

Appendix to: “A Comparison of Prediction Accuracy, Complexity, and Training Time of Thirty-three Old and New Classification Algorithms”, *Machine Learning Journal* (1999)

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Table 1. Breast cancer Wisconsin (bcw, 2 classes, 9 numerical attributes, 683 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.350. The noise attributes are 9 independent uniform integer variates between 1 and 10.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.0380	10	0.0425	15.5	0:02:00
QU1	0.0454	24	0.0469	19	0:01:58
QL0	0.0308	2.5	0.0293	1.5	0:02:35
QL1	0.0308	2.5	0.0293	1.5	0:02:36
FTU	0.0498	28.5	0.0498	22	0:00:09
FTL	0.0439	22	0.0424	14	0:00:10
C4T	0.0425	21	0.0513	24	0:00:04
C4R	0.0395	13.5	0.0395	12	0:00:17
IB	0.0424	19	0.0600	31	0:00:36
IBO	0.0336	4	0.0425	15.5	0:21:56
IM	0.0424	19	0.0453	17	0:00:35
IMO	0.0380	10	0.0409	13	0:28:30
ICO	0.0453	23	0.0542	27	0:00:59
IC1	0.0468	25	0.0541	26	0:00:53
OCU	0.0423	17	0.0584	29	0:00:21
OCL	0.0848	33	0.0526	25	0:15:59
OCM	0.0408	15	0.0585	30	0:13:28
STO	0.0512	30	0.0483	20	0:11:53
ST1	0.0498	28.5	0.0512	23	0:11:53
LMT	0.0351	7	0.0468	18	0:03:27
CAL	0.0706	31	0.0658	32	0:43:46
T1	0.0760	32	0.0760	33	0:00:05
<u>Statistical</u>					
LDA	0.0394	12	0.0379	9	0:00:11
QDA	0.0481	26	0.0496	21	0:00:11
NN	0.0482	27	0.0555	28	0:00:15
LOG	0.0337	5.5	0.0352	8	0:01:10
FM1	0.0366	8	0.0350	6.5	0:08:18
FM2	0.0380	10	0.0321	3	1:02:26
PDA	0.0395	13.5	0.0380	10	0:00:48
MDA	0.0409	16	0.0350	6.5	0:02:38
POL	0.0424	19	0.0383	11	2:41:04
<u>Neural Network</u>					
LVQ	0.0278	1	0.0336	5	0:00:58
RBF (2 hidden units)	0.0337	5.5	0.0322	4	1:56:54

Table 2. Contraceptive method choice (cmc, 3 classes, 2 numerical attributes, 7 categorical attributes, 1473 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.573. Error rates greater than that of the plurality rule are printed in *italics*. The noise attributes are 6 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.443	3	0.440	2.5	0:13:36
QU1	0.440	2	0.440	2.5	0:13:29
QL0	0.468	14	0.490	17	0:48:20
QL1	0.492	22	0.502	25.5	0:48:04
FTU	0.498	25	0.496	20	0:00:12
FTL	0.496	24	0.501	24	0:00:13
C4T	0.483	17	0.516	27	0:00:27
C4R	0.450	6	0.469	10	0:07:15
IB	0.505	28	0.523	30	0:01:47
I80	0.509	29	0.500	22.5	0:54:18
IM	0.447	4	0.457	8	0:01:48
IM0	0.463	12	0.480	13	1:05:26
IC0	0.451	7.5	0.446	5	0:03:31
IC1	0.449	5	0.445	4	0:03:03
OCU	0.475	15	0.489	15.5	0:03:16
OCL	0.504	27	0.502	25.5	0:42:21
OCM	0.478	16	0.478	12	0:43:34
ST0	0.457	9	0.462	9	1:36:46
ST1	0.451	7.5	0.456	7	1:26:02
LMT	0.514	30	0.544	32	0:19:53
CAL	0.503	26	0.485	14	21:15:04
T1	0.518	31	0.518	29	0:03:58
<u>Statistical</u>					
LDA	0.492	22	0.500	22.5	0:00:15
QDA	0.541	32	0.541	31	0:00:20
NN	<i>0.601</i>		<i>0.577</i>	33	0:00:31
LOG	0.489	19	0.494	18.5	0:07:34
FM1	0.466	13	0.472	11	0:43:54
FM2	0.460	11	0.455	6	6:27:28
PDA	0.492	22	0.499	21	0:02:03
MDA	0.486	18	0.494	18.5	0:06:33
POL	0.434	1	0.432	1	17:31:14
<u>Neural Network</u>					
LVQ	0.491	20	0.517	28	0:04:40
RBF (4 hidden units)	0.458	10	0.489	15.5	23:53:45

