

File - main

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1 /usr/local/bin/python3.12 /Users/lorispalmarin/PycharmProjects/MachLear/main.py
2 First rows of the dataset:
3          x1          x2          x3          x4 ...          x8          x9          x10   y
4 0  1.205492  5.823226  98.837539 -1.075852 ... -1.720267 -0.346191 -54.708330 -1
5 1  1.391530  3.611581  98.857197 -5.020318 ...  4.253865  2.041603 -54.317291  1
6 2  1.692571 -0.887019 100.901276 -0.595548 ...  0.907834  3.126815 -56.397484 -1
7 3  4.289320  1.416843 100.784735 -2.897154 ...  1.336237  2.183829 -56.197728  1
8 4  0.542420 -1.010095 100.015580 -3.070705 ... -0.284683 -2.104145 -55.794045  1
9
10 [5 rows x 11 columns]
11
12 Statistical summary:
13          x1          x2 ...          x10   y
14 count  10000.000000 10000.000000 ... 10000.000000 10000.000000
15 mean   1.591298   0.515879 ... -55.447678 -0.001600
16 std    1.321185   2.054488 ...  0.710082  1.000049
17 min    0.002443  -7.524934 ... -56.773931 -1.000000
18 25%   0.524758  -0.883862 ... -56.137679 -1.000000
19 50%   1.276243   0.492813 ... -55.397208 -1.000000
20 75%   2.352106   1.902003 ... -54.758351  1.000000
21 max   9.384223   8.302375 ... -54.208890  1.000000
22
23 [8 rows x 11 columns]
24 Final dataset shape: (9733, 11)
25
26 Statistical summary of training set after standardisation:
27          0          1 ...          6          7
28 count  7.786000e+03 7.786000e+03 ... 7.786000e+03 7.786000e+03
29 mean  -1.108797e-15 -2.628260e-16 ... -9.226287e-16 -2.920289e-17
30 std   1.000064e+00  1.000064e+00 ...  1.000064e+00  1.000064e+00
31 min  -1.210816e+00 -2.728141e+00 ... -2.793592e+00 -2.760765e+00
32 25%  -8.115617e-01 -6.980145e-01 ... -6.936736e-01 -6.787072e-01
33 50%  -2.333511e-01 -1.176852e-02 ... -9.258075e-03 -1.798967e-02
34 75%  5.805372e-01  6.981031e-01 ...  6.718357e-01  6.861826e-01
35 max   5.958668e+00  2.810010e+00 ...  2.756846e+00  2.753401e+00
36
37 [8 rows x 8 columns]
38 Running Perceptron with 3 different max_epochs: (1000, 2000, 5000), using 5-fold
cross-validation.
39 Training with parameters: max_epochs=1000
40 Max epochs (1000) reached. NO convergence.
41 Accuracy on training set: 0.6342
42 Training with parameters: max_epochs=1000
43 Max epochs (1000) reached. NO convergence.
44 Accuracy on training set: 0.6820
45 Training with parameters: max_epochs=1000
46 Max epochs (1000) reached. NO convergence.
47 Accuracy on training set: 0.6597
48 Training with parameters: max_epochs=1000
49 Max epochs (1000) reached. NO convergence.
50 Accuracy on training set: 0.6320
51 Training with parameters: max_epochs=1000
52 Max epochs (1000) reached. NO convergence.
53 Accuracy on training set: 0.5693
54 Training with parameters: max_epochs=2000
55 Max epochs (2000) reached. NO convergence.
56 Accuracy on training set: 0.6574
57 Training with parameters: max_epochs=2000
58 Max epochs (2000) reached. NO convergence.
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59 Accuracy on training set: 0.6794
