

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
3pk	21	1.72E+000	11	1.72E+000
aircrfta	7	0.00E+000	3	0.00E+000
aircrftb	10	6.23E-014	12	3.29E-027
airport	19	4.80E+004	16	4.80E+004
aljazzaf	25	7.50E+001	26	7.50E+001
allinit	12	1.67E+001	12	1.67E+001
allinitc	221	(IMP)	22	3.05E+001
allinitu	9	5.74E+000	14	5.74E+000
alsotame	10	8.21E-002	8	8.21E-002
argauss		(INF)		(ERROR)
arglina	2	1.00E+002	1	1.00E+002
arglinb	2	4.63E+000	2	4.63E+000
arglinc	2	6.14E+000	2	6.14E+000
argtrig	8	0.00E+000	3	0.00E+000
artif	203	0.00E+000		(INF)
arwhead	6	1.63E-011	6	-2.66E-015
aug2d	2	1.69E+006	1	1.69E+006
aug2dc	2	1.82E+006	1	1.82E+006
aug2dcqp	24	6.50E+006	28	6.50E+006
aug2dqp	23	6.24E+006	30	6.24E+006
aug3d	7	5.54E+002	2	5.54E+002
aug3dc	2	7.71E+002	1	7.71E+002
aug3dcqp	14	9.93E+002	21	9.93E+002
aug3dqp	14	6.75E+002	21	6.75E+002
avion2	78	9.47E+007	67	9.47E+007
bard	8	8.21E-003	8	8.21E-003
bdexp	13	2.41E-004	17	1.32E-006
bdqrtic	10	3.98E+003	9	3.98E+003
bdvalue	6	0.00E+000	1	0.00E+000
beale	8	1.28E-013	8	4.34E-018
bigbank	24	-4.21E+006	25	-4.21E+006
biggs3	9	7.24E-021	9	1.31E-026
biggs5	25	1.99E-014	20	1.08E-019
biggs6	36	1.84E-012	34	5.99E-021
biggsb1	22	1.50E-002	17	1.50E-002
biggs4	31	-2.45E+001	26	-2.45E+001
blockqp1	19	-9.96E+002	11	-9.97E+002
blockqp2	12	-9.95E+002	9	-9.96E+002
blockqp3	32	-4.97E+002	13	-4.98E+002
blockqp4	18	-4.98E+002	9	-4.98E+002
blockqp5	35	-4.97E+002	43	-4.98E+002
bloweya	13	-4.54E-002	10	-4.55E-002
bloweyb	13	-3.04E-002	8	-3.05E-002
bloweyc	16	-3.03E-002	12	-3.04E-002
booth	2	0.00E+000	1	0.00E+000
box2	9	8.68E-020	8	1.37E-027
box3	8	4.09E-011	9	1.69E-025
bqp1var	10	6.27E-009	6	-7.48E-009
bqpgabim	17	-3.79E-005	15	-3.79E-005
bqpgasim	17	-5.52E-005	15	-5.52E-005
bqpgauss	42	-3.63E-001	22	-3.63E-001

TABLE 1. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
brainpc0	2377	3.41E-001		(ERROR)
brainpc1	92	6.10E-004		(IL)
brainpc2	242	4.42E-004		(ERROR)
brainpc3	243	4.20E-004	78	3.81E-004
brainpc4		(IMP)	52	4.29E-004
brainpc5	66	3.90E-004	51	3.75E-004
brainpc6	346	(IMP)	68	3.93E-004
brainpc7	147	3.99E-004	139	3.57E-004
brainpc8	93	4.26E-004	55	3.93E-004
brainpc9	352	(IMP)		(ERROR)
bratu1d	6	-8.52E+000	4	-8.52E+000
bratu2d	6	0.00E+000	3	0.00E+000
bratu2dt	8	0.00E+000	10	0.00E+000*
bratu3d	6	0.00E+000	3	0.00E+000
bridgend	491	3.67E+004	49	3.67E+004
britgas	15	3.19E-008		(IL)
brkmcc	3	1.69E-001	3	1.69E-001
brownal	6	6.33E-008	7	1.50E-016
brownbs	7	2.47E-027	7	0.00E+000
brownden	8	8.58E+004	8	8.58E+004
broydn3d	7	0.00E+000	4	0.00E+000
broydn7d	48	3.64E+002	84	3.45E+002
broydnbd	8	0.00E+000	5	0.00E+000
brybnd	7	4.51E-007	8	1.22E-026
bt1	23	-1.00E+000	7	-1.00E+000
bt10	10	-1.00E+000	7	-1.00E+000
bt11	11	8.25E-001	8	8.25E-001
bt12	8	6.19E+000	4	6.19E+000
bt13	47	4.85E-026	24	-7.49E-009
bt2	18	3.26E-002	12	3.26E-002
bt3	2	4.09E+000	1	4.09E+000
bt4	11	-4.55E+001	9	-3.70E+000
bt5	9	9.62E+002	7	9.62E+002
bt6	13	2.77E-001	13	2.77E-001
bt7	19	3.60E+002	16	3.07E+002
bt8	14	1.00E+000	28	1.00E+000
bt9	11	-1.00E+000	13	-1.00E+000
byrdsphr	15	-4.68E+000	12	-4.68E+000
camel6	10	-1.03E+000	11	-1.03E+000
camshape	145	4.27E+000	57	-4.28E+000
cantilvr	16	1.34E+000	11	1.34E+000
catena	32	-2.31E+004	6	-2.31E+004
catenary	36	-3.48E+005	56	-3.48E+005
catmix	24	-4.81E-002	15	-4.81E-002
cb2	15	1.95E+000	9	1.95E+000
cb3	12	2.00E+000	9	2.00E+000
cbratu2d	6	0.00E+000	2	0.00E+000
cbratu3d	7	0.00E+000	2	0.00E+000
chaconn1	10	1.95E+000	7	1.95E+000
chaconn2	11	2.00E+000	6	2.00E+000
chain	1204	6.91E+000	7	5.07E+000

TABLE 2. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
chainwoo	72	4.79E+001	78	6.36E+001
chandheq	15	0.00E+000	14	0.00E+000
channel	20	1.00E+000	3	1.00E+000
chebyqad	180	1.03E-002	109	5.39E-003
chemrcta		(IMP)	7	0.00E+000
chemrctb		(IMP)	9	0.00E+000
chenhark	12	-2.00E+000	18	-2.00E+000
chnrosnb	44	6.87E-015	42	1.54E-022
cliff	28	2.00E-001	26	2.00E-001
clnlbeam	72	3.45E+002	205	3.45E+002
clplatea	6	-1.26E-002	6	-1.26E-002
clplateb	6	-6.99E+000	11	-6.99E+000
clplatec	2	-5.02E-003	2	-5.02E-003
cluster	10	0.00E+000	9	0.00E+000
concon	81	-6.23E+003	10	-6.23E+003
congigmz	28	2.80E+001	30	2.80E+001
cont6-qq	33	-4.28E+000	19	-4.28E+000
coolhans	234	9.99E-010	9	0.00E+000
core1	157	9.11E+001	84	9.11E+001
core2		(IMP)	145	7.29E+001
corkscrw	36	9.07E+001	271	9.07E+001
coshfun	56	-7.73E-001		(IL)
cosine	11	-1.00E+004	12	-1.00E+004
cragglvy	14	1.69E+003	14	1.69E+003
cresc100	293	5.70E-001		(ERROR)
cresc132	2069	6.85E-001		(ERROR)
cresc4	76	8.72E-001		(ERROR)
cresc50		(IL)		(ERROR)
csfi1	22	-4.91E+001	12	-4.91E+001
csfi2	105	5.50E+001	36	5.50E+001*
cube	27	4.04E-014	27	1.75E-024
curly10	14	-1.00E+006	22	-1.00E+006
curly20	16	-1.00E+006	26	-1.00E+006
curly30	12	-1.00E+006	30	-1.00E+006
cvxbqp1	19	2.25E+006	13	2.25E+006
cvxqp1	35	1.09E+006	19	1.09E+006
dallasl	51	-2.03E+005	249	-2.03E+005*
dallasm	36	-4.82E+004	294	-4.82E+004*
dallass	40	-3.24E+004	428	-3.24E+004
deconvb	64	2.57E-003		(IL)
deconvc	317	(IMP)	82	2.57E-003
deconvu	16	1.99E-006	220	3.09E-011
degenlpa	29	3.06E+000	29	3.05E+000
degenlpb	31	-3.07E+001	31	-3.08E+001
degenqp	13	6.80E-009	11	-2.75E-007
dembo7	143	1.75E+002	35	1.75E+002
demymalo	19	-3.00E+000	12	-3.00E+000
denschna	7	1.10E-023	6	1.10E-023
denschnb	28	3.13E-019	7	9.86E-032
denschnc	10	5.34E-011	10	2.18E-020
denschn d	30	1.69E-010	31	7.52E-007