Table 3. StatLog DNA (`dna`, 3 classes, 60 categorical attributes, 2000 observations). Error rates are estimated from a test set of 1186 observations. Standard errors range from 0.0059 to 0.014. Plurality rule error rate is 0.492. The noise attributes are 20 independent uniform integer variates between 1 and 4.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.0582	10	0.0582	6	0:05:33
QU1	0.0616	14	0.0616	9	0:05:40
QL0	0.0683	18	0.0691	19	0:20:17
QL1	0.0683	18	0.0658	15.5	0:20:08
FTU	0.115	25	0.115	25	0:00:05
FTL	0.0472	2	0.0489	2	0:00:23
C4T	0.0759	21	0.0759	20	0:00:02
C4R	0.0683	18	0.0683	18	0:00:22
IB	0.0793	22	0.0801	21	0:00:06
IB0	0.0573	7	0.0632	11.5	0:00:22
IM	0.0835	23	0.0835	22	0:00:06
IM0	0.0565	5	0.0641	13.5	0:00:21
IC0	0.0582	10	0.0582	6	0:00:17
IC1	0.0616	14	0.0616	9	0:00:13
OCU	0.0919	24	0.0927	24	0:12:25
OCL	0.196	29	0.167	28	0:21:21
OCM	0.175	28	0.158	27	0:30:47
ST0	0.0582	10	0.0582	6	0:13:12
ST1	0.0616	14	0.0616	9	0:12:50
LMT	0.0742	20	0.0843	23	0:33:52
CAL	0.278	30	0.277	29	6:43:22
T1	0.379	33	0.379	33	0:00:02
<u>Statistical</u>					
LDA	0.0600	12	0.0641	13.5	0:00:33
QDA	0.137	27	0.298	30	0:02:05
NN	0.317	32	0.375	32	0:05:06
LOG	0.0641	16	0.0675	17	0:11:40
FM1	0.0523	4	0.0548	4	17:50:48
FM2	0.0472	2	0.0438	1	950:46:10
PDA	0.0573	7	0.0632	11.5	0:10:26
MDA	0.0573	7	0.0658	15.5	0:09:10
POL	0.0472	2	0.0497	3	9:59:15
<u>Neural Network</u>					
LVQ	0.132	26	0.154	26	0:36:08
RBF (5 hidden units)	0.293	31	0.303	31	122:45:41

Table 4. StatLog heart disease (**hea**, 2 classes, 7 numerical attributes, 6 categorical attributes, 270 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.444. The noise attributes are 7 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.226	23.5	0.248	27	0:01:26
QU1	0.244	28	0.256	29	0:01:27
QL0	0.152	4.5	0.170	6	0:02:24
QL1	0.152	4.5	0.167	4	0:02:29
FTU	0.233	26.5	0.230	22	0:00:06
FTL	0.148	2.5	0.148	1	0:00:07
C4T	0.196	13.5	0.193	11	0:00:04
C4R	0.200	15.5	0.200	14	0:00:08
IB	0.222	21.5	0.226	20.5	0:00:31
IB0	0.196	13.5	0.189	10	1:11:24
IM	0.200	15.5	0.196	12.5	0:00:32
IMO	0.204	17	0.211	18	0:52:00
IC0	0.207	18	0.207	16	0:00:46
IC1	0.219	19.5	0.244	26	0:00:40
OCU	0.230	25	0.241	25	0:00:15
OCL	0.189	10	0.226	20.5	0:03:53
OCM	0.222	21.5	0.207	16	0:04:21
ST0	0.256	30	0.233	23	0:09:49
ST1	0.233	26.5	0.215	19	0:09:49
LMT	0.163	7.5	0.170	6	0:02:13
CAL	0.270	31.5	0.256	29	1:13:32
T1	0.270	31.5	0.270	32	0:00:18
<u>Statistical</u>					
LDA	0.141	1	0.156	2	0:00:09
QDA	0.248	29	0.259	31	0:00:09
NN	0.226	23.5	0.256	29	0:00:10
LOG	0.159	6	0.185	9	0:01:09
FM1	0.193	11.5	0.196	12.5	0:07:40
FM2	0.219	19.5	0.237	24	1:05:54
PDA	0.148	2.5	0.163	3	0:00:36
MDA	0.163	7.5	0.170	6	0:01:55
POL	0.174	9	0.207	16	0:27:43
<u>Neural Network</u>					
LVQ	0.341	33	0.311	33	0:00:21
REB (4 hidden units)	0.193	11.5	0.174	8	3:18:58

