Results supplement for:
Solving natural conic formulations with Hypatia.jl

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This file contains the results generated for "Solving natural conic formulations with Hypatia.jl".

Table 1: Portfolio rebalancing solver statistics.

k	Hypatia-NF			Hypatia-EF			MOSEK-EF		
	st	it	time	st	it	time	st	it	time
1000	co	31	0.6	co	25	2.7	co	9	1.7
2000	co	36	2.9	co	28	16	co	10	7.0
4000	co	45	20	co	29	92	co	10	34
6000	co	49	60	co	34	292	co	10	83
8000	co	51	131	co	33	615	co	10	160
10000	co	55	244	co	36	1192	co	12	305
12000	co	62	421	tl	32	1805	co	10	433
14000	co	61	624	sk	*	*	rl	*	*
16000	co	63	924	sk	*	*	sk	*	*
18000	co	64	1327	sk	*	*	sk	*	*
20000	co	66	1810	sk	*	*	sk	*	*

Table 2: Portfolio rebalancing EF LP solver time comparisons.

k	ECOS	MOSEK			Gurobi		
	conic	conic	intpnt	simplex	barrier	P simplex	D simplex
1000	192	1.7	2.3	39	2.8	68	57
4000	*	34	66	*	55	*	*
10000	*	305	783	*	548	*	*
20000	*	*	*	*	*	*	*

Table 3: Matrix completion formulation statistics. Note $p = \bar{p} = |S|$.

m	k	NF				EF-exp			EF-sec		
		ν	n	p	q	$\bar{\nu}$	$\bar{n}$	$\bar{q}$	$\bar{\nu}$	$\bar{n}$	$\bar{q}$
	5	57	251	200	302	207	302	1692	182	314	1730
	10	218	1001	794	1208	730	1208	6725	621	1256	6871
	15	472	2251	1795	2707	1532	2707	15062	1188	2762	15229
	20	846	4001	3176	4826	2694	4826	26784	2267	5024	27380
10	25	1299	6251	4978	7524	4093	7524	41768	4370	8298	44092
	30	1858	9001	7174	10828	5810	10828	60095	4425	11048	60757
	35	2477	12251	9810	14692	7707	14692	81627	8576	16346	86591
	40	3256	16001	12786	19216	10084	19216	106664	8631	20096	109306
	45	4142	20251	16155	24347	12782	24347	135047	8686	24346	135046
	5	114	501	393	609	428	609	5888	360	628	5947
	10	418	2001	1594	2408	1430	2408	23375	1233	2512	23689
	15	933	4501	3584	5418	3065	5418	52520	2362	5524	52840
20	20	1663	8001	6359	9643	5345	9643	93335	4515	10048	94552
	25	2513	12501	10014	14988	7985	14988	145535	8716	16596	150361
	30	3643	18001	14389	21613	11465	21613	209600	8821	22096	211051

Table 4: Matrix completion solver statistics.

m	k	NF			EF-exp						EF-sec					
		Hypatia			Hypatia			MOSEK			Hypatia			MOSEK		
		st	it	time	st	it	time	st	it	time	st	it	time	st	it	time
	5	co	14	0.0	co	19	0.1	co	15	0.9	co	18	0.2	co	11	0.7
	10	co	19	0.4	co	34	2.2	co	20	20	co	30	2.3	co	10	11
	15	co	23	2.6	co	42	16	co	21	120	co	41	18	co	9	58
	20	co	26	14	co	52	70	co	24	524	co	47	78	co	11	251
10	25	co	30	52	co	59	225	co	26	1758	co	69	387	co	11	770
	30	co	34	166	co	61	556	tl	11	1817	co	55	587	co	10	1712
	35	co	39	402	co	61	1228	sk	*	*	tl	61	1817	rl	*	*
	40	co	48	949	tl	34	1820	sk	*	*	sk	*	*	sk	*	*
	45	co	47	1806	sk	*	*	sk	*	*	sk	*	*	sk	*	*
	5	co	15	0.1	co	29	0.8	co	17	14	co	26	0.9	co	8	7.6
	10	co	22	2.2	co	48	25	co	25	448	co	45	27	co	10	203
20	15	co	30	24	co	59	179	tl	14	1871	co	52	176	co	10	1375
	20	co	33	119	co	71	786	sk	*	*	co	70	924	rl	*	*
	25	co	41	448	tl	47	1822	sk	*	*	tl	26	1804	sk	*	*
	30	co	52	1305	sk	*	*	sk	*	*	sk	*	*	sk	*	*

