The Steiner Tree Challenge: An updated Study

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Abstract. We report some results of our code for the classical Steiner problem in graphs.

1 Description

For a description of the used algorithms and the program, see [1]. For the results in this report we have used the same code (re-compiled).

All results presented here were produced single-threaded on a PC with an Intel Core i7 920 (2.66 GHz) CPU[3], using Linux 3.4.2-1.fc16.x86_64 operating system, gcc 4.6.3 compiler and CPLEX 12.6 LP-solver.

2 Results for the SteinLib Instances

Here we reproduce the (exact solution) results in [1] for the SteinLib instances using the same code in a new computing environment (as described in Section 1).

All results were produced by a single run of the same program with the same parameter values (in fact, the same as in [1]), with the following exception: For the instance groups I and PUC (Tables 9 to 12) we switched off the more time-consuming routines in the branch-and-bound algorithm, allowing more branching (and spending less time in each branch-and-bound tree node). It should be noted that for many groups of instances, a specific choice of the used routines and/or parameter settings could improve the running times significantly (compare for example the results for the LIN-instances (Table 5) with or without a group of strong, but time-consuming reductions).

If an instance is solved exactly within the time limit (24 hours in this section), we give the value of the optimal solution and the total time (in seconds) for the exact solution; otherwise we give an interval [*lower* − *upper*] showing the best lower and upper bounds reached before the time limit and also the used time limit.

[3] This machine produced a score of 306.508988 using the 11th DIMACS Challenge benchmark code.

instance	size			optimum	time
	$\lvert V\rvert$	$\lvert E\rvert$	$\lvert R\rvert$		
d01	1000	1250	5	106	0.02
d02	1000	1250	10	220	0.02
d03	1000	1250	167	1565	0.00
d04	1000	1250	250	1935	0.00
d05	1000	1250	500	3250	0.00
d06	1000	2000	5	67	0.05
d07	1000	2000	10	103	0.05
d08	1000	2000	167	1072	0.01
d09	1000	2000	250	1448	0.01
d10	1000	2000	500	2110	0.01
d11	1000	5000	5	29	0.04
d12	1000	5000	10	42	0.02
d13	1000	5000	167	500	0.01
d14	1000	5000	250	667	0.02
d15	1000	5000	500	1116	0.01
d16	1000	25000	5	13	0.04
d17	1000	25000	10	23	0.04
d18	1000	25000	167	223	0.12
d19	1000	25000	250	310	0.09
d20	1000	25000	500	537	0.02

instance	size			optimum	time
	$\lvert V\rvert$	$\lvert E\rvert$	$\lvert R\rvert$		
e01	2500	3125	5	111	0.08
e02	2500	3125	10	214	0.06
e03	2500	3125	417	4013	0.01
e04	2500	3125	625	5101	0.01
e05	2500	3125	1250	8128	0.01
e06	2500	5000	5	73	0.20
e07	2500	5000	10	145	0.20
e08	2500	5000	417	2640	0.03
e09	2500	5000	625	3604	0.03
e10	2500	5000	1250	5600	0.02
e11	2500	12500	5	34	0.16
e12	2500	12500	10	67	0.12
e13	2500	12500	417	1280	0.23
e14	2500	12500	625	1732	0.04
e15	2500	12500	1250	2784	0.03
e16	2500	62500	5	15	0.18
e17	2500	62500	10	25	0.12
e18	2500	62500	417	564	3.42
e19	2500	62500	625	758	0.66
e20	2500	62500	1250	1342	0.06

Table 1. Results on the D and E-instances. Type: Sparse with random weights and varying $|E|$ and $|R|$, from OR-Library.

instance	size			optimum	time
	$\lvert V\rvert$	$\lvert E\rvert$	$\lvert R\rvert$		
1r111	625	2352	6	28000	0.03
1r112	625	2352	6	28000	0.01
1r113	625	2352	6	26000	0.01
1r121	625	2340	6	36000	0.02
1r122	625	2342	6	45000	0.12
1r123	625	2343	6	40000	0.05
1r131	625	2336	6	43000	0.08
1r132	625	2340	6	37000	0.02
1r133	625	2326	6	36000	0.02
1r211	625	2352	31	77000	0.07
1r212	625	2352	30	81000	0.08
1r213	625	2352	29	70000	0.03
1r221	625	2341	31	79000	0.05
1r222	625	2343	31	68000	0.03
1r223	625	2340	31	77000	0.03
1r231	625	2331	30	80000	0.04
1r232	625	2335	29	86000	0.03
1r233	625	2327	31	71000	0.02
1r311	625	2352	56	108000	0.04
1r312	625	2352	60	113000	0.03
1r313	625	2352	58	106000	0.03
1r321	625	2338	59	118000	0.04
1r322	625	2336	60	113000	0.03
1r323	625	2341	60	117000	0.05
1r331	625	2319	58	103000	0.02
1r332	625	2333	58	109000	0.01
1r333	625	2331	58	113000	0.03

instance	size			optimum	time
	$\lvert V\rvert$	$\lvert E\rvert$	$\lvert R\rvert$		
2r111	1000	5800	9	28000	0.17
2r112	1000	5800	9	32000	0.18
2r113	1000	5800	9	28000	0.08
2r121	1000	5766	9	28000	0.03
2r122	1000	5772	9	29000	0.09
2r123	1000	5754	9	25000	0.12
2r131	1000	5726	9	27000	0.08
2r132	1000	5725	9	33000	1.08
2r133	1000	5729	9	29000	0.11
2r211	1000	5800	50	89000	43.88
2r212	1000	5800	49	80000	0.61
2r213	1000	5800	48	76000	8.95
2r221	1000	5764	50	83000	0.80
2r222	1000	5765	50	84000	6.01
2r223	1000	5770	49	84000	9.08
2r231	1000	5737	50	86000	8.89
2r232	1000	5733	49	87000	10.10
2r233	1000	5730	47	83000	3.57
2r311	1000	5800	95	129000	12.38
2r312	1000	5800	92	126000	14.46
2r313	1000	5800	97	128000	2.31
2r321	1000	5771	92	125000	0.34
2r322	1000	5753	92	130000	5.71
2r323	1000	5764	96	142000	13.51
2r331	1000	5736	93	134000	3.68
2r332	1000	5745	95	136000	17.46
2r333	1000	5741	98	143000	14.04

Table 2. Results on the 1R and 2R-instances. Type: 2D (respectively 3D) cross grid graph.