Table 5. Boston housing (`bos`, 3 classes, 12 numerical attributes, 1 binary attribute, 506 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.657. The noise attributes are 12 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.267	27	0.275	17.5	0:04:10
QU1	0.273	30	0.294	26.5	0:04:08
QL0	0.268	28	0.282	22.5	0:05:31
QL1	0.274	31	0.282	22.5	0:05:31
FTU	0.261	24	0.263	10	0:00:09
FTL	0.254	18.5	0.254	5	0:00:09
C4T	0.221	1	0.225	1	0:00:17
C4R	0.236	6	0.261	8.5	0:00:30
IB	0.251	16.5	0.274	16	0:01:15
IB0	0.249	14.5	0.259	7	1:25:32
IM	0.241	9.5	0.258	6	0:01:14
IMO	0.231	5	0.273	14.5	1:50:50
IC0	0.254	18.5	0.264	11	0:02:13
IC1	0.266	25.5	0.280	21	0:01:54
OCU	0.241	9.5	0.233	2	0:00:41
OCL	0.272	29	0.358	32	0:16:01
OCM	0.239	7.5	0.267	12	0:16:52
ST0	0.259	22.5	0.275	17.5	0:23:34
ST1	0.255	20	0.261	8.5	0:23:17
LMT	0.251	16.5	0.312	29	0:07:28
CAL	0.259	22.5	0.293	25	2:53:49
T1	0.287	32	0.287	24	0:03:53
<u>Statistical</u>					
LDA	0.249	14.5	0.279	20	0:00:10
QDA	0.266	25.5	0.273	14.5	0:00:12
NN	0.227	4	0.335	31	0:00:15
LOG	0.243	11.5	0.268	13	0:04:05
FM1	0.239	7.5	0.243	4	0:21:36
FM2	0.243	11.5	0.422	33	0:04:44
PDA	0.247	13	0.278	19	0:01:05
MDA	0.257	21	0.294	26.5	0:03:26
POL	0.225	2.5	0.239	3	5:28:53
<u>Neural Network</u>					
LVQ	0.314	33	0.322	30	0:01:00
REB (3 hidden units)	0.225	2.5	0.298	28	5:18:29

Table 6. LED display (`led`, 10 classes, 7 binary attributes, 2000 observations). Error rates are estimated from a test set of 4000 observations. Standard errors range from 0.0061 to 0.0079. Plurality rule error rate is 0.890. The noise attributes are 17 independent binary variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.278	19.5	0.277	11.5	0:05:18
QU1	0.287	27	0.280	13.5	0:05:13
QL0	0.274	12	0.286	15	0:22:44
QL1	0.278	19.5	0.290	18.5	0:22:53
FTU	0.285	24.5	0.288	16	0:00:07
FTL	0.271	4	0.266	2.5	0:00:07
C4T	0.271	4	0.290	18.5	0:00:02
C4R	0.275	16.5	0.309	23.5	0:00:33
IB	0.276	18	0.342	26	0:00:08
IBO	0.274	12	0.363	27	0:04:53
IM	0.274	12	0.290	18.5	0:00:07
IMO	0.274	12	0.296	22	0:02:16
ICO	0.279	21	0.277	11.5	0:00:11
IC1	0.286	26	0.274	10	0:00:07
OCU	0.272	6	0.269	8	0:00:51
OCL	0.275	16.5	0.369	28	0:13:57
OCM	0.280	22	0.329	25	0:13:55
STO	0.285	24.5	0.280	13.5	0:08:32
ST1	0.289	28	0.290	18.5	0:08:52
LMT	0.284	23	0.309	23.5	0:04:53
CAL	0.301	30	0.374	29	1:22:16
T1	0.816	33	0.813	33	0:00:01
<u>Statistical</u>					
LDA	0.271	4	0.265	1	0:00:05
QDA	0.273	7.5	0.292	21	0:00:11
NN	0.294	29	0.403	30	0:00:25
LOG	0.269	2	0.266	2.5	0:04:17
FM1	0.274	12	0.271	9	0:04:21
FM2	0.268	1	0.268	6.5	1:46:35
PDA	0.274	12	0.267	4.5	0:00:38
MDA	0.273	7.5	0.267	4.5	0:04:34
POL	0.274	12	0.268	6.5	0:54:13
<u>Neural Network</u>					
LVQ	0.313	31	0.413	31	0:01:13
RBF (3 hidden units)	0.446	32	0.430	32	12:25:14

