The Conic Optimizer in Mosek: A Status Report

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Improvements from version 7 to 8

General overview

- Presolve
  - Reduce memory requirements in the eliminator.
  - Conic presolve.
- Conic optimizer
  - Improve numerical stability, particularly for SDOs.
  - Added an automatic dualizer for conic quadratic problems.
- Convex quadratic optimizer
  - Use the conic optimizer internally.
- Mixed-integer optimizer
  - Improved performance.
- Fusion
  - Added a C++ version.
  - A lot of polishing and bug fixing.
- Optimization server.
- Conda availability.

Conic optimizer

- More aggressive problem scaling.
- Reworked interior-point code.
- Improved stopping criterion.
- Improved linear algebra.
- Automatic and transparent dualizer (not available for SDPs yet).
- Improved handling of ill-posed problems, e.g.,

$$\begin{array}{ll} \text{minimize} & x_3 \\ \text{subject to} & x_1 = 0, \\ & 2x_1x_2 \geq x_3^2. \end{array}$$

Convex quadratic optimizer

Convex QCQP:

$$\begin{array}{lll} \text{minimize} & (1/2)x^T Q_0 x + c_0^T x + r_0 & \\ \text{subject to} & (1/2)x^T Q_i x + c_i^T x + r_i & \leq \quad 0, \quad i = 1 \ldots, m, \end{array}$$

where $Q_i \succeq 0$. Converted internally to conic form:

$$\begin{array}{lll} \text{minimize} & t_0 + c_0^T x + r_0 & \\ \text{subject to} & t_i + c_i^T x + r_i = 0, & i = 1, \ldots, m \\ & (t_i, 1, F_i x) \in \mathcal{Q}_r^{k_i+2} & i = 0, \ldots, m, \end{array}$$

where $Q_i = F_i^T F_i$, $F_i \in \mathbb{R}^{n \times k_i}$.

- Faster and more robust solution.
- Transparent conversion for user.
- We only need to maintain the conic optimizer.

Benchmark results for conic quadratic problems

- We compare MOSEK v7.1 and v8.0 on Linux with 8 threads.
- Timing results t in wall clock seconds.
- A small problem: Fastest optimizer has $t \leq 6$.
- A medium problem: Fastest optimizer has $t \leq 60$.
- A large problem: Fastest optimizer has $t > 60$.
- Test problems: both public and customer supplied.

For each problem we compute

$$r = \frac{t_8 + 0.01}{t_7 + 0.01}$$

and we list the geometric average of r.

Conic quadratic problems

	small		medium		large		fails'	
	7	8	7	8	7	8	7	8
Num.	887	887	127	127	30	30	37	18
Firsts	579	535	20	107	2	28		
Total time	1985.9	794.1	3369.6	1678.9	22255.5	10794.7		
G. avg. r		0.88		0.50		0.59		

- Version 8 has fewer failures.
- Version 8 has more firsts.
- Version 8 is at least 40% faster on average for medium to large problems.

Convex QCQPs

	small		medium		large		fails'	
	7	8	7	8	7	8	7	8
Num.	466	466	19	19	8	8	28	34
Firsts	336	260	3	16	2	6		
Total time	44515.0	197.2	25958.1	415.9	5447.5	3167.3		
G. avg. r		0.97		0.27		0.64		

- Version 8 has a few more failures and slightly slower on average for small problems.
- Version 8 is faster for medium to large problems.

Mixed integer conic quadratic optimization

- Timeout set to 3600 seconds.
- Optimality gap set to 0.0.

Version	7	8
Num.	181	181
Firsts	30	58
Solved	123	128
Total time	46546	26162
G. avg. r		0.65

- Version 8 is significantly faster.
- Solves a few more problems to optimality.