60 Training with parameters: max_epochs=2000
61 Max epochs (2000) reached. NO convergence.
62 Accuracy on training set: 0.6364
63 Training with parameters: max_epochs=2000
64 Max epochs (2000) reached. NO convergence.
65 Accuracy on training set: 0.5868
66 Training with parameters: max_epochs=2000
67 Max epochs (2000) reached. NO convergence.
68 Accuracy on training set: 0.5645
69 Training with parameters: max_epochs=5000
70 Max epochs (5000) reached. NO convergence.
71 Accuracy on training set: 0.6549
72 Training with parameters: max_epochs=5000
73 Max epochs (5000) reached. NO convergence.
74 Accuracy on training set: 0.6720
75 Training with parameters: max_epochs=5000
76 Max epochs (5000) reached. NO convergence.
77 Accuracy on training set: 0.6336
78 Training with parameters: max_epochs=5000
79 Max epochs (5000) reached. NO convergence.
80 Accuracy on training set: 0.6015
81 Training with parameters: max_epochs=5000
82 Max epochs (5000) reached. NO convergence.
83 Accuracy on training set: 0.6105
84 Accuracy scores for each fold (1000 epochs): [0.63029525 0.69749518 0.63134232 0.
61528581 0.5728966 ]
85 Mean cross-validation accuracy (1000 epochs): 0.6294630320808837
86 Accuracy scores for each fold (2000 epochs): [0.65404365 0.69171484 0.60950546 0.
55748234 0.5728966 ]
87 Mean cross-validation accuracy (2000 epochs): 0.6171285749973411
88 Accuracy scores for each fold (5000 epochs): [0.65661104 0.68272319 0.60950546 0.
57482338 0.62813102]
89 Mean cross-validation accuracy (5000 epochs): 0.6303588168221201
90 Training with parameters: max_epochs=1000
91 Max epochs (1000) reached. NO convergence.
92 Accuracy on training set: 0.5965
93 Accuracy on test set: 0.60
94
95 Running Support Vector Machine with different values of parameters
96 Using grid search with 5-fold cross validation:
97 {'lambda_param': [0.001, 0.01, 0.1, 1], 'max_iter': [1000, 2000, 5000]}
98 Training with parameters: max_iter: 1000, lambda: 0.001
99 Accuracy on training set: 0.6896
100 Training with parameters: max_iter: 1000, lambda: 0.001
101 Accuracy on training set: 0.6884
102 Training with parameters: max_iter: 1000, lambda: 0.001
103 Accuracy on training set: 0.7126
104 Training with parameters: max_iter: 1000, lambda: 0.001
105 Accuracy on training set: 0.7062
106 Training with parameters: max_iter: 1000, lambda: 0.001
107 Accuracy on training set: 0.7022
108 Accuracy with lambda ( 0.001 ) and max_iter ( 1000 ) is 0.7029278516089086
109 Training with parameters: max_iter: 2000, lambda: 0.001
110 Accuracy on training set: 0.6930
111 Training with parameters: max_iter: 2000, lambda: 0.001
112 Accuracy on training set: 0.7173
113 Training with parameters: max_iter: 2000, lambda: 0.001
114 Accuracy on training set: 0.7125
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115 Training with parameters: max_iter: 2000, lambda: 0.001
116 Accuracy on training set: 0.7142
117 Training with parameters: max_iter: 2000, lambda: 0.001
118 Accuracy on training set: 0.7017
119 Accuracy with lambda ( 0.001 ) and max_iter ( 2000 ) is 0.7012620959796456
120 Training with parameters: max_iter: 5000, lambda: 0.001
121 Accuracy on training set: 0.7028
122 Training with parameters: max_iter: 5000, lambda: 0.001
123 Accuracy on training set: 0.6955
124 Training with parameters: max_iter: 5000, lambda: 0.001
125 Accuracy on training set: 0.7122
126 Training with parameters: max_iter: 5000, lambda: 0.001
127 Accuracy on training set: 0.6982
128 Training with parameters: max_iter: 5000, lambda: 0.001
129 Accuracy on training set: 0.7097
130 Accuracy with lambda ( 0.001 ) and max_iter ( 5000 ) is 0.6963781934746638
131 Training with parameters: max_iter: 1000, lambda: 0.01
132 Accuracy on training set: 0.7225
133 Training with parameters: max_iter: 1000, lambda: 0.01
134 Accuracy on training set: 0.7170
135 Training with parameters: max_iter: 1000, lambda: 0.01
136 Accuracy on training set: 0.7160
137 Training with parameters: max_iter: 1000, lambda: 0.01
138 Accuracy on training set: 0.7093