instance	size			optimum	time
	$\lvert V\rvert$	$\lvert E\rvert$	$\lvert R\rvert$		
wrp3-11	128	227	11	1100361	0.01
wrp3-12	84	149	12	1200237	0.00
wrp3-13	311	613	13	1300497	0.09
wrp3-14	128	247	14	1400250	0.01
wrp3-15	138	257	15	1500422	0.01
wrp3-16	204	374	16	1600208	0.03
wrp3-17	177	354	17	1700442	0.02
wrp3-19	189	353	19	1900439	0.03
wrp3-20	245	454	20	2000271	0.06
wrp3-21	237	444	21	2100522	0.04
wrp3-22	233	431	22	2200557	0.08
wrp3-23	132	230	23	2300245	0.01
wrp3-24	262	487	24	2400623	0.12
wrp3-25	246	468	25	2500540	0.04
wrp3-26	402	780	26	2600484	0.09
wrp3-27	370	721	27	2700502	0.22
wrp3-28	307	559	28	2800379	0.06
wrp3-29	245	436	29	2900479	0.03
wrp3-30	467	896	30	3000569	0.49
wrp3-31	323	592	31	3100635	0.14
wrp3-33	437	838	33	3300513	0.11
wrp3-34	1244	2474	34	3400646	55.26
wrp3-36	435	818	36	3600610	0.70
wrp3-37	1011	2010	37	3700485	23.21
wrp3-38	603	1207	38	3800656	2.73
wrp3-39	703	1616	39	3900450	30.38
wrp3-41	178	307	41	4100466	0.16
wrp3-42	705	1373	42	4200598	6.49
wrp3-43	173	298	43	4300457	0.15
wrp3-45	1414	2813	45	4500860	75.23
wrp3-48	925	1738	48	4800552	4.38
wrp3-49	886	1800	49	4900882	19.41
wrp3-50	1119	2251	50	5000673	168.22
wrp3-52	701	1352	52	5200825	10.30
wrp3-53	775	1471	53	5300847	1.36
wrp3-55	1645	3186	55	5500888	896.58
wrp3-56	853	1590	56	5600872	7.60
wrp3-60	838	1763	60	6001164	38.41
wrp3-62	670	1316	62	6201016	8.63
wrp3-64	1822	3610	64	6400931	151.48
wrp3-66	2521	4858	66	6600922	496.24
wrp3-67	987	1923	67	6700776	8.19
wrp3-69	856	1621	69	6900841	2.97
wrp3-70	1468	2931	70	7000890	24.76
wrp3-71	1221	2414	71	7101028	34.97
wrp3-73	1890	3613	73	7301207	656.49
wrp3-74	1019	1941	74	7400759	28.92
wrp3-75	729	1395	75	7501020	2.58
wrp3-76	1761	3370	76	7601028	105.16
wrp3-78	2346	4656	78	7801094	388.68
wrp3-79	833	1595	79	7900444	4.63
wrp3-80	1491	2831	80	8000849	31.74
wrp3-83	3168	6220	83	8300906	6073.19
wrp3-84	2356	4547	84	8401094	149.51
wrp3-85	528	1017	85	8500739	54.00
wrp3-86	1360	2607	86	86000746	70.87
wrp3-88	743	1409	88	88001175	4.26
wrp3-91	1343	2594	91	91000866	38.44
wrp3-92	1765	3613	92	92000764	60.73
wrp3-94	1976	3836	94	94001181	183.30
wrp3-96	2518	4985	96	96001172	532.56
wrp3-98	2265	4545	98	98001224	407.20
wrp3-99	2076	4072	99	99001097	181.37

instance	size			optimum	time
	$\lvert V\rvert$	$\lvert E\rvert$	$\lvert R\rvert$		
wrp4-11	123	233	11	1100179	0.01
wrp4-13	110	188	13	1300798	0.01
wrp4-14	145	283	14	1400290	0.02
wrp4-15	193	369	15	1500405	0.03
wrp4-16	311	579	16	1601190	0.04
wrp4-17	223	404	17	1700525	0.07
wrp4-18	211	380	18	1801464	0.04
wrp4-19	119	206	19	1901446	0.01
wrp4-21	529	1032	21	2103283	0.29
wrp4-22	294	568	22	2200394	0.46
wrp4-23	257	515	23	2300376	0.14
wrp4-24	493	963	24	2403332	0.33
wrp4-25	422	808	25	2500828	0.13
wrp4-26	396	781	26	2600443	2.62
wrp4-27	243	497	27	2700441	0.22
wrp4-28	272	545	28	2800466	0.77
wrp4-29	247	505	29	2900484	2.67
wrp4-30	361	724	30	3000526	3.05
wrp4-31	390	786	31	3100526	4.25
wrp4-32	311	632	32	3200554	2.31
wrp4-33	304	571	33	3300655	0.11
wrp4-34	314	650	34	3400525	0.15
wrp4-35	471	954	35	3500601	3.18
wrp4-36	363	750	36	3600596	2.18
wrp4-37	522	1054	37	3700647	6.43
wrp4-38	294	618	38	3800606	0.37
wrp4-39	802	1553	39	3903734	0.56
wrp4-40	538	1088	40	4000758	15.24
wrp4-41	465	955	41	4100695	5.92
wrp4-42	552	1131	42	4200701	14.54
wrp4-43	596	1148	43	4301508	0.60
wrp4-44	398	788	44	4401504	12.07
wrp4-45	388	815	45	4500728	0.57
wrp4-46	632	1287	46	4600756	6.84
wrp4-47	555	1098	47	4701318	1.54
wrp4-48	451	825	48	4802220	0.56
wrp4-49	557	1080	49	4901968	1.50
wrp4-50	564	1112	50	5001625	1.84
wrp4-51	668	1306	51	5101616	1.49
wrp4-52	547	1115	52	5201081	0.74
wrp4-53	615	1232	53	5301351	3.39
wrp4-54	688	1388	54	5401534	2.36
wrp4-55	610	1201	55	5501952	2.52
wrp4-56	839	1617	56	5602299	3.20
wrp4-58	757	1493	58	5801466	3.60
wrp4-59	904	1806	59	5901592	1.25
wrp4-60	693	1370	60	6001782	1.53
wrp4-61	775	1538	61	6102210	0.50
wrp4-62	1283	2493	62	6202100	6.97
wrp4-63	1121	2227	63	6301479	106.13
wrp4-64	632	1281	64	6401996	1.34
wrp4-66	844	1691	66	6602931	3.05
wrp4-67	1518	3060	67	6702800	12.00
wrp4-68	917	1850	68	6801753	6.06
wrp4-69	574	1165	69	6902328	1.33
wrp4-70	637	1269	70	7003022	0.39
wrp4-71	802	1609	71	7102320	0.79
wrp4-72	1151	2274	72	7202807	18.81
wrp4-73	1898	3616	73	7302643	39.54
wrp4-74	802	1620	74	7402046	6.92
wrp4-75	938	1869	75	7501712	4.57
wrp4-76	766	1535	76	7602040	3.38

Table 3. Results on the WRP-instances. Type: Wire routing problems from industry.

