Detecting pneumatic failures on temporary immersion bioreactors: An approach based on contrast patterns. Tables of the statistical tests for all the tested classifiers, according to the AUC measure.

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1 Average rankings of Friedman test

Average ranks obtained by applying the Friedman procedure

Algorithm	Ranking
MLP	2.1786
PBC4cip	3.3214
RF	3.3929
3NN	7.7857
AB.M1	6
C4.5	9.5357
BaggingTPMinerEuclidean	9.3571
LogReg	5.8571
NBayes	9.0714
SVM	6.6786
TreeBagger	6.5357
OCKRA	8.2857

Table 1: Average Rankings of the algorithms

Friedman statistic considering reduction performance (distributed according to chi-square with 11 degrees of freedom: 73.18956.

P-value computed by Friedman Test: 8.032297049709314E-11.

2 Post hoc comparisons

Results achieved on post hoc comparisons for $\alpha = 0.05$, $\alpha = 0.10$ and adjusted p-values.

2.1 P-values for $\alpha = 0.05$

Shaffer's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000758.

i	algorithms	$z = (R_0 - R_i)/SE$	p	Shaffer
66	C4.5 vs. MLP	5.398667	0	0.000758
65	BaggingTPMinerEuclidean vs. MLP	5.267631	0	0.000909
64	MLP vs. NBayes	5.057974	0	0.000909
63	C4.5 vs. PBC4cip	4.560039	0.000005	0.000909
62	C4.5 vs. RF	4.507625	0.000007	0.000909
61	MLP vs. OCKRA	4.481418	0.000007	0.000909
60	BaggingTPMinerEuclidean vs. PBC4cip	4.429003	0.000009	0.000909
59	BaggingTPMinerEuclidean vs. RF	4.376589	0.000012	0.000909
58	NBayes vs. PBC4cip	4.219346	0.000025	0.000909
57	NBayes vs. RF	4.166932	0.000031	0.000909
56	3NN vs. MLP	4.114518	0.000039	0.000909
55	PBC4cip vs. OCKRA	3.64279	0.00027	0.000909
54	RF vs. OCKRA	3.590376	0.00033	0.001087
53	MLP vs. SVM	3.302097	0.00096	0.001087
52	3NN vs. PBC4cip	3.27589	0.001053	0.001087
51	3NN vs. RF	3.223476	0.001266	0.001087
50	MLP vs. TreeBagger	3.197269	0.001387	0.001087
49	AB.M1 vs. MLP	2.804162	0.005045	0.001087
48	LogReg vs. MLP	2.699333	0.006948	0.001087
47	C4.5 vs. LogReg	2.699333	0.006948	0.001087
46	AB.M1 vs. C4.5	2.594505	0.009473	0.001087
45	BaggingTPMinerEuclidean vs. LogReg	2.568298	0.01022	0.001111