TABLE 3. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
denschne	11	4.89E-025	14	1.86E-017
denschnf	6	2.31E-010	6	6.51E-022
dipigri	25	6.81E+002	11	6.81E+002
disc2	42	1.56E+000	42	1.56E+000
discs	91	1.53E+001	153	1.20E+001
dittert		(IMP)	23	-2.00E+000
dixchlng	34	2.47E+003	10	2.47E+003
dixchlnv	437	(IMP)	24	0.00E+000
dixmaana	6	1.00E+000	7	1.00E+000
dixmaanb	10	1.00E+000	11	1.00E+000
dixmaanb	9	1.00E+000	9	1.00E+000
dixmaand	10	1.00E+000	9	1.00E+000
dixmaane	12	1.00E+000	10	1.00E+000
dixmaanf	15	1.00E+000	19	1.00E+000
dixmaang	17	1.00E+000	16	1.00E+000
dixmaanb	16	1.00E+000	19	1.00E+000
dixmaani	16	1.00E+000	18	1.00E+000
dixmaanb	27	1.00E+000	20	1.00E+000
dixmaank	21	1.00E+000	24	1.00E+000
dixmaanl	21	1.00E+000	27	1.00E+000
dixon3dq	2	2.86E-018	1	0.00E+000
djtl	9	-8.85E+003	376	-8.95E+003
dnieper	27	1.87E+004	18	1.87E+004
dqdrtic	2	5.82E-019	1	7.91E-029
dqrtic	25	7.77E+000	30	4.72E-004
drugdis		(IMP)		(INF)
drugdise		(IMP)	145	4.04E+002
dtoc1l	7	1.25E+002	6	1.25E+002
dtoc1na	7	1.27E+001	6	1.27E+001
dtoc1nb	7	1.59E+001	6	1.59E+001
dtoc1nc	10	2.50E+001	15	2.50E+001
dtoc1nd	60	1.26E+001	27	1.28E+001
dtoc2	14	5.09E-001	10	5.09E-001
dtoc3	2	2.35E+002	1	2.35E+002
dtoc4	11	2.87E+000	3	2.87E+000
dtoc5	10	1.53E+000	4	1.54E+000
dtoc6	21	1.35E+005	11	1.35E+005
dual1	22	3.50E-002	16	3.50E-002
dual2	20	3.37E-002	14	3.37E-002
dual3	27	1.36E-001	15	1.36E-001
dual4	23	7.46E-001	14	7.46E-001
dualc1	26	6.16E+003	26	6.16E+003
dualc2	20	3.55E+003	19	3.55E+003
dualc5	12	4.27E+002	10	4.27E+002
dualc8	18	1.83E+004	15	1.83E+004
edensch	7	1.20E+004	7	1.20E+004
eg1	8	-1.43E+000	8	-1.43E+000
eg2	4	-9.99E+002	4	-9.99E+002
eg3	22	3.79E-012	24	9.28E-014
eigena2	12	3.53E-011	2	5.98E-030
eigenaco	17	1.68E-011	3	0.00E+000

TABLE 4. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
eigenb2	56	5.59E-002		(IMP)
eigenbco	50	1.09E-010		(IMP)
eigenc2	44	9.87E-010	19	1.10E-028
eigencco	16	1.89E-011		(IMP)
eigmaxa	60	-1.00E+000	23	-1.00E+000
eigmaxb	13	-4.12E-001	12	-9.67E-004
eigmaxc	93	-2.54E-001		(INF)
eigmina	51	1.00E+000	23	1.00E+000
eigminc	14	2.54E-001		(INF)
elattar	39	1.12E-009	66	-5.32E-009
elec	117	1.84E+004	345	1.84E+004
engval1	8	5.55E+003	8	5.55E+003
engval2	17	5.45E-014	21	1.70E-020
eqc	82	-9.11E+002	18	-9.11E+002
errinbar		(IMP)	43	2.87E+001
errinros	29	4.04E+001	28	4.04E+001
expfit	7	2.41E-001	8	2.41E-001
expfita	20	1.14E-003	29	1.14E-003
expfitb	24	5.02E-003	34	5.02E-003
expfitc	34	2.33E-002	125	2.33E-002
explin	22	-7.24E+005	21	-7.24E+005
explin2	22	-7.24E+005	19	-7.24E+005
expquad	50	-3.62E+006	27	-3.62E+006
extrasim	10	1.00E+000	6	1.00E+000
extrosnb	1	0.00E+000	0	0.00E+000
fccu	2	1.11E+001	1	1.11E+001
fletcbv2	2	-5.14E-001	2	-5.14E-001
fletcher	15	7.88E-009	37	5.20E-018
fletcher	15	1.95E+001	25	1.95E+001
flosp2hh	3	3.89E+001		(IL)
flosp2hl	3	3.89E+001	5	3.89E+001
flosp2hm	3	3.89E+001	5	3.89E+001
flosp2th	4	1.00E+001	38	1.00E+001*
flosp2tl	2	1.00E+001	5	1.00E+001
flosp2tm	2	1.00E+001	7	1.00E+001
fminsrf2		(IL)	25	1.00E+000
fminsurf		(IL)	40	1.00E+000
freuroth	8	6.08E+005	8	6.08E+005
gasoil	95	5.24E-003	20	5.24E-003
gausselm	1778	-1.80E+001	1021	-1.77E+001
genhs28	2	9.27E-001	1	9.27E-001
genhumps	101	3.29E-020	167	2.99E-035
genrose	741	1.00E+000	744	1.00E+000
gigomez1	16	-3.00E+000	15	-3.00E+000
gigomez2	12	1.95E+000	9	1.95E+000
gigomez3	12	2.00E+000	8	2.00E+000
gilbert	25	4.82E+002	19	4.82E+002
glider		(IL)	1035	-1.25E+003
gmncase1	14	2.67E-001	13	2.67E-001
gmncase2	12	-9.94E-001	12	-9.94E-001
gmncase3	13	1.53E+000	11	1.53E+000

