

**A regularization method for constrained nonlinear least squares**

SUPPLEMENTARY MATERIAL

D. Orban,  
A. Soares Siqueira

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# A regularization method for constrained nonlinear least squares

## SUPPLEMENTARY MATERIAL

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## 1 Legend

The table headers are as follows:

- “Name” is the problem name;
- $n$ ,  $p$  and  $m$  are the number of variables, residuals and constraints, respectively;
- S is the status, which is empty if all goes well, “x” if an exception occurs, or “i”, “e” or “t”, if we reach the maximum number of inner iterations, function evaluations, or time;
- $\Delta t$  is the elapsed time;
- $\|\nabla L\|$  is the norm of the Lagrangian gradient;
- #F, #JF, #HF are the number of evaluations of the residual, its Jacobian, and sum of its component Hessians;
- #c, #Jc, #Hc are the number of evaluations of the constraint functions, their Jacobian, and sum of its component Hessians;
- Nfact is the number of factorizations performed;
- nBK is the total number of backtracking steps performed.

IPOPT terminates with an exception on RAT43 with a restoration failure.

## 2 CaNNOLeS results

Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc	Nfact	nBK
10FOLDTR	1000	1000	0		9.421e-11	7.9e+01	8.8e-09	87	87	86	0	0	0	139	0
ARGAUSS	3	15	0		5.640e-09	5.4e-04	3.4e-11	3	3	2	0	0	0	2	0
ARGLALE	200	400	0		1.000e+02	1.9e-01	6.8e-14	2	2	1	0	0	0	1	0
ARGLBLE	200	400	0		4.981e+01	6.3e-01	4.0e-09	3	3	2	0	0	0	6	0
ARGLCLE	200	399	0		5.006e+01	1.0e+00	2.5e-09	3	3	2	0	0	0	6	0
ARGTRIG	200	200	0		1.295e-20	1.1e+00	1.5e-10	7	7	6	0	0	0	12	0
ARWHDNE	500	998	0		6.971e+01	1.1e-02	1.6e-11	7	7	6	0	0	0	6	0
BA-L1	57	12	0		1.539e-25	1.2e-02	1.2e-10	11	11	10	0	0	0	26	0
BA-L1SP	57	12	0		4.538e-27	3.9e-02	6.0e-12	11	11	10	0	0	0	26	0
BARDNE	3	15	0		4.664e-01	1.7e-03	1.3e-15	14	14	13	0	0	0	20	0
BENNETT5	3	154	0		2.620e-04	2.9e-02	1.2e-15	29	29	28	0	0	0	56	0
BIGGS6NE	6	13	0		1.760e-15	1.2e-01	3.7e-10	90	81	76	0	0	0	177	9
BOOTH	2	2	0		3.550e-30	3.8e-04	3.6e-15	2	2	1	0	0	0	1	0
BOX3NE	3	10	0		5.321e-17	9.1e-04	1.6e-09	8	8	7	0	0	0	10	0
BOXBOD	2	6	0		5.840e+02	6.2e-03	5.4e-13	48	43	41	0	0	0	94	5
BROWNALE	200	200	0		6.994e-23	2.3e-01	3.1e-15	12	9	7	0	0	0	9	3
BROWNDENE	4	20	0		4.291e+04	1.2e-03	6.3e-11	12	11	9	0	0	0	9	1
BROYDN3D	5000	5000	0		4.724e-20	9.2e-02	5.5e-10	6	6	5	0	0	0	5	0
BROYDNBD	5000	5000	0		3.052e-26	5.7e-01	1.9e-14	12	12	11	0	0	0	20	0
CHANDHEU	500	500	0		3.704e-13	3.3e+00	9.8e-09	19	19	18	0	0	0	18	0
CHNRSBNE	50	98	0		4.475e-26	1.8e-02	7.0e-13	44	40	37	0	0	0	73	4
CHWIRUT1	3	214	0		1.192e+03	7.5e-03	2.5e-10	12	10	7	0	0	0	15	2
CHWIRUT2	3	54	0		2.565e+02	2.6e-03	1.2e-10	9	9	7	0	0	0	16	0
CLUSTER	2	2	0		1.353e-18	1.1e-03	2.3e-11	15	15	14	0	0	0	21	0
COOLHANS	9	9	0		1.973e-26	7.5e-03	9.4e-15	30	30	29	0	0	0	57	0
CUBENE	2	2	0		1.578e-28	3.9e-04	9.2e-18	4	4	3	0	0	0	3	0
DANWOOD	2	6	0		2.159e-03	2.9e-03	4.3e-11	41	35	31	0	0	0	51	6
ECKERLE4	3	35	0		3.498e-01	1.2e-03	8.1e-09	5	5	4	0	0	0	9	0
EIGENAU	2550	2550	0		6.756e-17	6.4e+01	1.1e-10	20	20	18	0	0	0	33	0
EIGENC	2652	2652	0	t	2.807e+03	3.0e+02	3.0e+00	71	71	70	0	0	0	180	0
ENSO	9	168	0		3.943e+02	1.3e-01	3.6e-14	13	13	12	0	0	0	19	0
FBRAIN	2	2211	0		2.083e-01	9.0e-02	2.3e-14	7	7	6	0	0	0	6	0
FBRAIN2	4	2211	0		1.595e-01	1.2e+00	1.1e-11	137	116	105	0	0	0	176	21
FBRAIN3	6	2211	0	i	1.146e-01	1.8e+02	5.2e-03	15890	10617	10603	0	0	0	12544	5273
FREURONE	2	2	0		2.449e+01	5.7e-04	4.3e-10	7	7	6	0	0	0	6	0

Continued on next page

Table 1 — continued from previous page

Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc	Nfact	nBK
GAUSS1	8	250	0		6.579e+02	7.3e-03	8.2e-12	6	6	5	0	0	0	5	0
GAUSS2	8	250	0		6.238e+02	7.8e-03	1.2e-11	6	6	5	0	0	0	5	0
GAUSS3	8	250	0		6.222e+02	3.1e-02	8.6e-11	13	11	9	0	0	0	17	2
GBRAIN	2	2200	0		1.426e+01	2.3e-01	5.9e-11	6	6	5	0	0	0	5	0
GOTTFR	2	2	0		2.302e-17	1.4e-03	2.2e-09	18	18	17	0	0	0	32	0
GROWTH	3	12	0		5.020e-01	5.9e-03	2.1e-14	78	52	45	0	0	0	93	26
GULFNE	3	99	0		1.642e+01	8.8e-03	1.1e-21	17	17	16	0	0	0	40	0
HAHN1	7	236	0		1.579e+01	1.7e-01	6.6e-10	140	116	104	0	0	0	193	24
HATFLDF	3	3	0		3.008e-05	5.7e-03	2.9e-11	95	82	77	0	0	0	124	13
HATFLDG	25	25	0		5.689e-25	3.8e-03	1.3e-13	14	14	13	0	0	0	25	0
HEART6	6	6	0		4.036e-25	7.8e-03	5.6e-14	78	66	60	0	0	0	132	12
HEART8	8	8	0		3.014e-18	5.3e-03	8.7e-10	39	34	31	0	0	0	69	5
HELIXNE	3	3	0		1.985e-26	1.7e-03	2.0e-12	22	22	21	0	0	0	35	0
HIMMELBA	2	2	0		0.000e+00	2.5e-04	0.0e+00	2	2	1	0	0	0	1	0
HIMMELBC	2	2	0		1.610e-25	8.0e-04	1.4e-12	9	9	8	0	0	0	16	0
HIMMELBD	2	2	0		2.961e+00	6.3e-04	4.5e-12	8	8	7	0	0	0	7	0
HIMMELBE	3	3	0		0.000e+00	4.0e-04	0.0e+00	4	4	3	0	0	0	3	0
HYDCAR20	99	99	0		1.909e-26	4.9e-02	4.1e-15	29	29	28	0	0	0	48	0
HYDCAR6	29	29	0		1.934e-21	1.6e-02	8.3e-12	32	28	26	0	0	0	51	4
HYP CIR	2	2	0		3.982e-24	9.2e-04	2.6e-12	11	11	10	0	0	0	18	0
INTEQNE	12	12	0		6.782e-23	5.6e-04	5.6e-12	4	4	3	0	0	0	3	0
JENSMPNE	2	10	0		6.218e+01	8.5e-04	1.0e-11	9	9	8	0	0	0	8	0
KIRBY2	5	151	0		1.953e+00	1.5e-02	4.4e-09	17	15	13	0	0	0	25	2
KOWOSBNE	4	11	0		9.075e-04	6.5e-03	7.1e-09	50	50	49	0	0	0	107	0
KSS	1000	1000	0		2.504e-20	5.0e+00	4.0e-21	9	9	8	0	0	0	8	0
LANCZOS1	6	24	0		2.809e-15	2.5e-02	1.9e-10	129	109	102	0	0	0	222	20
LANCZOS2	6	24	0		1.115e-11	1.5e-02	5.2e-11	81	63	58	0	0	0	120	18
LANCZOS3	6	24	0		8.059e-09	3.1e-02	8.2e-19	152	124	115	0	0	0	239	28
LSC1	3	6	0		3.856e+00	2.6e-03	1.5e-12	34	28	25	0	0	0	57	6
LSC2	3	6	0		6.667e+00	3.1e-03	6.1e-11	41	41	40	0	0	0	56	0
LUKSAN11	100	198	0		8.640e-23	1.4e-01	6.7e-11	537	323	290	0	0	0	334	214
LUKSAN12	98	192	0		2.146e+03	2.3e-02	1.4e-12	33	27	23	0	0	0	48	6
LUKSAN13	98	224	0		1.259e+04	2.1e-02	3.2e-14	35	26	22	0	0	0	40	9
LUKSAN14	98	224	0		6.196e+01	1.1e-02	1.3e-15	15	15	14	0	0	0	21	0
LUKSAN15	100	196	0		1.785e+00	2.7e-02	2.9e-10	15	14	12	0	0	0	27	1
LUKSAN16	100	196	0		1.785e+00	8.9e-03	7.0e-09	9	8	6	0	0	0	12	1
LUKSAN17	100	196	0		2.466e-01	2.5e-02	5.2e-14	23	23	21	0	0	0	40	0
LUKSAN21	100	100	0		1.321e-19	7.8e-03	2.0e-11	16	16	15	0	0	0	25	0
LUKSAN22	100	198	0		4.345e+02	1.7e-02	5.4e-11	24	19	17	0	0	0	28	5
METHANB8	31	31	0		7.507e-18	2.8e-03	9.0e-12	6	6	5	0	0	0	9	0
METHANL8	31	31	0		2.297e-18	1.1e-02	8.7e-13	19	19	18	0	0	0	35	0
MEYER3NE	3	16	0		4.397e+01	1.9e-02	6.4e-09	257	191	186	0	0	0	200	66
MGH09	4	11	0		9.050e-04	6.3e-03	7.8e-09	61	51	48	0	0	0	94	10
MGH10	3	16	0		4.397e+01	1.3e-01	8.1e-10	1538	1147	1145	0	0	0	1297	391
MGH10S	3	16	0		4.397e+01	4.1e-02	5.9e-10	504	355	352	0	0	0	427	149
MGH17	5	33	0		3.986e-05	1.5e-02	1.7e-09	63	56	49	0	0	0	120	7
MGH17S	5	33	0	e	2.933e-02	3.7e+00	5.4e-06	73226	13394	13386	0	0	0	26107	59832
MISRA1A	2	14	0		6.228e-02	2.5e-03	2.3e-09	35	27	24	0	0	0	33	8
MISRA1B	2	14	0		3.773e-02	2.3e-03	2.5e-10	34	25	22	0	0	0	29	9
MISRA1C	2	14	0		2.048e-02	1.3e-03	7.3e-12	22	16	13	0	0	0	13	6
MISRA1D	2	14	0		2.821e-02	2.1e-03	3.6e-12	28	22	19	0	0	0	25	6
MOREBVNE	10	10	0		1.332e-30	5.0e-04	5.3e-16	4	4	3	0	0	0	3	0
MSQRTA	1024	1024	0		4.238e-16	5.6e+00	1.2e-10	17	17	16	0	0	0	33	0
MSQR TB	1024	1024	0		2.186e-24	5.7e+00	2.3e-14	18	18	17	0	0	0	34	0
MUONSINE	1	512	0		2.194e+04	1.3e-02	7.1e-11	15	15	13	0	0	0	23	0
NELSON	3	128	0		1.899e+00	4.4e-02	4.5e-13	215	124	122	0	0	0	142	91
OSBORNE1	5	33	0		1.760e-02	2.8e-01	2.4e-09	2150	1545	1540	0	0	0	1691	605
OSBORNE2	11	65	0		2.007e-02	1.2e-02	1.3e-10	20	17	14	0	0	0	25	3
OSCIPANE	10	10	0	i	4.998e-01	1.2e+00	6.6e-02	22589	14226	14166	0	0	0	14245	8363
PENLT1NE	10	11	0		3.723e-10	1.2e-03	8.5e-11	13	13	12	0	0	0	12	0
PENLT2NE	4	8	0		4.783e-11	7.8e-04	1.4e-09	7	7	6	0	0	0	10	0
POWELLBS	2	2	0		4.286e-19	1.5e-03	7.1e-12	22	22	21	0	0	0	26	0
POWELLSE	4	4	0		7.973e-13	1.5e-03	9.0e-09	20	20	19	0	0	0	19	0