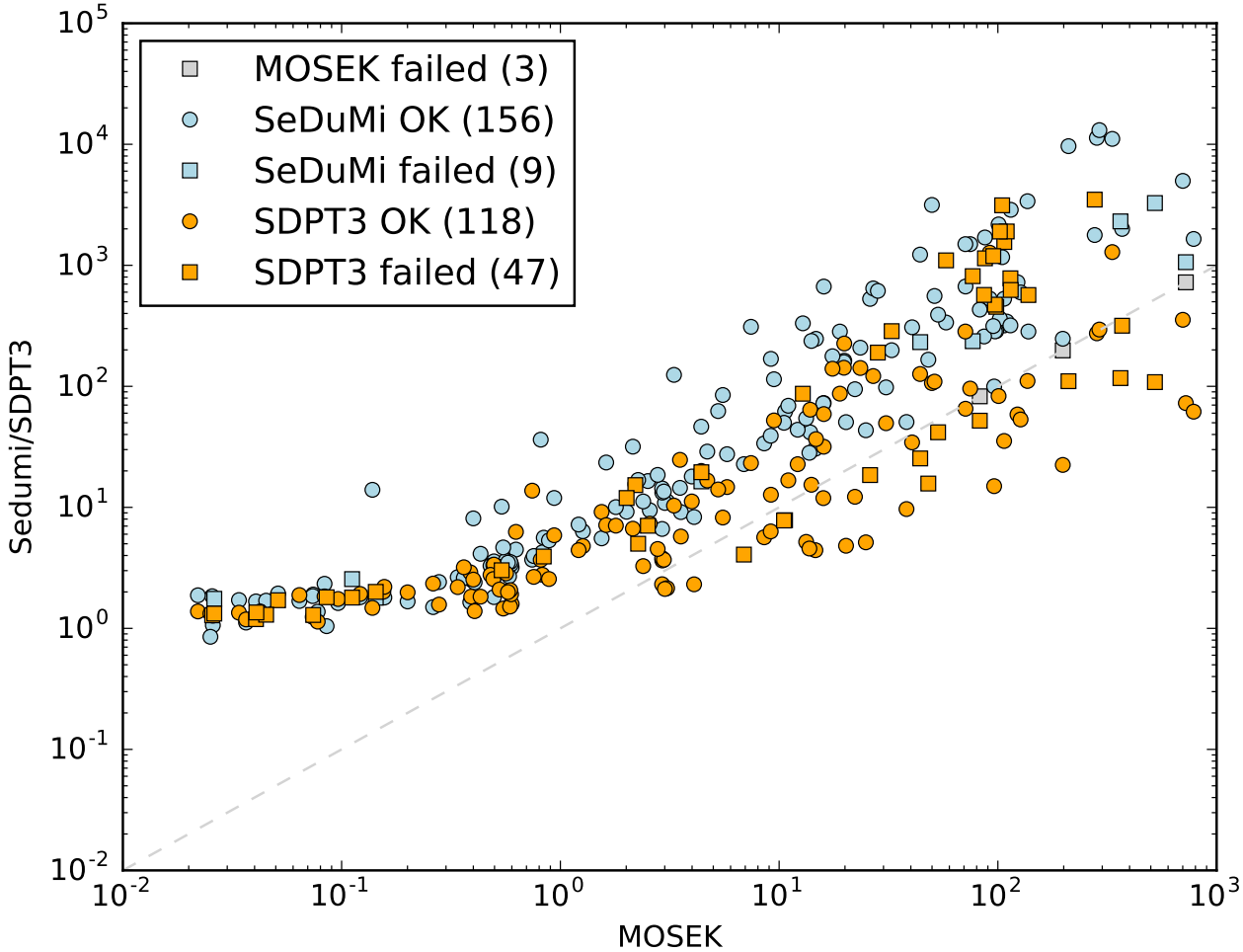
Semidefinite problems

	small		medium		large		fails'	
	7	8	7	8	7	8	7	8
Num.	111	111	55	55	22	22	62	8
Firsts	35	94	0	55	0	22		
Total time	228.0	124.4	2484.9	1621.5	7077.6	4111.8		
G. avg. r		0.73		0.65		0.59		

- Version 8 is more stable and has the most firsts.
- Version 8 is at least 40% faster on average for medium to large problems.