instance	size			optimum	time
	$\lvert V\rvert$	$\lvert E\rvert$	$\lvert R\rvert$		
alue2087	1244	1971	34	1049	0.02
alue2105	1220	1858	34	1032	0.01
alue3146	3626	5869	64	2240	0.06
alue5067	3524	5560	68	2586	0.15
alue5345	5179	8165	68	3507	0.65
alue5623	4472	6938	68	3413	0.33
alue5901	11543	18429	68	3912	0.53
alue6179	3372	5213	67	2452	0.13
alue6457	3932	6137	68	3057	0.18
alue6735	4119	6696	68	2696	0.14
alue6951	2818	4419	67	2386	0.12
alue7065	34046	54841	544	23881	14.75
alue7066	6405	10454	16	2256	1.24
alue7080	34479	55494	2344	62449	10.03
alue7229	940	1474	34	824	0.00
alut0787	1160	2089	34	982	0.01
alut0805	966	1666	34	958	0.02
alut1181	3041	5693	64	2353	0.08
alut2010	6104	11011	68	3307	0.22
alut2288	9070	16595	68	3843	0.52
alut2566	5021	9055	68	3073	0.42
alut2610	33901	62816	204	12239	14.65
alut2625	36711	68117	879	35459	53.90
alut2764	387	626	34	640	0.00
diw0234	5349	10086	25	1996	0.24
diw0250	353	608	11	350	0.00
diw0260	539	985	12	468	0.00
diw0313	468	822	14	397	0.00
diw0393	212	381	11	302	0.00
diw0445	1804	3311	33	1363	0.02
diw0459	3636	6789	25	1362	0.03
diw0460	339	579	13	345	0.00
diw0473	2213	4135	25	1098	0.02
diw0487	2414	4386	25	1424	0.03
diw0495	938	1655	10	616	0.01
diw0513	918	1684	10	604	0.01
diw0523	1080	2015	10	561	0.01
diw0540	286	465	10	374	0.00
diw0559	3738	7013	18	1570	0.08
diw0778	7231	13727	24	2173	0.18
diw0779	11821	22516	50	4440	1.26
diw0795	3221	5938	10	1550	0.17
diw0801	3023	5575	10	1587	0.15
diw0819	10553	20066	32	3399	0.52
diw0820	11749	22384	37	4167	1.06
dmxa0296	233	386	12	344	0.00
dmxa0368	2050	3676	18	1017	0.03
dmxa0454	1848	3286	16	914	0.03
dmxa0628	169	280	10	275	0.00
dmxa0734	663	1154	11	506	0.01
dmxa0848	499	861	16	594	0.01
dmxa0903	632	1087	10	580	0.02
dmxa1010	3983	7108	23	1488	0.03
dmxa1109	343	559	17	454	0.00
dmxa1200	770	1383	21	750	0.01
dmxa1304	298	503	10	311	0.00
dmxa1516	720	1269	11	508	0.01
dmxa1721	1005	1731	18	780	0.01
dmxa1801	2333	4137	17	1365	0.07
gap1307	342	552	17	549	0.00
gap1413	541	906	10	457	0.00
gap1500	220	374	17	254	0.00
gap1810	429	702	17	482	0.00
gap1904	735	1256	21	763	0.02
gap2007	2039	3548	17	1104	0.03
gap2119	1724	2975	29	1244	0.03
gap2740	1196	2084	14	745	0.02
gap2800	386	653	12	386	0.00
gap2975	179	293	10	245	0.00
gap3036	346	583	13	457	0.01
gap3100	921	1558	11	640	0.02
gap3128	10393	18043	104	4292	0.68
msm0580	338	541	11	467	0.00
msm0654	1290	2270	10	823	0.01
msm0709	1442	2403	16	884	0.02
msm0920	752	1264	26	806	0.01
msm1008	402	695	11	494	0.01
msm1234	933	1632	13	550	0.01
msm1477	1199	2078	31	1068	0.02
msm1707	278	478	11	564	0.00
msm1844	90	135	10	188	0.00
msm1931	875	1522	10	604	0.01
msm2000	898	1562	10	594	0.01
msm2152	2132	3702	37	1590	0.05
msm2326	418	723	14	399	0.00
msm2492	4045	7094	12	1459	0.07
msm2525	3031	5239	12	1290	0.05
msm2601	2961	5100	16	1440	0.08
msm2705	1359	2458	13	714	0.01
msm2802	1709	2963	18	926	0.02
msm2846	3263	5783	89	3135	0.13
msm3277	1704	2991	12	869	0.01
msm3676	957	1554	10	607	0.00
msm3727	4640	8255	21	1376	0.10
msm3829	4221	7255	12	1571	0.29
msm4038	237	390	11	353	0.00
msm4114	402	690	16	393	0.00
msm4190	391	666	16	381	0.00
msm4224	191	302	11	311	0.00
msm4312	5181	8893	10	2016	0.59
msm4414	317	476	11	408	0.00
msm4515	777	1358	13	630	0.01
taq0014	6466	11046	128	5326	0.48
taq0023	572	963	11	621	0.01
taq0365	4186	7074	22	1914	0.15
taq0377	6836	11715	136	6393	1.04
taq0431	1128	1905	13	897	0.03
taq0631	609	932	10	581	0.00
taq0739	837	1438	16	848	0.03
taq0741	712	1217	16	847	0.02
taq0751	1051	1791	16	939	0.03
taq0891	331	560	10	319	0.00
taq0903	6163	10490	130	5099	0.94
taq0910	310	514	17	370	0.00
taq0920	122	194	17	210	0.00
taq0978	777	1239	10	566	0.01

Table 4. Results on the VLSI instances. Type: Grid graph with holes (not geometric) from VLSI design.

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
lin01	53	80	4	503	0.00
lin02	55	82	6	557	0.00
lin03	57	84	8	926	0.00
lin04	157	266	6	1239	0.00
lin05	160	269	9	1703	0.00
lin06	165	274	14	1348	0.00
lin07	307	526	6	1885	0.01
lin08	311	530	10	2248	0.01
lin09	313	532	12	2752	0.01
lin10	321	540	20	4132	0.01
lin11	816	1460	10	4280	0.04
lin12	818	1462	12	5250	0.06
lin13	822	1466	16	4609	0.03
lin14	828	1472	22	5824	0.05
lin15	840	1484	34	7145	0.04
lin16	1981	3633	12	6618	0.11
lin17	1989	3641	20	8405	0.13
lin18	1994	3646	25	9714	0.24
lin19	2010	3662	41	13268	0.25
lin20	3675	6709	11	6673	0.29
lin21	3683	6717	20	9143	0.22
lin22	3692	6726	28	10519	0.38
lin23	3716	6750	52	17560	0.54
lin24	7998	14734	16	15076	1.68
lin25	8007	14743	24	17803	2.23
lin26	8013	14749	30	21757	2.78
lin27	8017	14753	36	20678	2.54
lin28	8062	14798	81	32584	18.41
lin29	19083	35636	24	23765	5.38
lin30	19091	35644	31	27684	16.69
lin31	19100	35653	40	31696	1272.35
lin32	19112	35665	53	39832	3031.86
lin33	19177	35730	117	56061	1017.26
lin34	38282	71521	34	45018	17592.43
lin35	38294	71533	45	50559	33913.55
lin36	38307	71546	58	[55216 − 55670]	86400.00
lin37	38418	71657	172	[99098 − 99585]	86521.00

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
lin01	53	80	4	503	0.00
lin02	55	82	6	557	0.00
lin03	57	84	8	926	0.00
lin04	157	266	6	1239	0.00
lin05	160	269	9	1703	0.00
lin06	165	274	14	1348	0.00
lin07	307	526	6	1885	0.00
lin08	311	530	10	2248	0.00
lin09	313	532	12	2752	0.01
lin10	321	540	20	4132	0.00
lin11	816	1460	10	4280	0.03
lin12	818	1462	12	5250	0.05
lin13	822	1466	16	4609	0.03
lin14	828	1472	22	5824	0.04
lin15	840	1484	34	7145	0.03
lin16	1981	3633	12	6618	0.10
lin17	1989	3641	20	8405	0.12
lin18	1994	3646	25	9714	0.24
lin19	2010	3662	41	13268	0.24
lin20	3675	6709	11	6673	0.29
lin21	3683	6717	20	9143	0.20
lin22	3692	6726	28	10519	0.38
lin23	3716	6750	52	17560	0.54
lin24	7998	14734	16	15076	1.73
lin25	8007	14743	24	17803	2.33
lin26	8013	14749	30	21757	2.98
lin27	8017	14753	36	20678	2.52
lin28	8062	14798	81	32584	14.59
lin29	19083	35636	24	23765	5.85
lin30	19091	35644	31	27684	14.74
lin31	19100	35653	40	31696	206.90
lin32	19112	35665	53	39832	816.51
lin33	19177	35730	117	56061	319.17
lin34	38282	71521	34	45018	1848.24
lin35	38294	71533	45	50559	1911.09
lin36	38307	71546	58	55608	39931.77
lin37	38418	71657	172	99560	19409.67

Table 5. Results on the LIN-instances. Type: Grid graph with holes (not geometric) from VLSI design. The table on the right shows the results using stronger reductions.