Continued on next page

**Table 1 — continued from previous page**

Name	n	p	m	S	$\frac{1}{2} \ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc	Nfact	nBK
POWELLSQ	2	2	0		5.989e+01	9.2e-04	2.9e-13	17	12	10	0	0	0	18	5
RAT42	3	9	0		4.028e+00	3.6e-03	4.0e-15	44	36	33	0	0	0	61	8
RAT43	4	15	0		4.393e+03	6.5e-03	1.8e-12	46	41	36	0	0	0	78	5
RECIPE	3	3	0		1.478e-12	1.3e-03	4.5e-09	19	19	18	0	0	0	18	0
ROSZMAN1	4	25	0	e	4.344e-03	7.5e-01	5.5e+01	92716	3655	3653	0	0	0	3860	89061
RSNBRNE	2	2	0		0.000e+00	4.4e-04	3.3e-17	4	4	3	0	0	0	3	0
SINVALNE	2	2	0		6.178e-31	3.3e-04	2.8e-17	3	3	2	0	0	0	2	0
SPIN	1327	1325	0		1.751e-10	1.9e+00	2.0e-09	35	34	32	0	0	0	91	1
SPIN2	102	100	0		9.486e-21	1.6e-01	1.8e-09	11	11	10	0	0	0	25	0
SPMSQRT	4999	8329	0		9.278e-16	9.6e-01	6.6e-14	22	22	21	0	0	0	41	0
SSINE	3	2	0		3.484e-16	2.2e-03	3.9e-10	29	29	28	0	0	0	45	0
THURBER	7	37	0		2.821e+03	8.6e-03	5.4e-09	23	23	20	0	0	0	40	0
VANDANIUMS	22	10	0	e	3.900e+00	1.1e+01	5.7e-08	33494	33494	33014	0	0	0	66028	0
VARDIMNE	10	12	0		6.336e-30	1.7e-03	2.1e-19	14	14	13	0	0	0	13	0
VESUVIA	8	1025	0		4.957e+02	3.3e-01	7.4e-10	47	42	33	0	0	0	71	5
VESUVIO	8	1025	0	i	4.957e+02	5.6e+01	8.4e-08	30965	11008	11004	0	0	0	11011	19957
VESUVIOU	8	1025	0		2.386e-01	5.4e-02	8.7e-12	10	10	8	0	0	0	13	0
WATSONNE	12	31	0		2.529e-09	7.4e-03	8.5e-09	14	14	13	0	0	0	28	0
WOODSNE	4000	3001	0		5.000e-01	6.4e-02	2.9e-15	6	6	5	0	0	0	9	0
YFITNE	3	17	0		3.335e-13	1.7e-03	7.1e-11	14	13	11	0	0	0	18	1
ZANGWIL3	3	3	0		1.893e-29	2.8e-04	0.0e+00	2	2	1	0	0	0	1	0
NZF1	13	5	0		3.703e-22	2.5e-03	3.1e-11	15	15	14	0	0	0	33	0
hs06	2	1	1		0.000e+00	1.4e-01	1.2e-17	216	36	34	216	36	34	38	180
hs26	3	2	1		6.984e-17	1.6e-03	1.9e-12	23	23	22	23	23	22	26	0
hs27	3	2	1		2.000e-02	8.7e-04	1.0e-15	12	12	11	12	12	11	18	0
hs28	3	2	1		0.000e+00	2.4e-04	3.5e-19	3	3	2	3	3	2	2	0
hs42	4	4	2		6.929e+00	3.4e-04	3.9e-14	5	5	4	5	5	4	4	0
hs46	5	4	2		6.962e-16	2.0e-02	1.1e-11	354	142	140	354	142	140	320	212
hs48	5	3	2		0.000e+00	3.0e-04	1.0e-17	3	3	2	3	3	2	2	0
hs49	5	4	2		2.239e-11	1.2e-03	7.3e-09	17	17	16	17	17	16	16	0
hs50	5	4	3		3.559e-28	7.7e-04	1.2e-14	10	10	9	10	10	9	9	0
hs51	5	4	3		2.768e-27	4.7e-04	1.2e-22	5	5	4	5	5	4	4	0
hs52	5	4	3		2.663e+00	5.4e-04	2.2e-16	6	6	5	6	6	5	5	0
hs61	3	3	2		2.360e+01	9.7e-03	1.9e-09	745	151	148	745	151	148	158	594
hs77	5	5	2		1.208e-01	1.4e-03	3.0e-14	33	18	16	33	18	16	16	15
hs79	5	5	3		3.939e-02	4.8e-04	6.9e-09	5	5	4	5	5	4	4	0
mgh01	2	2	0		0.000e+00	2.6e-04	3.3e-17	4	4	3	0	0	0	3	0
mgh02	2	2	0		2.449e+01	3.8e-04	4.3e-10	7	7	6	0	0	0	6	0
mgh03	2	2	0		4.286e-19	1.2e-03	7.1e-12	22	22	21	0	0	0	26	0
mgh04	2	3	0		0.000e+00	6.2e-02	2.7e-14	14	11	9	0	0	0	13	3
mgh05	2	3	0		3.364e-22	6.2e-04	2.4e-11	9	9	8	0	0	0	13	0
mgh06	2	10	0		6.218e+01	6.6e-04	1.0e-11	9	9	8	0	0	0	8	0
mgh07	3	3	0		6.344e-29	1.4e-03	5.5e-14	21	21	20	0	0	0	35	0
mgh08	3	15	0		4.664e-01	1.5e-03	1.1e-15	14	14	13	0	0	0	20	0
mgh09	3	15	0		5.640e-09	3.1e-04	3.4e-11	3	3	2	0	0	0	2	0
mgh10	3	16	0		4.397e+01	4.6e-02	8.5e-09	243	186	181	0	0	0	195	57
mgh11	3	100	0		1.642e+01	5.1e-03	3.6e-13	9	9	8	0	0	0	19	0
mgh12	3	10	0		3.268e-21	1.7e-03	1.2e-11	18	18	17	0	0	0	25	0
mgh13	4	4	0		7.720e-13	1.1e-03	3.2e-09	18	18	17	0	0	0	17	0
mgh14	4	6	0		1.305e-25	2.3e-03	9.5e-13	30	30	29	0	0	0	55	0
mgh15	4	11	0		5.137e-04	1.1e-01	3.6e-18	104	100	98	0	0	0	187	4
mgh16	4	20	0		4.291e+04	1.4e-03	6.3e-11	12	11	9	0	0	0	9	1
mgh17	5	33	0		1.760e-02	2.5e-01	1.2e-09	1639	1190	1184	0	0	0	1342	449
mgh18	6	13	0		5.458e-15	1.1e-02	1.5e-09	63	63	62	0	0	0	146	0
mgh19	11	65	0		1.374e-01	3.5e-02	1.7e-12	48	40	36	0	0	0	71	8
mgh20	6	31	0		1.144e-03	2.6e-03	3.5e-17	9	9	8	0	0	0	8	0
mgh21	20	20	0		0.000e+00	3.9e-04	3.3e-17	4	4	3	0	0	0	3	0
mgh22	20	20	0		8.329e-15	4.6e-03	8.2e-09	40	40	39	0	0	0	54	0
mgh23	4	5	0		1.125e-05	7.9e-04	6.2e-19	14	14	13	0	0	0	13	0
mgh24	4	8	0		1.728e-06	8.9e-04	1.5e-15	11	11	10	0	0	0	14	0
mgh25	10	12	0		0.000e+00	1.4e-03	2.1e-19	14	14	13	0	0	0	13	0
mgh26	10	10	0		1.398e-05	1.9e-03	2.4e-10	12	12	11	0	0	0	23	0
mgh27	10	10	0		2.179e-21	9.8e-04	3.7e-12	9	9	8	0	0	0	8	0

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**Table 1** — continued from previous page

Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc	Nfact	nBK
mgh28	10	10	0		3.331e-25	3.8e-04	3.0e-14	4	4	3	0	0	0	3	0
mgh29	10	10	0		6.782e-23	5.3e-04	5.6e-12	4	4	3	0	0	0	3	0
mgh30	10	10	0		4.747e-20	5.2e-04	5.6e-10	6	6	5	0	0	0	5	0
mgh31	10	10	0		9.148e-19	8.2e-04	4.3e-09	8	8	7	0	0	0	7	0
mgh32	10	20	0		5.000e+00	3.7e-04	2.0e-15	2	2	1	0	0	0	1	0
mgh33	10	20	0		2.317e+00	9.0e-04	5.7e-14	3	3	2	0	0	0	4	0
mgh34	10	20	0		3.068e+00	8.4e-04	2.1e-14	3	3	2	0	0	0	4	0
mgh35	10	10	0		3.252e-03	2.0e-02	8.0e-12	18	18	17	0	0	0	39	0
mgh01	2	2	0		0.000e+00	2.6e-04	3.3e-17	4	4	3	0	0	0	3	0
tp201	2	2	0		0.000e+00	1.3e-04	0.0e+00	2	2	1	0	0	0	1	0
tp202	2	2	0		2.449e+01	4.2e-04	0.0e+00	8	8	7	0	0	0	7	0
tp203	2	3	0		6.215e-29	4.1e-04	1.0e-14	7	7	6	0	0	0	6	0
tp204	2	3	0		9.180e-02	3.6e-04	2.6e-12	6	6	5	0	0	0	5	0
tp205	2	3	0		2.127e-20	5.9e-04	2.4e-10	9	9	8	0	0	0	13	0
tp206	2	2	0		0.000e+00	2.3e-04	2.9e-20	4	4	3	0	0	0	3	0
tp207	2	2	0		0.000e+00	2.3e-04	0.0e+00	4	4	3	0	0	0	3	0
tp208	2	2	0		0.000e+00	2.3e-04	3.3e-17	4	4	3	0	0	0	3	0
tp209	2	2	0		9.861e-28	2.3e-04	1.5e-16	4	4	3	0	0	0	3	0
tp210	2	2	0		0.000e+00	1.2e-02	2.0e-20	509	306	271	0	0	0	271	203
tp211	2	2	0		1.578e-28	2.5e-04	9.2e-18	4	4	3	0	0	0	3	0
tp212	2	2	0		3.512e-28	7.0e-04	7.3e-14	12	12	11	0	0	0	15	0
tp213	2	1	0		7.116e-12	1.4e-03	4.3e-09	30	30	29	0	0	0	29	0
tp216	2	2	1		4.997e-01	4.4e-04	1.6e-12	7	7	6	7	7	6	6	0
tp235	3	2	1		2.000e-02	4.5e-04	4.8e-19	7	7	6	7	7	6	6	0
tp240	3	3	0		1.893e-29	1.4e-04	0.0e+00	2	2	1	0	0	0	1	0
tp241	3	5	0		1.548e-19	6.1e-03	5.3e-10	21	20	18	0	0	0	34	1
tp245	3	10	0		3.268e-21	1.6e-03	1.2e-11	18	18	17	0	0	0	25	0
tp246	3	3	0		0.000e+00	2.7e-04	0.0e+00	4	4	3	0	0	0	3	0
tp256	4	4	0		5.495e-13	1.1e-03	3.8e-09	19	19	18	0	0	0	18	0
tp260	4	7	0		1.305e-25	2.3e-03	9.5e-13	30	30	29	0	0	0	55	0
tp261	4	5	0		1.858e-12	1.1e-03	3.7e-09	16	16	15	0	0	0	16	0
tp266	5	10	0		5.000e-01	1.0e-03	6.1e-09	7	7	6	0	0	0	10	0
tp267	5	11	0		1.325e-03	1.0e-02	5.2e-09	78	75	71	0	0	0	154	3
tp269	5	4	3		2.047e+00	5.2e-04	4.4e-16	5	5	4	5	5	4	4	0
tp271	6	6	0		7.457e-30	1.5e-04	2.1e-14	2	2	1	0	0	0	1	0
tp272	6	13	0		1.454e-19	1.2e-02	5.8e-12	65	65	64	0	0	0	151	0
tp273	6	7	0		0.000e+00	7.9e-04	2.3e-17	11	11	10	0	0	0	10	0
tp282	10	11	0		4.088e-18	7.8e-03	4.1e-09	61	39	34	0	0	0	55	22
tp286	20	20	0		0.000e+00	3.7e-04	3.3e-17	4	4	3	0	0	0	3	0
tp288	20	20	0		2.029e-12	1.9e-03	3.0e-09	19	19	18	0	0	0	18	0
tp290	2	1	0		1.443e-12	8.0e-04	5.1e-09	17	17	16	0	0	0	16	0
tp291	10	1	0		1.113e-12	1.1e-03	4.9e-09	20	20	19	0	0	0	19	0
tp292	30	1	0		1.693e-12	1.7e-03	6.9e-09	22	22	21	0	0	0	21	0
tp293	50	1	0		1.857e-12	2.2e-03	7.5e-09	23	23	22	0	0	0	22	0
tp294	6	10	0		1.987e+00	1.2e-03	4.8e-13	15	15	14	0	0	0	21	0
tp295	10	18	0		1.993e+00	1.9e-03	1.2e-14	18	18	17	0	0	0	26	0
tp296	16	30	0		1.993e+00	3.6e-03	4.4e-16	29	26	24	0	0	0	39	3
tp297	30	58	0		3.499e-18	1.3e-02	4.9e-10	57	44	39	0	0	0	73	13
tp298	50	98	0		2.681e-24	2.7e-02	4.3e-12	106	77	66	0	0	0	124	29
tp299	100	198	0		3.490e-19	1.2e-01	1.0e-09	326	215	175	0	0	0	256	111
tp303	20	22	0		2.219e-36	2.5e-03	2.1e-17	12	12	11	0	0	0	11	0
tp304	50	52	0		3.035e-32	1.4e-02	6.2e-15	15	15	14	0	0	0	14	0
tp305	100	102	0		1.811e-36	8.2e-02	9.5e-17	18	18	17	0	0	0	17	0
tp308	2	3	0		3.866e-01	5.6e-04	5.2e-15	9	9	8	0	0	0	8	0
tp311	2	2	0		1.610e-25	6.0e-04	1.4e-12	9	9	8	0	0	0	16	0
tp312	2	2	0		2.961e+00	4.3e-04	4.5e-12	8	8	7	0	0	0	7	0
tp316	2	2	1		1.672e+02	5.1e-04	5.3e-14	8	8	7	8	8	7	7	0
tp317	2	2	1		1.862e+02	4.8e-04	3.1e-09	8	8	7	8	8	7	7	0
tp318	2	2	1		2.064e+02	5.3e-04	1.1e-13	9	9	8	9	9	8	8	0
tp319	2	2	1		2.262e+02	5.3e-04	2.4e-13	9	9	8	9	9	8	8	0
tp320	2	2	1		2.428e+02	6.2e-04	1.4e-11	11	11	10	11	11	10	10	0
tp321	2	2	1		2.481e+02	6.7e-04	1.3e-12	10	10	9	10	10	9	13	0
tp322	2	2	1		2.500e+02	6.5e-04	2.2e-09	10	10	9	10	10	9	14	0

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**Table 1 — continued from previous page**