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Table 5: Multi-response regression formulation and solver statistics.

		form. stats.		Hypatia-NF			Hypatia-EF			MOSEK-EF		
m	k	$\bar{n}$	q	st	it	time	st	it	time	st	it	time
15	50	1622	977	co	11	0.1	co	12	1.1	co	4	0.6
	100	5397	1727	co	10	0.5	co	12	17	co	5	6.7
	150	11672	2477	co	10	1.2	co	13	98	co	5	36
	250	31722	3977	co	10	3.3	co	14	1331	co	5	308
	500	125597	7727	co	10	17	m	*	*	tl	*	*
	1000	*	15227	co	13	129	sk	*	*	sk	*	*
	1500	*	22727	co	10	209	sk	*	*	sk	*	*
	2000	*	30227	co	9	395	sk	*	*	sk	*	*
	2500	*	37727	co	11	949	sk	*	*	sk	*	*
	3000	*	45227	co	11	1375	sk	*	*	sk	*	*
30	50	2642	2402	co	13	1.4	co	11	3.7	co	5	1.6
	100	6417	3902	co	14	4.9	co	11	23	co	5	12
	150	12692	5402	co	12	7.0	co	12	123	co	5	47
	250	32742	8402	co	15	41	co	13	1412	co	5	409
	500	126617	15902	co	11	107	m	*	*	tl	*	*
	750	*	23402	co	11	232	sk	*	*	sk	*	*
	1000	*	30902	co	13	768	sk	*	*	sk	*	*
	1250	*	38402	co	12	1098	sk	*	*	sk	*	*
	1500	*	45902	co	12	1637	sk	*	*	sk	*	*

Table 6: D-optimal experiment design logdet variant formulation and solver statistics.

	form. stats.			Hypatia-NF			Hypatia-EF			MOSEK-EF		
k	$\bar{n}$	q	$\bar{q}$	st	it	time	st	it	time	st	it	time
50	1426	1378	5401	co	25	0.3	co	21	4.5	co	15	12
100	5351	5253	20801	co	26	0.9	co	25	91	co	15	277
150	11776	11628	46201	co	29	3.0	co	27	690	tl	14	1825
200	20701	20503	81601	co	28	7.2	tl	17	1849	sk	*	*
300	46051	45753	182401	co	36	36	sk	*	*	sk	*	*
400	81401	81003	323201	co	36	81	m	*	*	sk	*	*
500	126751	126253	504001	co	36	169	sk	*	*	sk	*	*
600	182101	181503	724801	co	36	298	sk	*	*	sk	*	*
700	*	246753	*	co	39	624	sk	*	*	m	*	*
800	*	322003	*	co	37	838	sk	*	*	sk	*	*
900	*	407253	*	co	37	1282	sk	*	*	sk	*	*
1000	*	502503	*	tl	37	1838	sk	*	*	sk	*	*

Table 7: D-optimal experiment design rtdet variant solver statistics.