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
es10000fst01	27019	39407	10000	716174280	138.00

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
es1000fst01	2865	4267	1000	230535806	3.14
es1000fst02	2629	3793	1000	227886471	2.25
es1000fst03	2762	4047	1000	227807756	1.61
es1000fst04	2778	4083	1000	230200846	2.29
es1000fst05	2676	3894	1000	228330602	1.88
es1000fst06	2815	4162	1000	231028456	3.71
es1000fst07	2604	3756	1000	230945623	0.94
es1000fst08	2834	4207	1000	230639115	2.99
es1000fst09	2846	4187	1000	227745838	2.48
es1000fst10	2546	3620	1000	229267101	0.91
es1000fst11	2763	4038	1000	231605619	2.72
es1000fst12	2984	4484	1000	230904712	3.07
es1000fst13	2532	3615	1000	228031092	0.98
es1000fst14	2840	4200	1000	234318491	3.09
es1000fst15	2733	3997	1000	229965775	2.15

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
a280fst	313	328	279	2502	0.00
att48fst	139	202	48	30236	0.05
att532fst	1468	2152	532	84009	0.80
berlin52fst	89	104	52	6760	0.00
bier127fst	258	357	127	104284	0.01
d1291fst	1365	1456	1291	481421	0.00
d1655fst	1906	2083	1655	584948	0.01
d198fst	232	256	198	129175	0.00
d2103fst	2206	2272	2103	769797	0.00
d493fst	1055	1473	493	320137	0.10
d657fst	1416	1978	657	471589	0.44
dsj1000fst	2562	3655	1000	17564659	0.31
eil101fst	330	538	101	605	0.21
eil51fst	181	289	51	409	0.38
eil76fst	237	378	76	513	1.40
fl1400fst	2694	4546	1400	17980523	26.34
fl1577fst	2413	3412	1577	19825626	0.20
fl3795fst	4859	6539	3795	25529856	31.04
fl417fst	732	1084	417	10883190	0.18
fnl4461fst	17127	27352	4461	182361	1161.44
gil262fst	537	723	262	2306	0.02
kroA100fst	197	250	100	20401	0.00
kroA150fst	389	562	150	25700	0.13
kroA200fst	500	714	200	28652	0.06
kroB100fst	230	313	100	21211	0.01
kroB150fst	420	619	150	25217	0.09
kroB200fst	480	670	200	28803	0.11
kroC100fst	244	337	100	20492	0.02
kroD100fst	216	288	100	20437	0.00
kroE100fst	226	306	100	21245	0.02

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
lin105fst	216	323	105	13429	0.02
lin318fst	678	1030	318	39335	0.09
linhp318fst	678	1030	318	39335	0.09
nrw1379fst	5096	8105	1379	56207	35.99
p654fst	777	867	654	314925	0.00
pcb1173fst	1912	2223	1173	53301	0.03
pcb3038fst	5829	7552	3038	131895	0.63
pcb442fst	503	531	442	47675	0.00
pla7397fst	8790	9815	7397	22481625	0.04
pr1002fst	1473	1715	1002	243176	0.01
pr107fst	111	110	107	34850	0.00
pr124fst	154	165	124	52759	0.00
pr136fst	196	250	136	86811	0.00
pr144fst	221	285	144	52925	0.00
pr152fst	308	431	152	64323	0.01
pr226fst	255	269	226	70700	0.00
pr2392fst	3398	3966	2392	358989	0.03
pr264fst	280	287	264	41400	0.00
pr299fst	420	500	299	44671	0.00
pr439fst	572	662	439	97400	0.00
pr76fst	168	247	76	95908	0.01
rat195fst	560	870	195	2386	0.30
rat575fst	1986	3176	575	6808	4.23
rat783fst	2397	3715	783	8883	4.55
rat99fst	269	399	99	1225	0.03
rd100fst	201	253	100	764269099	0.00
rd400fst	1001	1419	400	1490972006	0.30
rl11849fst	13963	15315	11849	8779590	0.13
rl1304fst	1562	1694	1304	236649	0.01
rl1323fst	1598	1750	1323	253620	0.00
rl1889fst	2382	2674	1889	295208	0.04
rl5915fst	6569	6980	5915	533226	0.02
rl5934fst	6827	7365	5934	529890	0.03
st70fst	133	169	70	626	0.00
ts225fst	225	224	225	1120	0.00
tsp225fst	242	252	225	356850	0.00
u1060fst	1835	2429	1060	21265372	0.23
u1432fst	1432	1431	1432	1465	0.00
u159fst	184	186	159	390	0.00
u1817fst	1831	1846	1817	5513053	0.00
u2152fst	2167	2184	2152	6253305	0.00
u2319fst	2319	2318	2319	2322	0.00
u574fst	990	1258	574	3509275	0.04
u724fst	1180	1537	724	4069628	0.05
vm1084fst	1679	2058	1084	2248390	0.09
vm1748fst	2856	3641	1748	3194670	1.17

Table 6. Results on the ES10000, ES1000 and TSP-instances. Type: Originally rectilinear instances, derived with GeoSteiner from 1000 (respectively 10000) random points in the plane or from TSPLIB.

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
berlin52	52	1326	16	1044	0.00
brasil58	58	1653	25	13655	0.01
world666	666	221445	174	122467	0.23

Table 7. Results on the X-instances. Type: Complete with Euclidean weights.

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
mc11	400	760	213	11689	0.00
mc13	150	11175	80	92	0.47
mc2	120	7140	60	71	0.25
mc3	97	4656	45	47	1.12
mc7	400	760	170	3417	0.00
mc8	400	760	188	1566	0.00

Table 8. Results on the MC-instances. Type: Constructed difficult instances.

instance	size |V|	size |E|	size |R|	optimum	time
i160-001	160	240	7	2490	0.00
i160-002	160	240	7	2158	0.00
i160-003	160	240	7	2297	0.00
i160-004	160	240	7	2370	0.00
i160-005	160	240	7	2495	0.00
i160-011	160	812	7	1677	0.00
i160-012	160	812	7	1750	0.00
i160-013	160	812	7	1661	0.00
i160-014	160	812	7	1778	0.00
i160-015	160	812	7	1768	0.00
i160-021	160	12720	7	1352	0.02
i160-022	160	12720	7	1365	0.02
i160-023	160	12720	7	1351	0.02
i160-024	160	12720	7	1371	0.02
i160-025	160	12720	7	1366	0.02
i160-031	160	320	7	2170	0.00
i160-032	160	320	7	2330	0.00
i160-033	160	320	7	2101	0.00
i160-034	160	320	7	2083	0.00
i160-035	160	320	7	2103	0.00
i160-041	160	2544	7	1494	0.00
i160-042	160	2544	7	1486	0.00
i160-043	160	2544	7	1549	0.01
i160-044	160	2544	7	1478	0.00
i160-045	160	2544	7	1554	0.01
i160-101	160	240	12	3859	0.00
i160-102	160	240	12	3747	0.00
i160-103	160	240	12	3837	0.00
i160-104	160	240	12	4063	0.00
i160-105	160	240	12	3563	0.00
i160-111	160	812	12	2869	0.00
i160-112	160	812	12	2924	0.01
i160-113	160	812	12	2866	0.01
i160-114	160	812	12	2989	0.01
i160-115	160	812	12	2937	0.02
i160-121	160	12720	12	2363	0.03
i160-122	160	12720	12	2348	0.03
i160-123	160	12720	12	2355	0.03
i160-124	160	12720	12	2352	0.03
i160-125	160	12720	12	2351	0.03
i160-131	160	320	12	3356	0.00
i160-132	160	320	12	3450	0.00
i160-133	160	320	12	3585	0.00
i160-134	160	320	12	3470	0.00
i160-135	160	320	12	3716	0.00
i160-141	160	2544	12	2549	0.01
i160-142	160	2544	12	2562	0.03
i160-143	160	2544	12	2557	0.04
i160-144	160	2544	12	2607	0.02
i160-145	160	2544	12	2578	0.03

