our NEOS solvers within last twelve months

Concorde	19,000	CPLEX	500,000
SCIP	19,000	Couenne	200,000
BPMPD	3,000	BARON	190,000
PENBMI	2,300	Gurobi	50,000
CSDP	2,000	solvers used most	
PENBMI, QSOPT-EX	1,500		
FEASPUMP	1,200		
SDPA	1,000		
others below	1,000		

Overview of Talk

- Current and Selected Benchmarks
  - Benchmarks of Continuous Optimization Software
    - Simplex/Barrier QLIB, SOCP, SDP, NLP
  - Benchmarks of Discrete Optimization Software
    - MILP, QPLIB, MISOCP, MINLP
- Observations and Conclusions

COMBINATORIAL OPTIMIZATION

Concorde-TSP with different LP solvers (3-29-2019)

LINEAR PROGRAMMING

* Benchmark of Simplex LP solvers (10-9-2019)
* Benchmark of Barrier LP solvers (10-9-2019)
Large Network-LP Benchmark (commercial vs free) (10-9-2019)

SEMIDEFINITE/SQL PROGRAMMING

SQL problems from the 7th DIMACS Challenge (8-8-2002)
Several SDP codes on sparse and other SDP problems (7-23-2019)
Infeasible SDP Benchmark (5-21-2019)
* Large SOCP Benchmark (10-10-2019)
* MISOCP Benchmark (10-14-2019)

PROBLEMS WITH EQUILIBRIUM CONSTRAINTS

MPEC Benchmark (4-17-2018)

MIXED INTEGER LINEAR PROGRAMMING

* MILP Benchmark - MIPLIB2017 (8-19-2019)
* MILP cases that are slightly pathological (9-6-2019)

NONLINEAR PROGRAMMING

AMPL-NLP Benchmark (6-9-2019)

MIXED INTEGER QPs and QCPs

Non-commercial convex QP Benchmark (9-16-2019)
* Binary Non-Convex QPLIB Benchmark (9-8-2019)
* Discrete Non-Convex QPLIB Benchmark (non-binary) (10-10-2019)
* Continuous Non-Convex QPLIB Benchmark (10-9-2019)
* Convex Continuous QPLIB Benchmark (10-10-2019)
* Convex Discrete QPLIB Benchmark (10-10-2019)

MIXED INTEGER NONLINEAR PROGRAMMING

MINLP Benchmark (8-24-2019)

Important features of all our benchmarks

- NO PERFORMANCE PROFILES! (unreliable, TOMS 43)
- Statistics of problems (dimensions etc)
- Links to codes, problems and logfiles given
- Same selection for commercial/free codes
- many benchmark talks on personal webpage to TRACK PERFORMANCE OVER TIME

Reasons for updates

- New versions of commercial software
  - SAS-OR-15.1, KNITRO-12, MOSEK-9.1, MATLAB-2019a/b
  - soon: Gurobi for nonconv MIQCP, KNITRO for SOCP
- New versions of "free" software (COUENNE and ANTIGONE static)
  - SCIP, MIPCL, COPT. HiGHS, soon: various Julia codes
- benchmark the complete QPLIB (453 instances)

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9 Oct 2019

Benchmark of Simplex LP solvers

H. Mittelmann (mittelmann@asu.edu)

This benchmark was run on a Linux-PC (i7-4790K, 4.0GHz, 32GB).

MOSEK-9.1.1	www.mosek.com
CLP-1.17.3	projects.coin-or.org/Clp
Google-GLOP	LP with Glop
SOPLEX-4.0.1	soplex.zib.de/
LP_SOLVE-5.5.2	lpsolve.sourceforge.net/
GLPK-4.65	www.gnu.org/software/glpk/glpk.html
MATLAB-R2019a	mathworks.com (dual-simplex)
COPT-1.0.1beta:	COPT
QSOPT-1.0:	QSOPT
HiGHS-1.0.0:	HiGHS
SAS-OR-15.1:	SAS (dual-simplex)

Scaled shifted (by 10 sec) geometric mean of runtimes

	3.69	1.43	7.19	9.99	108	28.1	8.06	1	26.0	5.42	3.19
solved	38	40	35	36	23	31	32	40	34	37	37

40 probs	MSK	CLP	GLOP	SPLX	LPSLV	GLPK	MATL	COPT	QSOPT	HiGHS	SAS

9 Oct 2019 ==========

Benchmark of Barrier LP solvers

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H. Mittelmann (mittelmann@asu.edu)

This benchmark was run on a Linux-PC (i7-4790K, 4GHz, 32GB).