Name	n	p	m	S	$\frac{1}{2} \ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc	Nfact	nBK
tp333	3	8	0		2.164e-02	7.5e-04	5.6e-15	8	8	7	0	0	0	10	0
tp334	3	15	0		4.664e-01	1.6e-03	1.1e-15	14	14	13	0	0	0	20	0
tp344	3	3	1		1.628e-02	5.1e-04	1.7e-16	7	7	6	7	7	6	6	0
tp345	3	3	1		1.628e-02	1.1e-03	2.4e-11	15	14	12	15	14	12	23	1
tp350	4	11	0		5.137e-04	1.2e-02	3.6e-18	104	100	98	0	0	0	187	4
tp351	4	7	0		1.593e+02	8.2e-04	5.4e-13	8	8	7	0	0	0	12	0
tp352	4	40	0		4.516e+02	2.5e-04	1.6e-13	2	2	1	0	0	0	1	0
tp370	6	31	0		1.144e-03	2.7e-03	1.4e-17	9	9	8	0	0	0	8	0
tp371	9	31	0		6.999e-07	3.7e-03	3.3e-12	8	8	7	0	0	0	7	0
tp373	9	6	6		6.695e+03	9.0e-04	1.8e-11	10	10	8	10	10	8	8	0
tp379	11	65	0		2.007e-02	1.6e-02	1.4e-14	25	20	17	0	0	0	27	5
tp395	50	100	1		9.583e-01	5.7e-03	4.3e-15	17	17	16	17	17	16	22	0
Lukšan-Vlček 5.1	100	198	98		3.116e+00	7.7e-03	3.6e-15	8	8	7	8	8	7	7	0
Lukšan-Vlček 5.1	500	998	498		3.116e+00	5.2e-02	3.6e-15	8	8	7	8	8	7	7	0
Lukšan-Vlček 5.1	1000	9998	998		3.116e+00	1.1e-01	3.6e-15	8	8	7	8	8	7	7	0
Lukšan-Vlček 5.1	5000	9998	4998		3.116e+00	6.8e-01	3.6e-15	8	8	7	8	8	7	7	0
Lukšan-Vlček 5.2	100	294	93		1.374e+03	4.0e-02	2.7e-13	13	13	12	13	13	12	12	0
Lukšan-Vlček 5.2	500	1494	493		7.011e+03	1.8e-01	2.7e-11	12	12	11	12	12	11	11	0
Lukšan-Vlček 5.2	1000	2994	993		1.406e+04	5.1e-01	2.7e-11	12	12	11	12	12	11	11	0
Lukšan-Vlček 5.2	5000	14994	4993		7.043e+04	2.1e+00	2.7e-11	12	12	11	12	12	11	11	0
Lukšan-Vlček 5.3	100	196	2		7.084e+00	2.2e-02	5.8e-09	27	17	14	27	17	14	20	10
Lukšan-Vlček 5.3	500	996	2		7.084e+00	9.7e-02	5.8e-09	27	17	14	27	17	14	20	10
Lukšan-Vlček 5.3	1000	1996	2		7.084e+00	2.0e-01	1.4e-14	20	16	13	20	16	13	18	4
Lukšan-Vlček 5.3	5000	9996	2		7.084e+00	1.1e+00	3.6e-15	23	20	17	23	20	17	22	3
Lukšan-Vlček 5.4	100	245	98		2.429e+02	3.9e-02	1.1e-13	22	20	18	22	20	18	23	2
Lukšan-Vlček 5.4	500	1245	498		1.215e+03	2.2e-01	1.1e-13	22	20	18	22	20	18	23	2
Lukšan-Vlček 5.4	1000	2495	998		2.429e+03	6.3e-01	7.7e-14	22	20	18	22	20	18	23	2
Lukšan-Vlček 5.4	5000	12495	4998		1.215e+04	2.5e+00	1.1e-13	22	20	18	22	20	18	23	2
Lukšan-Vlček 5.11	101	132	66	e	2.013e+02	6.0e+00	2.3e-05	42483	3765	3761	42483	3765	3761	4870	38718
Lukšan-Vlček 5.11	500	664	332	e	2.037e+02	4.1e+01	4.1e-05	41957	4028	4023	41957	4028	4023	5847	37929
Lukšan-Vlček 5.11	1001	1332	666	e	2.021e+02	1.1e+02	4.0e-05	42461	3777	3770	42461	3777	3770	4278	38684
Lukšan-Vlček 5.11	5000	6664	3332		1.717e+00	7.8e+01	5.9e-11	2435	800	798	2435	800	798	1980	1635
Lukšan-Vlček 5.12	101	100	75		7.519e+01	1.0e-02	6.8e-14	8	8	7	8	8	7	11	0
Lukšan-Vlček 5.12	501	500	375		3.762e+02	4.7e-02	3.1e-10	8	8	7	8	8	7	11	0
Lukšan-Vlček 5.12	1001	1000	750		7.525e+02	1.2e-01	2.8e-10	9	9	8	9	9	8	12	0
Lukšan-Vlček 5.12	5001	5000	3750		3.762e+03	1.1e+00	9.6e-10	10	10	9	10	10	9	13	0
Lukšan-Vlček 5.13	101	99	66		3.738e+02	3.2e-02	4.6e-12	32	32	31	32	32	31	54	0
Lukšan-Vlček 5.13	500	498	332		1.977e+03	1.5e-01	4.6e-12	32	32	31	32	32	31	54	0
Lukšan-Vlček 5.13	1001	999	666		3.991e+03	3.2e-01	4.6e-12	32	32	31	32	32	31	54	0
Lukšan-Vlček 5.13	5000	4998	3332		2.006e+04	1.8e+00	4.6e-12	32	32	31	32	32	31	54	0
Lukšan-Vlček 5.14	101	132	66		2.590e+02	2.8e+00	3.2e-10	18863	2599	2596	18863	2599	2596	3231	16264
Lukšan-Vlček 5.14	500	664	332		1.309e+03	4.0e-02	1.3e-15	10	10	9	10	10	9	13	0
Lukšan-Vlček 5.14	1001	1332	666		2.627e+03	2.3e-01	2.7e-15	25	24	21	25	24	21	31	1
Lukšan-Vlček 5.14	5000	6664	3332		1.315e+04	9.4e-01	1.0e-10	17	17	14	17	17	14	26	0
Lukšan-Vlček 5.15	101	100	75		2.880e-22	3.1e-02	8.3e-12	30	30	28	30	30	28	55	0
Lukšan-Vlček 5.15	501	500	375		4.000e-30	8.3e-02	6.8e-15	19	19	18	19	19	18	29	0
Lukšan-Vlček 5.15	1001	1000	750		2.650e-30	2.1e-01	1.3e-17	21	21	20	21	21	20	34	0
Lukšan-Vlček 5.15	5001	5000	3750		9.189e-25	1.3e+00	3.2e-13	24	24	22	24	24	22	42	0
Lukšan-Vlček 5.16	101	100	75		9.582e-27	9.5e-03	1.3e-13	8	8	7	8	8	7	11	0
Lukšan-Vlček 5.16	501	500	375		9.575e-27	4.5e-02	1.3e-13	8	8	7	8	8	7	11	0
Lukšan-Vlček 5.16	1001	1000	750		9.590e-27	7.8e-02	1.3e-13	8	8	7	8	8	7	11	0
Lukšan-Vlček 5.16	5001	5000	3750		9.687e-27	3.1e-01	1.3e-13	8	8	7	8	8	7	11	0
Lukšan-Vlček 5.17	101	100	75		7.144e+01	4.6e-03	1.3e-15	9	9	8	9	9	8	8	0
Lukšan-Vlček 5.17	501	500	375		3.572e+02	4.4e-02	8.9e-16	9	9	8	9	9	8	8	0
Lukšan-Vlček 5.17	1001	1000	750		7.144e+02	6.2e-02	8.9e-16	9	9	8	9	9	8	8	0
Lukšan-Vlček 5.17	5001	5000	3750		3.572e+03	4.1e-01	8.9e-16	9	9	8	9	9	8	8	0
Lukšan-Vlček 5.18	101	100	75		5.999e+01	1.2e-02	1.7e-09	12	12	11	12	12	11	16	0
Lukšan-Vlček 5.18	501	500	375		2.999e+02	5.4e-02	1.7e-09	12	12	11	12	12	11	16	0
Lukšan-Vlček 5.18	1001	1000	750		5.999e+02	1.0e-01	1.7e-09	12	12	11	12	12	11	16	0
Lukšan-Vlček 5.18	5001	5000	3750		2.999e+03	6.3e-01	1.7e-09	12	12	11	12	12	11	16	0
BNST2	100	100	99		5.484e-19	2.4e-03	2.3e-10	4	4	3	4	4	3	3	0
BNST2	500	500	499		3.084e-19	9.9e-03	7.6e-10	4	4	3	4	4	3	3	0
BNST2	1000	1000	999		3.853e-22	2.4e-02	1.7e-12	4	4	3	4	4	3	3	0

Continued on next page



Table 1 — continued from previous page

Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc	Nfact	nBK
BNST2	5000	5000	4999		6.747e-24	1.9e-01	7.2e-12	4	4	3	4	4	3	3	0
BNST3	100	100	50		1.281e-28	1.7e-03	2.5e-15	4	4	3	4	4	3	3	0
BNST3	500	500	250		6.406e-28	1.4e-02	2.5e-15	4	4	3	4	4	3	3	0
BNST3	1000	1000	500		1.281e-27	1.6e-02	2.5e-15	4	4	3	4	4	3	3	0
BNST3	5000	5000	2500		6.406e-27	1.2e-01	2.5e-15	4	4	3	4	4	3	3	0
tp394	100	200	1		9.583e-01	1.4e-02	4.4e-10	16	16	15	16	16	15	24	0
tp394	500	1000	1		9.583e-01	1.3e-01	4.4e-15	23	23	21	23	23	21	32	0
tp394	1000	2000	1		9.583e-01	3.6e-01	2.0e-10	23	23	21	23	23	21	35	0
tp394	5000	10000	1		9.583e-01	1.5e+00	8.3e-11	24	24	23	24	24	23	37	0

### 3 IPOPT results

Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc
10FOLDTR	1000	1000	0		3.119e-17	1.7e+01	4.1e-13	59	60	59	0	0	0
ARGAUSS	3	15	0		5.640e-09	0.0e+00	1.8e-08	2	3	2	0	0	0
ARGLALE	200	400	0		1.000e+02	1.3e-02	4.4e-13	2	3	2	0	0	0
ARGLBLE	200	400	0		4.981e+01	4.8e-02	6.0e-03	3	4	3	0	0	0
ARGLCLE	200	399	0		5.006e+01	4.5e-02	9.9e-04	3	4	3	0	0	0
ARGTRIG	200	200	0		3.322e-19	2.2e-02	9.3e-08	4	5	4	0	0	0
ARWHDNE	500	998	0	i	7.895e+01	2.9e+00	1.9e+01	18139	3203	2800	0	0	0
BA-L1	57	12	0		3.039e-26	0.0e+00	2.8e-10	7	8	7	0	0	0
BA-L1SP	57	12	0		1.553e-23	4.0e-03	9.2e-09	6	7	6	0	0	0
BARDNE	3	15	0		4.107e-03	1.0e-03	2.0e-11	6	7	6	0	0	0
BENNETT5	3	154	0		2.620e-04	2.0e-03	1.1e-07	13	9	8	0	0	0
BIGGS6NE	6	13	0		1.877e-17	1.2e-02	2.7e-10	59	56	55	0	0	0
BOOTH	2	2	0		0.000e+00	0.0e+00	0.0e+00	2	3	2	0	0	0
BOX3NE	3	10	0		3.196e-19	1.0e-03	4.9e-10	6	7	6	0	0	0
BOXBOD	2	6	0		5.840e+02	2.3e-02	4.3e-09	25	16	15	0	0	0
BROWNALE	200	200	0		4.929e-25	3.6e-02	1.9e-10	16	10	9	0	0	0
BROWDENE	4	20	0		4.291e+04	7.0e-03	5.6e-11	67	26	25	0	0	0
BROYDN3D	5000	5000	0		5.769e-19	2.9e-02	3.3e-09	5	6	5	0	0	0
BROYDNBD	5000	5000	0		6.542e-29	7.4e-02	4.4e-13	8	9	8	0	0	0
CHANDHEU	500	500	0		3.899e-16	9.1e-01	1.3e-08	15	16	15	0	0	0
CHNRSBNE	50	98	0		1.386e-22	7.0e-03	6.4e-11	45	33	32	0	0	0
CHWIRUT1	3	214	0		1.192e+03	3.0e-03	2.9e-09	10	7	6	0	0	0
CHWIRUT2	3	54	0		2.565e+02	1.0e-03	5.1e-09	9	7	6	0	0	0
CLUSTER	2	2	0		8.387e-23	1.0e-03	3.8e-13	10	11	10	0	0	0
COOLHANS	9	9	0		8.204e-26	3.0e-03	2.1e-08	10	11	10	0	0	0
CUBENE	2	2	0		2.465e-28	0.0e+00	7.0e-13	3	3	2	0	0	0
DANWOOD	2	6	0		2.159e-03	1.0e-03	2.8e-11	6	7	6	0	0	0
ECKERLE4	3	35	0		7.318e-04	7.0e-03	4.8e-09	35	27	26	0	0	0
EIGENAU	2550	2550	0		8.129e-20	1.6e+01	3.6e-08	5	6	5	0	0	0
EIGENC	2652	2652	0		8.480e-19	7.0e+01	5.3e-08	22	23	22	0	0	0
ENSO	9	168	0		3.943e+02	1.1e-02	2.5e-13	16	15	14	0	0	0
FBRAIN	2	2211	0		2.083e-01	2.2e-02	9.6e-14	6	7	6	0	0	0
FBRAIN2	4	2211	0		1.939e-01	8.2e-01	4.2e-11	429	95	94	0	0	0
FBRAIN3	6	2211	0		3.577e-01	1.0e+02	2.3e+01	1545	246	243	0	0	0
FREURONE	2	2	0		4.701e-22	1.4e-02	1.3e-09	210	36	31	0	0	0
GAUSS1	8	250	0		6.579e+02	4.0e-03	2.2e-09	6	7	6	0	0	0
GAUSS2	8	250	0		6.238e+02	4.0e-03	1.6e-09	6	7	6	0	0	0
GAUSS3	8	250	0		6.222e+02	5.0e-03	3.6e-08	7	8	7	0	0	0
GBRAIN	2	2200	0		1.426e+01	2.3e-02	1.5e-13	6	7	6	0	0	0
GOTTFR	2	2	0		2.381e-20	3.0e-03	1.1e-09	9	7	6	0	0	0
GROWTH	3	12	0		5.020e-01	4.0e-03	9.3e-12	64	22	21	0	0	0
GULFNE	3	99	0	i	2.208e-01	1.2e+00	3.2e+02	3214	3003	3001	0	0	0
HAHN1	7	236	0		1.612e+01	8.8e-02	3.6e-04	489	123	122	0	0	0
HATFLDF	3	3	0		3.008e-05	1.0e-01	5.7e-05	1699	147	144	0	0	0
HATFLDG	25	25	0		1.833e-23	2.0e-03	8.5e-11	22	9	8	0	0	0
HEART6	6	6	0		5.522e-01	1.0e-03	8.9e-10	49	30	29	0	0	0
HEART8	8	8	0		4.241e-25	7.0e-03	2.6e-11	69	31	30	0	0	0

