```
 1 C:\Users\Sapan\Downloads\4p76Assign1\assign1\venv\Scripts\python.exe C:/Users/Sapan/
   Downloads/4p76Assign1/assign1/main.py
 2 Enter 1 for Digits classification, Enter 2 for Cancer classification: 1
 3 Enter number of tests to compare (only works on 3), if don't want to run tests just
   single run enter 1: 3
 4 Give name to your Test for files: digit_momentum
 5
 6 Test no.: 0
 7 Enter number of neurons for hidden layer: 25
 8 Enter number of epochs: 25
 9 Enter 1 for sigmoid or 2 for tanh activation function: 1
10 Enter learning rate: 1.7
11 Enter Momentum: 0.15
12 Running---------
13 Fold no.:  0
14 Accumulated sum error over epochs:  [32718.18685516299, 22486.77974468117, 7808.
   967263921127, 4059.1721242887907, 2865.513586387602, 1607.8269343676027, 1214.
   9021857573189, 1073.846459158084, 902.0482502094309, 895.2775630301682, 782.1917523995725
   , 772.2741607744678, 754.4040551039841, 704.3011433966919, 684.9406052677277, 639.
   5096712290707, 657.5211594778262, 605.7553184905763, 647.4634655827963, 557.5649944462423
   , 555.7680172967644, 501.3170933452908, 560.6661245704245, 526.156405505446, 537.
   1461924104143]
15
16 Correct classification validation set:  1589
17
18 Correct classification test set:  3619
19 end of fold
20
21 Running---------
22 Fold no.:  1
23 Accumulated sum error over epochs:  [40397.407735998975, 8170.771755643622, 5712.
   151472375217, 5201.357658817725, 2991.7491026927823, 1611.1097912530045, 1291.
   9946271069582, 1184.953781199514, 1047.6158472887844, 998.0638587429012, 867.484463633124
   , 844.7618833501655, 849.4478913233905, 850.8992527317554, 755.95778291429, 728.
   4825372145285, 695.8781598342655, 615.706917709496, 674.6925002503201, 605.3748590447154
   , 557.280770017249, 550.1358853644982, 557.249249254777, 544.7522457582602, 509.
   13953282115824]
24
25 Correct classification validation set:  1607
26
27 Correct classification test set:  3722
28 end of fold
29
30 Running---------
31 Fold no.:  2
32 Accumulated sum error over epochs:  [30487.711553035195, 16364.741612088083, 13958.
   222486169007, 13655.505100469245, 11099.141025963007, 3510.2115572817715, 2058.
   2407084167507, 1198.487567058223, 1032.2666700532732, 923.5760060820755, 854.
   3730838879388, 859.2697698698929, 802.1595799633235, 762.9809270626596, 733.1157470164632
   , 752.8219720887579, 675.3256011141045, 631.074200369604, 625.3477091407327, 607.
   013949254244, 615.3300569290909, 564.9108081751515, 544.2392766891903, 567.3558002602882
   , 516.7043726288915]
33
34 Correct classification validation set:  1634
35
36 Correct classification test set:  3695
37 end of fold
38
39 Running---------
40 Fold no.:  3
41 Accumulated sum error over epochs:  [43603.41042349399, 43069.231383312814, 32313.
   13567259361, 22366.214280392258, 22103.192988065057, 21555.595667899193, 21412.
   867761549915, 15887.050198654188, 10190.46469297297, 3938.3135464705465, 1596.
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41 5953641030444, 1168.1466290407031, 1080.8767892141082, 926.3372288586329, 909.
    8686344124728, 813.5642420617737, 743.2849315121775, 765.385713423965, 691.662334273769
    , 659.6445957866291, 658.2398901956623, 644.4461211392228, 611.2713375455795, 629.
    3353100509639, 626.9622300932415]
42
43 Correct classification validation set:  1603
44
45 Correct classification test set:  3685
46 end of fold
47
48 Fold test accuracies%:  [90.47500000000001, 93.05, 92.375, 92.125]
49 Fold validation accuracies%:  [90.85191538021726, 91.88107489994283, 93.42481417953115,
    91.65237278444826]
50 Mean fold validation accuracies%:  91.95254431103487
51
52 Test no.: 1
53 Enter number of neurons for hidden layer: 25
54 Enter number of epochs: 25
55 Enter 1 for sigmoid or 2 for tanh activation function: 1
56 Enter learning rate: 1.7
57 Enter Momentum: 0.5
58 Running---------
59 Fold no.:  0
60 Accumulated sum error over epochs:  [43174.77847823563, 16977.186882090013, 7180.
    215035759389, 4387.062947229955, 3583.583426789519, 3514.265848856747, 3451.932799981806
    , 3460.483503701717, 3412.366807235465, 3409.5631155541028, 3402.1754756612354, 3389.