139 Training with parameters: max_iter: 1000, lambda: 0.01
140 Accuracy on training set: 0.7003
141 Accuracy with lambda ( 0.01 ) and max_iter ( 1000 ) is 0.7133315689713027
142 Training with parameters: max_iter: 2000, lambda: 0.01
143 Accuracy on training set: 0.7147
144 Training with parameters: max_iter: 2000, lambda: 0.01
145 Accuracy on training set: 0.7138
146 Training with parameters: max_iter: 2000, lambda: 0.01
147 Accuracy on training set: 0.7165
148 Training with parameters: max_iter: 2000, lambda: 0.01
149 Accuracy on training set: 0.7064
150 Training with parameters: max_iter: 2000, lambda: 0.01
151 Accuracy on training set: 0.7173
152 Accuracy with lambda ( 0.01 ) and max_iter ( 2000 ) is 0.7134614227188818
153 Training with parameters: max_iter: 5000, lambda: 0.01
154 Accuracy on training set: 0.7238
155 Training with parameters: max_iter: 5000, lambda: 0.01
156 Accuracy on training set: 0.7242
157 Training with parameters: max_iter: 5000, lambda: 0.01
158 Accuracy on training set: 0.7242
159 Training with parameters: max_iter: 5000, lambda: 0.01
160 Accuracy on training set: 0.7232
161 Training with parameters: max_iter: 5000, lambda: 0.01
162 Accuracy on training set: 0.7179
163 Accuracy with lambda ( 0.01 ) and max_iter ( 5000 ) is 0.7254050818573291
164 Training with parameters: max_iter: 1000, lambda: 0.1
165 Accuracy on training set: 0.7182
166 Training with parameters: max_iter: 1000, lambda: 0.1
167 Accuracy on training set: 0.7247
168 Training with parameters: max_iter: 1000, lambda: 0.1
169 Accuracy on training set: 0.7215
170 Training with parameters: max_iter: 1000, lambda: 0.1
171 Accuracy on training set: 0.7263
172 Training with parameters: max_iter: 1000, lambda: 0.1
173 Accuracy on training set: 0.7157
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174 Accuracy with Lambda ( 0.1 ) and max_iter ( 1000 ) is 0.718214647008046
175 Training with parameters: max_iter: 2000, lambda: 0.1
176 Accuracy on training set: 0.7176
177 Training with parameters: max_iter: 2000, lambda: 0.1
178 Accuracy on training set: 0.7136
179 Training with parameters: max_iter: 2000, lambda: 0.1
180 Accuracy on training set: 0.7208
181 Training with parameters: max_iter: 2000, lambda: 0.1
182 Accuracy on training set: 0.7266
183 Training with parameters: max_iter: 2000, lambda: 0.1
184 Accuracy on training set: 0.7211
185 Accuracy with lambda ( 0.1 ) and max_iter ( 2000 ) is 0.7174436043113093
186 Training with parameters: max_iter: 5000, lambda: 0.1
187 Accuracy on training set: 0.7219
188 Training with parameters: max_iter: 5000, lambda: 0.1
189 Accuracy on training set: 0.7191
190 Training with parameters: max_iter: 5000, lambda: 0.1
191 Accuracy on training set: 0.7245
192 Training with parameters: max_iter: 5000, lambda: 0.1
193 Accuracy on training set: 0.7239
194 Training with parameters: max_iter: 5000, lambda: 0.1
195 Accuracy on training set: 0.7231
196 Accuracy with lambda ( 0.1 ) and max_iter ( 5000 ) is 0.7232227144297607
197 Training with parameters: max_iter: 1000, lambda: 1
198 Accuracy on training set: 0.7224
199 Training with parameters: max_iter: 1000, lambda: 1
200 Accuracy on training set: 0.7107
201 Training with parameters: max_iter: 1000, lambda: 1
202 Accuracy on training set: 0.7147
203 Training with parameters: max_iter: 1000, lambda: 1
204 Accuracy on training set: 0.7208
205 Training with parameters: max_iter: 1000, lambda: 1
206 Accuracy on training set: 0.7136
207 Accuracy with lambda ( 1 ) and max_iter ( 1000 ) is 0.7123037044182429
208 Training with parameters: max_iter: 2000, lambda: 1
209 Accuracy on training set: 0.7174
210 Training with parameters: max_iter: 2000, lambda: 1
211 Accuracy on training set: 0.7134
212 Training with parameters: max_iter: 2000, lambda: 1
213 Accuracy on training set: 0.7197
214 Training with parameters: max_iter: 2000, lambda: 1
215 Accuracy on training set: 0.7223
216 Training with parameters: max_iter: 2000, lambda: 1
217 Accuracy on training set: 0.7142