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**Table 2 — continued from previous page**

Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc
HELIXNE	3	3	0		6.606e-21	0.0e+00	1.2e-09	12	9	8	0	0	0
HIMMELBA	2	2	0		0.000e+00	0.0e+00	0.0e+00	2	3	2	0	0	0
HIMMELBC	2	2	0		0.000e+00	1.0e-03	0.0e+00	9	8	7	0	0	0
HIMMELBD	2	2	0	i	3.302e+03	7.6e-01	1.9e+05	20288	3213	2790	0	0	0
HIMMELBE	3	3	0		2.465e-32	1.0e-03	3.8e-16	3	4	3	0	0	0
HYDCAR20	99	99	0		2.818e-26	1.0e-03	8.0e-11	12	11	10	0	0	0
HYDCAR6	29	29	0		1.369e-23	1.0e-03	9.8e-10	9	7	6	0	0	0
HYP CIR	2	2	0		2.890e-25	1.0e-03	3.1e-12	8	7	6	0	0	0
INTEQNE	12	12	0		2.011e-29	0.0e+00	8.2e-15	4	5	4	0	0	0
JENSMPNE	2	10	0		6.218e+01	3.0e-03	1.2e-12	18	11	10	0	0	0
KIRBY2	5	151	0		1.953e+00	2.0e-03	2.7e-06	7	8	7	0	0	0
KOWOSBNE	4	11	0		1.539e-04	1.0e-03	9.4e-13	13	8	7	0	0	0
KSS	1000	1000	0		2.720e-22	3.8e+00	2.3e-08	7	8	7	0	0	0
LANCZOS1	6	24	0		1.552e-17	5.0e-03	3.5e-09	44	21	20	0	0	0
LANCZOS2	6	24	0		1.115e-11	6.0e-03	3.9e-12	45	23	22	0	0	0
LANCZOS3	6	24	0		8.059e-09	6.0e-03	4.9e-08	46	21	20	0	0	0
LSC1	3	6	0		3.856e+00	3.0e-03	1.6e-12	29	13	12	0	0	0
LSC2	3	6	0		2.021e+00	6.0e-03	3.9e-09	107	22	21	0	0	0
LUKSAN11	100	198	0		4.068e-22	5.0e-02	2.9e-10	88	78	77	0	0	0
LUKSAN12	98	192	0		2.096e+03	1.2e-02	5.5e-10	44	28	27	0	0	0
LUKSAN13	98	224	0		1.270e+04	1.9e-02	4.5e-10	46	41	40	0	0	0
LUKSAN14	98	224	0		6.196e+01	8.0e-03	4.7e-09	26	18	17	0	0	0
LUKSAN15	100	196	0		1.785e+00	9.0e-03	5.4e-12	9	8	7	0	0	0
LUKSAN16	100	196	0		1.785e+00	5.0e-03	6.1e-12	6	7	6	0	0	0
LUKSAN17	100	196	0		2.466e-01	2.3e-02	4.3e-07	25	20	19	0	0	0
LUKSAN21	100	100	0		1.046e-18	3.0e-03	2.5e-10	14	7	6	0	0	0
LUKSAN22	100	198	0		4.345e+02	9.0e-03	6.3e-09	21	19	18	0	0	0
METHANB8	31	31	0		8.192e-26	1.0e-03	1.5e-10	4	5	4	0	0	0
METHANL8	31	31	0		1.363e-21	1.0e-03	2.3e-08	5	6	5	0	0	0
MEYER3NE	3	16	0		4.397e+01	3.0e-03	9.7e-04	19	11	10	0	0	0
MGH09	4	11	0		8.974e-04	6.0e-03	1.2e-09	151	32	31	0	0	0
MGH10	3	16	0		1.945e+09	1.0e-03	0.0e+00	9	5	4	0	0	0
MGH10S	3	16	0		1.945e+09	1.0e-03	0.0e+00	9	5	4	0	0	0
MGH17	5	33	0		1.226e-02	7.4e-02	1.7e-10	577	167	163	0	0	0
MGH17S	5	33	0		1.226e-02	1.5e-02	1.1e-09	141	46	43	0	0	0
MISRA1A	2	14	0		6.228e-02	1.0e-03	3.3e-09	42	14	13	0	0	0
MISRA1B	2	14	0		3.773e-02	3.0e-03	1.5e-05	25	11	10	0	0	0
MISRA1C	2	14	0		2.048e-02	3.0e-03	2.9e-05	8	8	7	0	0	0
MISRA1D	2	14	0		2.821e-02	3.0e-03	1.0e-05	16	9	8	0	0	0
MOREBVNE	10	10	0		2.425e-29	1.0e-03	1.9e-15	4	5	4	0	0	0
MSQRTA	1024	1024	0		2.120e-26	3.6e-01	1.9e-12	9	7	6	0	0	0
MSQR TB	1024	1024	0		1.011e-25	2.9e-01	3.5e-12	9	7	6	0	0	0
MUONSINE	1	512	0		2.194e+04	6.0e-03	6.0e-11	13	11	10	0	0	0
NELSON	3	128	0		2.721e+01	3.0e-03	9.2e-10	12	6	5	0	0	0
OSBORNE1	5	33	0		2.732e-05	1.0e-03	6.1e-09	8	7	6	0	0	0
OSBORNE2	11	65	0		2.007e-02	7.0e-03	4.7e-09	20	13	12	0	0	0
OSCI PANE	10	10	0	i	2.829e+07	1.1e+00	5.4e+07	38273	3407	2596	0	0	0
PENLT1NE	10	11	0		3.544e-10	3.0e-03	1.1e-15	11	12	11	0	0	0
PENLT2NE	4	8	0		4.688e-11	1.0e-03	1.5e-12	16	10	9	0	0	0
POWELLBS	2	2	0		7.497e-24	3.0e-03	3.5e-07	164	30	29	0	0	0
POWELLSE	4	4	0		4.340e-17	1.0e-03	8.0e-12	17	18	17	0	0	0
POWELLSQ	2	2	0		4.457e-24	2.0e-02	3.0e-10	166	43	40	0	0	0
RAT42	3	9	0		4.028e+00	1.0e-03	2.1e-12	42	27	26	0	0	0
RAT43	4	15	0	x	1.543e+05	6.0e-03	5.1e+03	22	14	12	0	0	0
RECIPE	3	3	0		1.694e-17	1.0e-03	8.9e-13	17	18	17	0	0	0
ROSZMAN1	4	25	0		1.507e-02	1.0e-02	6.0e-12	87	39	38	0	0	0
RSNBRNE	2	2	0		3.947e-29	0.0e+00	2.0e-13	3	3	2	0	0	0
SINVALNE	2	2	0		0.000e+00	0.0e+00	0.0e+00	3	3	2	0	0	0
SPIN	1327	1325	0		3.416e-23	5.1e-02	3.0e-11	8	9	8	0	0	0
SPIN2	102	100	0		1.041e-27	2.2e-02	1.9e-12	6	7	6	0	0	0
SPMSQRT	4999	8329	0		9.278e-16	1.1e-01	4.4e-13	9	7	6	0	0	0
SSINE	3	2	0		2.707e-09	3.0e-03	4.1e-04	42	18	17	0	0	0
THURBER	7	37	0		7.689e+03	7.1e-02	5.5e-03	1223	200	197	0	0	0

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Table 2 — continued from previous page

Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc
VANDANIUMS	22	10	0		3.899e+00	3.0e-03	2.9e-09	21	22	21	0	0	0
VARDIMNE	10	12	0		4.112e-20	3.0e-03	5.6e-09	22	16	15	0	0	0
VESUVIA	8	1025	0		7.439e+02	7.0e-02	2.0e-08	60	32	31	0	0	0
VESUVIO	8	1025	0		7.179e+02	6.6e-01	2.4e-08	113	75	74	0	0	0
VESUVIOU	8	1025	0		2.386e-01	5.5e-02	5.7e-11	32	28	27	0	0	0
WATSONNE	12	31	0		1.430e-15	1.0e-03	2.2e-13	5	6	5	0	0	0
WOODSNE	4000	3001	0		5.000e-01	1.9e-02	1.6e-07	4	5	4	0	0	0
YFITNE	3	17	0		3.335e-13	3.0e-03	2.1e-10	12	11	10	0	0	0
ZANGWIL3	3	3	0		0.000e+00	0.0e+00	0.0e+00	2	3	2	0	0	0
NZF1	13	5	0		1.089e-25	1.0e-03	1.3e-12	7	8	7	0	0	0
hs06	2	1	1		2.465e-32	0.0e+00	2.2e-16	3	3	2	3	3	2
hs26	3	2	1		3.958e-23	4.0e-03	7.5e-17	17	18	17	17	18	17
hs27	3	2	1	i	5.533e-02	9.5e-01	3.4e-01	17520	3181	2822	17520	3181	2822
hs28	3	2	1		0.000e+00	0.0e+00	0.0e+00	2	3	2	2	3	2
hs42	4	4	2		6.929e+00	1.0e-03	1.5e-10	6	7	6	6	7	6
hs46	5	4	2		9.852e-17	8.0e-03	3.3e-12	20	21	20	20	21	20
hs48	5	3	2		0.000e+00	1.0e-03	0.0e+00	2	3	2	2	3	2
hs49	5	4	2		6.939e-18	3.0e-03	4.5e-13	17	18	17	17	18	17
hs50	5	4	3		4.930e-32	3.0e-03	4.0e-16	11	12	11	11	12	11
hs51	5	4	3		0.000e+00	1.0e-03	0.0e+00	2	3	2	2	3	2
hs52	5	4	3		2.663e+00	0.0e+00	3.1e-16	2	3	2	2	3	2
hs61	3	3	2		2.360e+01	3.0e-03	1.8e-15	14	11	10	14	11	10
hs77	5	5	2		1.208e-01	3.0e-03	1.1e-10	10	11	10	10	11	10
hs79	5	5	3		3.939e-02	1.0e-03	4.6e-09	5	6	5	5	6	5
mgh01	2	2	0		3.947e-29	0.0e+00	2.0e-13	3	3	2	0	0	0
mgh02	2	2	0		4.666e-22	8.0e-03	1.3e-09	210	36	31	0	0	0
mgh03	2	2	0		7.497e-24	8.0e-03	3.5e-07	164	30	29	0	0	0
mgh04	2	3	0		0.000e+00	4.0e-03	0.0e+00	45	24	21	0	0	0
mgh05	2	3	0		1.860e-28	1.0e-03	8.8e-14	22	14	13	0	0	0
mgh06	2	10	0		6.218e+01	1.0e-03	1.5e-12	18	11	10	0	0	0
mgh07	3	3	0		6.606e-21	1.0e-03	1.2e-09	12	9	8	0	0	0
mgh08	3	15	0		4.107e-03	1.0e-03	2.0e-11	6	7	6	0	0	0
mgh09	3	15	0		5.640e-09	0.0e+00	1.8e-08	2	3	2	0	0	0
mgh10	3	16	0		4.397e+01	3.0e-03	2.6e-04	24	14	13	0	0	0
mgh11	3	100	0		1.642e+01	2.4e-02	4.5e-09	94	42	41	0	0	0
mgh12	3	10	0		5.052e-20	1.0e-03	4.9e-10	6	7	6	0	0	0
mgh13	4	4	0		1.431e-17	3.0e-03	1.3e-12	16	17	16	0	0	0
mgh14	4	6	0		4.082e-17	6.0e-03	2.0e-07	41	31	30	0	0	0
mgh15	4	11	0		1.538e-04	1.0e-03	9.5e-13	13	8	7	0	0	0
mgh16	4	20	0		4.291e+04	9.0e-03	8.2e-09	85	28	27	0	0	0
mgh17	5	33	0		2.732e-05	2.0e-03	6.1e-09	8	7	6	0	0	0
mgh18	6	13	0		1.194e-19	1.4e-02	6.7e-10	59	56	55	0	0	0
mgh19	11	65	0		4.384e-02	2.6e-02	1.2e-11	48	28	27	0	0	0
mgh20	6	31	0		1.144e-03	2.0e-03	8.0e-12	6	7	6	0	0	0
mgh21	20	20	0		3.947e-28	0.0e+00	6.3e-13	3	3	2	0	0	0
mgh22	20	20	0		3.036e-17	3.0e-03	4.2e-09	17	18	17	0	0	0
mgh23	4	5	0		1.125e-05	1.0e-03	1.5e-12	9	10	9	0	0	0
mgh24	4	8	0		1.728e-06	3.0e-03	5.8e-09	14	10	9	0	0	0
mgh25	10	12	0		4.112e-20	3.0e-03	5.6e-09	22	16	15	0	0	0
mgh26	10	10	0		2.378e-21	1.0e-03	4.9e-11	18	10	9	0	0	0
mgh27	10	10	0		9.978e-27	4.0e-03	4.2e-13	24	13	12	0	0	0
mgh28	10	10	0		1.439e-31	1.0e-03	2.4e-16	4	5	4	0	0	0
mgh29	10	10	0		2.031e-29	1.0e-03	8.2e-15	4	5	4	0	0	0
mgh30	10	10	0		5.643e-19	1.0e-03	3.3e-09	5	6	5	0	0	0
mgh31	10	10	0		1.198e-16	1.0e-03	9.2e-08	6	7	6	0	0	0
mgh32	10	20	0		5.000e+00	0.0e+00	4.1e-16	2	3	2	0	0	0
mgh33	10	20	0		2.317e+00	1.0e-03	9.3e-09	3	4	3	0	0	0
mgh34	10	20	0		3.068e+00	1.0e-03	8.7e-09	3	4	3	0	0	0
mgh35	10	10	0		2.386e-03	2.3e-01	9.4e-13	349	69	66	0	0	0
mgh01	2	2	0		3.947e-29	0.0e+00	2.0e-13	3	3	2	0	0	0
tp201	2	2	0		0.000e+00	0.0e+00	0.0e+00	2	3	2	0	0	0
tp202	2	2	0		4.647e-22	1.0e-02	1.3e-09	210	36	31	0	0	0
tp203	2	3	0		7.611e-18	1.0e-03	1.7e-08	5	6	5	0	0	0

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**Table 2** — continued from previous page

Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc
tp204	2	3	0		9.180e-02	0.0e+00	3.6e-09	15	10	9	0	0	0
tp205	2	3	0		0.000e+00	1.0e-03	0.0e+00	9	10	9	0	0	0
tp206	2	2	0		3.944e-31	1.0e-03	2.0e-15	3	4	3	0	0	0
tp207	2	2	0		9.121e-31	0.0e+00	3.2e-15	3	3	2	0	0	0
tp208	2	2	0		3.947e-29	0.0e+00	2.0e-13	3	3	2	0	0	0
tp209	2	2	0		9.861e-28	0.0e+00	9.9e-12	3	3	2	0	0	0
tp210	2	2	0		9.861e-26	1.0e-03	9.9e-10	3	3	2	0	0	0
tp211	2	2	0		2.465e-28	1.0e-03	7.0e-13	3	3	2	0	0	0
tp212	2	2	0		0.000e+00	0.0e+00	0.0e+00	2	3	2	0	0	0
tp213	2	1	0		1.947e-17	4.0e-03	7.8e-14	24	25	24	0	0	0
tp216	2	2	1		4.997e-01	0.0e+00	4.0e-11	49	12	11	49	12	11
tp235	3	2	1	i	4.750e-01	8.2e-01	9.7e-01	17765	3186	2817	17765	3186	2817
tp240	3	3	0		0.000e+00	0.0e+00	0.0e+00	2	3	2	0	0	0
tp241	3	5	0		2.310e-28	3.0e-03	1.3e-12	21	14	13	0	0	0
tp245	3	10	0		5.052e-20	1.0e-03	4.9e-10	6	7	6	0	0	0
tp246	3	3	0		2.465e-30	1.0e-03	3.8e-14	3	4	3	0	0	0
tp256	4	4	0		4.364e-18	3.0e-03	8.0e-13	17	18	17	0	0	0
tp260	4	7	0		4.082e-17	5.0e-03	2.0e-07	41	31	30	0	0	0
tp261	4	5	0		2.500e-16	9.0e-03	1.6e-12	77	35	34	0	0	0
tp266	5	10	0		5.000e-01	2.0e-03	2.3e-11	8	9	8	0	0	0
tp267	5	11	0		1.325e-03	4.0e-03	4.8e-09	21	16	15	0	0	0
tp269	5	4	3		2.047e+00	0.0e+00	3.1e-16	2	3	2	2	3	2
tp271	6	6	0		0.000e+00	0.0e+00	0.0e+00	2	3	2	0	0	0
tp272	6	13	0		6.333e-19	1.4e-02	2.4e-09	66	60	59	0	0	0
tp273	6	7	0		2.586e-24	0.0e+00	2.6e-11	13	12	11	0	0	0
tp282	10	11	0		3.147e-23	5.0e-03	4.3e-11	60	26	25	0	0	0
tp286	20	20	0		3.947e-28	0.0e+00	6.3e-13	3	3	2	0	0	0
tp288	20	20	0		2.182e-17	4.0e-03	1.8e-12	17	18	17	0	0	0
tp290	2	1	0		7.500e-18	1.0e-03	5.7e-13	16	17	16	0	0	0
tp291	10	1	0		6.653e-18	3.0e-03	1.0e-12	18	19	18	0	0	0
tp292	30	1	0		2.903e-17	4.0e-03	5.2e-12	19	20	19	0	0	0
tp293	50	1	0		1.363e-17	3.0e-03	3.8e-12	20	21	20	0	0	0
tp294	6	10	0		2.634e-19	0.0e+00	1.1e-08	25	17	16	0	0	0
tp295	10	18	0		1.451e-17	3.0e-03	1.2e-07	17	15	14	0	0	0
tp296	16	30	0		1.141e-28	3.0e-03	2.3e-13	32	24	23	0	0	0
tp297	30	58	0		3.475e-20	7.0e-03	5.3e-09	52	35	34	0	0	0
tp298	50	98	0		0.000e+00	1.4e-02	0.0e+00	80	53	52	0	0	0
tp299	100	198	0		1.309e-19	4.2e-02	8.6e-09	157	95	94	0	0	0
tp303	20	22	0		3.865e-28	4.0e-03	7.5e-13	13	14	13	0	0	0
tp304	50	52	0		5.920e-35	7.0e-03	1.1e-15	23	17	16	0	0	0
tp305	100	102	0		1.605e-22	1.6e-02	5.2e-09	34	20	19	0	0	0
tp308	2	3	0		3.866e-01	3.0e-03	9.8e-13	27	14	13	0	0	0
tp311	2	2	0		0.000e+00	1.0e-03	0.0e+00	9	8	7	0	0	0
tp312	2	2	0	i	9.255e+04	8.6e-01	1.0e+06	19860	3211	2792	0	0	0
tp316	2	2	1		1.672e+02	1.0e-03	2.1e-10	8	9	8	8	9	8
tp317	2	2	1		1.862e+02	3.0e-03	5.0e-15	11	12	11	11	12	11
tp318	2	2	1		2.064e+02	3.0e-03	2.1e-10	11	12	11	11	12	11
tp319	2	2	1		2.262e+02	3.0e-03	2.9e-09	12	13	12	12	13	12
tp320	2	2	1		2.428e+02	4.0e-03	5.2e-10	22	17	16	22	17	16
tp321	2	2	1		2.481e+02	4.0e-03	1.8e-15	25	19	18	25	19	18
tp322	2	2	1		2.500e+02	3.0e-03	6.9e-13	21	13	12	21	13	12
tp333	3	8	0		2.164e-02	1.0e-03	3.7e-09	6	7	6	0	0	0
tp334	3	15	0		4.107e-03	0.0e+00	2.0e-11	6	7	6	0	0	0
tp344	3	3	1		1.628e-02	1.0e-03	6.7e-17	7	8	7	7	8	7
tp345	3	3	1		1.628e-02	3.0e-03	3.2e-12	20	12	11	20	12	11
tp350	4	11	0		1.538e-04	1.0e-03	9.5e-13	13	8	7	0	0	0
tp351	4	7	0		1.593e+02	6.0e-03	1.8e-08	27	24	23	0	0	0
tp352	4	40	0		4.516e+02	1.0e-03	9.6e-14	2	3	2	0	0	0
tp370	6	31	0		1.144e-03	2.0e-03	7.9e-12	6	7	6	0	0	0
tp371	9	31	0		6.999e-07	1.3e-02	7.6e-08	5	6	5	0	0	0
tp373	9	6	6		6.695e+03	1.0e-03	5.5e-12	4	5	4	4	5	4
tp379	11	65	0		2.007e-02	1.1e-02	2.5e-09	43	22	21	0	0	0
tp395	50	100	1		9.583e-01	9.0e-03	1.4e-09	34	22	21	34	22	21