44	AB.M1 vs. BaggingTPMinerEuclidean	2.463469	0.01376	0.001136
43	SVM vs. PBC4cip	2.463469	0.01376	0.001163
42	RF vs. SVM	2.411055	0.015906	0.00119
41	LogReg vs. NBayes	2.358641	0.018342	0.00122
40	TreeBagger vs. PBC4cip	2.358641	0.018342	0.00125
39	RF vs. TreeBagger	2.306227	0.021098	0.001282
38	AB.M1 vs. NBayes	2.253812	0.024208	0.001316
37	C4.5 vs. TreeBagger	2.201398	0.027708	0.001351
36	C4.5 vs. SVM	2.09657	0.036032	0.001389
35	BaggingTPMinerEuclidean vs. TreeBagger	2.070363	0.038418	0.001429
34	BaggingTPMinerEuclidean vs. SVM	1.965534	0.049352	0.001471
33	AB.M1 vs. PBC4cip	1.965534	0.049352	0.001515
32	AB.M1 vs. RF	1.91312	0.055733	0.001563
31	NBayes vs. TreeBagger	1.860706	0.062786	0.001613
30	LogReg vs. PBC4cip	1.860706	0.062786	0.001667
29	LogReg vs. RF	1.808291	0.070561	0.001724
28	LogReg vs. OCKRA	1.782084	0.074735	0.001786
27	NBayes vs. SVM	1.755877	0.079109	0.001852
26	AB.M1 vs. OCKRA	1.677256	0.093492	0.001923
25	3NN vs. LogReg	1.415185	0.157014	0.002
24	3NN vs. AB.M1	1.310356	0.190075	0.002083
23	3NN vs. C4.5	1.284149	0.19909	0.002174
22	TreeBagger vs. OCKRA	1.284149	0.19909	0.002273
21	SVM vs. OCKRA	1.17932	0.238271	0.002381
20	3NN vs. BaggingTPMinerEuclidean	1.153113	0.248864	0.0025
19	3NN vs. NBayes	0.943456	0.345448	0.002632
18	3NN vs. TreeBagger	0.917249	0.359012	0.002778
17	C4.5 vs. OCKRA	0.917249	0.359012	0.002941
16	MLP vs. RF	0.891042	0.372907	0.003125
15	MLP vs. PBC4cip	0.838628	0.401678	0.003333
14	3NN vs. SVM	0.812421	0.41655	0.003571
13	BaggingTPMinerEuclidean vs. OCKRA	0.786214	0.431742	0.003846
12	LogReg vs. SVM	0.602764	0.546666	0.004167
11	NBayes vs. OCKRA	0.576557	0.564239	0.004545
10	LogReg vs. TreeBagger	0.497935	0.61853	0.005
9	AB.M1 vs. SVM	0.497935	0.61853	0.005556
8	AB.M1 vs. TreeBagger	0.393107	0.694241	0.00625
7	3NN vs. OCKRA	0.3669	0.713694	0.007143
6	C4.5 vs. NBayes	0.340693	0.733335	0.008333
5	BaggingTPMinerEuclidean vs. NBayes	0.209657	0.833935	0.01
4	C4.5 vs. BaggingTPMinerEuclidean	0.131036	0.895747	0.0125
3	AB.M1 vs. LogReg	0.104828	0.916512	0.016667
2	SVM vs. TreeBagger	0.104828	0.916512	0.025
1	RF vs. PBC4cip	0.052414	0.958199	0.05