TABLE 5. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
goffin	11	2.39E-007		(IMP)
gottfr	12	0.00E+000	5	0.00E+000
gouldqp2	29	1.88E-004	15	1.88E-004
gouldqp3	17	2.07E+000	15	2.07E+000
gpp	20	1.44E+004	23	1.44E+004
gridneta	26	3.05E+002	21	3.05E+002
gridnetb	2	1.43E+002	2	1.43E+002
gridnetc	28	1.62E+002	27	1.62E+002
gridnetd	28	5.66E+002	20	5.66E+002
gridnete	13	2.07E+002	6	2.07E+002
gridnetf	28	2.42E+002	27	2.42E+002
gridnetg	12	7.33E+001	11	7.33E+001
gridneth	10	3.96E+001	6	3.96E+001
gridneti	14	4.02E+001	13	4.02E+001
grouping	12	1.39E+001		(ERROR)
growth	65	1.00E+000	70	1.00E+000
growthls	68	1.00E+000	71	1.00E+000
gulf	20	2.15E-016	22	4.33E-028
hadamals	345	2.53E+001	133	2.53E+001
hadamard	9	1.00E+000	9	1.00E+000
hager1	9	8.81E-001	1	8.81E-001
hager2		(IMP)	1	4.32E-001
hager3		(IMP)	1	1.41E-001
hager4	824	2.79E+000	13	2.79E+000
haifam	27	-4.50E+001	64	-4.50E+001
haifas	19	-4.50E-001	8	-4.50E-001
hairy	39	2.00E+001	74	2.00E+001
haldmads	42	3.41E-002	84	3.33E-002
hanging	18	-6.20E+002	17	-6.20E+002
harkerp2	28	-5.00E-001	17	-4.97E-001
hart6	11	-3.32E+000	9	-3.32E+000
hatflda	8	1.62E-015	10	7.24E-016
hatfldb	11	5.57E-003	10	5.57E-003
hatfldc	7	2.11E-016	6	2.95E-018
hatfldd	20	6.62E-008	21	6.62E-008
hatflde	23	4.43E-007	26	4.43E-007
hatfldf	18	0.00E+000		(INF)
hatfldg	10	7.06E-003	7	0.00E+000
hatfldh	26	-2.45E+001	18	-2.45E+001
heart6	168	0.00E+000	45	0.00E+000
heart6ls	21	4.17E-001	885	3.70E-024
heart8	36	0.00E+000	14	0.00E+000
heart8ls	146	3.51E-012	106	4.11E-029
helix	12	2.32E-013	13	6.04E-025
helsby	86	3.19E+001	65	3.19E+001*
het-z	44	1.00E+000	13	1.00E+000
hilberta	2	1.17E-014	1	3.44E-020
hilbertb	2	1.99E-019	1	2.68E-029
himmelbb	8	1.42E-015	11	2.13E-021
himmelbc	8	0.00E+000	6	0.00E+000
himmelbd		(INF)		(INF)

TABLE 6. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
himmelbf	11	3.19E+002	10	3.19E+002
himmelbg	6	3.00E-017	6	3.63E-022
himmelbh	23	-1.00E+000	4	-1.00E+000
himmelbi	23	-1.75E+003	22	-1.75E+003
himmelbj	71	-1.91E+003		(ERROR)
himmelbk	21	5.18E-002	18	5.18E-002
himmelp1	13	-6.21E+001	11	-6.21E+001
himmelp2	18	-6.21E+001	18	-8.20E+000
himmelp3	16	-5.90E+001	13	-5.90E+001
himmelp4	33	-5.90E+001	24	-5.90E+001
himmelp5	41	-5.90E+001	56	-5.90E+001
himmelp6	26	-5.90E+001	8	-5.90E+001
hong	19	1.35E+000	12	1.35E+000
hs001	31	7.67E-019	25	5.89E-016
hs002	29	4.94E+000	12	4.94E+000
hs003	11	2.45E-009	5	-7.49E-009
hs004	8	2.67E+000	6	2.67E+000
hs005	10	-1.91E+000	8	-1.91E+000
hs006	8	3.57E-016	5	0.00E+000
hs007	14	-1.73E+000	27	-1.73E+000
hs008	8	-1.00E+000	5	-1.00E+000
hs009	6	-4.64E-001	3	-5.00E-001
hs010	14	-1.00E+000	12	-1.00E+000
hs011	12	-8.50E+000	9	-8.50E+000
hs012	16	-3.00E+001	9	-3.00E+001
hs013	251	(IMP)	55	9.95E-001
hs014	10	1.39E+000	8	1.39E+000
hs015	18	3.07E+002	17	3.06E+002
hs016	12	2.50E-001	19	2.50E-001
hs017	13	1.00E+000	17	1.00E+000
hs018	14	5.00E+000	17	5.00E+000
hs019	18	-6.96E+003	16	-6.96E+003
hs020	14	3.82E+001	7	4.02E+001
hs021	13	-1.00E+002	8	-1.00E+002
hs022	9	1.00E+000	6	1.00E+000
hs023	15	2.00E+000	10	2.00E+000
hs024	13	-1.00E+000	10	-1.00E+000
hs025	1	3.28E+001	36	8.53E-016
hs026	17	1.77E-010	25	1.29E-016
hs027	28	4.00E-002	56	4.00E-002
hs028	2	1.99E-019	1	1.20E-030
hs029	18	-2.26E+001	9	-2.26E+001
hs030	8	1.00E+000	18	1.00E+000
hs031	15	6.00E+000	8	6.00E+000
hs032	21	1.00E+000	16	1.00E+000
hs033	29	2.00E+000	11	-4.59E+000
hs034	15	-8.34E-001	9	-8.34E-001
hs035	10	1.11E-001	7	1.11E-001
hs036	16	-3.30E+003	13	-3.30E+003
hs037	11	-3.46E+003	13	-3.46E+003
hs038	39	1.83E-019	40	2.76E-019

TABLE 7. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
hs039	1	-1.00E+000	0	-1.00E+000
hs040	11	-2.50E-001	3	-2.50E-001
hs041	9	1.93E+000	9	1.93E+000
hs042	9	1.39E+001	6	1.39E+001
hs043	16	-4.40E+001	9	-4.40E+001
hs044	16	-1.50E+001	18	-1.30E+001
hs045	1	2.00E+000	14	1.00E+000
hs046	17	3.63E-010	19	8.55E-016
hs047	21	4.33E-011	19	6.58E-014
hs048	2	2.32E-028	1	1.97E-031
hs049	17	6.70E-009	19	1.06E-011
hs050	15	4.00E-014	9	0.00E+000
hs051	2	5.35E-017	1	4.93E-032
hs052	2	5.33E+000	1	5.33E+000
hs053	9	4.09E+000	7	4.09E+000
hs054	11	1.93E-001	7	1.93E-001
hs055	10	6.33E+000	7	6.67E+000
hs056	10	-3.46E+000	39	-3.46E+000
hs057	15	2.85E-002	23	3.06E-002
hs059	19	-7.80E+000	43	-7.80E+000
hs060	10	3.26E-002	7	3.26E-002
hs061	11	-1.44E+002	10	-1.44E+002
hs062	13	-2.63E+004	8	-2.63E+004
hs063	9	9.62E+002	8	9.62E+002
hs064	27	6.30E+003	17	6.30E+003
hs065	18	9.54E-001	27	9.54E-001
hs066	14	5.18E-001	7	5.18E-001
hs067		(IMP)	12	-1.16E+003
hs070	24	9.40E-003	20	9.40E-003
hs071	12	1.70E+001	8	1.70E+001
hs072	42	7.28E+002	16	7.28E+002
hs073	18	2.99E+001	8	2.99E+001
hs074	16	5.13E+003	10	5.13E+003
hs075	17	5.17E+003	11	5.17E+003
hs076	11	-4.68E+000	7	-4.68E+000
hs077	11	2.42E-001	11	2.42E-001
hs078	8	-2.92E+000	4	-2.92E+000
hs079	7	7.88E-002	4	7.88E-002
hs080	9	5.39E-002	7	5.39E-002
hs083	14	-3.07E+004	15	-3.07E+004
hs084	132	-5.28E+006	19	-5.28E+006
hs085	29	-1.91E+000	22	-1.91E+000
hs086	14	-3.23E+001	10	-3.23E+001
hs087	27	8.83E+003	17	8.83E+003
hs088	25	1.36E+000	16	1.36E+000
hs089	41	1.36E+000	20	1.36E+000
hs090	68	1.36E+000	21	1.36E+000
hs091	26	1.36E+000	14	1.36E+000
hs092	25	1.36E+000	19	1.36E+000
hs093	12	1.35E+002	9	1.35E+002
hs095	15	1.56E-002	21	1.56E-002