Table 7. BUPA liver disorders (b1d, 2 classes, 6 numerical attributes, 345 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.419. Error rates greater than that of the plurality rule are printed in *italics*. The noise attributes are 9 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.389	27	0.403	29	0:01:47
QU1	0.399	28	0.376	25	0:01:47
QL0	0.306	7	0.380	26	0:02:05
QL1	0.320	14	0.369	23	0:02:01
FTU	0.401	29.5	0.402	28	0:00:06
FTL	0.413	31	0.419	30	0:00:05
C4T	0.308	8	0.329	9	0:00:06
C4R	0.292	5	0.320	4.5	0:00:12
IB	0.328	21	0.340	12.5	0:00:41
IBO	0.322	16.5	0.333	10	1:28:47
IM	0.320	14	0.340	12.5	0:00:40
IMO	0.312	11	0.336	11	1:26:18
ICO	0.327	20	0.327	7	0:00:58
IC1	0.319	12	0.313	2	0:00:52
OCU	0.350	25	0.347	19	0:00:13
OCL	0.296	6	0.328	8	0:08:26
OCM	0.279	1	0.367	22	0:08:30
STO	0.311	10	0.326	6	0:15:50
ST1	0.326	18.5	0.351	20	0:14:13
LMT	0.322	16.5	0.362	21	0:02:45
CAL	<i>0.420</i>	32	0.398	27	1:06:51
T1	<i>0.432</i>	33	<i>0.441</i>	33	0:00:26
<u>Statistical</u>					
LDA	0.326	18.5	0.343	15	0:00:08
QDA	0.401	29.5	<i>0.435</i>	32	0:00:09
NN	0.370	26	<i>0.423</i>	31	0:00:10
LOG	0.309	9	0.344	17	0:00:39
FM1	0.289	4	0.314	3	0:03:05
FM2	0.280	2	0.320	4.5	0:20:35
PDA	0.329	22.5	0.343	15	0:00:31
MDA	0.320	14	0.374	24	0:01:54
POL	0.286	3	0.286	1	1:12:40
<u>Neural Network</u>					
LVQ	0.329	22.5	0.343	15	0:00:23
RBF (1 hidden units)	0.330	24	0.346	18	0:37:23

Table 8. Pima Indians diabetes (pid, 2 classes, 7 numerical attributes, 532 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.333. The noise attributes are 8 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.226	7	0.230	11.5	0:02:45
QU1	0.230	11	0.230	11.5	0:02:34
QL0	0.225	5	0.221	2.5	0:03:14
QL1	0.223	4	0.221	2.5	0:03:08
FTU	0.247	24.5	0.258	25	0:00:07
FTL	0.221	1.5	0.225	6	0:00:07
C4T	0.242	21	0.252	21	0:00:08
C4R	0.227	9	0.233	13.5	0:00:16
IB	0.252	30	0.278	31	0:00:51
IB0	0.258	31	0.259	26	1:29:08
IM	0.233	14	0.246	17	0:00:49
IM0	0.246	23	0.265	28	1:44:21
IC0	0.237	16.5	0.233	13.5	0:01:21
IC1	0.239	20	0.248	18	0:01:13
OCU	0.237	16.5	0.256	23.5	0:00:21
OCL	0.310	33	0.318	33	0:16:00
OCM	0.247	24.5	0.261	27	0:17:19
ST0	0.237	16.5	0.269	30	0:19:06
ST1	0.250	28.5	0.244	16	0:18:30
LMT	0.249	27	0.253	22	0:03:53
CAL	0.226	7	0.250	19.5	1:30:23
T1	0.250	28.5	0.250	19.5	0:00:40
<u>Statistical</u>					
LDA	0.221	1.5	0.223	4	0:00:10
QDA	0.238	19	0.256	23.5	0:00:10
NN	0.295	32	0.313	32	0:00:12
LOG	0.230	11	0.226	7	0:00:57
FM1	0.222	3	0.224	5	0:04:39
FM2	0.248	26	0.228	9	0:32:16
PDA	0.226	7	0.228	9	0:00:40
MDA	0.231	13	0.228	9	0:02:18
POL	0.237	16.5	0.217	1	2:27:44
<u>Neural Network</u>					
LVQ	0.243	22	0.267	29	0:00:38
RBF (2 hidden units)	0.230	11	0.240	15	1:20:23