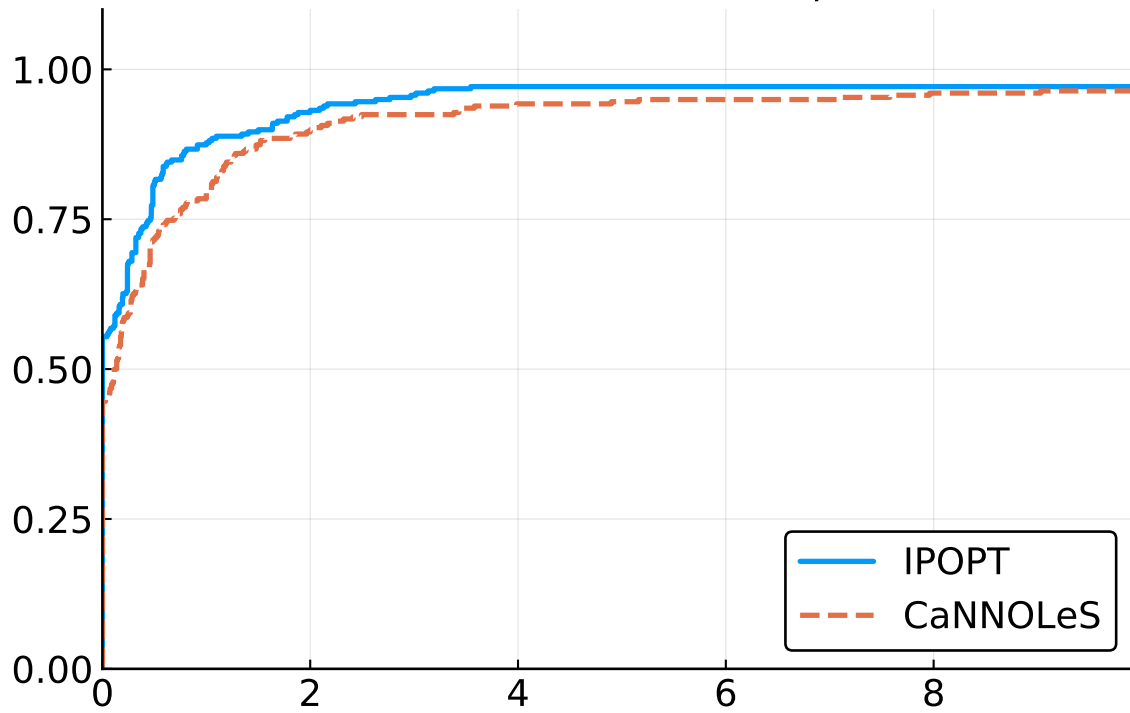
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Table 2 — continued from previous page

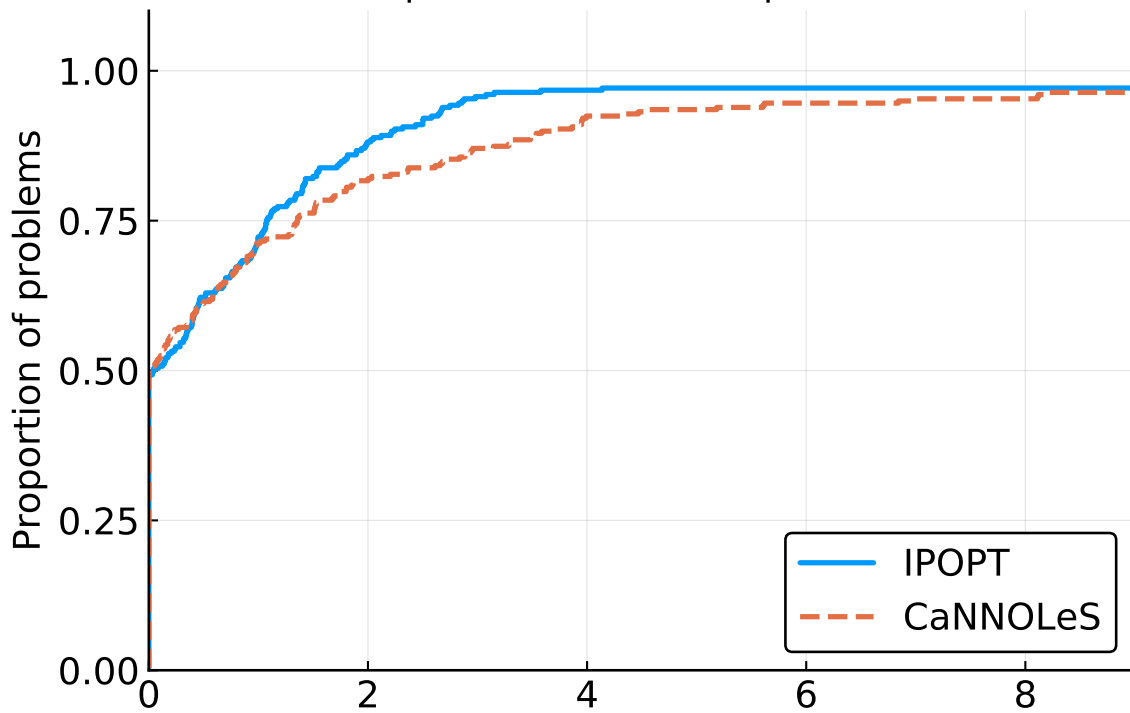
Name	n	p	m	S	$\frac{1}{2}\ F(x)\ ^2$	$\Delta t$	$\ \nabla L\ $	#F	#JF	#HF	#c	#Jc	#Hc
Lukšan-Vlček 5.1	100	198	98		3.116e+00	1.1e-02	7.9e-14	8	9	8	8	9	8
Lukšan-Vlček 5.1	500	998	498		3.116e+00	7.2e-02	7.9e-14	8	9	8	8	9	8
Lukšan-Vlček 5.1	1000	1998	998		3.116e+00	9.4e-02	7.9e-14	8	9	8	8	9	8
Lukšan-Vlček 5.1	5000	9998	4998		3.116e+00	8.9e-01	7.9e-14	8	9	8	8	9	8
Lukšan-Vlček 5.2	100	294	93		1.374e+03	1.2e-01	1.8e-09	97	33	32	97	33	32
Lukšan-Vlček 5.2	500	1494	493		7.011e+03	5.1e-01	3.8e-09	86	36	35	86	36	35
Lukšan-Vlček 5.2	1000	2994	993		1.406e+04	1.0e+00	4.1e-09	81	30	29	81	30	29
Lukšan-Vlček 5.2	5000	14994	4993		7.043e+04	6.0e+00	7.1e-13	56	27	26	56	27	26
Lukšan-Vlček 5.3	100	196	2		7.084e+00	1.3e-02	2.0e-09	9	10	9	9	10	9
Lukšan-Vlček 5.3	500	996	2		7.084e+00	3.8e-02	2.8e-09	9	10	9	9	10	9
Lukšan-Vlček 5.3	1000	1996	2		7.084e+00	1.1e-01	3.5e-09	9	10	9	9	10	9
Lukšan-Vlček 5.3	5000	9996	2		7.084e+00	8.3e-01	7.0e-09	9	10	9	9	10	9
Lukšan-Vlček 5.4	100	245	98		2.273e+02	2.5e-01	6.1e-14	260	56	55	260	56	55
Lukšan-Vlček 5.4	500	1245	498		1.199e+03	1.6e+00	8.0e-11	549	78	73	549	78	73
Lukšan-Vlček 5.4	1000	2495	998		2.414e+03	2.6e+00	1.6e-10	394	68	65	394	68	65
Lukšan-Vlček 5.4	5000	12495	4998		1.213e+04	6.7e+00	4.5e-09	89	32	31	89	32	31
Lukšan-Vlček 5.11	101	132	66		5.843e-30	2.7e-02	1.6e-15	23	17	16	23	17	16
Lukšan-Vlček 5.11	500	664	332		1.807e-27	2.4e-01	2.8e-14	106	47	46	106	47	46
Lukšan-Vlček 5.11	1001	1332	666		1.782e-27	6.6e-01	2.8e-14	106	47	46	106	47	46
Lukšan-Vlček 5.11	5000	6664	3332		1.809e-27	4.8e+00	2.8e-14	106	47	46	106	47	46
Lukšan-Vlček 5.12	101	100	75		7.519e+01	1.8e-02	5.4e-13	18	11	10	18	11	10
Lukšan-Vlček 5.12	501	500	375		3.762e+02	4.2e-02	3.9e-11	18	11	10	18	11	10
Lukšan-Vlček 5.12	1001	1000	750		7.525e+02	8.6e-02	2.3e-11	18	11	10	18	11	10
Lukšan-Vlček 5.12	5001	5000	3750		3.762e+03	6.8e-01	5.1e-11	18	11	10	18	11	10
Lukšan-Vlček 5.13	101	99	66		3.849e+02	2.3e-01	3.6e-12	27	23	22	27	23	22
Lukšan-Vlček 5.13	500	498	332		1.988e+03	4.2e-02	3.6e-12	27	23	22	27	23	22
Lukšan-Vlček 5.13	1001	999	666		4.002e+03	9.6e-02	3.6e-12	27	23	22	27	23	22
Lukšan-Vlček 5.13	5000	4998	3332		2.007e+04	5.0e-01	3.6e-12	27	23	22	27	23	22
Lukšan-Vlček 5.14	101	132	66		2.590e+02	1.0e-02	5.0e-15	15	16	15	15	16	15
Lukšan-Vlček 5.14	500	664	332		1.309e+03	3.5e-02	4.9e-09	14	15	14	14	15	14
Lukšan-Vlček 5.14	1001	1332	666		2.627e+03	7.9e-02	4.9e-09	14	15	14	14	15	14
Lukšan-Vlček 5.14	5000	6664	3332		1.315e+04	8.8e-01	4.9e-09	14	15	14	14	15	14
Lukšan-Vlček 5.15	101	100	75		3.872e-21	3.0e-02	2.9e-10	26	27	26	26	27	26
Lukšan-Vlček 5.15	501	500	375		3.902e-21	7.6e-02	2.9e-10	26	27	26	26	27	26
Lukšan-Vlček 5.15	1001	1000	750		3.902e-21	2.1e-01	2.9e-10	26	27	26	26	27	26
Lukšan-Vlček 5.15	5001	5000	3750		8.040e-20	1.7e+00	2.1e-09	27	27	26	27	27	26
Lukšan-Vlček 5.16	101	100	75		1.381e-30	1.9e-02	5.0e-15	9	10	9	9	10	9
Lukšan-Vlček 5.16	501	500	375		2.755e-30	3.8e-02	5.4e-15	9	10	9	9	10	9
Lukšan-Vlček 5.16	1001	1000	750		2.545e-30	3.6e-02	5.5e-15	9	10	9	9	10	9
Lukšan-Vlček 5.16	5001	5000	3750		2.237e-30	4.2e-01	5.8e-15	9	10	9	9	10	9
Lukšan-Vlček 5.17	101	100	75		7.144e+01	4.1e-02	3.2e-10	13	12	11	13	12	11
Lukšan-Vlček 5.17	501	500	375		3.572e+02	4.5e-02	3.2e-10	13	12	11	13	12	11
Lukšan-Vlček 5.17	1001	1000	750		7.144e+02	4.8e-02	3.2e-10	13	12	11	13	12	11
Lukšan-Vlček 5.17	5001	5000	3750		3.572e+03	5.3e-01	3.2e-10	13	12	11	13	12	11
Lukšan-Vlček 5.18	101	100	75		5.997e+01	1.2e-02	6.5e-13	10	11	10	10	11	10
Lukšan-Vlček 5.18	501	500	375		2.999e+02	7.3e-02	6.5e-13	10	11	10	10	11	10
Lukšan-Vlček 5.18	1001	1000	750		5.999e+02	6.1e-02	6.5e-13	10	11	10	10	11	10
Lukšan-Vlček 5.18	5001	5000	3750		2.999e+03	5.0e-01	6.5e-13	10	11	10	10	11	10
BNST2	100	100	99		1.388e-26	4.0e-03	8.5e-13	4	5	4	4	5	4
BNST2	500	500	499		2.342e-25	1.6e-02	6.7e-13	4	5	4	4	5	4
BNST2	1000	1000	999		3.988e-26	2.4e-02	3.0e-13	4	5	4	4	5	4
BNST2	5000	5000	4999		1.102e-28	1.7e-01	2.0e-14	4	5	4	4	5	4
BNST3	100	100	50		1.031e-30	3.0e-03	2.0e-15	4	5	4	4	5	4
BNST3	500	500	250		5.154e-30	9.0e-03	4.5e-15	4	5	4	4	5	4
BNST3	1000	1000	500		1.031e-29	1.7e-02	6.3e-15	4	5	4	4	5	4
BNST3	5000	5000	2500		5.154e-29	1.0e-01	1.4e-14	4	5	4	4	5	4
tp394	100	200	1		9.583e-01	6.7e-02	2.7e-13	74	30	29	74	30	29
tp394	500	1000	1		9.583e-01	1.1e-01	8.4e-12	44	26	25	44	26	25
tp394	1000	2000	1		9.583e-01	2.2e-01	1.6e-10	47	27	26	47	27	26
tp394	5000	10000	1		9.583e-01	1.2e+01	9.7e-15	400	89	86	400	89	86