TABLE 8. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
hs096	18	1.56E-002	20	1.56E-002
hs097	17	4.07E+000	19	4.07E+000
hs098	44	3.14E+000	17	4.07E+000
hs099	23	-8.31E+008	7	-8.31E+008
hs100	25	6.81E+002	11	6.81E+002
hs100lnp	22	6.81E+002	20	6.81E+002
hs100mod	23	6.79E+002	10	6.79E+002
hs101	38	1.81E+003	44	1.81E+003
hs102	55	9.12E+002	22	9.12E+002
hs103	72	5.44E+002	27	5.44E+002
hs104	13	3.95E+000	9	3.95E+000
hs105	19	1.14E+003	20	1.14E+003
hs106	24	7.05E+003	17	7.05E+003
hs107	13	5.06E+003	10	5.06E+003
hs108	16	-6.75E-001	16	-6.75E-001
hs109	24	5.33E+003	21	5.33E+003
hs110	8	-4.58E+001	6	-4.58E+001
hs111	20	-4.78E+001	15	-4.78E+001
hs111lnp	25	-4.78E+001	15	-4.78E+001
hs112	16	-4.78E+001	18	-4.78E+001
hs113	20	2.43E+001	11	2.43E+001
hs114	25	-1.77E+003	19	-1.77E+003
hs116	52	9.76E+001	24	9.76E+001
hs117	20	3.23E+001	22	3.23E+001
hs118	16	6.65E+002	11	6.65E+002
hs119	22	2.45E+002	14	2.45E+002
hs21mod	20	-9.60E+001	16	-9.60E+001
hs268	15	2.97E-008	16	6.36E-007
hs35i	10	1.11E-001	7	1.11E-001
hs35mod	15	2.50E-001	15	2.50E-001
hs3mod	7	1.56E-008	6	-7.49E-009
hs44new	20	-1.50E+001	13	-1.50E+001
hs76i	11	-4.68E+000	7	-4.68E+000
hs99exp	260	-1.01E+009	23	-1.01E+009
hubfit	10	1.69E-002	8	1.69E-002
hues-mod	216	3.48E+007	30	3.48E+007
huestis	1009	3.48E+011	28	3.48E+011
humps	144	2.08E-012	493	8.03E-032
hvyrcrash	128	(IMP)	143	-1.44E-001
hydc20ls	17	3.68E+001		(IL)
hydcar20		(IL)		(ERROR)
hydcar6		(IMP)		(ERROR)
hydroell	66	-3.59E+006	235	-3.59E+006
hydroelm	42	-3.58E+006	209	-3.58E+006
hydroels	34	-3.58E+006	120	-3.58E+006
hypcir	7	0.00E+000	5	0.00E+000
integreq	6	0.00E+000	3	0.00E+000
jannson3	10	2.00E+004	17	2.00E+004
jannson4	10	2.00E+004	17	2.00E+004
jensmp	9	1.24E+002	9	1.24E+002
jnlbrng1	14	-1.80E-001	15	-1.81E-001

TABLE 9. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
jnlbrng2	14	-4.15E+000	15	-4.15E+000
jnlbrnga	14	-2.68E-001	16	-2.68E-001
jnlbrngb	16	-6.28E+000	15	-6.28E+000
junktur	37	6.96E-009	31	2.33E-022
kissing	27	1.00E+000	83	1.00E+000
kissing2	100	3.86E+000	146	4.48E+000
kiwcresc	109	-3.20E-014	9	-4.99E-009
kowosb	8	3.08E-004	8	3.08E-004
ksip	47	5.76E-001	26	5.76E-001
lakes	373	3.51E+005	15	3.51E+005
launch		(IMP)		(INF)
lch	29	-4.32E+000	22	-4.29E+000
leaknet	48	8.00E+000		(IL)
lewispol		(INF)		(ERROR)
lhaifam		(IMP)		(ERROR)
liarwhd	12	1.24E-009	12	8.20E-022
lin	7	-1.76E-002	6	-1.76E-002
linspanh	10	-7.70E+001	15	-7.70E+001
liswet1		(IL)	35	2.71E+001
liswet10	10	2.50E+001	43	3.93E+001
liswet11	10	2.50E+001	36	4.65E+001
liswet12		(IMP)	29	-3.38E+003
liswet2	10	2.50E+001	30	2.50E+001
liswet3	10	2.50E+001	36	2.50E+001
liswet4	10	2.50E+001	37	2.50E+001
liswet5	10	2.50E+001	37	2.50E+001
liswet6	10	2.50E+001	34	2.50E+001
liswet7	10	2.50E+001	21	3.91E+002
liswet8	10	2.50E+001	26	6.51E+002
liswet9		(IMP)	28	1.90E+003
loadbal	21	4.53E-001	15	4.53E-001
loghairy	514	1.82E-001		(IL)
logros	1	0.00E+000	65	0.00E+000
lootsma	28	8.00E+000	11	1.41E+000
lotschd	15	2.40E+003	14	2.40E+003
lsnnodoc	17	1.23E+002	11	1.23E+002
lsqfit	9	3.38E-002	7	3.38E-002
lubrif		(IMP)		(INF)
lubrifc		(IMP)		(INF)
lukvle1	21	6.23E+000	6	6.23E+000
lukvle10	56	1.77E+004	13	1.77E+004
lukvle11	9	2.48E-010	8	4.42E-024
lukvle12	16	7.72E+004	7	7.72E+004
lukvle13	13	4.02E+005	23	4.02E+005
lukvle14	25	3.80E+005	21	3.80E+005
lukvle15	49	3.61E-013	53	5.77E-021
lukvle16	13	2.00E-007	7	2.08E-029
lukvle17	14	7.14E+004	8	7.14E+004
lukvle18	12	6.00E+004	13	6.00E+004
lukvle2	22	1.41E+006	17	1.41E+006
lukvle3	15	6.51E+001	9	6.51E+001

TABLE 10. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
lukvle4	22	2.43E+005	16	2.43E+005
lukvle5	25	9.96E-012	29	1.52E-015
lukvle6	34	3.14E+006	15	3.14E+006
lukvle7	26	-6.61E+004	17	-6.61E+004
lukvle8	121	5.02E+006	13	4.13E+006
lukvle9	15	4.99E+003	21	4.99E+003
lukvli1		(IL)		(IL)
lukvli10		(IL)	92	1.77E+004
lukvli11	14	4.42E-004	41	2.08E-005
lukvli12	20	4.13E-007	28	5.25E-009
lukvli13	14	9.17E-005	23	1.04E-005
lukvli14	32	3.80E+005	25	3.80E+005
lukvli15	34	5.87E+000	327	6.39E+000
lukvli16	20	2.81E-004	24	4.70E-005
lukvli17	27	1.62E-003	75	1.55E+000
lukvli18	26	3.22E-004	19	4.66E-005
lukvli2	16	1.33E+006	16	1.33E+006
lukvli3	12	1.16E+001	10	1.16E+001
lukvli4	22	2.01E+004	26	2.01E+004
lukvli5		(IL)	44	5.27E-001
lukvli6	59	3.14E+006	13	3.14E+006
lukvli7	17	-1.86E+004	22	-1.86E+004
lukvli8	59	5.02E+006	57	5.02E+006
lukvli9	110	4.99E+003	39	4.99E+003
madsen	22	6.16E-001	20	6.16E-001
madsschj	28	-7.97E+002	81	-7.97E+002
makela1	12	-1.41E+000	18	-1.41E+000
makela2	19	7.20E+000	8	7.20E+000
makela3	15	1.39E-007	16	4.01E-008
makela4	10	1.25E-006	8	9.02E-008
mancino	4	1.22E-004	4	7.55E-019
maratos	9	-1.00E+000	4	-1.00E+000
maratosb	10	-1.00E+000	32	-1.00E+000
marine	33	1.97E+007	12	1.97E+007
matrix2	18	5.37E-009	20	5.11E-009
maxlika	19	1.14E+003	20	1.14E+003
mccormck	9	-4.57E+004	8	-4.57E+004
mconcon	81	-6.23E+003	10	-6.23E+003
mdhole	12	3.40E-010	43	4.28E-008
mesh		(IL)		(IL)
methanb8	21	3.31E-007	8	2.44E-026
methanl8	75	4.72E-006	40	5.70E-017
methanol		(IL)	15	9.02E-003
mexhat	4	-4.01E-002	4	-4.01E-002
meyer3	6	5.37E+004	189	8.79E+001*
mifflin1	13	-1.00E+000	6	-1.00E+000
mifflin2	17	-1.00E+000	15	-1.00E+000
minc44		(IMP)	15	2.57E-003
minmaxbd	54	1.16E+002	72	1.16E+002
minmaxrb	12	8.99E-010	10	2.36E-011
minperm	38	3.63E-004	7	3.63E-004