instance	size |V|	size |E|	size |R|	optimum	time
i160-201	160	240	24	6923	0.00
i160-202	160	240	24	6930	0.00
i160-203	160	240	24	7243	0.00
i160-204	160	240	24	7068	0.00
i160-205	160	240	24	7122	0.00
i160-211	160	812	24	5583	0.07
i160-212	160	812	24	5643	0.19
i160-213	160	812	24	5647	0.17
i160-214	160	812	24	5720	0.28
i160-215	160	812	24	5518	0.10
i160-221	160	12720	24	4729	0.03
i160-222	160	12720	24	4697	0.03
i160-223	160	12720	24	4730	0.03
i160-224	160	12720	24	4721	0.03
i160-225	160	12720	24	4728	0.03
i160-231	160	320	24	6662	0.00
i160-232	160	320	24	6558	0.01
i160-233	160	320	24	6339	0.00
i160-234	160	320	24	6594	0.00
i160-235	160	320	24	6764	0.01
i160-241	160	2544	24	5086	0.13
i160-242	160	2544	24	5106	0.34
i160-243	160	2544	24	5050	0.09
i160-244	160	2544	24	5076	0.36
i160-245	160	2544	24	5084	0.09
i160-301	160	240	40	11816	0.00
i160-302	160	240	40	11497	0.00
i160-303	160	240	40	11445	0.00
i160-304	160	240	40	11448	0.00
i160-305	160	240	40	11423	0.00
i160-311	160	812	40	9135	0.84
i160-312	160	812	40	9052	0.73
i160-313	160	812	40	9159	1.37
i160-314	160	812	40	8941	0.17
i160-315	160	812	40	9086	0.74
i160-321	160	12720	40	7876	0.03
i160-322	160	12720	40	7859	0.02
i160-323	160	12720	40	7876	0.03
i160-324	160	12720	40	7884	0.03
i160-325	160	12720	40	7862	0.04
i160-331	160	320	40	10414	0.00
i160-332	160	320	40	10806	0.03
i160-333	160	320	40	10561	0.00
i160-334	160	320	40	10327	0.00
i160-335	160	320	40	10589	0.00
i160-341	160	2544	40	8331	0.24
i160-342	160	2544	40	8348	1.52
i160-343	160	2544	40	8275	0.19
i160-344	160	2544	40	8307	0.21
i160-345	160	2544	40	8327	0.84

Table 9. Results on the I160-instances. Type: Incidence networks, constructed with the aim of being difficult for known reduction techniques.

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
i320-001	320	480	8	2672	0.00
i320-002	320	480	8	2847	0.00
i320-003	320	480	8	2972	0.00
i320-004	320	480	8	2905	0.00
i320-005	320	480	8	2991	0.00
i320-011	320	1845	8	2053	0.02
i320-012	320	1845	8	1997	0.00
i320-013	320	1845	8	2072	0.01
i320-014	320	1845	8	2061	0.00
i320-015	320	1845	8	2059	0.01
i320-021	320	51040	8	1553	0.10
i320-022	320	51040	8	1565	0.10
i320-023	320	51040	8	1549	0.11
i320-024	320	51040	8	1553	0.10
i320-025	320	51040	8	1550	0.10
i320-031	320	640	8	2673	0.00
i320-032	320	640	8	2770	0.00
i320-033	320	640	8	2769	0.00
i320-034	320	640	8	2521	0.00
i320-035	320	640	8	2385	0.00
i320-041	320	10208	8	1707	0.04
i320-042	320	10208	8	1682	0.02
i320-043	320	10208	8	1723	0.03
i320-044	320	10208	8	1681	0.02
i320-045	320	10208	8	1686	0.02
i320-101	320	480	17	5548	0.00
i320-102	320	480	17	5556	0.00
i320-103	320	480	17	6239	0.00
i320-104	320	480	17	5703	0.00
i320-105	320	480	17	5928	0.00
i320-111	320	1845	17	4273	0.03
i320-112	320	1845	17	4213	0.18
i320-113	320	1845	17	4205	0.15
i320-114	320	1845	17	4104	0.04
i320-115	320	1845	17	4238	0.07
i320-121	320	51040	17	3321	0.14
i320-122	320	51040	17	3314	0.13
i320-123	320	51040	17	3332	0.14
i320-124	320	51040	17	3323	0.14
i320-125	320	51040	17	3340	0.14
i320-131	320	640	17	5255	0.00
i320-132	320	640	17	5052	0.00
i320-133	320	640	17	5125	0.00
i320-134	320	640	17	5272	0.00
i320-135	320	640	17	5342	0.00
i320-141	320	10208	17	3606	0.18
i320-142	320	10208	17	3567	0.17
i320-143	320	10208	17	3561	0.06
i320-144	320	10208	17	3512	0.02
i320-145	320	10208	17	3601	0.09

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
i320-201	320	480	34	10044	0.00
i320-202	320	480	34	11223	0.00
i320-203	320	480	34	10148	0.01
i320-204	320	480	34	10275	0.01
i320-205	320	480	34	10573	0.00
i320-211	320	1845	34	8039	0.95
i320-212	320	1845	34	8044	1.20
i320-213	320	1845	34	7984	4.16
i320-214	320	1845	34	8046	1.63
i320-215	320	1845	34	8015	11.53
i320-221	320	51040	34	6679	0.14
i320-222	320	51040	34	6686	0.15
i320-223	320	51040	34	6695	0.14
i320-224	320	51040	34	6694	0.15
i320-225	320	51040	34	6691	0.14
i320-231	320	640	34	9862	0.07
i320-232	320	640	34	9933	0.06
i320-233	320	640	34	9787	0.00
i320-234	320	640	34	9517	0.01
i320-235	320	640	34	9945	0.01
i320-241	320	10208	34	7027	0.32
i320-242	320	10208	34	7072	2.07
i320-243	320	10208	34	7044	0.80
i320-244	320	10208	34	7078	0.91
i320-245	320	10208	34	7046	0.32
i320-301	320	480	80	23279	0.01
i320-302	320	480	80	23387	0.01
i320-303	320	480	80	22693	0.01
i320-304	320	480	80	23451	0.03
i320-305	320	480	80	22547	0.01
i320-311	320	1845	80	17945	356.65
i320-312	320	1845	80	18122	2067.50
i320-313	320	1845	80	17991	1105.61
i320-314	320	1845	80	18088	2915.12
i320-315	320	1845	80	17987	1535.65
i320-321	320	51040	80	15648	0.43
i320-322	320	51040	80	15646	0.47
i320-323	320	51040	80	15654	0.37
i320-324	320	51040	80	15667	0.89
i320-325	320	51040	80	15649	0.30
i320-331	320	640	80	21517	0.46
i320-332	320	640	80	21674	0.06
i320-333	320	640	80	21339	0.70
i320-334	320	640	80	21415	0.13
i320-335	320	640	80	21378	0.48
i320-341	320	10208	80	16296	102.77
i320-342	320	10208	80	16228	2.65
i320-343	320	10208	80	16281	58.78
i320-344	320	10208	80	16295	34.82
i320-345	320	10208	80	16289	59.38

Table 10. Results on the I320-instances. Type: Incidence networks, constructed with the aim of being difficult for known reduction techniques.