Comparison with SeDuMi and SDPT3

A subset of 165 problems from Mittlemann's site



Solution time for MOSEK vs SeDuMi/SDPT3 on 165 problems.

Problems where SDPT3 is faster

Failures colored in red

	MOSEK		SDPT3		
	time	# iter	time	# iter	# SDP vars
1et_1024	136.6	14	110.7	20	1
1tc_1024	100.7	17	83.0	21	1
1zc_1024	283.4	9	274.1	15	1
buck3	10.6	50	7.8	31	2
buck4	40.5	47	34.3	37	2
cancer_100	210.3	23	110.2	14	1
cnhil10	26	12	18.4	23	1
equalG11	38.2	22	9.6	17	1
equalG51	96.1	31	14.9	18	1
G40_mb	723.1	28	72.6	20	1
G40mc	122.9	14	58.5	18	1
hand	198.0	30	22.4	17	1
inc_1200	363.3	43	116.9	38	1
inc_600	44.1	37	25.3	34	1
maxG32	106.7	11	35.3	16	1
maxG51	15.9	12	11.9	17	1
qpG11	9.1	13	6.3	16	1
qpG51	22.2	17	12.2	17	1
rendl1_2000_1e-6	785.0	34	61.7	16	2
shmup3	71.1	45	65.2	36	2
shmup4	700.5	54	354.5	57	1
swissroll	82.6	39	52.0	41	1
trto4	48.0	54	15.7	33	1
trto5	522.3	57	108.3	30	1
Truss502_no_blocks	126.9	32	53.2	38	1
TSPbays29	369.8	42	316.8	39	14
vibra3	10.5	53	7.7	32	2
vibra4	53.2	58	41.7	48	2

The difficult SDPs

The problems where MOSEK failed all have a constraint

$$\sum_{i,j} X_{ij} = e^T X e = 0, \quad X \succeq 0.$$

- Feasible set with empty interior.
- Easy to eliminate as

$$X = VYV^T, \quad Y \succeq 0,$$

where

$$V = \begin{bmatrix} 1 & 0 & 0 & \cdots & 0 & 0 \\ -1 & 1 & 0 & \cdots & 0 & 0 \\ 0 & -1 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & -1 & 1 \\ 0 & 0 & 0 & \cdots & 0 & -1 \end{bmatrix} \in \mathbb{R}^{n \times (n-1)}$$

Effect of reformulation

- We apply the reformulation on different benchmark problems.
- Problems: GPPs, image segmentation, manifold unrolling.
- Failures colored in red, near-optimal in orange.
- Improves numerical behaviour in most cases.

	original		reformulation	
	time	# iter	time	# iter
foot	1171.6	38	1257.8	61
G40_mb	723.1	28	417.7	42
gpp250-1	2.9	31	1.5	29
gpp250-2	4.1	33	1.3	27
gpp250-3	3.1	29	1.3	26
gpp250-4	3.0	30	1.2	24
gpp500-1	13.3	29	8.5	36
gpp500-2	20.2	32	7.2	30
gpp500-3	14.7	27	7.4	31
gpp500-4	13.8	25	7.6	30
hand	198.0	30	102.7	37
inc_1200	363.3	43	455.7	37
inc_600	44.2	37	51.8	36
rendl1_2000_1e-6	785.1	34	241.2	25
rendl1_600_0	25.0	30	7.8	21
swissroll	82.7	39	72.0	33

Effect of reformulation

Maximum variance unrolling

The manifold unrolling problem (swissroll, inc_600, inc_1200) is

$$\begin{array}{ll} \text{maximize} & \mathbf{tr}(X) \\ \text{subject to} & X_{ii} + X_{jj} - 2X_{ij} = b_{ij}, \quad \forall (i,j) \in \mathcal{G} \\ & e^T X e = 0 \\ X \succeq 0 & \end{array}$$

where $\mathcal{G}$ is a nearest-neighbor graph.