TABLE 11. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
minsurf	5	1.00E+000	4	1.00E+000
minsurfo	16	2.51E+000	49	2.51E+000
mistake	13	-1.00E+000	14	-1.00E+000
model	13	5.74E+003	12	5.74E+003
morebv	1	1.04E-011	1	5.82E-015
mosarqp1	14	-9.53E+002	15	-9.53E+002
mosarqp2	18	-1.60E+003	14	-1.60E+003
nrribasis	37	1.82E+001	57	1.82E+001
msqrta	13	0.00E+000	5	0.00E+000
msqrtals	22	9.58E-005	24	4.22E-016
msqrtb	12	0.00E+000	5	0.00E+000
msqrtbls	18	2.03E-004	28	8.03E-019
mss1		(IL)		(IL)
mss2		(IMP)	298	-1.18E+002
mwright	13	2.50E+001	10	2.50E+001
nasty	2	5.00E-021	1	0.00E+000
ncb20	6	1.67E+003	6	1.67E+003
ncb20b	8	1.72E+003	8	1.72E+003
ncvxbqp1	671	-1.99E+010	144	-1.99E+010
ncvxbqp2	441	-1.33E+010	455	-1.33E+010
ncvxbqp3	320	-6.52E+009	741	-6.44E+009
ncvxqp1	422	-7.16E+007	188	-7.15E+007
ncvxqp2	208	-5.78E+007	239	-5.78E+007
ncvxqp3	151	-3.12E+007	290	-3.05E+007
ncvxqp4	398	-9.40E+007	193	-9.40E+007
ncvxqp5	211	-6.63E+007	229	-6.63E+007
ncvxqp6	131	-3.52E+007	301	-3.41E+007
ncvxqp7	459	-4.35E+007	178	-4.34E+007
ncvxqp8	190	-3.05E+007	209	-3.04E+007
ncvxqp9	117	-2.16E+007	207	-2.15E+007
net1	67	9.41E+005	35	9.41E+005
net2	65	9.92E+005	59	9.92E+005
net3	196	5.86E+006	157	5.86E+006
ngone	282	-6.43E-001	46	-6.37E-001
nlmsurf	42	3.91E+001	49	3.91E+001
nobndtor	29	-4.41E-001	15	-4.41E-001
noncvxu2	287	2.32E+003	402	2.32E+003
noncvxun	55	2.32E+003	32	2.32E+003
nondia	3	3.30E-004	4	2.60E-013
nondquar	22	1.62E-011	19	4.14E-010
nonmsqrt	279	7.52E-001		(IL)
nonscomp	28	3.47E-007	23	5.41E-006
nuffield		(IL)		(ERROR)
nuffield_continuum	9	2.55E+000	6	-2.55E+000
nuffield2		(IL)	241	-5.20E+000*
nuffield2_trap	59	5.20E+000	48	-5.20E+000
nystrom5		(IMP)		(ERROR)
obstclae	39	1.90E+000	18	1.90E+000
obstclal	24	1.40E+000	15	1.40E+000
obstclbl	13	2.88E+000	12	2.88E+000
obstclbm	26	7.28E+000	17	7.28E+000

TABLE 12. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
obstclbu	14	2.88E+000	12	2.88E+000
odfits	14	-2.38E+003	11	-2.38E+003
oet1	13	5.38E-001	27	5.38E-001
oet2	49	8.72E-002	79	8.72E-002
oet3	13	4.51E-003	16	4.51E-003
oet4	41	4.30E-003	59	4.30E-003
oet5	62	2.65E-003	55	2.65E-003
oet6	114	2.07E-003	147	2.07E-003
oet7	152	4.48E-005	133	4.45E-005
optcdeg2	67	2.30E+002	29	2.30E+002
optcdeg3	42	4.61E+001	25	4.61E+001
optcntrl	42	5.50E+002	42	5.50E+002
optctrl3	33	2.05E+003	30	2.05E+003
optctrl6	33	2.05E+003	30	2.05E+003
optmass	20	-1.90E-001	22	-1.90E-001
optprloc	21	-1.64E+001	20	-1.64E+001
orthrdm2	12	1.56E+002	6	1.56E+002
orthrds2	82	3.05E+001		(ERROR)
orthrega	56	1.41E+003	63	1.41E+003
orthregb	14	2.30E-002	2	4.52E-020
orthregc	33	1.90E+002	14	1.90E+002
orthregd	11	1.52E+003	6	1.52E+003
orthrege	16	7.85E-001	49	1.52E+000
orthregf	79	7.95E+001	71	7.10E+001
orthrgdm	15	1.51E+003	6	1.51E+003
orthrgds	98	1.63E+003	16	1.52E+003
osbornea	22	5.46E-005	64	5.46E-005
osborneb	14	4.01E-002	19	4.01E-002
oslbqp	21	6.25E+000	14	6.25E+000
palmer1	15	1.18E+004	698	1.18E+004
palmer1a	62	8.59E+003	38	8.99E-002
palmer1b	34	1.44E+004	20	3.45E+000
palmer1c	2	9.76E-002	1	9.76E-002
palmer1d	2	6.53E-001	1	6.53E-001
palmer1e	107	1.14E-001	68	8.35E-004
palmer2	12	3.65E+003	32	3.65E+003
palmer2a	93	5.03E+003	111	1.72E-002
palmer2b	160	1.38E+003	19	6.23E-001
palmer2c	2	1.44E-002	1	1.44E-002
palmer2e	13	3.68E-002	25	2.15E-004
palmer3	71	2.27E+003	215	2.27E+003
palmer3a	256	2.04E-002	87	2.04E-002
palmer3b	19	4.23E+000	14	4.23E+000
palmer3c	2	1.95E-002	1	1.95E-002
palmer3e	4	3.17E-002	63	5.07E-005
palmer4	18	2.29E+003	180	2.29E+003
palmer4a	61	2.53E+003	60	4.06E-002
palmer4b	21	6.84E+000	15	6.84E+000
palmer4c	2	5.03E-002	1	5.03E-002
palmer4e	13	6.56E-002	23	1.48E-004
palmer5a	855	2.13E+000		(IL)