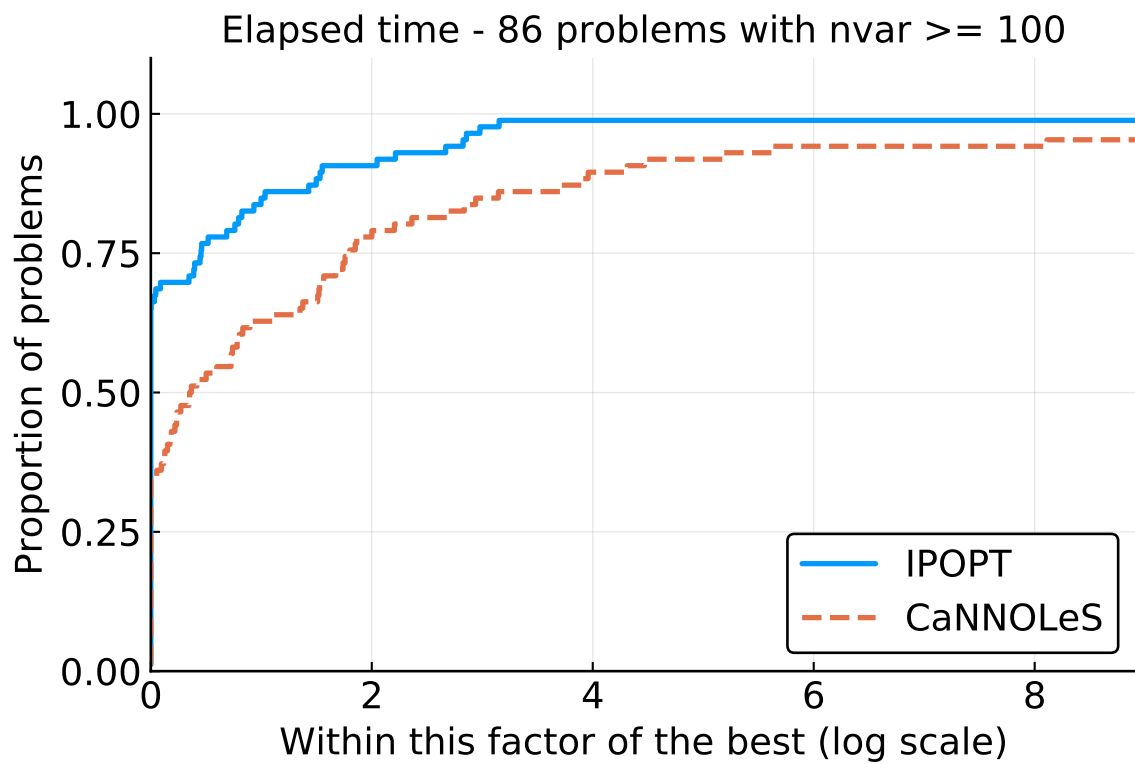
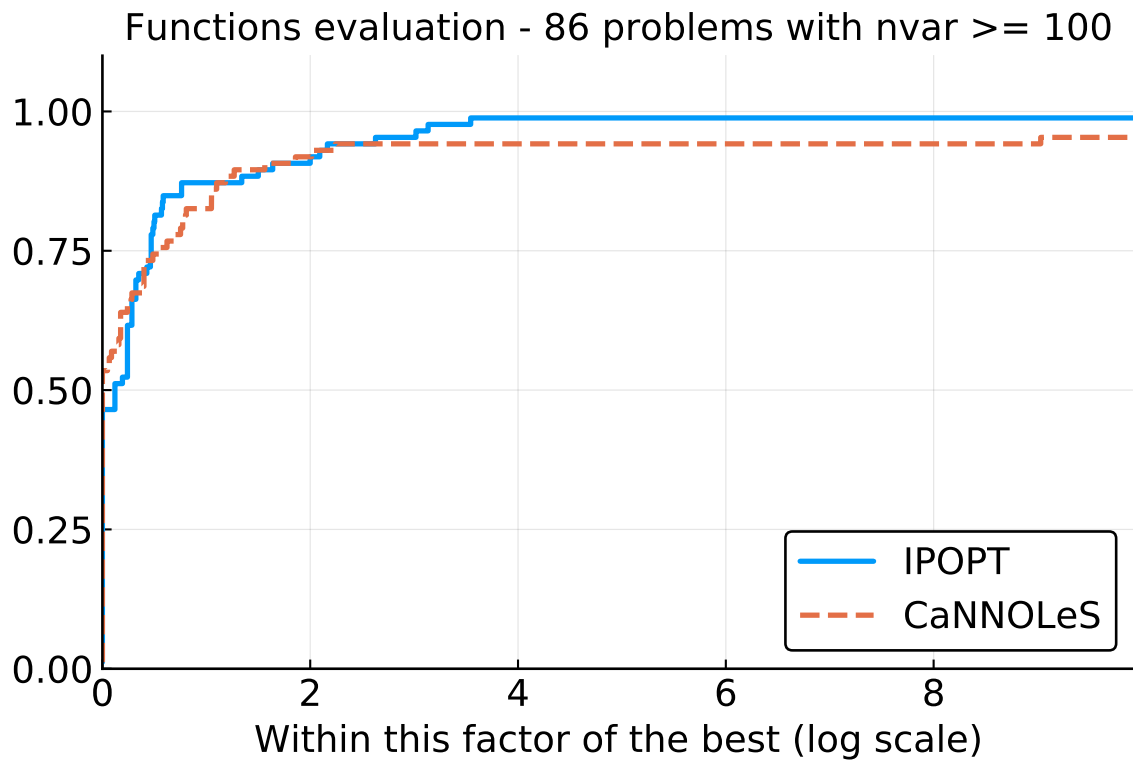
## 4 Performance profiles

Functions evaluation - All 278 problems

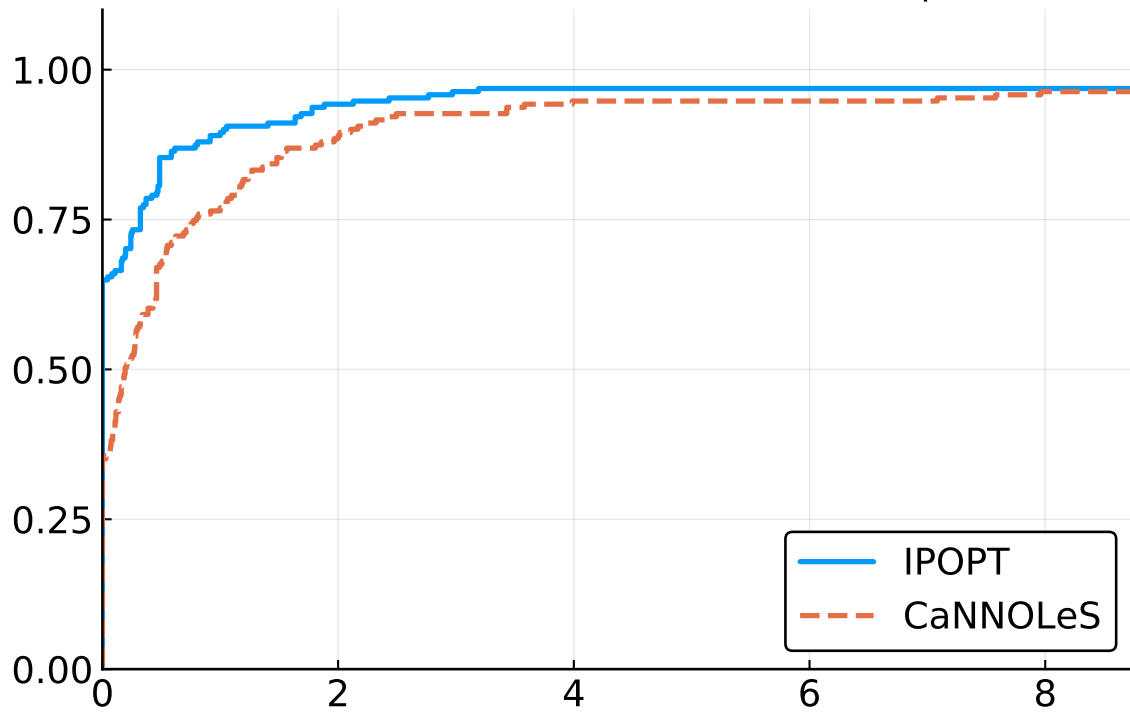


Elapsed time - All 278 problems





Functions evaluation - 191 unconstrained problems



Elapsed time - 191 unconstrained problems