| | NF | | | EF-exp | | | | | | EF-sec | | | | | |
| | Hypatia | | | Hypatia | | | MOSEK | | | Hypatia | | | MOSEK | | |
k	st	it	time	st	it	time	st	it	time	st	it	time	st	it	time
50	co	25	0.3	co	22	4.7	co	14	11	co	22	5.1	co	11	10
100	co	25	0.9	co	25	93	co	13	247	co	26	97	co	11	220
150	co	26	2.6	co	27	696	co	12	1580	sp	36	921	co	10	1432
200	co	23	5.8	tl	17	1821	tl	0	1821	tl	17	1848	tl	0	1868
300	co	31	31	sk	*	*	sk	*	*	sk	*	*	sk	*	*
400	co	29	67	m	*	*	sk	*	*	m	*	*	sk	*	*
500	co	32	152	sk	*	*	sk	*	*	sk	*	*	sk	*	*
600	co	33	281	sk	*	*	sk	*	*	sk	*	*	sk	*	*
700	co	32	530	sk	*	*	m	*	*	sk	*	*	sk	*	*
800	co	32	728	sk	*	*	sk	*	*	sk	*	*	sk	*	*
900	co	36	1253	sk	*	*	sk	*	*	sk	*	*	sk	*	*
1000	co	33	1729	sk	*	*	sk	*	*	sk	*	*	sk	*	*

Table 8: Polynomial minimization formulation and solver statistics.

		form. stats.			Hypatia-NF			Hypatia-EF			MOSEK-EF		
m	k	ν	n	$\bar{q}$	st	it	time	st	it	time	st	it	time
1	100	201	201	10201	co	12	0.1	co	34	1.2	co	15	27
1	200	401	401	40401	co	14	0.3	co	39	13	co	11	409
1	500	1001	1001	251001	co	18	2.4	co	57	329	rl	∗	∗
1	1000	2001	2001	∗	co	19	11	m	∗	∗	sk	∗	∗
1	2000	4001	4001	∗	co	21	73	sk	∗	∗	sk	∗	∗
1	3000	6001	6001	∗	co	24	235	sk	∗	∗	sk	∗	∗
1	4000	8001	8001	∗	co	24	508	sk	∗	∗	sk	∗	∗
1	5000	10001	10001	∗	co	24	916	sk	∗	∗	sk	∗	∗
2	15	376	496	23836	co	15	0.4	co	21	5.0	co	10	87
2	30	1426	1891	339946	co	25	10	co	49	751	rl	∗	∗
2	45	3151	4186	∗	co	22	58	m	∗	∗	sk	∗	∗
2	60	5551	7381	∗	co	28	300	sk	∗	∗	sk	∗	∗
2	75	8626	11476	∗	co	30	1019	sk	∗	∗	sk	∗	∗
3	6	252	455	8358	co	17	0.3	co	17	1.6	co	9	9.1
3	9	715	1330	65395	co	20	3.1	co	24	104	co	9	799
3	12	1547	2925	303030	co	23	20	co	33	1775	rl	∗	∗
3	15	2856	5456	∗	co	26	89	m	∗	∗	sk	∗	∗
3	18	4750	9139	∗	er	34	1340	sk	∗	∗	sk	∗	∗
4	4	210	495	5005	co	18	0.4	co	16	1.7	co	8	3.9
4	6	714	1820	54159	co	15	4.8	co	18	222	co	10	579
4	8	1815	4845	∗	co	20	63	m	∗	∗	m	∗	∗
4	10	3861	10626	∗	co	22	458	sk	∗	∗	sk	∗	∗
8	2	117	495	1395	co	26	0.5	co	21	0.7	co	11	0.9
8	3	525	3003	21975	co	18	15	co	16	148	co	8	125
8	4	1815	12870	∗	co	27	633	m	∗	∗	m	∗	∗
16	1	33	153	169	co	13	0.1	co	12	0.7	co	7	0.0
16	2	425	4845	14229	co	27	86	co	22	174	sp	10	192
32	1	65	561	593	co	15	0.7	co	12	1.0	co	7	0.2
64	1	129	2145	2209	co	15	14	co	12	3.1	co	9	3.0

Table 9: Smooth density estimation formulation and solver statistics.