Table 9. StatLog satellite image (*sat*, 6 classes, 36 numerical attributes, 4435 observations). Error rates are estimated from a test set of 2000 observations. Standard errors range from 0.0066 to 0.011. Plurality rule error rate is 0.765. The noise attributes are 24 independent uniform integer variates between 20 and 160.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.145	11.5	0.140	4	0:18:31
QU1	0.145	11.5	0.149	11	0:18:57
QL0	0.155	22	0.157	19	0:46:33
QL1	0.154	20.5	0.161	24	0:46:56
FTU	0.151	17.5	0.152	14	0:00:08
FTL	0.157	23	0.154	15	0:00:15
C4T	0.146	13.5	0.158	20.5	0:00:44
C4R	0.148	16	0.150	13	0:02:01
IB	0.146	13.5	0.144	7	0:01:40
IB0	0.153	19	0.149	11	0:15:34
IM	0.144	9.5	0.146	9	0:01:38
IMO	0.177	29	0.143	5.5	0:17:04
ICO	0.138	5	0.143	5.5	0:04:40
IC1	0.154	20.5	0.155	16	0:03:54
OCU	0.158	24	0.158	20.5	0:02:59
OCL	0.250	32	0.268	30	2:19:22
OCM	0.142	7	0.164	26.5	0:22:02
ST0	0.151	17.5	0.156	17.5	0:36:08
ST1	0.168	27	0.159	22	0:35:44
LMT	0.147	15	0.166	28	1:39:42
CAL	0.210	30	0.226	29	4:45:06
T1	0.400	33	0.400	32	0:07:08
<u>Statistical</u>					
LDA	0.160	25	0.163	25	0:00:12
QDA	0.141	6	0.145	8	0:00:31
NN	0.217	31	0.304	31	0:01:43
LOG	0.163	26	0.164	26.5	1:58:16
FM1	0.143	8	0.135	3	7:00:18
FM2	0.129	3	0.116	1	147:06:36
PDA	0.172	28	0.160	23	0:06:46
MDA	0.144	9.5	0.156	17.5	0:06:49
POL	0.136	4	0.124	2	6:03:55
<u>Neural Network</u>					
LVQ	0.098	1	0.410	33	0:45:26
RBF (8 hidden units)	0.121	2	0.149	11	53:00:10

Table 10. StatLog image segmentation (**seg**, 7 classes, 19 numerical attributes, 2310 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.857. The noise attributes are 9 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.0416	13	0.0481	12	0:23:14
QU1	0.0472	17	0.0515	14	0:22:39
QL0	0.0459	15	0.0550	17.5	0:33:25
QL1	0.0476	18	0.0580	21	0:33:36
FTU	0.0576	22	0.0576	20	0:00:34
FTL	0.0593	23	0.0593	22	0:00:36
C4T	0.0320	3	0.0359	4.5	0:01:26
C4R	0.0364	7	0.0403	9	0:02:31
IB	0.0342	6	0.0351	3	0:04:41
IB0	0.0247	2	0.0264	1	0:34:34
IM	0.0377	11	0.0359	4.5	0:04:43
IMO	0.0325	4.5	0.0338	2	0:40:56
IC0	0.0372	10	0.0476	11	0:07:30
IC1	0.0532	20	0.0532	15	0:08:34
OCU	0.0368	8	0.0407	10	0:03:43
OCL	0.0770	24	0.0823	25.5	2:10:38
OCM	0.0571	21	0.0571	19	2:04:52
ST0	0.0369	9	0.0363	6	0:23:38
ST1	0.0528	19	0.0489	13	0:15:23
LMT	0.0403	12	0.0550	17.5	0:36:43
CAL	0.124	30	0.137	30	13:28:46
T1	0.360	32	0.360	32	0:42:58
<u>Statistical</u>					
LDA	0.0831	26	0.0844	27	0:00:28
QDA	0.123	29	0.118	29	0:00:48
NN	0.0221	1	0.0823	25.5	0:01:07
LOG	0.0429	14	0.0545	16	1:18:28
FM1	0.515	33	0.574	33	4:54:33
FM2	0.0468	16	0.0398	8	32:52:03
PDA	0.0835	27	0.0853	28	0:06:35
MDA	0.0788	25	0.0792	24	0:27:53
POL	0.0325	4.5	0.0364	7	22:56:23
<u>Neural Network</u>					
LVQ	0.0844	28	0.0771	23	0:15:59
REB (5 hidden units)	0.1260	31	0.1720	31	150:15:17