- Both bounded and feasible by construction.
- Numerically difficult to solve (not solved by any solver).
- Solutions seem to have very large norms.
- The reformulation makes solver progress worse.

Difficult problems: swissroll

Log for standard formulation

```
ITE PFEAS    DFEAS    GFEAS    PRSTATUS   POBJ              DOBJ              MU       TIME
0   8.0e+02  1.2e+00  2.0e+02  0.00e+00   3.200000000e+03   0.000000000e+00   1.0e+00  1.87
1   2.5e+02  3.9e-01  4.9e+01  -5.64e-01  3.302312779e+03   1.031197170e+03   3.1e-01  3.60
2   8.8e+01  1.4e-01  1.5e+01  -3.04e-01  3.958061358e+03   2.408220615e+03   1.1e-01  5.26
3   3.1e+01  4.8e-02  4.8e+00  -1.72e-01  5.714752709e+03   4.671869712e+03   3.8e-02  6.96
4   1.4e+01  2.2e-02  2.0e+00  -1.65e-01  9.067739327e+03   8.213134700e+03   1.8e-02  8.64
5   5.1e+00  8.0e-03  5.3e-01  -3.06e-01  2.070991001e+04   1.993894737e+04   6.4e-03  10.34
6   2.4e+00  3.8e-03  1.7e-01  -6.25e-01  4.804998569e+04   4.707959918e+04   3.1e-03  12.00
7   6.3e-01  9.8e-04  2.5e-02  -7.63e-01  1.573823671e+05   1.561361902e+05   7.9e-04  13.67
8   2.3e-01  3.7e-04  7.7e-03  -5.92e-01  2.993840931e+05   2.980044734e+05   2.9e-04  15.34
9   1.0e-01  1.6e-04  3.5e-03  -2.28e-01  4.149783148e+05   4.137919235e+05   1.3e-04  17.06
10  5.8e-02  9.0e-05  2.1e-03  1.53e-01   4.715214279e+05   4.705920835e+05   7.2e-05  18.72
11  2.8e-02  4.4e-05  1.2e-03  3.44e-01   5.263545723e+05   5.257153433e+05   3.5e-05  20.44
12  1.4e-02  2.2e-05  7.3e-04  4.74e-01   5.531348114e+05   5.526947107e+05   1.8e-05  22.15
13  7.5e-03  1.2e-05  4.6e-04  5.31e-01   5.653299245e+05   5.650144470e+05   9.4e-06  23.87
14  5.0e-03  7.8e-06  3.6e-04  7.12e-01   5.728974450e+05   5.726765380e+05   6.3e-06  25.56
15  2.0e-03  3.1e-06  1.8e-04  6.48e-01   5.765876204e+05   5.764539985e+05   2.5e-06  27.23
16  1.2e-03  1.8e-06  1.3e-04  6.88e-01   5.761821821e+05   5.760885573e+05   1.5e-06  28.91
17  7.5e-04  1.2e-06  9.1e-05  6.41e-01   5.748369520e+05   5.747623423e+05   9.4e-07  30.58
18  4.1e-04  6.4e-07  5.6e-05  5.45e-01   5.725683067e+05   5.725094454e+05   5.1e-07  32.26