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
i640-001	640	960	9	4033	0.00
i640-002	640	960	9	3588	0.00
i640-003	640	960	9	3438	0.00
i640-004	640	960	9	4000	0.00
i640-005	640	960	9	4006	0.00
i640-011	640	4135	9	2392	0.01
i640-012	640	4135	9	2465	0.03
i640-013	640	4135	9	2399	0.02
i640-014	640	4135	9	2171	0.01
i640-015	640	4135	9	2347	0.01
i640-021	640	204480	9	1749	0.52
i640-022	640	204480	9	1756	0.52
i640-023	640	204480	9	1754	0.51
i640-024	640	204480	9	1751	0.51
i640-025	640	204480	9	1745	0.52
i640-031	640	1280	9	3278	0.00
i640-032	640	1280	9	3187	0.00
i640-033	640	1280	9	3260	0.00
i640-034	640	1280	9	2953	0.00
i640-035	640	1280	9	3292	0.00
i640-041	640	40896	9	1897	0.25
i640-042	640	40896	9	1934	0.16
i640-043	640	40896	9	1931	0.13
i640-044	640	40896	9	1938	0.14
i640-045	640	40896	9	1866	0.10
i640-101	640	960	25	8764	0.00
i640-102	640	960	25	9109	0.00
i640-103	640	960	25	8819	0.00
i640-104	640	960	25	9040	0.00
i640-105	640	960	25	9623	0.03
i640-111	640	4135	25	6167	1.29
i640-112	640	4135	25	6304	0.88
i640-113	640	4135	25	6249	7.84
i640-114	640	4135	25	6308	3.09
i640-115	640	4135	25	6217	2.69
i640-121	640	204480	25	4906	0.68
i640-122	640	204480	25	4911	0.70
i640-123	640	204480	25	4913	0.68
i640-124	640	204480	25	4906	0.67
i640-125	640	204480	25	4920	0.70
i640-131	640	1280	25	8097	0.04
i640-132	640	1280	25	8154	0.02
i640-133	640	1280	25	8021	0.01
i640-134	640	1280	25	7754	0.00
i640-135	640	1280	25	7696	0.02
i640-141	640	40896	25	5199	0.96
i640-142	640	40896	25	5193	0.65
i640-143	640	40896	25	5194	0.53
i640-144	640	40896	25	5205	0.59
i640-145	640	40896	25	5218	1.68

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
i640-201	640	960	50	16079	0.01
i640-202	640	960	50	16324	0.01
i640-203	640	960	50	16124	0.03
i640-204	640	960	50	16239	0.02
i640-205	640	960	50	16616	0.01
i640-211	640	4135	50	11984	3182.47
i640-212	640	4135	50	11795	70.18
i640-213	640	4135	50	11879	112.42
i640-214	640	4135	50	11898	506.31
i640-215	640	4135	50	12081	363.48
i640-221	640	204480	50	9821	1.31
i640-222	640	204480	50	9798	1.11
i640-223	640	204480	50	9811	1.14
i640-224	640	204480	50	9805	0.65
i640-225	640	204480	50	9807	0.69
i640-231	640	1280	50	15014	0.36
i640-232	640	1280	50	14630	0.12
i640-233	640	1280	50	14797	0.13
i640-234	640	1280	50	15203	0.06
i640-235	640	1280	50	14803	2.26
i640-241	640	40896	50	10230	8.63
i640-242	640	40896	50	10195	1.76
i640-243	640	40896	50	10215	2.74
i640-244	640	40896	50	10246	18.71
i640-245	640	40896	50	10223	5.29
i640-301	640	960	160	45005	0.18
i640-302	640	960	160	45736	0.18
i640-303	640	960	160	44922	0.06
i640-304	640	960	160	46233	0.06
i640-305	640	960	160	45902	0.19
i640-311	640	4135	160	[34617, 36120]	86400.00
i640-312	640	4135	160	[34691, 35834]	86400.00
i640-313	640	4135	160	[34572, 35591]	86400.00
i640-314	640	4135	160	[34518, 35704]	86400.00
i640-315	640	4135	160	[34673, 35943]	86400.00
i640-321	640	204480	160	31094	55.04
i640-322	640	204480	160	31068	13.28
i640-323	640	204480	160	31080	17.16
i640-324	640	204480	160	31092	24.93
i640-325	640	204480	160	31081	25.06
i640-331	640	1280	160	42796	8.66
i640-332	640	1280	160	42548	354.21
i640-333	640	1280	160	42345	77.78
i640-334	640	1280	160	42768	1272.27
i640-335	640	1280	160	43035	232.49
i640-341	640	40896	160	32042	5972.89
i640-342	640	40896	160	31978	423.54
i640-343	640	40896	160	32015	3331.39
i640-344	640	40896	160	31991	2535.53
i640-345	640	40896	160	31994	1759.76

Table 11. Results on the I640-instances. Type: Incidence networks, constructed with the aim of being difficult for known reduction techniques.

instance	size			optimum [4]	time
	$\|V\|$	$\|E\|$	$\|R\|$		
cc10-2p	1024	5120	135	[34133, 35680]	86400.02
cc10-2u	1024	5120	135	[331, 343]	86400.08
cc11-2p	2048	11263	244	[61773, 64366]	86400.22
cc11-2u	2048	11263	244	[600, 620]	86400.01
cc12-2p	4096	24574	473	[117941, 122925]	86400.51
cc12-2u	4096	24574	473	[1144, 1197]	86400.60
cc3-10p	1000	13500	50	[12173, 12881]	86400.09
cc3-10u	1000	13500	50	[115, 127]	86400.00
cc3-11p	1331	19965	61	[14883, 15797]	86400.03
cc3-11u	1331	19965	61	[140, 154]	86400.06
cc3-12p	1728	28512	74	[17947, 19010]	86400.05
cc3-12u	1728	28512	74	[171, 186]	86400.12
cc3-4p	64	288	8	2338	1.99
cc3-4u	64	288	8	23	1.37
cc3-5p	125	750	13	3661	87.98
cc3-5u	125	750	13	36	115.83
cc5-3p	243	1215	27	7299	8254.25
cc5-3u	243	1215	27	71	41176.78
cc6-2p	64	192	12	3271	0.40
cc6-2u	64	192	12	32	0.90
cc6-3p	729	4368	76	[19847, 20406]	86400.01
cc6-3u	729	4368	76	[194, 198]	86400.01
cc7-3p	2187	15308	222	[54694, 57413]	86400.16
cc7-3u	2187	15308	222	[531, 554]	86400.17
cc9-2p	512	2304	64	[16520, 17346]	86400.06
cc9-2u	512	2304	64	[161, 170]	86400.13

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
bip42p	1200	3982	200	24657	43511.43
bip42u	1200	3982	200	236	57600.07
bip52p	2200	7997	200	[24180, 24742]	86400.02
bip52u	2200	7997	200	[230, 234]	86400.01
bip62p	1200	10002	200	[22436, 22886]	86400.02
bip62u	1200	10002	200	[214, 221]	86400.05
bipa2p	3300	18073	300	[34671, 35548]	86400.24
bipa2u	3300	18073	300	[330, 341]	86400.08
bipe2p	550	5013	50	5616	503.81
bipe2u	550	5013	50	54	484.49
hc10p	1024	5120	512	[59202, 60416]	86400.01
hc10u	1024	5120	512	[568, 575]	86400.12
hc11p	2048	11264	1024	[117360, 120854]	86400.34
hc11u	2048	11264	1024	[1126, 1159]	86400.22
hc12p	4096	24576	2048	[232849, 239741]	86400.02
hc12u	4096	24576	2048	[2233, 2303]	86400.20
hc6p	64	192	32	4003	5.65
hc6u	64	192	32	39	2.62
hc7p	128	448	64	7905	3140.66
hc7u	128	448	64	77	3440.11
hc8p	256	1024	128	15322	81963.74
hc8u	256	1024	128	[146, 148]	86400.00
hc9p	512	2304	256	[29866, 30271]	86400.00
hc9u	512	2304	256	[287, 292]	86400.02

Table 12. Results on the PUC-instances. Type: Constructed difficult instances: hypercubes, from code covering, and bipartite graphs.