Table 11. Attitudes towards workplace smoking restrictions (smo, 3 classes, 5 categorical attributes, 3 numerical attributes, 1855 observations). Error rates are estimated from a test set of 1000 observations. Standard errors range from 0.015 to 0.016. Plurality rule error rate is 0.305. Error rates greater than that of the plurality rule are printed in *italics*. The noise attributes are 7 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.305	9.5	0.305	7.5	0:02:00
QU1	0.305	9.5	0.305	7.5	0:02:03
QL0	0.305	9.5	0.305	7.5	0:06:23
QL1	0.305	9.5	0.305	7.5	0:06:21
FTU	0.305	9.5	0.305	7.5	0:00:01
FTL	0.305	9.5	0.305	7.5	0:00:01
C4T	0.305	9.5	<i>0.405</i>	30	0:00:04
C4R	<i>0.353</i>	28	<i>0.349</i>	27	0:01:04
IB	<i>0.424</i>	32	<i>0.411</i>	31	0:00:18
IB0	<i>0.393</i>	30	<i>0.387</i>	29	0:04:59
IM	0.305	9.5	<i>0.308</i>	16.5	0:00:16
IM0	<i>0.311</i>	22	<i>0.339</i>	26	0:04:08
IC0	<i>0.319</i>	26	0.305	7.5	0:00:31
IC1	0.305	9.5	0.305	7.5	0:00:28
OCU	<i>0.312</i>	23	0.305	7.5	0:00:26
OCL	<i>0.317</i>	25	0.305	7.5	0:07:54
OCM	0.305	9.5	0.305	7.5	0:08:06
ST0	0.305	9.5	0.305	7.5	0:11:12
ST1	0.305	9.5	0.305	7.5	0:11:06
LMT	<i>0.350</i>	27	<i>0.306</i>	15	0:02:08
CAL	<i>0.316</i>	24	<i>0.310</i>	19	0:56:18
T1	0.304	1	<i>0.317</i>	23.5	0:01:10
<u>Statistical</u>					
LDA	0.305	9.5	<i>0.311</i>	21	0:00:04
QDA	<i>0.454</i>	33	<i>0.442</i>	32	0:00:04
NN	<i>0.410</i>	31	<i>0.445</i>	33	0:00:09
LOG	0.305	9.5	<i>0.308</i>	16.5	0:00:37
FM1	<i>0.310</i>	20.5	<i>0.323</i>	25	0:04:06
FM2	<i>0.307</i>	18.5	<i>0.311</i>	21	0:19:21
PDA	0.305	9.5	<i>0.311</i>	21	0:00:29
MDA	<i>0.310</i>	20.5	<i>0.309</i>	18	0:01:05
POL	0.305	9.5	0.305	7.5	3:45:44
<u>Neural Network</u>					
LVQ	<i>0.366</i>	29	<i>0.358</i>	28	0:00:49
RBF (3 hidden units)	<i>0.307</i>	18.5	<i>0.317</i>	23.5	1:31:31

Table 12. Thyroid disease (**thy**, 3 classes, 6 numerical attributes, 15 binary attributes, 3772 observations). Error rates are estimated from a test set of 3428 observations. Standard errors range from 0.0012 to 0.0056. Plurality rule error rate is 0.0729. Error rates greater than that of the plurality rule are printed in *italics*. The noise attributes are 10 independent binary variates and 4 independent uniform variates between 0 and 1.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.00820	12.5	0.00820	12.5	0:03:42
QU1	0.00820	12.5	0.00820	12.5	0:03:49
QL0	0.0175	17	0.0190	17.5	0:10:02
QL1	0.0242	21	0.0260	21	0:09:55
FTU	0.0149	16	0.0155	16	0:00:05
FTL	0.0198	19	0.0190	17.5	0:00:06
C4T	0.00613	3	0.00467	1	0:00:03
C4R	0.00554	1	0.00496	2.5	0:00:07
IB	0.00583	2	0.00496	2.5	0:00:15
IB0	0.00759	11	0.00759	11	0:02:04
IM	0.00700	9.5	0.00525	4	0:00:14
IM0	0.00700	9.5	0.00583	5	0:02:01
IC0	0.00671	8	0.00671	10	0:00:16
IC1	0.00642	5.5	0.00642	7.5	0:00:16
OCU	0.00642	5.5	0.00642	7.5	0:00:56
OCL	0.0268	22	0.0368	22	0:11:47
OCM	0.0102	14.5	0.0108	14	0:04:43
ST0	0.00642	5.5	0.00642	7.5	0:06:25
ST1	0.00642	5.5	0.00642	7.5	0:06:16
LMT	0.0195	18	0.0228	19	0:06:34
CAL	0.0726	32	<i>0.0750</i>	30	0:43:11
T1	0.0400	25	0.0400	24	0:00:32
<u>Statistical</u>					
LDA	0.0619	28	0.0619	27	0:00:06
QDA	<i>0.890</i>	33	<i>0.875</i>	33	0:00:08
NN	0.0645	30	<i>0.0961</i>	32	0:01:21
LOG	0.0405	26	0.0403	25	0:03:59
FM1	0.0347	24	0.0374	23	0:09:51
FM2	0.0228	20	0.0242	20	5:49:25
PDA	0.0621	29	0.0621	28	0:00:56
MDA	0.0598	27	0.0586	26	0:02:18
POL	0.0102	14.5	0.0137	15	8:48:33
<u>Neural Network</u>					
LVQ	0.0712	31	<i>0.0890</i>	31	0:06:25
RBF (5 hidden units)	0.0318	23	0.0633	29	16:06:50