19  2.2e-04  3.5e-07  3.6e-05  6.44e-01   5.707427443e+05   5.707018643e+05   2.8e-07  33.95
20  1.1e-04  1.7e-07  1.9e-05  4.67e-01   5.683283146e+05   5.682950859e+05   1.3e-07  35.66
21  6.7e-05  1.0e-07  1.3e-05  4.85e-01   5.670353857e+05   5.670087534e+05   8.3e-08  37.36
22  2.5e-05  3.9e-08  5.5e-06  3.68e-01   5.646144905e+05   5.645936945e+05   3.1e-08  39.07
23  1.0e-05  1.8e-08  2.5e-06  3.31e-01   5.627261142e+05   5.627092584e+05   1.3e-08  40.76
24  5.3e-06  1.0e-07  1.3e-06  1.51e-01   5.613719912e+05   5.613548957e+05   6.6e-09  42.45
25  3.1e-06  3.3e-08  7.4e-07  1.12e-01   5.602585202e+05   5.602410716e+05   3.8e-09  44.15
26  1.2e-06  6.4e-08  2.8e-07  7.60e-03   5.582827736e+05   5.582628941e+05   1.5e-09  45.86
27  6.4e-07  1.9e-08  1.3e-07  -7.62e-02  5.566910716e+05   5.566684876e+05   8.0e-10  47.56
28  2.6e-07  5.6e-08  5.2e-08  -1.40e-01  5.544174821e+05   5.543895567e+05   3.5e-10  49.25
29  1.2e-07  7.0e-08  2.2e-08  -1.65e-01  5.520345037e+05   5.520005847e+05   1.6e-10  50.94
30  4.1e-08  6.2e-08  8.7e-09  -1.97e-01  5.491575995e+05   5.491148321e+05   7.1e-11  52.64
31  1.4e-08  2.1e-08  3.1e-09  3.79e-02   5.451772158e+05   5.451367168e+05   2.5e-11  55.25
32  7.5e-09  2.7e-08  1.7e-09  3.14e-02   5.428315445e+05   5.427925365e+05   1.3e-11  56.96
33  3.1e-09  2.9e-08  7.5e-10  1.12e-01   5.395560107e+05   5.395234225e+05   5.4e-12  58.63
34  1.4e-09  2.5e-08  5.6e-10  2.97e-01   5.381281943e+05   5.381019560e+05   3.6e-12  60.32
35  5.8e-10  2.7e-07  2.4e-10  7.97e-01   5.365545481e+05   5.365477886e+05   7.9e-13  62.94
36  3.4e-10  2.9e-07  1.7e-10  6.40e-01   5.360397379e+05   5.360354128e+05   4.6e-13  66.45
37  2.4e-10  1.1e-06  6.8e-11  8.50e-01   5.353913683e+05   5.353903438e+05   9.2e-14  69.32
38  2.4e-10  1.1e-06  6.8e-11  9.96e-01   5.353913683e+05   5.353903438e+05   9.2e-14  77.98
Optimizer terminated. Time: 85.24

Interior-point solution summary
  Problem status  : UNKNOWN
  Solution status : UNKNOWN
  Primal.  obj: 5.3539136832e+05    nrm: 3e+03    Viol.  con: 1e-03    barvar: 0e+00
  Dual.    obj: 5.3539034382e+05    nrm: 3e+07    Viol.  con: 0e+00    barvar: 5e+00
```