TABLE 13. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
palmer5b	94	9.75E-003	9	2.86E-002
palmer5c	2	2.13E+000	1	2.13E+000
palmer5d	2	8.73E+001	1	8.73E+001
palmer5e		(IL)		(IL)
palmer6a	105	5.59E-002	119	5.59E-002
palmer6c	2	1.64E-002	1	1.64E-002
palmer6e	190	2.24E-004	30	2.24E-004
palmer7a	145	2.49E+001		(IL)
palmer7c	2	6.02E-001	1	6.02E-001
palmer7e	484	1.01E+001		(IL)
palmer8a	71	7.40E-002	43	7.40E-002
palmer8c	2	1.60E-001	1	1.60E-001
palmer8e	22	6.34E-003	17	6.34E-003
penalty1	40	9.69E-003	31	9.70E-003
penalty2	19	9.71E+004	18	9.71E+004
penalty3	11	1.00E-003	15	1.00E-003
pentagon	29	1.37E-004	16	1.37E-004
pentdi	16	-7.50E-001	15	-7.50E-001
pfit1	46	1.01E-004	263	2.44E-022
pfit1ls	46	1.01E-004	263	2.44E-022
pfit2	14	1.25E-004	81	6.37E-026
pfit2ls	14	1.25E-004	81	6.37E-026
pfit3	15	1.68E-003	132	5.50E-025
pfit3ls	15	1.68E-003	132	5.50E-025
pfit4	18	6.76E-003	215	7.42E-022
pfit4ls	18	6.76E-003	215	7.42E-022
pinene	43	1.99E+001	15	1.99E+001
polak1	11	2.72E+000	7	2.72E+000
polak2	12	5.46E+001	19	5.46E+001
polak3	33	5.93E+000		(ERROR)
polak4	10	-7.02E-009	18	-5.89E-009
polak5	48	5.00E+001	31	5.00E+001
polak6	20	-4.40E+001		(ERROR)
polygon	70	7.79E-001	35	-7.20E-001
porous1	18	0.00E+000	13	0.00E+000
porous2	14	0.00E+000	8	0.00E+000
portf1	17	2.05E-002	10	2.05E-002
portf2	18	2.97E-002	9	2.97E-002
portf3	18	3.27E-002	10	3.27E-002
portf4	17	2.63E-002	10	2.63E-002
portf6	16	2.58E-002	9	2.58E-002
portsnqp	39	3.32E+002	30	3.32E+002
portsqp	13	3.31E+002	20	3.31E+002
powell20	352	5.21E+007	146	5.21E+007
powellbs	30	0.00E+000	11	0.00E+000
powellsg	18	1.71E-010	19	6.67E-012
powellsq		(INF)		(INF)
power	2	4.11E-021	1	2.84E-024
primal1	27	-3.50E-002	19	-3.50E-002
primal2	19	-3.37E-002	17	-3.37E-002
primal3	33	-1.36E-001	15	-1.36E-001

TABLE 14. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
primal4	18	-7.46E-001	15	-7.46E-001
primalc1	32	-6.16E+003	19	-6.16E+003
primalc2	69	-3.55E+003	20	-3.55E+003
primalc5	39	-4.27E+002	15	-4.27E+002
primalc8	63	-1.83E+004	29	-1.83E+004
probpen1	29	-3.49E-005	6	3.98E-007
prodpl0	18	6.09E+001	15	6.09E+001
prodpl1	18	5.30E+001	16	5.30E+001
pspdoc	8	2.41E+000	7	2.41E+000
pt	13	1.78E-001	20	1.78E-001
qc	46	-9.65E+002	32	-9.65E+002
qcnew	42	-9.00E+002	17	-9.00E+002
qpcblend	33	-7.84E-003	23	-7.84E-003
qpcboei1	64	1.44E+007	129	1.44E+007
qpcboei2	102	8.29E+006	95	8.29E+006
qpcstair	190	6.20E+006	233	6.20E+006
qpnblend	32	-9.14E-003	23	-9.14E-003
qpnboei1	1971	8.51E+006	511	8.46E+006
qpnboei2	168	1.27E+006	163	1.28E+006
qpnstair	302	5.15E+006	285	5.15E+006
qr3d	117	2.19E-017	49	1.05E-016
qr3dbd	179	3.40E-016	26	1.05E-016
qr3dls	212	2.11E-016	49	1.05E-016
qrtquad	25	-3.65E+006	23	-3.65E+006
quartc	24	1.26E+003	32	6.03E-004
qudlin	23	-7.20E+003	25	-7.20E+003
raybendl	1	9.80E+001		(IL)
reading1	1184	-1.60E-001	22	-1.60E-001
reading2	22	-1.26E-002	16	-1.26E-002
reading3		(IMP)	18	-1.53E-001
reading4		(IL)		(IL)
reading5	36	1.49E-015	8	0.00E+000
reading6	24	-1.45E+002	20	-1.45E+002
reading7	675	-1.41E+003	458	-1.31E+003
reading9	85	-4.44E-002	96	-4.44E-002*
res	11	0.00E+000	10	0.00E+000
rk23	95	1.48E+000	9	8.33E-002
robot	17	6.59E+000	8	1.34E+001
robotarm	226	9.14E+000	36	9.14E+000
rocket	27	1.01E+000	36	-1.01E+000
rosenbr	21	8.52E-012	21	3.74E-021
rosenmmx	16	-4.40E+001	19	-4.40E+001
rotdisc	72	7.87E+000	72	7.87E+000
s201	2	2.81E-020	1	0.00E+000
s202	7	4.90E+001	7	4.90E+001
s203	7	2.36E-014	4	1.74E-018
s204	5	1.84E-001	5	1.84E-001
s205	12	1.17E-016	11	2.15E-021
s206	4	7.73E-012	4	3.08E-029
s207	7	1.18E-012	7	1.40E-024
s208	21	8.52E-012	21	3.74E-021

TABLE 15. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
s209	79	1.58E-009	80	1.10E-022
s210	2	4.84E+000	346	1.03E-015
s211	27	4.04E-014	27	1.75E-024
s212	9	1.94E-017	11	5.24E-023
s213	30	1.10E-009	24	5.25E-007
s215	13	2.02E-009	14	-8.64E-009
s216	12	9.99E-001	6	9.99E-001
s217	17	-8.00E-001	9	-8.00E-001
s218	16	1.27E-007	16	-8.18E-009
s219	15	-1.00E+000	55	-1.00E+000
s220	74	1.00E+000	3	1.00E+000
s221	166	(IMP)	44	-1.00E+000
s222	10	-1.50E+000	6	-1.50E+000
s223	11	-8.34E-001	9	-8.34E-001
s224	11	-3.04E+002	9	-3.04E+002
s225	12	2.00E+000	10	2.00E+000
s226	9	-5.00E-001	8	-5.00E-001
s227	10	1.00E+000	7	1.00E+000
s228	18	-3.00E+000	10	-3.00E+000
s229	25	1.66E-019	22	2.99E-017
s230	10	3.75E-001	10	3.75E-001
s231	26	7.87E-011	27	1.39E-017
s232	12	-1.00E+000	14	-1.00E+000
s233	18	2.31E-010	11	8.35E-017
s234	17	-8.00E-001	17	-8.00E-001
s235	20	4.00E-002	13	4.00E-002
s236	19	-5.89E+001	15	-8.20E+000
s237	40	-5.89E+001	26	-5.89E+001
s238	73	-8.20E+000	35	-5.89E+001
s239	15	-5.89E+001	14	-8.20E+000
s240	2	1.27E-017	1	1.83E-027
s241	13	3.35E-012	11	1.14E-016
s242	24	4.58E-009	21	7.74E-010
s243	5	7.97E-001	5	7.97E-001
s244	21	6.73E-011	16	4.22E-009
s245	13	5.36E-014	16	3.28E-021
s246	10	5.95E-012	10	1.04E-021
s247	11	2.13E-018	8	1.31E-019
s248	15	-8.00E-001	13	-8.00E-001
s249	23	1.00E+000	7	1.00E+000
s250	16	-3.30E+003	13	-3.30E+003
s251	11	-3.46E+003	13	-3.46E+003
s252	20	4.00E-002	22	4.00E-002
s253	12	6.93E+001	18	6.93E+001
s255		(IL)		(ERROR)
s256	18	1.71E-010	19	6.67E-012
s257	9	1.28E-018	10	8.37E-016
s258	38	4.67E-011	40	4.84E-027
s259	12	-8.54E+000	12	-8.54E+000
s260	38	4.52E-011	40	4.93E-027
s261	14	3.06E-009	17	6.24E-012