Table 13. StatLog vehicle silhouette (**veh**, 4 classes, 18 numerical attributes, 846 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.739. The noise attributes are 12 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.305	24	0.309	23	0:09:07
QU1	0.322	27	0.311	24	0:08:54
QL0	0.207	7.5	0.257	12	0:11:53
QL1	0.206	6	0.243	10	0:11:49
FTU	0.310	25	0.318	25	0:00:20
FTL	0.410	32	0.406	31	0:00:24
C4T	0.277	18	0.272	15	0:00:31
C4R	0.260	14.5	0.279	17.5	0:01:04
IB	0.260	14.5	0.296	21	0:02:21
IB0	0.274	17	0.267	13	1:03:24
IM	0.289	21	0.290	20	0:02:22
IMO	0.278	19	0.271	14	0:56:36
IC0	0.265	16	0.304	22	0:04:03
IC1	0.298	22.5	0.326	26	0:03:32
OCU	0.298	22.5	0.286	19	0:01:19
OCL	0.355	29	0.384	30	0:45:59
OCM	0.316	26	0.334	27	0:45:06
ST0	0.251	13	0.279	17.5	0:49:02
ST1	0.279	20	0.278	16	0:48:34
LMT	0.215	9	0.234	9	0:11:22
CAL	0.350	28	0.360	28	7:44:05
T1	0.487	33	0.487	33	0:25:58
<u>Statistical</u>					
LDA	0.224	11.5	0.229	8	0:00:14
QDA	0.145	1	0.155	1	0:00:19
NN	0.224	11.5	0.252	11	0:00:24
LOG	0.196	4	0.223	6	0:19:19
FM1	0.207	7.5	0.211	5	4:11:03
FM2	0.204	5	0.172	3	18:22:20
PDA	0.221	10	0.228	7	0:01:43
MDA	0.194	3	0.178	4	0:06:10
POL	0.162	2	0.169	2	22:48:03
<u>Neural Network</u>					
LVQ	0.374	31	0.376	29	0:02:28
REB (4 hidden units)	0.372	30	0.429	32	28:59:24

Table 14. 1984 United States Congressional voting records (*vote*, 2 classes, 16 categorical attributes, 435 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.386. The noise attributes are 14 independent uniform integer variates between 1 and 3.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.0412	4	0.0412	1	0:01:51
QU1	0.0435	9	0.0435	5	0:01:49
QL0	0.0364	1	0.0503	21	0:02:47
QL1	0.0503	23.5	0.0480	17.5	0:02:46
FTU	0.0435	9	0.0435	5	0:00:08
FTL	0.0457	14.5	0.0457	11.5	0:00:12
C4T	0.0480	17.5	0.0503	21	0:00:02
C4R	0.0526	28	0.0457	11.5	0:00:12
IB	0.0526	28	0.0554	27	0:00:22
IBO	0.0386	3	0.0506	23	1:07:06
IM	0.0503	23.5	0.0594	29	0:00:22
IMO	0.0367	2	0.0457	11.5	0:07:00
ICO	0.0480	17.5	0.0548	26	0:00:28
IC1	0.0435	9	0.0457	11.5	0:00:24
OCU	0.0435	9	0.0435	5	0:01:08
OCL	0.0574	31	0.0651	32	0:03:40
OCM	0.0580	32	0.0662	33	0:04:23
STO	0.0500	21	0.0500	19	0:14:21
ST1	0.0432	5.5	0.0432	2	0:14:31
LMT	0.0483	19	0.0529	24	0:04:51
CAL	0.0457	14.5	0.0457	11.5	0:46:59
T1	0.0435	9	0.0435	5	0:00:02
<u>Statistical</u>					
LDA	0.0458	16	0.0458	15	0:00:13
QDA	0.0549	30	0.0617	31	0:00:18
NN	0.0526	28	0.0577	28	0:00:26
LOG	0.0500	21	0.0435	5	0:08:18
FM1	0.0455	12.5	0.0457	11.5	0:57:29
FM2	0.0432	5.5	0.0480	17.5	49:12:23
PDA	0.0455	12.5	0.0455	8	0:01:59
MDA	0.0617	33	0.0545	25	0:03:23
POL	0.0523	25.5	0.0477	16	0:33:46
<u>Neural Network</u>					
LVQ	0.0500	21	0.0614	30	0:01:18
RBF (7 hidden units)	0.0523	25.5	0.0503	21	35:26:12