The barrier methods were tested of:

MOSEK-9.1.1 www.mosek.com
MATLAB-R2019a mathworks.com (interior-point, NO CROSSOVER!)
BPMPD-2.21: NEOS-BPMPD run locally (interior-point, NO CROSSOVER!)
CLP-1.17.3 projects.coin-or.org/Clp
SAS-OR-15.1: SAS

Scaled shifted (by 10 sec) geometric mean of runtimes

45 probs	1	8.95	3.33	11.7	1.22
solved	43	36	39	39	44

problem	MOSEK	MATLAB	BPMPD	CLP	SAS

10 Oct 2019

Large Second Order Cone Benchmark

Hans D. Mittelmann (mittelmann@asu.edu)

time limit 1 hour

problem	MOSEK	ECOS	KNITRO
beam7	31	354	
beam30	252	t	
chainsing-50000-1	3	f	
chainsing-50000-2	9	f	
chainsing-50000-3	6	f	
db-joint-soerensen	51	f	
db-plate-yield-line	10	f	
dsNRL	107	t	
firL1	50	2309	
firL1Linfalph	105	t	
firL1Linfeps	43	t	
firL2L1alph	9	371	
firL2L1eps	32	1449	
firL2Linfalph	73	t	
firL2Linfeps	47	1226	
firL2a	7	1625	
firLinf	181	t	
wbNRL	20	t	

20 Aug 2019

Continuous Non-Convex QPLIB Benchmark

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Logiles at plato.asu.edu/ftp/cnconv_logs/

Baron-19.7.13	BARON
ANTIGONE-1.1	ANTIGONE
(F)SCIP-6.0.2	(Fiber)SCIP/SOPLEX
COUENNE-0.5	COUENNE
MINOTAUR-0.2.1	MINOTAUR

The above solvers were run on an Intel Xeon E5-4657L (48 cores, 512GB) on
the continuous non-convex problems (102 total) from QPLIB.
Times given are elapsed times in seconds. Time limit 3hrs.
Only those instances are shown for which at least one solver succeeded.
Shifted and scaled geometric mean of runtimes:

mean	1	1.59	1.89	3.05	3.66	2.89
solved	31	23	14	9	6	4

prob#	ANTIGONE	BARON	FSCIP	COUENNE	MINOTAUR	SCIP

10 Oct 2019

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Convex Continuous QPLIB Benchmark
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Logiles at plato.asu.edu/ftp/cconvex_logs/

MOSEK-9.1.1	MOSEK
KNITRO-12.0	KNITRO
IPOPT-3.12.13	projects.coin-or.org/Ipopt

The above solvers were run on a 3 GHz Intel i7-5960X (8 cores, 48GB) on
the 32 continuous convex problems from QPLIB. Times given are elapsed
times in seconds; time limit 2hrs, 8 threads
Shifted and scaled geometric mean of runtimes:

mean	1	1.08	2.96
solved	29	30	28

prob#	MOSEK	KNITRO	IPOPT

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14 Oct 2019 ==========

Mixed-integer SOCP Benchmark

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Logfiles for these runs are at: plato.la.asu.edu/ftp/misocp_logs/

MOSEK-9.1.1 MOSEK
SCIP-6.0.2 SCIP+Soplex

These codes were tested on a selection of the MISOCP problems from
CBLIB2014 and from here. Given are total CPU seconds.
The codes were run in default mode (except mipgap=0) on an
Intel i7-4790K (4.0 GHz, 32GB). Time limit 2 hrs.

Scaled shifted geometric means of runtimes (t counted as maxtime)

	1	4.00	
problem	MOSEK	SCIP	KNITRO
solved of 47	32	29	

19 Aug 2019

The MIPLIB2017 Benchmark Instances

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The following codes were run with a limit of 2 hours on the MIPLIB2017
benchmark set on two platforms.

1 thread: Intel i7-4790K, 4 cores, 32GB, 4GHz;
8 threads: Intel i7-5960X, 8 cores, 48GB, 3Ghz;

(F)SCIP/spx]-6.0.2:	FiberSCIP (SCIP+SOPLEX on 1 thread)
CBC-2.10.0:	CBC
GLPK-4.65:	www.gnu.org/software/glpk/glpk.html
LP_SOLVE-5.5.2:	lpsolve.sourceforge.net/
MATLAB-2019a:	MATLAB (intlinprog)
MIPCL-2.5.0:	MIPCL
SAS-OR-15.1:	SAS

19 Aug 2019

The MIPLIB2017 Benchmark Instances

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The third line lists the number of problems (240 total) solved.