Difficult problems: swissroll

Log for reformulation

```
ITE PFEAS    DFEAS    GFEAS    PRSTATUS   POBJ              DOBJ              MU       TIME
0   5.7e+00  1.5e+00  4.0e+02  0.00e+00   6.392000000e+03   0.000000000e+00   1.0e+00  1.55
1   1.4e+00  3.6e-01  7.2e+01  -5.22e-01  5.487615758e+03   1.520684089e+03   2.4e-01  3.26
2   4.6e-01  1.2e-01  2.1e+01  -2.69e-01  5.399269750e+03   2.774044899e+03   8.0e-02  4.97
3   1.9e-01  5.1e-02  8.3e+00  -1.66e-01  6.090004253e+03   4.156746073e+03   3.4e-02  6.68
4   6.6e-02  1.8e-02  2.6e+00  -1.33e-01  7.906840579e+03   6.607208117e+03   1.2e-02  8.35
5   3.4e-02  8.9e-03  1.2e+00  -1.59e-01  1.007427135e+04   8.985574056e+03   6.0e-03  10.05
6   1.2e-02  3.2e-03  3.9e-01  -1.84e-01  1.448078003e+04   1.371298557e+04   2.1e-03  11.72
7   5.5e-03  1.5e-03  1.6e-01  -1.62e-01  1.831259090e+04   1.769978268e+04   9.7e-04  13.41
8   2.5e-03  6.6e-04  6.6e-02  -2.09e-01  2.295291664e+04   2.243710282e+04   4.4e-04  15.12
9   1.2e-03  3.1e-04  2.7e-02  -2.64e-01  2.878308472e+04   2.832159533e+04   2.0e-04  16.80
10  9.2e-04  2.4e-04  2.0e-02  -3.84e-01  3.172869173e+04   3.124762378e+04   1.6e-04  18.53
11  3.8e-04  9.9e-05  7.0e-03  -4.07e-01  4.396561440e+04   4.350656307e+04   6.6e-05  20.23
12  2.7e-04  7.1e-05  4.4e-03  -4.05e-01  5.179530104e+04   5.127084967e+04   4.7e-05  21.93
13  1.0e-04  2.6e-05  1.4e-03  -4.08e-01  7.614288444e+04   7.557792641e+04   1.8e-05  23.62
14  6.4e-05  1.7e-05  7.6e-04  -3.55e-01  9.431485634e+04   9.360316541e+04   1.1e-05  25.28
15  2.5e-05  6.6e-06  2.7e-04  -3.52e-01  1.356060732e+05   1.348118377e+05   4.4e-06  26.97
16  1.6e-05  4.3e-06  1.6e-04  -2.24e-01  1.623434156e+05   1.614290978e+05   2.8e-06  28.67
17  7.1e-06  1.9e-06  7.5e-05  -5.28e-02  2.003937689e+05   1.996248054e+05   1.3e-06  30.35
18  5.4e-06  1.4e-06  5.4e-05  4.11e-02   2.190666767e+05   2.182337686e+05   9.4e-07  32.03
19  2.5e-06  6.6e-07  2.7e-05  1.27e-01   2.579136955e+05   2.572169809e+05   4.4e-07  33.73
20  1.9e-06  5.0e-07  1.9e-05  -2.72e-02  2.786936613e+05   2.778284457e+05   3.4e-07  35.47
21  8.3e-07  2.2e-07  8.8e-06  6.52e-02   3.331691636e+05   3.324402619e+05   1.5e-07  37.24
22  6.8e-07  1.8e-07  6.8e-06  1.94e-01   3.519324722e+05   3.511400233e+05   1.2e-07  38.96
23  4.1e-07  1.1e-07  4.5e-06  2.56e-01   3.882437718e+05   3.875935682e+05   7.2e-08  40.71
24  3.6e-07  9.4e-08  3.8e-06  6.52e-02   4.040829814e+05   4.033675573e+05   6.3e-08  42.44
25  2.0e-07  5.3e-08  2.2e-06  1.36e-01   4.551619530e+05   4.545156624e+05   3.5e-08  44.19
26  1.4e-07  3.8e-08  1.7e-06  3.55e-01   4.816265524e+05   4.810613996e+05   2.5e-08  45.88
27  8.1e-08  2.1e-08  1.2e-06  5.11e-01   5.160299462e+05   5.156553892e+05   1.4e-08  47.57
28  5.0e-08  1.3e-08  8.9e-07  7.52e-01   5.346699994e+05   5.344206116e+05   8.7e-09  49.24
29  2.8e-08  7.4e-09  6.3e-07  9.06e-01   5.458366879e+05   5.456824780e+05   4.9e-09  50.93
30  1.9e-08  3.3e-09  4.5e-07  1.23e+00   5.589144262e+05   5.588540527e+05   2.2e-09  54.47
31  1.2e-08  1.3e-09  2.2e-07  6.29e-01   5.612714373e+05   5.612405605e+05   7.7e-10  57.95
32  1.2e-08  1.3e-09  2.2e-07  1.21e+00   5.612714373e+05   5.612405605e+05   7.7e-10  66.32
Optimizer terminated. Time: 73.21

Interior-point solution summary
  Problem status  : UNKNOWN
  Solution status : UNKNOWN
  Primal.  obj: 5.6127143730e+05    nrm: 3e+05    Viol.  con: 7e-03    barvar: 0e+00
  Dual.    obj: 5.6124056054e+05    nrm: 9e+05    Viol.  con: 0e+00    barvar: 3e-04
```

