



# The Conic Optimizer in Mosek: A Status Report

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- 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.





- 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 QCQP:

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

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

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

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.





- 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  $r$ .





	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.





	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.





- 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.







	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		

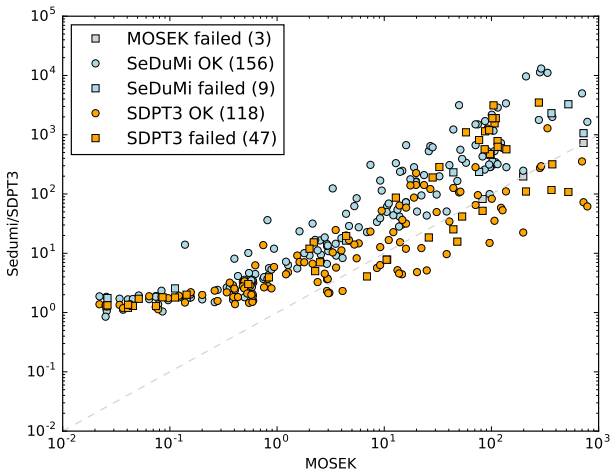
- Version 8 is more stable and has the most firsts.
- Version 8 is at least 40% faster on average for medium to large problems.



# 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
rend1l_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 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

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

where

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





- 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





The manifold unrolling problem (swissroll, inc\_600, inc\_1200) is

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

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	3.3023127779e+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	2.6e-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	6.3920000000e+03	0.0000000000e+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 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: 5.473457051e+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.



- 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.com](mailto:support@mosek.com).