1 thr	CBC	SCIP	MATLB	MIPCL	GLPK	LP_SOL	SAS
unscal	2113	1213	3351	1736	5032	5335	743
scaled	2.84	1.63	4.51	2.34	6.77	7.18	1
solved	88	119	59	99	23	20	147

the best commercial solvers would have a geomean of about .2 to .3

8 thr	CBC	FSCIP	MIPCL	SAS
unscal	1585	988	1246	580
scaled	2.73	1.70	2.15	1
solved	102	140	115	157

the best commercial codes would have a geomean of about .2

6 Sep 2019

MILP cases that are slightly pathological

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CBC-2.10.3 CBC
FSCIP-6.0.2: FiberSCIP with SOPLEX
MIPCL-2.5.3: MIPCL
MATLAB-2019a: MATLAB (intlinprog)
SAS-OR-15.1: SAS
SCIP-6.0.2: SCIP with SOPLEX
GLPK-4.65: www.gnu.org/software/glpk/glpk.html

These codes were run with the MIPLIB2017 scripts in default mode on 12
threads of an Intel Xeon E5-4657L (48 cores, 512GB) on problems from here. i
Times given are elapsed CPU seconds. Time limit 3 hrs. This benchmark is not
giving a representative impression of the relative performance of the codes.

Scaled shifted geometric mean of runtimes and problems solved (45 total)

CBC	FSCIP	MIPCL	MATLAB	SAS	SCIP	GLPK
4.40	2.83	3.18	8.10	1	3.86	6.78
13	22	14	2	31	21	6

the best commercial solvers have a geomean of .25 to .3 and solve 40 problems

8 Sep 2019

Binary Non-Convex QPLIB Benchmark

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Logiles at plato.asu.edu/ftp/qplib_logs/

Baron-19.7.13	BARON
(F)SCIP-6.0.2	(Fiber)SCIP-SOPLEX (only open source code included)
ANTIGONE-1.1	ANTIGONE
MINOTAUR-0.2.1	MINOTAUR

The above solvers were run on a 3 GHz Intel i7-5960X (8 cores, 48GB)
on the binary nonconvex problems (128 total) from QPLIB.
Times given are elapsed times in seconds. Mipgap is zero, time limit 1hr;
8 threads, except SCIP&Minotaur.
Only those instances are shown for which at least one solver succeeded.
Shifted and scaled geometric mean of runtimes:

mean	1	6.86	6.07	4.37	10.1
solved	41	19	22	24	7

prob#	BARON	SCIP	ANTIGONE	FSCIP	MINOTAUR

20 Aug 2019

Discrete Non-Convex QPLIB Benchmark (non-binary)

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Logiles at plato.asu.edu/ftp/nonbinary_logs/

Baron-19.7.13	BARON
ANTIGONE-1.1	ANTIGONE
(F)SCIP-6.0.2	(Fiber)SCIP/SOPLEX
COUENNE-0.5	COUENNE
MINOTAUR-0.2.1	MINOTAUR

The above solvers were run on an Intel Xeon E5-4657L (48 cores, 512GB)
on the discrete non-convex problems (160 total) with not only binary variables
from QPLIB. Times given are elapsed times in seconds. Time limit 3hrs.
Only those instances are shown for which at least one solver succeeded.
Shifted and scaled geometric mean of runtimes:

mean	3.94	3.58	1	11.2	13.5	6.82
solved	29	24	41	8	4	15

prob#	ANTIGONE	BARON	FSCIP	COUENNE	MINOTAUR	SCIP

10 Oct 2019

Convex Discrete QPLIB Benchmark

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Logiles at plato.asu.edu/ftp/convex_logs/

MOSEK-9.1.1	MOSEK
KNITRO-12.0	KNITRO
Baron-19.7.13	BARON
Bonmin-1.8.7	BONMIN
(F)SCIP-6.0.0	(Fiber)SCIP with SOPLEX-4.0.0
ANTIGONE-1.1	ANTIGONE
MINOTAUR-0.2.1	MINOTAUR
CBC-2.10.2:	CBC

The above solvers were run on a 3 GHz Intel i7-5960X (8 cores, 48GB) on the 31 discrete convex problems from QPLIB. Times given are elapsed times in seconds. Mipgap zero, time limit 2hrs, 8 threads; SCIP, Minotaur 1 thread
Shifted and scaled geometric mean of runtimes:

mean	1	1.63	1.04	1.54	1.92	2.90	4.09	2.55	4.43
solved	12	9	11	10	11	8	2	11	2

prob#	MOSEK	KNITRO	BARON	BONMIN	SCIP	FSCIP	ANTIGONE	MINOTAUR	CBC

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"TOP PERFORMERS"

LP-Simplex:	COPT, CLP
LP-Barrier:	MOSEK, SAS
Network-LP:	SAS, COPT
MILP:	SAS, (F)SCIP
SOCP:	MOSEK
MISOCP:	MOSEK, SCIP
nonc BQCP:	BARON, FSCIP
nonc DQCP:	FSCIP
nonc CQCP:	ANTIGONE, BARON
conv DQCP:	MOSEK, BARON
conv CQCP:	MOSEK, KNITRO
MINLP:	BARON, SCIP

Thank you!

slides at: `http://plato.asu.edu/talks/`

Expect updates soon!