TABLE 16. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
s262	12	-1.00E+001	9	-1.00E+001
s263	19	-1.00E+000	21	-1.00E+000
s264	16	-4.41E+001	10	-4.41E+001
s265	12	1.90E+000	6	1.90E+000
s266	8	1.00E+000	8	1.00E+000
s267	23	1.86E-012	33	1.42E-018
s268	15	2.98E-008	16	6.36E-007
s269	2	4.09E+000	1	4.09E+000
s270	11	5.56E-009	16	1.98E-009
s271	2	1.22E-022	1	0.00E+000
s272	107	2.43E-001	75	3.11E-015
s272a	46	1.17E-012	64	6.28E-026
s273	11	7.01E-018	10	7.01E-018
s274	2	4.00E-020	1	0.00E+000
s275	2	4.00E-020	1	1.29E-029
s276	2	4.02E-020	1	7.96E-025
s277	11	5.08E+000	10	5.08E+000
s278	11	7.84E+000	12	7.84E+000
s279	11	1.06E+001	11	1.06E+001
s280	11	1.34E+001	13	1.34E+001
s281	23	9.77E-004		(IMP)
s281a	2	2.99E-021	1	0.00E+000
s282	60	5.67E-009	61	3.76E-027
s283	36	1.23E-010	31	2.61E-008
s284	25	-1.84E+003	26	-1.84E+003
s285	17	-8.25E+003	12	-8.25E+003
s286	21	8.52E-011	21	3.74E-020
s287	38	1.84E-010	40	2.42E-026
s288	18	8.54E-010	19	3.33E-011
s289	4	0.00E+000	8	0.00E+000
s290	2	3.75E-021	1	0.00E+000
s291	2	7.32E-021	1	0.00E+000
s292	2	9.99E-021	1	0.00E+000
s293	2	1.12E-020	1	0.00E+000
s294	20	3.97E+000	19	3.97E+000
s295	25	3.99E+000	27	3.99E+000
s296	34	3.99E+000	35	3.99E+000
s297	59	1.20E-008	60	4.59E-027
s298	89	9.47E-012	89	2.28E-021
s299	163	8.52E-015	162	6.84E-021
s300	2	-2.00E+001	1	-2.00E+001
s301	2	-5.00E+001	1	-5.00E+001
s302	2	-1.00E+002	1	-1.00E+002
s303	12	1.12E-032	11	1.12E-032
s304	16	1.62E-020	15	1.62E-020
s305	20	1.24E-038	18	9.16E-014
s307	14	1.24E+002	10	1.24E+002
s308	10	7.73E-001	9	7.73E-001
s309	7	2.89E-001	7	2.89E-001
s311	6	1.96E-013	6	5.80E-025
s312	18	5.92E+000	19	5.92E+000

TABLE 17. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
s314	3	1.69E-001	3	1.69E-001
s315	18	-8.00E-001	13	-8.00E-001
s316	15	3.34E+002	7	3.34E+002
s317	15	3.72E+002	10	3.72E+002
s318	16	4.13E+002	10	4.13E+002
s319	17	4.52E+002	11	4.52E+002
s320	18	4.86E+002	15	4.86E+002
s321	16	4.96E+002	18	4.96E+002
s322	17	5.00E+002	30	5.00E+002
s323	11	3.80E+000	7	3.80E+000
s324	17	5.00E+000	17	5.00E+000
s325	10	3.79E+000	9	3.79E+000
s326	16	-7.98E+001	9	-7.98E+001
s327	16	2.85E-002	20	3.06E-002
s328	8	1.74E+000	10	1.74E+000
s329	18	-6.96E+003	17	-6.96E+003
s330	14	1.62E+000	10	1.62E+000
s330a	14	1.62E+000	12	1.62E+000
s331	7	4.26E+000	6	4.26E+000
s332		(IL)		(ERROR)
s332a	26	2.99E+001	17	2.99E+001
s333	11	4.33E-002	6	4.33E-002
s334	8	8.21E-003	8	8.21E-003
s335	41	-4.47E-003	25	-4.47E-003
s336	15	-3.38E-001	17	-3.38E-001
s337	20	6.00E+000	8	6.00E+000
s338	19	-7.21E+000	46	-7.21E+000
s339	24	3.36E+000	8	3.36E+000
s340		(IL)	9	-5.40E-002
s340a		(IL)	9	-5.40E-002
s341	16	-2.26E+001	9	-2.26E+001
s342	23	-2.26E+001	13	-2.26E+001
s343	13	-5.68E+000	11	-5.68E+000
s344	9	3.26E-002	7	3.26E-002
s345	12	3.26E-002	10	3.26E-002
s346	13	-5.68E+000	11	-5.68E+000
s348		(IMP)	13	3.70E+001
s348a		(IMP)	20	3.70E+001
s350	8	3.08E-004	8	3.08E-004
s351	11	3.19E+002	10	3.19E+002
s352	2	9.03E+002	1	9.03E+002
s353	15	-3.99E+001	8	-3.99E+001
s354	17	1.14E-001	10	1.14E-001
s355	380	1.22E+002	36	6.97E+001
s355a	380	1.22E+002	36	6.97E+001
s356	36	1.88E+000	14	1.88E+000
s357	11	3.58E-001	11	3.58E-001
s357a	11	3.58E-001	11	3.58E-001
s358	24	5.46E-005	23	5.46E-005
s359	12	-5.50E+006	12	-5.50E+006
s360	61	-5.28E+006	16	-5.28E+006

TABLE 18. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
s361	27	-1.53E+004	29	-1.53E+004
s365	229	5.21E+001	22	5.21E+001
s365mod	27	5.21E+001	26	5.22E+001
s366	46	1.23E+003	21	1.23E+003
s367	32	-3.74E+001	26	-3.74E+001
s368	1	0.00E+000	47	-7.11E-015
s368cute	1	0.00E+000	6	5.12E-019
s369	16	7.05E+003	15	7.05E+003
s370	12	2.29E-003	12	2.29E-003
s371	13	1.40E-006	13	1.40E-006
s372	51	1.34E+004		(INF)
s372a	58	1.34E+004		(INF)
s373	78	1.34E+004	3	1.34E+004
s374	44	2.33E-001	101	2.33E-001
s375	19	-1.52E+001	19	-1.52E+001
s376		(IMP)	42	-4.43E+003
s377	91	-7.95E+002	24	-7.95E+002
s378	25	-4.78E+001	15	-4.78E+001
s379	14	4.01E-002	19	4.01E-002
s380	28	2.45E+005	39	3.17E+000
s380a	28	2.45E+005	18	3.17E-005
s381	14	1.01E+000	11	1.01E+000
s382	15	1.04E+000	9	1.04E+000
s383	19	7.29E+005	18	7.29E+005
s384	17	-8.31E+003	12	-8.31E+003
s385	20	-8.31E+003	16	-8.31E+003
s386	2	2.81E-020	1	0.00E+000
s387	21	-8.25E+003	24	-8.25E+003
s388	21	-5.82E+003	1406	-5.82E+003
s389	23	-5.81E+003	51	-5.81E+003
s391		(IL)		(IL)
s392	33	-1.10E+006	21	-1.10E+006
s393	78	8.74E-001	35	8.63E-001
s394	16	1.92E+000	10	1.92E+000
s395	18	1.92E+000	14	1.92E+000
sawpath	1031	1.82E+002	15	1.82E+002
sbrybnd	60	5.73E-012	60	8.07E-024
schmvett	3	-3.00E+004	3	-3.00E+004
scon1dls	27	5.68E-001	445	1.29E-009
scosine	49	-3.76E+003	129	-1.00E+004
scurly10	53	-7.68E+005	217	-1.00E+006
scurly20	48	-7.75E+005	219	-1.00E+006
scurly30	42	-7.65E+005	195	-1.00E+006
semicon1	298	0.00E+000	1055	0.00E+000
semicon2	48	0.00E+000	22	0.00E+000
sim2bqp	11	8.64E-009	7	-7.47E-009
simbqp	11	5.97E-009	7	-7.42E-009
simplpa	11	1.00E+000	10	1.00E+000
simplpb	12	1.10E+000	10	1.10E+000
sineali	29	-1.90E+003		(IL)
sineval	43	4.33E-035	42	5.79E-043