Table 2: P-values Table for $\alpha = 0.05$

2.2 P-values for $\alpha = 0.10$

i	algorithms	$z = (R_0 - R_i)/SE$	p	Shaffer
66	C4.5 vs. MLP	5.398667	0	0.001515
65	BaggingTPMinerEuclidean vs. MLP	5.267631	0	0.001818
64	MLP vs. NBayes	5.057974	0	0.001818
63	C4.5 vs. PBC4cip	4.560039	0.000005	0.001818
62	C4.5 vs. RF	4.507625	0.000007	0.001818
61	MLP vs. OCKRA	4.481418	0.000007	0.001818
60	BaggingTPMinerEuclidean vs. PBC4cip	4.429003	0.000009	0.001818
59	BaggingTPMinerEuclidean vs. RF	4.376589	0.000012	0.001818
58	NBayes vs. PBC4cip	4.219346	0.000025	0.001818
57	NBayes vs. RF	4.166932	0.000031	0.001818
56	3NN vs. MLP	4.114518	0.000039	0.001818
55	PBC4cip vs. OCKRA	3.64279	0.00027	0.001818
54	RF vs. OCKRA	3.590376	0.00033	0.002174
53	MLP vs. SVM	3.302097	0.00096	0.002174
52	3NN vs. PBC4cip	3.27589	0.001053	0.002174
51	3NN vs. RF	3.223476	0.001266	0.002174
50	MLP vs. TreeBagger	3.197269	0.001387	0.002174
49	AB.M1 vs. MLP	2.804162	0.005045	0.002174
48	LogReg vs. MLP	2.699333	0.006948	0.002174
47	C4.5 vs. LogReg	2.699333	0.006948	0.002174
46	AB.M1 vs. C4.5	2.594505	0.009473	0.002174
45	BaggingTPMinerEuclidean vs. LogReg	2.568298	0.01022	0.002222
44	AB.M1 vs. BaggingTPMinerEuclidean	2.463469	0.01376	0.002273
43	SVM vs. PBC4cip	2.463469	0.01376	0.002326
42	RF vs. SVM	2.411055	0.015906	0.002381
41	LogReg vs. NBayes	2.358641	0.018342	0.002439
40	TreeBagger vs. PBC4cip	2.358641	0.018342	0.0025
39	RF vs. TreeBagger	2.306227	0.021098	0.002564
38	AB.M1 vs. NBayes	2.253812	0.024208	0.002632
37	C4.5 vs. TreeBagger	2.201398	0.027708	0.002703
36	C4.5 vs. SVM	2.09657	0.036032	0.002778
35	BaggingTPMinerEuclidean vs. TreeBagger	2.070363	0.038418	0.002857
34	BaggingTPMinerEuclidean vs. SVM	1.965534	0.049352	0.002941
33	AB.M1 vs. PBC4cip	1.965534	0.049352	0.00303
32	AB.M1 vs. RF	1.91312	0.055733	0.003125
31	NBayes vs. TreeBagger	1.860706	0.062786	0.003226
30	LogReg vs. PBC4cip	1.860706	0.062786	0.003333
29	LogReg vs. RF	1.808291	0.070561	0.003448
28	LogReg vs. OCKRA	1.782084	0.074735	0.003571
27	NBayes vs. SVM	1.755877	0.079109	0.003704
26	AB.M1 vs. OCKRA	1.677256	0.093492	0.003846
25	3NN vs. LogReg	1.415185	0.157014	0.004
24	3NN vs. AB.M1	1.310356	0.190075	0.004167
23	3NN vs. C4.5	1.284149	0.19909	0.004348
22	TreeBagger vs. OCKRA	1.284149	0.19909	0.004545
21	SVM vs. OCKRA	1.17932	0.238271	0.004762
20	3NN vs. BaggingTPMinerEuclidean	1.153113	0.248864	0.005
19	3NN vs. NBayes	0.943456	0.345448	0.005263
18	3NN vs. TreeBagger	0.917249	0.359012	0.005556
17	C4.5 vs. OCKRA	0.917249	0.359012	0.005882
16	MLP vs. RF	0.891042	0.372907	0.00625
15	MLP vs. PBC4cip	0.838628	0.401678	0.006667
14	3NN vs. SVM	0.812421	0.41655	0.007143
13	BaggingTPMinerEuclidean vs. OCKRA	0.786214	0.431742	0.007692
12	LogReg vs. SVM	0.602764	0.546666	0.008333
11	NBayes vs. OCKRA	0.576557	0.564239	0.009091
10	LogReg vs. TreeBagger	0.497935	0.61853	0.01
9	AB.M1 vs. SVM	0.497935	0.61853	0.011111
8	AB.M1 vs. TreeBagger	0.393107	0.694241	0.0125
7	3NN vs. OCKRA	0.3669	0.713694	0.014286
6	C4.5 vs. NBayes	0.340693	0.733335	0.016667
5	BaggingTPMinerEuclidean vs. NBayes	0.209657	0.833935	0.02
4	C4.5 vs. BaggingTPMinerEuclidean	0.131036	0.895747	0.025
3	AB.M1 vs. LogReg	0.104828	0.916512	0.033333
2	SVM vs. TreeBagger	0.104828	0.916512	0.05
1	RF vs. PBC4cip	0.052414	0.958199	0.1

Table 3: P-values Table for $\alpha = 0.10$

Shaffer's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.001515.