The difficult SDPs

Better conditioned reformulations

- The transformation

$$V = \begin{bmatrix} 1 & 0 & 0 & \cdots & 0 & 0 \\ -1 & 1 & 0 & \cdots & 0 & 0 \\ 0 & -1 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & -1 & 1 \\ 0 & 0 & 0 & \cdots & 0 & -1 \end{bmatrix} \in \mathbb{R}^{n \times (n-1)}$$

  has a (moderately) high condition number.

- Alternatively, find a dense V from a QR factorization of ee^T.
- Each constraint becomes dense, but low-rank (not yet exploited by MOSEK).

Difficult problems: swissroll

Log for slow reformulation

```
ITE PFEAS    DFEAS    GFEAS    PRSTATUS   POBJ              DOBJ              MU       TIME
0   7.4e+00  1.3e+00  2.0e+02  0.00e+00   3.196000000e+03   0.000000000e+00   1.0e+00  454.33
1   1.4e+00  2.3e-01  2.6e+01  -5.64e-01  3.432139830e+03   1.700158467e+03   1.8e-01  1001.03
2   2.9e-01  4.9e-02  5.0e+00  -2.18e-01  5.738711170e+03   4.827482877e+03   3.9e-02  1548.90
3   7.1e-02  1.2e-02  8.5e-01  -2.02e-01  1.777177001e+04   1.702238101e+04   9.5e-03  2097.08
4   3.6e-02  6.2e-03  2.9e-01  -6.52e-01  3.939217231e+04   3.841749145e+04   4.9e-03  2633.71
5   4.3e-03  7.2e-04  1.5e-02  -7.71e-01  2.714678586e+05   2.699414740e+05   5.8e-04  3181.98
6   6.4e-04  1.1e-04  2.4e-03  -3.46e-01  5.324148938e+05   5.313865907e+05   8.6e-05  3730.20
7   2.2e-04  3.8e-05  1.0e-03  3.00e-01   5.557255782e+05   5.550889643e+05   3.0e-05  4270.55
8   5.7e-05  9.6e-06  4.0e-04  5.29e-01   5.782132673e+05   5.779484981e+05   7.7e-06  4814.81
9   1.9e-05  3.2e-06  1.8e-04  5.51e-01   5.788922717e+05   5.787545599e+05   2.6e-06  5353.95
10  9.3e-06  1.6e-06  1.1e-04  5.43e-01   5.764797548e+05   5.763888120e+05   1.3e-06  5893.07
11  3.7e-06  6.3e-07  5.4e-05  5.47e-01   5.729570881e+05   5.728996262e+05   5.0e-07  6447.64
12  1.6e-06  2.7e-07  2.8e-05  5.36e-01   5.699983928e+05   5.699588564e+05   2.1e-07  6983.18
13  8.3e-07  1.4e-07  1.7e-05  5.43e-01   5.680717656e+05   5.680426388e+05   1.1e-07  7517.28
14  2.1e-07  4.4e-08  5.2e-06  3.15e-01   5.646905449e+05   5.646712714e+05   2.9e-08  8055.23
15  6.6e-08  1.4e-08  1.8e-06  1.83e-01   5.621726859e+05   5.621564409e+05   8.9e-09  8593.16
16  2.1e-08  1.9e-08  5.6e-07  8.04e-02   5.597836021e+05   5.597668698e+05   2.8e-09  9129.77
17  3.3e-09  9.9e-08  7.5e-08  -9.10e-02  5.555267848e+05   5.555040681e+05   4.5e-10  9675.44
18  1.3e-09  4.0e-08  2.9e-08  1.84e-01   5.530483383e+05   5.530309649e+05   1.5e-10  10741.84
19  8.5e-10  3.8e-07  5.2e-09  1.36e-01   5.499327808e+05   5.499228196e+05   2.1e-11  11299.53
20  8.3e-10  4.3e-07  5.0e-09  2.80e-01   5.498354448e+05   5.498259182e+05   2.0e-11  11838.70
21  6.6e-10  1.4e-07  3.0e-09  1.98e-01   5.488770602e+05   5.488701486e+05   1.0e-11  12377.71
22  4.9e-10  2.7e-07  8.8e-10  4.27e-01   5.473457051e+05   5.473439879e+05   1.7e-12  12936.87
23  4.9e-10  2.7e-07  8.8e-10  9.01e-01   5.473457051e+05   5.473439879e+05   1.7e-12  14055.65
Optimizer terminated. Time: 14108.02

Interior-point solution summary
  Problem status  : UNKNOWN
  Solution status : UNKNOWN
  Primal.  obj: 5.4734570511e+05    nrm: 4e+03    Viol.  con: 1e-03    barvar: 0e+00
  Dual.    obj: 5.4734398786e+05    nrm: 2e+07    Viol.  con: 0e+00    barvar: 3e-01
```