		form. stats.			Hypatia-NF			Hypatia-EF			MOSEK-EF		
m	$2k$	ν	n	$\bar{n}$	st	it	time	st	it	time	st	it	time
1	250	753	252	16628	co	35	0.2	sp	43	1040	co	25	112
1	500	1003	502	64003	co	42	1.1	rl	∗	∗	tl	18	1814
1	1000	1503	1002	∗	co	41	5.1	m	∗	∗	m	∗	∗
1	2000	2503	2002	∗	co	56	23	sk	∗	∗	sk	∗	∗
1	4000	4503	4002	∗	co	82	185	sk	∗	∗	sk	∗	∗
1	6000	6503	6002	∗	co	106	663	sk	∗	∗	sk	∗	∗
2	20	678	232	6023	co	50	0.3	co	29	73	co	19	7.4
2	40	1153	862	72468	co	34	2.9	rl	∗	∗	sp	22	1522
2	60	1928	1892	∗	co	36	11	m	∗	∗	m	∗	∗
2	80	3003	3322	∗	co	53	64	sk	∗	∗	sk	∗	∗
2	100	4378	5152	∗	co	64	247	sk	∗	∗	sk	∗	∗
3	12	754	456	9314	co	57	0.9	co	25	293	sp	19	20
3	18	1217	1331	67226	co	55	6.6	rl	∗	∗	sp	17	1216
3	24	2049	2926	∗	co	46	35	m	∗	∗	m	∗	∗
3	30	3358	5457	∗	co	63	348	sk	∗	∗	sk	∗	∗
4	8	712	496	6001	co	57	1.0	co	25	133	sp	22	12
4	12	1216	1821	56480	co	72	16	tl	∗	∗	sp	20	934
4	16	2317	4846	∗	co	70	192	m	∗	∗	m	∗	∗
8	4	619	496	2391	co	96	2.1	co	30	9.8	sp	17	2.1
8	6	1027	3004	25479	co	90	62	tl	∗	∗	sp	17	379

Table 10: Shape constrained regression formulation and solver statistics.

		form. stats.				Hypatia-NF			Hypatia-EF			MOSEK-EF		
m	$2k$	ν	n	$\bar{n}$	q	st	it	time	st	it	time	st	it	time
2	10	72	67	952	203	co	18	0.0	co	24	0.6	sp	19	0.4
2	20	292	232	14527	803	co	37	0.5	sp	68	1348	sp	20	60
2	30	662	497	73727	1803	co	58	5.6	rl	*	*	tl	12	1845
2	40	1182	862	*	3203	co	84	34	m	*	*	sk	*	*
2	50	1852	1327	*	5003	er	52	161	sk	*	*	sk	*	*
2	60	2672	1892	*	7203	er	120	939	sk	*	*	sk	*	*
3	8	152	166	3391	671	co	19	0.1	co	27	14	sp	23	4.3
3	12	485	456	31347	2173	co	38	3.5	tl	*	*	sp	15	244
3	16	1118	970	161584	5051	co	61	44	m	*	*	rl	*	*
3	20	2147	1772	*	9753	co	87	325	sk	*	*	sk	*	*
3	24	3668	2926	*	16727	co	111	1605	sk	*	*	sk	*	*
4	6	142	211	2881	912	co	17	0.4	co	23	7.8	sp	18	3.7
4	8	382	496	17686	2597	co	24	3.1	co	38	1621	sp	14	94
4	10	842	1002	79822	5953	co	38	35	rl	*	*	tl	12	2068
4	12	1626	1821	*	11832	co	58	283	m	*	*	sk	*	*
4	14	2858	3061	*	21262	co	72	1430	sk	*	*	sk	*	*
6	4	80	211	1240	800	co	13	0.3	co	15	0.7	co	9	0.6
6	6	422	925	20539	5336	co	22	15	co	32	1630	sp	17	260
6	8	1514	3004	215440	22409	co	29	638	m	*	*	rl	*	*
8	4	138	496	3412	2117	co	19	2.1	co	20	8.0	co	11	4.1
8	6	938	3004	89008	20825	co	31	515	rl	*	*	rl	*	*
10	4	212	1002	7657	4633	co	26	13	co	24	87	co	13	25
12	4	302	1821	15003	8920	co	29	73	co	28	504	co	11	125
14	4	408	3061	26686	15662	co	33	346	tl	0	1884	sp	21	767

Figure 1: Solve times (in seconds) for solve runs satisfying the convergence check in (19).