2.3 Adjusted p-values

i	hypothesis	unadjusted p	p_{Shaf}
1	C4.5 vs .MLP	0	0.000004
2	BaggingTPMinerEuclidean vs .MLP	0	0.000008
3	MLP vs .NBayes	0	0.000023
4	C4.5 vs .PBC4cip	0.000005	0.000281
5	C4.5 vs .RF	0.000007	0.000361
6	MLP vs .OCKRA	0.000007	0.000408
7	BaggingTPMinerEuclidean vs .PBC4cip	0.000009	0.000521
8	BaggingTPMinerEuclidean vs .RF	0.000012	0.000663
9	NBayes vs .PBC4cip	0.000025	0.001348
10	NBayes vs .RF	0.000031	0.001698
11	3NN vs .MLP	0.000039	0.002134
12	PBC4cip vs .OCKRA	0.00027	0.014833
13	RF vs .OCKRA	0.00033	0.015189
14	MLP vs .SVM	0.00096	0.044144
15	3NN vs .PBC4cip	0.001053	0.048452
16	3NN vs .RF	0.001266	0.058257
17	MLP vs .TreeBagger	0.001387	0.063818
18	AB.M1 vs .MLP	0.005045	0.232059
19	LogReg vs .MLP	0.006948	0.319601
20	C4.5 vs .LogReg	0.006948	0.319601
21	AB.M1 vs .C4.5	0.009473	0.435745
22	BaggingTPMinerEuclidean vs .LogReg	0.01022	0.459897
23	AB.M1 vs .BaggingTPMinerEuclidean	0.01376	0.536639
24	SVM vs .PBC4cip	0.01376	0.536639
25	RF vs .SVM	0.015906	0.620351
26	LogReg vs .NBayes	0.018342	0.715338
27	TreeBagger vs .PBC4cip	0.018342	0.715338
28	RF vs .TreeBagger	0.021098	0.822821
29	AB.M1 vs .NBayes	0.024208	0.895695
30	C4.5 vs .TreeBagger	0.027708	1.02519
31	C4.5 vs .SVM	0.036032	1.297141
32	BaggingTPMinerEuclidean vs .TreeBagger	0.038418	1.306226
33	BaggingTPMinerEuclidean vs .SVM	0.049352	1.677984
34	AB.M1 vs .PBC4cip	0.049352	1.677984
35	AB.M1 vs .RF	0.055733	1.727714
36	NBayes vs .TreeBagger	0.062786	1.946359
37	LogReg vs .PBC4cip	0.062786	1.946359
38	LogReg vs .RF	0.070561	2.046274
39	LogReg vs .OCKRA	0.074735	2.092594
40	NBayes vs .SVM	0.079109	2.135954
41	AB.M1 vs .OCKRA	0.093492	2.337312
42	3NN vs .LogReg	0.157014	3.92536
43	3NN vs .AB.M1	0.190075	4.56181
44	3NN vs .C4.5	0.19909	4.579067
45	TreeBagger vs .OCKRA	0.19909	4.579067
46	SVM vs .OCKRA	0.238271	5.003683
47	3NN vs .BaggingTPMinerEuclidean	0.248864	5.003683
48	3NN vs .NBayes	0.345448	6.563503
49	3NN vs .TreeBagger	0.359012	6.563503
50	C4.5 vs .OCKRA	0.359012	6.563503
51	MLP vs .RF	0.372907	6.563503
52	MLP vs .PBC4cip	0.401678	6.563503
53	3NN vs .SVM	0.41655	6.563503
54	BaggingTPMinerEuclidean vs .OCKRA	0.431742	6.563503
55	LogReg vs .SVM	0.546666	6.563503
56	NBayes vs .OCKRA	0.564239	6.563503
57	LogReg vs .TreeBagger	0.61853	6.563503
58	AB.M1 vs .SVM	0.61853	6.563503
59	AB.M1 vs .TreeBagger	0.694241	6.563503
60	3NN vs .OCKRA	0.713694	6.563503
61	C4.5 vs .NBayes	0.733335	6.563503
62	BaggingTPMinerEuclidean vs .NBayes	0.833935	6.563503
63	C4.5 vs .BaggingTPMinerEuclidean	0.895747	6.563503
64	AB.M1 vs .LogReg	0.916512	6.563503
65	SVM vs .TreeBagger	0.916512	6.563503
66	RF vs .PBC4cip	0.958199	6.563503

Table 4: Adjusted p-values