    0143573703435, 3382.6213242783106, 3365.827760736631, 3372.7089724789844, 3355.
    323850387542, 3347.0337562133686, 3339.6890807741893, 3148.8778048047934, 3019.
    3169586217136, 2967.968026334477, 2989.354726779152, 2949.461572630801, 2952.
    3601235303277, 2927.0262254243376]
61
62 Correct classification validation set:  827
63
64 Correct classification test set:  1855
65 end of fold
66
67 Running---------
68 Fold no.:  1
69 Accumulated sum error over epochs:  [15594.005949988392, 9203.65634682858, 9000.
    596106383973, 8781.06076391943, 6579.677193145347, 4052.6474515587456, 3732.
    5649273807535, 3706.6639248231704, 3644.3474452944274, 3634.3069363390723, 3574.
    652790090555, 3524.8147340738487, 3515.7997183397033, 3481.3708791280883, 3445.
    8560223980976, 3162.166345311554, 3055.8787299643345, 3027.701105527306, 2994.
    841869419546, 2992.841742851589, 3008.2027852593947, 2960.7042866476995, 2938.
    975475108951, 2921.0821679138126, 2893.893627856423]
70
71 Correct classification validation set:  826
72
73 Correct classification test set:  1918
74 end of fold
75
76 Running---------
77 Fold no.:  2
78 Accumulated sum error over epochs:  [14175.738300382547, 9305.073973439035, 7345.
    603116722468, 4316.610530456467, 3915.4259614078246, 3235.77189740491, 2641.714371396593
    , 2549.819655685682, 2518.4495405272864, 2504.622101518102, 2459.2929269746774, 2445.
    7471198795847, 2443.7094287307627, 2412.033860698522, 2399.396790669895, 2419.
    9312052780847, 2399.643431126174, 2373.2144978612896, 2357.8890840907043, 2362.
    047848012087, 2359.2423214706037, 2365.7047030371564, 2322.056538895954, 2330.
    7675470217805, 2330.4308680811246]
79
80 Correct classification validation set:  981
81
```

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 82 Correct classification test set:   2295
 83 end of fold
 84
 85 Running---------
 86 Fold no.:   3
 87 Accumulated sum error over epochs:  [28465.49908696391, 9503.150968329937, 7158.
    911181560772, 4964.417366947348, 4802.801808613942, 4354.205513071039, 3916.
    7589874339446, 3526.9122008680715, 3485.6528541502626, 3389.535435673578, 3359.
    8256509515545, 3331.513908079516, 3286.316740306292, 3274.0865091565734, 3229.
    2290244170686, 3248.4768471771454, 3218.4246414548875, 3171.4276996654253, 3170.
    67373788011, 3108.056492317528, 3117.7584869344655, 3100.5197137983414, 3098.
    047378670691, 3087.8691119242426, 3077.844174144417]
 88
 89 Correct classification validation set:   803
 90
 91 Correct classification test set:   1847
 92 end of fold
 93
 94 Fold test accuracies%:  [46.375, 47.949999999999996, 57.375, 46.175]
 95 Fold validation accuracies%:  [47.284162378502, 47.22698684962836, 56.089193825042884,
    45.911949685534594]
 96 Mean fold validation accuracies%:  49.128073184676964
 97
 98 Test no.: 2
 99 Enter number of neurons for hidden layer: 25
100 Enter number of epochs: 25
101 Enter 1 for sigmoid or 2 for tanh activation function: 1
102 Enter learning rate: 1.7
103 Enter Momentum: 0.85
104 Running---------
105 Fold no.:   0
106 Accumulated sum error over epochs:  [20715.859800342387, 8712.992843155167, 5274.
    959806852399, 5281.780792304994, 5200.392274047932, 4862.983794710205, 4845.570909726933
    , 4809.271824040734, 4819.226783459641, 4812.302289570171, 4812.549426945029, 4831.
    395157769089, 4803.3208578032, 4802.446320816478, 4800.36367208871, 4800.91736626699,
    4790.886543036269, 4790.456159668144, 4790.370135389669, 4784.196737318348, 4796.
    4936975257915, 4778.7507196474935, 4780.008372800811, 4787.688050149433, 4771.
    1558203694785]
107
108 Correct classification validation set:   189
109
110 Correct classification test set:   400
111 end of fold
112
113 Running---------
114 Fold no.:   1
115 Accumulated sum error over epochs:  [24792.23214966898, 5300.538578794845, 5287.
    2711338078925, 5289.00864555812, 5291.165183133187, 5290.7819021775795, 5289.
    663039251213, 5289.77730575578, 5291.426348329086, 5291.338744303875, 5295.267770552997
    , 5298.625545810833, 5300.171506333282, 5294.771469499133, 5291.6229702918035, 5286.
    064254421995, 5292.256564226454, 5285.708549890824, 5282.236968090914, 5296.67925058734
    , 5295.458239956575, 4919.817035897372, 4760.845815183912, 4746.496659880187, 4748.