Table 15. Waveform (`wav`, 3 classes, 21 numerical attributes, 600 observations). Error rates are estimated from a test set of 3000 observations. Standard errors range from 0.0065 to 0.0091. Plurality rule error rate is 0.667. The noise attributes are 19 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.266	21	0.261	20	0:01:37
QU1	0.277	22	0.261	20	0:01:47
QL0	0.177	8.5	0.192	9	0:02:12
QL1	0.177	8.5	0.198	11.5	0:02:18
FTU	0.291	27	0.276	27.5	0:00:07
FTL	0.179	12.5	0.162	2	0:00:06
C4T	0.261	19	0.272	25	0:00:05
C4R	0.261	19	0.253	17.5	0:00:08
IB	0.285	25	0.270	24	0:00:31
IB0	0.261	19	0.253	17.5	0:07:04
IM	0.284	24	0.261	20	0:00:31
IMO	0.243	17	0.243	15	0:08:43
ICO	0.297	29	0.276	27.5	0:00:47
IC1	0.313	30	0.279	29	0:00:43
OCU	0.278	23	0.268	23	0:00:23
OCL	0.224	16	0.239	14	0:05:23
OCM	0.218	15	0.248	16	0:05:20
ST0	0.290	26	0.274	26	0:05:35
ST1	0.293	28	0.265	22	0:05:23
LMT	0.176	7	0.198	11.5	0:01:13
CAL	0.382	31	0.303	30	0:48:26
T1	0.477	33	0.429	32	0:00:43
<u>Statistical</u>					
LDA	0.178	10.5	0.184	7.5	0:00:04
QDA	0.179	12.5	0.237	13	0:00:07
NN	0.396	32	0.446	33	0:00:17
LOG	0.154	2	0.163	3.5	0:01:43
FM1	0.165	4	0.166	5	0:11:16
FM2	0.180	14	0.196	10	3:14:15
PDA	0.178	10.5	0.184	7.5	0:00:35
MDA	0.163	3	0.160	1	0:00:54
POL	0.169	5	0.173	6	1:19:30
<u>Neural Network</u>					
LVQ	0.170	6	0.163	3.5	0:00:35
RBF (5 hidden units)	0.151	1	0.392	31	4:17:58

Table 16. Teaching assistant evaluation (τ_{ae} , 3 classes, 1 numerical attribute, 4 categorical attributes, 151 observations). Error rates are estimated using 10-fold cross-validation experiment. Plurality rule error rate is 0.656. Error rates greater than that of the plurality rule are printed in *italics*. The noise attributes are 5 independent standard normal variates.

Methods	Original		+ Noise		CPU Time (hh:mm:ss)
	Error Rate	Rank	Error Rate	Rank	
<u>Tree & Rules</u>					
QU0	0.430	8	0.516	14.5	0:01:05
QU1	0.490	16.5	0.516	14.5	0:01:05
QL0	0.444	10	0.503	9	0:01:40
QL1	0.470	14.5	0.510	11.5	0:01:41
FTU	0.538	22.5	0.555	22	0:00:06
FTL	<i>0.693</i>	33	<i>0.681</i>	31	0:00:06
C4T	0.503	19	0.502	8	0:00:08
C4R	0.583	26	0.529	17	0:00:18
IB	0.373	4	0.451	3	0:00:31
I80	0.325	1	0.470	6	0:06:10
IM	0.538	22.5	0.530	18	0:00:31
IM0	0.492	18	0.549	21	0:40:21
IC0	0.372	3	0.543	20	0:00:41
IC1	0.537	21	0.582	25	0:00:38
OCU	0.451	12	0.650	29	0:00:34
OCL	0.590	27	0.596	26	0:00:59
OCM	0.418	7	0.563	23	0:01:29
ST0	<i>0.669</i>	30.5	<i>0.682</i>	32	2:19:50
ST1	<i>0.675</i>	32	<i>0.696</i>	33	2:18:38
LMT	0.470	14.5	0.573	24	0:06:53
CAL	0.439	9	0.510	11.5	0:35:50
T1	0.540	24	0.536	19	0:00:26
<u>Statistical</u>					
LDA	0.411	6	0.450	2	0:00:12
QDA	0.543	25	0.511	13	0:00:18
NN	0.349	2	0.460	5	0:00:17
LOG	0.450	11	0.458	4	0:02:26
FM1	0.636	29	0.628	27	0:45:56
FM2	<i>0.669</i>	30.5	0.642	28	4:23:09
PDA	0.490	16.5	0.478	7	0:00:56
MDA	0.404	5	0.445	1	0:02:25
POL	0.530	20	0.518	16	0:16:20
<u>Neural Network</u>					
LVQ	0.628	28	<i>0.669</i>	30	0:00:18
RBF (5 hidden units)	0.464	13	0.504	10	10:13:24