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
antiwheel5	10	15	5	7	0.00
design432	8	20	4	9	0.00
oddcycle3	6	9	3	4	0.00
oddwheel3	7	9	4	5	0.00
se03	13	21	4	12	0.00
w13c29	783	2262	406	[500 − 507]	86400.12
w23c23	1081	3174	552	[684 − 690]	86400.48
w3c571	3997	10278	2284	2854	897.11

Table 13. Results on the SP-instances. Type: Constructed difficult instances, combination of odd wheels and odd circles, difficult for linear programming approaches.

[4] Note that the branch-and-bound algorithm called for these instances (I and PUC) performs only fast calculations of bounds. Better bounds could be achieved by using specific methods.

3 Results for the New Instances

Here we report the results for some instances not present in SteinLib at the time [1] was written.

All results were produced by a single run of the same program with the same parameter values. In fact, the calls were quite similar to those in Section 2, with some minor changes. For example, as some of the new instances have edges of cost zero, we added a preprocessing step eliminating such edges (by non-cyclic contraction). Also, as some of the new instances are quite large, some more time-consuming reduction routines were omitted or restricted to the advanced stages of the reduction process.

If an instance is solved exactly within the time limit (usually 24 hours in this section), we give the value of the optimal solution and the total time (in seconds) for the exact solution; otherwise we give an interval [*lower* − *upper*] showing the best lower and upper bounds reached before the time limit and also the used time limit.

instance	size			optimum	time[5]
	$\|V\|$	$\|E\|$	$\|R\|$		
ind1	18	31	10	604	0.00
ind2	31	57	10	9500	0.00
ind3	16	23	10	600	0.00
ind4	74	146	25	1086	0.00
ind5	114	228	33	1341	0.01
rc01	21	35	10	25980	0.00
rc02	87	176	30	41350	0.00
rc03	109	202	50	54160	0.00
rc04	121	197	70	59070	0.00
rc05	247	486	100	74070	0.04
rc06	2502	6244	100	79714	22.43
rc07	2740	6578	200	108740	56.37
rc08	7527	18170	200	112564	617.99
rc09	6128	15264	200	111005	299.16
rc10	1572	3245	500	164150	1.89
rc11	2858	5819	1000	230837	6.48
rt01	262	740	10	2146	0.08
rt02	788	1938	50	45852	1.99
rt03	1725	4092	100	7964	14.05
rt04	9469	22743	100	9693	5603.23
rt05	15473	38928	200	51313	95314.98

Table 14. Results on the Copenhagen(14)-instances. Type: Originally obstacle-avoiding rectilinear Steiner tree instances, transformed to instances of the Steiner problem in networks via FST-generation by the software package ObSteiner.

[5] Using other parameters, the same code solved the instance rt05 in 18778 seconds.

instance	size			optimum	time[6]
	$\|V\|$	$\|E\|$	$\|R\|$		
G101	67966	82485	100	3492405	14.10
G102	111707	160504	2052	15187538	296.12
G103	135543	201803	3033	19938744	523.33
G104	158212	240022	3914	26165528	864.96
G105	79244	101189	550	12507877	85.87
G106	204621	318136	5556	44547208	3588.28
G107	85568	114113	938	7325530	32.48
G201	44624	56205	190	3484028	10.13
G202	62174	87562	1015	6849423	38.17
G203	88728	133625	2041	13155210	175.71
G204	50002	65203	386	5313548	13.18
G205	120866	187312	3224	24819583	595.61
G206	60446	82940	803	9175622	59.38
G207	42481	52552	97	2265834	5.45
G301	80736	98750	191	4797441	20.39
G302	117756	165153	1879	13300990	96.18
G303	147718	214176	2992	27941456	548.35
G304	86413	108872	419	6721180	29.54
G305	172687	255825	3902	40632152	1009.73
G306	196404	300036	4937	33949874	2813.22
G307	235686	366093	6313	51219090	4384.97
G308	78834	95732	88	4699474	20.79
G309	97928	128632	902	11256303	58.25

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
G101a	10734	16345	96	2528993	9.99
G102a	27896	43925	2003	12707118	281.56
G103a	36270	57370	2930	16686894	513.66
G104a	44251	70029	3776	21794694	1133.44
G105a	14586	22450	525	9690792	80.80
G106a	62618	100067	5373	36879201	6476.49
G107a	15536	23858	893	6143970	41.64
G201a	8286	12617	188	2978695	9.68
G202a	14028	21610	985	5926154	35.20
G203a	25651	40610	1999	11754775	187.56
G204a	9939	15249	376	4513194	19.35
G205a	37398	59323	3146	21276170	1814.62
G206a	13688	21197	789	7843219	46.03
G207a	7565	11521	98	1967178	4.90
G301a	13291	20261	181	3891983	23.30
G302a	24951	38647	1797	10834825	104.80
G303a	37085	57711	2915	23210268	687.58
G304a	15213	23329	403	5466965	33.23
G305a	47016	73861	3809	34364413	1268.35
G306a	55423	87779	4766	28198617	1066.92
G307a	71184	113616	6107	42269121	4468.17
G308a	13298	20351	86	3756628	26.07
G309a	18704	28851	868	9218709	67.73

Table 15. Results on the (Vienna-)Geo-instances. Type: Real-world fiber-optic network design problems. The table on the right contains the same instances after some "advanced" preprocessing by the creators.

[6] For the instance G306 we switched off the CPXbaropt routine of CPLEX as a makeshift remediation concerning a (memory allocation) bug (but this does not necessarily mean that the bug is in CPLEX).