Semidefinite relaxations of optimal powerflow problems

An increasingly important application

Popular beliefs about the SDP relaxation:

- it does not scale.
- it cannot be solved reliably using general-purpose solvers.

We think those beliefs are largely wrong.

We use models generated by software from:
`https://github.com/martinandersen/opfsdr`

M. S. Andersen, A. Hansson, L. Vandenberghe, "Reduced-Complexity Semidefinite Relaxations of Optimal Power Flow Problems", IEEE Transactions on Power Systems, 29 (4), pp. 1855-1863, 2014.

Currently being added to CBLIB.

Semidefinite relaxations of optimal powerflow problems

Benchmark results

	MOSEK		SeDuMi		SDPT3	
	time	# iter	time	# iter	time	# iter
case1354pegase	6.2	37	18.4	6	33.4	51
case1888rte	10.3	47	15.6	4	88.6	60
case1951rte	10.8	50	23.7	6	80.8	66
case2848rte	15.9	47	48.9	8	98.8	70
case2869pegase	16.1	39	47.0	8	181.5	68
case2868rte	16.4	49	41.9	8	179.4	79
case2737sop	39.8	57	50.2	7	374.4	83
case2383wp	41.7	58	50.3	8	280.6	76
case2746wp	42.9	57	56.6	8	355.8	80
case2736sp	44.7	55	44.3	6	325.0	76
case2746wop	50.1	58	89.5	9	out of memory	
case3012wp	64.9	61	68.4	8	out of memory	
case3375wp	66.0	56	70.3	7	out of memory	
case3120sp	72.9	68	78.9	9	out of memory	
case6468rte	82.7	52	78.8	5	out of memory	
case6515rte	84.4	52	145.1	10	out of memory	
case6470rte	85.4	52	90.7	5	out of memory	
case6495rte	87.6	54	146.1	10	out of memory	
case13659pegase	102.5	36	2089.7	46	out of memory	
case9241pegase	161.6	50	383.4	15	out of memory	

	# consts	# vars	# SOCs	SD cones			
				total	min	max	gmean
case9241pegase	170275	62032	12590	8577	4	70	6.5
case13659pegase	158960	43686	12997	12997	4	70	5.5

- Default parameters in MOSEK, all instances solved optimally.

Conclusion

- MOSEK 8 is a significant improvement over version 7.
- Robustness of the semidefinite optimizer has been improved dramatically. If MOSEK 8 cannot solve your SDP, then it probably has issues with scaling or degeneracy.
- On average a 20% to 40% reduction in the solution time can be expected for quadratic and conic problems.

Plea: if MOSEK cannot solve your problem, then write `support@mosek`.