TABLE 19. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
sinquad	22	2.92E-011	20	9.27E-013
sinrosnb	4	-9.99E+004	6	-9.99E+004
sipow1	12	-1.00E+000	23	-1.00E+000
sipow1m	12	-1.00E+000	25	-1.00E+000
sipow2	12	-1.00E+000	24	-1.00E+000
sipow2m	12	-1.00E+000	25	-1.00E+000
sipow3	15	5.36E-001	14	5.36E-001
sipow4	14	2.73E-001	15	2.73E-001
sisser	15	4.85E-010	20	8.12E-013
smbank	25	-7.13E+006	14	-7.13E+006
smmprsf	134	1.05E+006	110	1.05E+006
snail	65	5.37E-019	63	1.82E-018
snake	51	6.71E-014	14	-2.00E-004
sosqp2	29	-5.00E+003	17	-5.00E+003
spanhyd	137	(IMP)	21	2.40E+002
specan	22	1.66E-018	10	3.79E-013
spiral	84	-6.89E-011	63	-4.99E-009
sreadin3	11	-3.80E-005	8	-6.45E-005
srosenbr	20	1.41E-003	21	1.87E-017
sseblin	12	1.62E+007	61	1.62E+007
ssebnln	51	1.62E+007	123	1.62E+007
ssnbeam	63	3.38E+002	21	3.38E+002
stancmin	17	4.25E+000	10	4.25E+000
static3		(IMP)		(ERROR)
stcqp1	19	1.55E+005	15	1.55E+005
stcqp2	20	2.23E+004	15	2.23E+004
steenbra	20	1.70E+004	23	1.70E+004
steenbrb	660	(IMP)	49	9.08E+003
steenbrd	170	9.03E+003	104	9.03E+003
steenbre	562	(IMP)	75	2.85E+004
steenbrf	574	(IMP)	415	2.83E+002
steenbrg	592	(IMP)	77	2.75E+004
steering	28	5.55E-001	21	5.55E-001
stnqp1	31	-1.36E+005	18	-1.36E+005
stnqp2	37	-2.48E+005	20	-2.48E+005
supersim	10	6.67E-001	7	6.67E-001
svanberg	14	8.36E+003	31	8.36E+003
swopf	22	6.79E-002	17	6.79E-002
synthes1	16	7.59E-001	9	7.59E-001
tame	9	0.00E+000	6	0.00E+000
tenbars1	22	2.30E+003	30	2.30E+003
tenbars2	20	2.30E+003	30	2.30E+003
tenbars3	21	2.25E+003	17	2.25E+003
tenbars4	16	2.37E+003	17	2.37E+003
testquad	2	9.14E-019	1	1.83E-020
tfi2	13	6.49E-001	23	6.49E-001
tfi3		(IL)	37	4.30E+000
tointgor	32	1.37E+003	81	1.37E+003
tointgss	2	1.00E+001	1	1.00E+001
tointpsp		(IL)		(IL)
tointqor	2	1.18E+003	1	1.18E+003

TABLE 20. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).

Problem	HYBRID		IPOPT	
	Iters	$f(x^*)$	Iters	$f(x^*)$
torsion1	23	-4.26E-001	14	-4.26E-001
torsion2	23	-4.26E-001	13	-4.26E-001
torsion3	21	-1.21E+000	14	-1.21E+000
torsion4	22	-1.21E+000	13	-1.21E+000
torsion5	21	-2.86E+000	13	-2.86E+000
torsion6	21	-2.86E+000	13	-2.86E+000
torsiona	21	-4.18E-001	14	-4.18E-001
torsionb	21	-4.18E-001	12	-4.18E-001
torsionc	22	-1.20E+000	14	-1.20E+000
torsiond	22	-1.20E+000	13	-1.20E+000
torsione	23	-2.85E+000	13	-2.85E+000
torsionf	23	-2.85E+000	13	-2.85E+000
tquartic	3	6.15E-026	1	1.07E-021
trainf	4542	3.10E+000	40	3.10E+000
trainh		(IL)	70	1.23E+001
tridia	2	2.19E-020	1	2.48E-024
trigger	40	7.95E-026	15	0.00E+000
trimloss	34	9.06E+000	32	9.06E+000
truspyr1	17	1.12E+001	12	1.12E+001
truspyr2	16	1.12E+001	12	1.12E+001
try-b	16	7.89E-016	19	1.57E-018
twirimd1	1004	-1.03E+000	211	-1.03E+000
twirism1	185	-1.01E+000	100	-1.01E+000
twobars	9	1.51E+000	9	1.51E+000
ubh1	7	1.12E+000	6	1.12E+000
ubh5	8	1.12E+000	6	1.12E+000
vanderm1	392	(IMP)	44	0.00E+000
vanderm2		(IMP)	94	0.00E+000
vanderm3	654	1.74E+006	71	0.00E+000
vanderm4	39	0.00E+000	34	0.00E+000
vardim	24	5.37E-004	25	8.08E-028
vibrbeam	18	6.68E+000	58	3.32E-001
water	24	1.05E+004	24	1.05E+004
watson	13	6.08E-007	13	1.02E-013
weeds	6	9.21E+003	24	9.21E+003
womflet	16	6.05E+000	11	6.05E+000
woods	38	1.72E-004	40	1.21E-023
yao		(IMP)	29	1.96E+002
yfit	42	6.67E-013	85	6.72E-013
yfitu	36	7.71E-009	36	6.67E-013
yorknet	38	1.42E+004	60	1.42E+004
zamb2	1693	-4.14E+000	33	-4.14E+000
zamb2-10	133	-1.58E+000	29	-1.58E+000
zamb2-11		(IMP)	22	-1.12E+000
zamb2-8	61	-1.53E-001	20	-1.53E-001
zamb2-9	34	-3.55E-001	22	-3.55E-001
zangwil2	2	-1.82E+001	1	-1.82E+001
zangwil3	2	0.00E+000	1	0.00E+000
zecevic2	12	-4.12E+000	8	-4.13E+000
zecevic3	15	9.73E+001	22	9.73E+001
zecevic4	80	7.56E+000	10	7.56E+000
zigzag	37	3.16E+000	22	3.16E+000
zy2	12	2.00E+000	9	2.00E+000

TABLE 21. Numerical comparison of the default code to the penalty code. (IL) signifies that the algorithm reached its iteration limit. (INF) signifies that the problem was determined to be locally infeasible. (IMP) signifies that the algorithm was far away from the solution and could not make further progress. (ERROR) signifies that the solver quit with an error message. The problems where the solution found had a lower level of accuracy than the default are denoted by (\*).