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
I001	30190	47748	1184	253921201	5.37
I002	49920	77871	1665	399809303	17.87
I003	44482	73419	3222	788774494	31.20
I004	5556	8552	570	279512692	0.19
I005	10284	15980	1017	390876350	0.39
I006	31754	52875	2202	504526035	37.38
I007	15122	24371	737	177909660	2.33
I008	15714	25567	871	201788202	2.68
I009	33188	52007	1262	275558727	5.56
I010	29905	47457	943	207889674	2.72
I011	25195	41298	1428	317589880	5.62
I012	12355	19962	503	118893243	0.49
I013	18242	28976	891	193190339	2.16
I014	12715	20632	475	105173465	0.54
I015	48833	79987	2493	592240832	23.71
I016	72038	115055	4391	1110914623	48.37
I017	15095	24091	478	109739695	1.17
I018	31121	51113	1898	463887832	9.90
I019	25946	41645	866	217647693	3.06
I020	21808	34921	594	146515460	1.33
I021	16013	25269	392	106470644	0.90
I022	16224	25691	437	106799980	2.95
I023	22805	35307	582	131044872	4.58
I024	68464	108732	3001	758483415	23.54
I025	23412	37952	945	232790758	4.48
I026	47429	79307	3334	928032223	44.74
I027	85085	138888	3954	976812226	36.28
I028	72701	115430	1790	384053191	18.72
I029	69988	111804	2162	492193565	15.11
I030	33188	53680	1263	321646787	3.56
I031	54351	88211	2182	578284709	5.59
I032	56023	91399	3017	773096651	13.65
I033	18555	29730	636	134461857	2.59
I034	22311	35516	735	165115148	2.59
I035	30585	50454	1704	414440370	6.20
I036	37208	60356	1411	375260864	9.98
I037	13694	22126	427	105720727	1.47
I038	18747	30639	967	255767543	12.27
I039	8755	14449	347	85566290	0.74
I040	40389	65820	1762	431498867	9.07
I041	47197	75307	1193	301914840	6.45
I042	51896	85550	2171	532131412	7.58
I043	10398	16787	367	95722094	0.92
I044	68905	113889	3358	804532332	29.74
I045	14685	23466	421	105944062	1.30
I046	70843	117209	3598	925470052	23.65
I047	28524	46251	2354	695163406	20.46
I048	13189	21219	358	91509264	0.97
I049	30857	49591	990	294811505	4.41
I050	43073	71276	2868	792599114	581.28
I051	27028	45406	1524	357230839	10.71
I052	2363	3761	40	13309487	0.04
I053	3224	5285	126	30854904	0.10
I054	3803	6213	38	15841596	0.11
I055	13332	21580	570	144164924	0.86
I056	1991	3176	51	14171206	0.05
I057	33231	55149	1569	412746415	5.76
I058	23527	39628	1256	305024188	1.88
I059	9287	14975	363	107617854	0.46
I060	42008	67572	1242	337290460	10.03
I061	39160	63659	1458	363042722	10.44
I062	66048	110491	3343	792941137	10.46
I063	26840	43661	1645	459801704	10.98
I064	63158	107345	3458	863103567	623.54
I065	3898	6356	144	32965718	0.21
I066	15038	24596	551	174219813	0.79
I067	20547	33230	627	175540750	3.72
I068	33118	55127	1553	420730046	4.44
I069	9574	16208	543	135161583	1.16
I070	15079	24608	550	136700139	1.69
I071	33203	54427	1494	382539099	4.24
I072	26948	44194	993	289019226	2.30
I073	21653	35171	1847	663004987	9.67
I074	13316	22033	653	165573383	0.91
I075	57551	95381	2973	815404026	11.52
I076	14023	22895	598	166249692	0.79
I077	20856	34237	1787	472503150	46.03
I078	13294	21948	835	185525490	1.67
I079	19867	31271	565	150506933	4.25
I080	18695	29708	548	164299652	1.76
I081	25081	40739	888	247527679	2.43
I082	15592	24788	515	147407632	1.07
I083	89596	148583	4991	1405593856	20.53
I084	44934	73727	2319	627187559	13.79
I085	9113	14491	301	80628079	0.51

instance	size			optimum	time
	$\|V\|$	$\|E\|$	$\|R\|$		
I001a	14675	22055	941	55295019	4.81
I002a	23800	35758	1282	58566202	16.15
I003a	16270	23919	2336	96567800	35.54
I004a	867	1238	263	42990860	0.09
I005a	1677	2430	491	53974585	0.11
I006a	13339	19532	1842	136193630	28.92
I007a	6873	10299	599	37370196	1.71
I008a	6522	9629	708	33153078	1.58
I009a	14977	22435	1053	48394720	4.75
I010a	13041	19545	782	47321625	2.04
I011a	9298	13685	1202	63848241	5.00
I012a	3500	5214	387	20593258	0.22
I013a	7147	10608	670	37689678	1.66
I014a	3577	5311	364	19455897	0.21
I015a	20573	30541	2119	146197744	24.19
I016a	27214	39824	3434	165077665	114.02
I017a	7571	11571	386	19021186	1.13
I018a	12258	18014	1549	67324183	9.36
I019a	11693	17624	732	49575126	2.51
I020a	6405	9564	508	24770758	0.79
I021a	5195	7861	295	17025666	0.45
I022a	8869	13551	356	24538643	2.77
I023a	13724	20863	403	17381764	4.16
I024a	32357	48250	2511	170437219	22.13
I025a	10055	14961	833	57209916	4.77
I026a	18155	26568	2661	137747708	42.02
I027a	40772	60555	3490	257384375	35.62
I028a	43690	66461	1597	102890845	19.98
I029a	32979	49627	1946	129941358	17.81
I030a	12941	19279	1093	79824759	2.87
I031a	21054	31410	1832	124055874	4.41
I032a	21345	31353	2454	144185378	11.94
I033a	8500	12700	548	31604828	2.20
I034a	9128	13668	606	28842122	2.22
I035a	13129	19420	1428	102037560	6.42
I036a	17036	25482	1258	104902070	8.75
I037a	5886	8869	392	29768713	1.27
I038a	7733	11478	798	48470499	11.52
I039a	3719	5533	306	22582804	0.45
I040a	18837	28156	1501	88121321	8.02
I041a	22466	33868	1014	61286700	6.01
I042a	23925	35806	1923	144759521	7.24
I043a	4511	6740	335	24407752	0.69
I044a	31500	46757	2954	232129301	30.77
I045a	6775	10227	378	23565890	1.07
I046a	32376	48054	3154	233783282	24.16
I047a	10622	15440	1791	121092256	19.74
I048a	4920	7356	320	15853402	0.59
I049a	15045	22713	821	35284597	4.06
I050a	17787	26176	2232	177289306	224.37
I051a	12130	17892	1337	86017056	11.39
I052a	160	237	23	2091965	0.00
I053a	693	1023	102	7323696	0.05
I054a	540	817	25	3980445	0.03
I055a	4701	6979	483	12836314	0.64
I056a	290	439	34	3862936	0.00
I057a	13078	19368	1346	74679827	4.87
I058a	7877	11657	997	57811949	1.41
I059a	2800	4157	286	13114616	0.24
I060a	18991	28536	1158	120144739	9.90
I061a	20958	31465	1337	64707445	10.19
I062a	23714	35305	2812	188764371	8.86
I063a	9600	14042	1291	79669224	7.67
I064a	31712	46711	3182	186838948	441.26
I065a	1185	1756	119	5371105	0.12
I066a	4551	6821	417	29106036	0.52
I067a	10318	15588	579	40604110	3.23
I068a	12191	18023	1302	81648214	3.99
I069a	3508	5156	452	17391265	1.07
I070a	6739	10064	511	27055351	1.41
I071a	12772	18886	1281	54833821	3.51
I072a	11628	17411	851	60112400	1.79
I073a	7510	10873	1337	126342447	9.11
I074a	4441	6562	548	40966401	0.58
I075a	23195	34362	2498	179352127	9.54
I076a	4909	7268	498	31927556	0.53
I077a	9153	13363	1490	191673586	45.86
I078a	5864	8662	692	56348302	1.29
I079a	7933	11807	497	30571900	4.44
I080a	7589	11256	499	26039027	1.70
I081a	10747	16029	751	48911750	2.09
I082a	5850	8693	435	32637881	0.60
I083a	34221	50301	4138	323126608	16.77
I084a	17050	25201	1918	130135969	14.20
I085a	2780	4123	243	14397376	0.24

Table 16. Results on the (Vienna-)I-instances. Type: Real-world fiber-optic network design problems. The tables on the left and right contain the instances after some "simple" and "advanced" preprocessing by the creators.

References

1. S. Vahdati Daneshmand. *Algorithmic Approaches to the Steiner Problem in Networks*. PhD thesis, University of Mannheim, 2004. `http://bibserv7.bib.uni-mannheim.de/madoc/volltexte/2004/176`.