    3597765055565]
116
117 Correct classification validation set:   161
118
119 Correct classification test set:   400
120 end of fold
121
122 Running---------
123 Fold no.:   2
124 Accumulated sum error over epochs:  [12519.334170330996, 5300.95594882806, 5296.
    117231651747, 5302.807980509905, 5294.115932939414, 5290.4554139989705, 5295.
```

```
124 077774065243, 5297.154463519703, 5290.549434960178, 5287.354399587281, 5281.814794558567
    , 5284.787316798921, 5291.227829500289, 5289.391642848953, 5301.933643630362, 5294.
    1085914451505, 5284.737328045643, 5280.279796816903, 5298.092820571461, 5290.
    642549237538, 5290.068062812277, 5300.036764007868, 5292.8641620078315, 5285.
    760003852532, 5292.010627768211]
125
126 Correct classification validation set:  169
127
128 Correct classification test set:  400
129 end of fold
130
131 Running---------
132 Fold no.:  3
133 Accumulated sum error over epochs:  [24158.368220146374, 10690.370350839941, 5285.
    343620583893, 5284.218238771269, 5270.819553028861, 5266.991665294794, 5270.739293054191
    , 5273.081187506258, 5269.162010111559, 5275.952765008311, 5269.482059452877, 5271.
    7312798269095, 5274.056801801343, 5276.201901349819, 5276.942165551363, 5276.
    545016309262, 5271.979215196041, 5283.258968655391, 5284.338658169873, 5276.397588211916
    , 5272.6421815786125, 5282.36728110536, 5289.11191080433, 5285.021420206339, 5278.
    253426624508]
134
135 Correct classification validation set:  181
136
137 Correct classification test set:  400
138 end of fold
139
140 Fold test accuracies%:  [10.0, 10.0, 10.0, 10.0]
141 Fold validation accuracies%:  [10.806174957118353, 9.205260148656375, 9.662664379645513
    , 10.348770726129217]
142 Mean fold validation accuracies%:  10.005717552887365
143
144 Test results:
145      test0    test1    test2
146 0   90.475   46.375    10.0
147 1   93.050   47.950    10.0
148 2   92.375   57.375    10.0
149 3   92.125   46.175    10.0
150 Test stats:
151            test0       test1   test2
152 count   4.000000    4.000000     4.0
153 mean   92.006250   49.468750    10.0
154 std     1.093041    5.330274     0.0
155 min    90.475000   46.175000    10.0
156 25%    91.712500   46.325000    10.0
157 50%    92.250000   47.162500    10.0
158 75%    92.543750   50.306250    10.0
159 max    93.050000   57.375000    10.0
160
161 Validation results:
162      test0        test1        test2
163 0   90.851915   47.284162   10.806175
164 1   91.881075   47.226987    9.205260
165 2   93.424814   56.089194    9.662664
166 3   91.652373   45.911950   10.348771
167 Valid stats:
168            test0       test1        test2
169 count   4.000000    4.000000     4.000000
170 mean   91.952544   49.128073   10.005718
171 std     1.076131    4.683830    0.711064
172 min    90.851915   45.911950    9.205260
173 25%    91.452258   46.898228    9.548313
174 50%    91.766724   47.255575   10.005718
175 75%    92.267010   49.485420   10.463122
```

```
176 max       93.424814   56.089194   10.806175
177
178 shapiro test for testing accuracies
179 test0 stats=0.9153, p=0.5111
180 test1 stats=0.7432, p=0.0333
181 test2 stats=1.0000, p=1.0000
182
183 shapiro test for validation accuracies
184 test0 stats=0.9391, p=0.6491
185 test1 stats=0.7454, p=0.0349
186 test2 stats=0.9722, p=0.8552
187
188 ANOVA test
189                       sum_sq  df          F     PR(>F)
190 df_test.iloc[:, 1]    0.378030  1.0    0.235813  0.675237
191 df_test.iloc[:, 2]  271.741449  1.0  169.510589  0.005848
192 Residual              3.206188  2.0         NaN       NaN
193
194 t-tests:
195 Ttest_indResult(statistic=15.635362862200564, pvalue=0.00035894378619672884)
196 Ttest_indResult(statistic=14.809275699421347, pvalue=0.0006680146919011217)
197 Ttest_indResult(statistic=150.05149340651573, pvalue=6.526500031761628e-07)
198
199 Statistically better mean available, the one with highest average accuracy
200 C:\Users\Sapan\Downloads\4p76Assign1\assign1\venv\lib\site-packages\scipy\stats\
    morestats.py:1678: UserWarning: Input data for shapiro has range zero. The results may
    not be accurate.
201   warnings.warn("Input data for shapiro has range zero. The results "
202
203 Process finished with exit code 0
204
```