218 Accuracy with lambda ( 1 ) and max_iter ( 2000 ) is 0.7188550939357887
219 Training with parameters: max_iter: 5000, lambda: 1
220 Accuracy on training set: 0.7153
221 Training with parameters: max_iter: 5000, lambda: 1
222 Accuracy on training set: 0.7173
223 Training with parameters: max_iter: 5000, lambda: 1
224 Accuracy on training set: 0.7215
225 Training with parameters: max_iter: 5000, lambda: 1
226 Accuracy on training set: 0.7197
227 Training with parameters: max_iter: 5000, lambda: 1
228 Accuracy on training set: 0.7173
229 Accuracy with lambda ( 1 ) and max_iter ( 5000 ) is 0.7162858860106702
230 Best Parameters: {'lambda_param': 0.01, 'max_iter': 5000}
231 Best Cross-Validation Accuracy: 0.73
232 Training with parameters: max_iter: 5000, lambda: 0.01
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233 Accuracy on training set: 0.7163
234 Accuracy on test set: 0.73
235
236 Running Regularised Logistic Regression with different values of parameters
237 Grid search with 5-fold cross validation:
238 {'lambda_param': [0.001, 0.01, 0.1, 1], 'max_iter': [1000, 2000, 5000]}
239 Training with parameters: max_iter: 1000, lambda: 0.001
240 Accuracy on training set: 0.7126
241 Training with parameters: max_iter: 1000, lambda: 0.001
242 Accuracy on training set: 0.6913
243 Training with parameters: max_iter: 1000, lambda: 0.001
244 Accuracy on training set: 0.7120
245 Training with parameters: max_iter: 1000, lambda: 0.001
246 Accuracy on training set: 0.7224
247 Training with parameters: max_iter: 1000, lambda: 0.001
248 Accuracy on training set: 0.7064
249 Accuracy with Lambda ( 0.001 ) and max_iter ( 1000 ) is 0.7096067863629656
250 Training with parameters: max_iter: 2000, lambda: 0.001
251 Accuracy on training set: 0.7222
252 Training with parameters: max_iter: 2000, lambda: 0.001
253 Accuracy on training set: 0.7054
254 Training with parameters: max_iter: 2000, lambda: 0.001
255 Accuracy on training set: 0.7008
256 Training with parameters: max_iter: 2000, lambda: 0.001
257 Accuracy on training set: 0.7221
258 Training with parameters: max_iter: 2000, lambda: 0.001
259 Accuracy on training set: 0.7012
260 Accuracy with Lambda ( 0.001 ) and max_iter ( 2000 ) is 0.7090939671185577
261 Training with parameters: max_iter: 5000, lambda: 0.001
262 Accuracy on training set: 0.6673
263 Training with parameters: max_iter: 5000, lambda: 0.001
264 Accuracy on training set: 0.7131
265 Training with parameters: max_iter: 5000, lambda: 0.001
266 Accuracy on training set: 0.7223
267 Training with parameters: max_iter: 5000, lambda: 0.001
268 Accuracy on training set: 0.7125
269 Training with parameters: max_iter: 5000, lambda: 0.001
270 Accuracy on training set: 0.7096
271 Accuracy with lambda ( 0.001 ) and max_iter ( 5000 ) is 0.709097924566103
272 Training with parameters: max_iter: 1000, lambda: 0.01
273 Accuracy on training set: 0.7126
274 Training with parameters: max_iter: 1000, lambda: 0.01
275 Accuracy on training set: 0.6881
276 Training with parameters: max_iter: 1000, lambda: 0.01
277 Accuracy on training set: 0.6894
278 Training with parameters: max_iter: 1000, lambda: 0.01
279 Accuracy on training set: 0.7165
280 Training with parameters: max_iter: 1000, lambda: 0.01
281 Accuracy on training set: 0.7094
282 Accuracy with lambda ( 0.01 ) and max_iter ( 1000 ) is 0.7044701843428534
283 Training with parameters: max_iter: 2000, lambda: 0.01
284 Accuracy on training set: 0.7132
285 Training with parameters: max_iter: 2000, lambda: 0.01
286 Accuracy on training set: 0.7120
287 Training with parameters: max_iter: 2000, lambda: 0.01
288 Accuracy on training set: 0.7226
289 Training with parameters: max_iter: 2000, lambda: 0.01
290 Accuracy on training set: 0.7240
291 Training with parameters: max_iter: 2000, lambda: 0.01
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292 Accuracy on training set: 0.7179
293 Accuracy with lambda ( 0.01 ) and max_iter ( 2000 ) is 0.7120496857539309
294 Training with parameters: max_iter: 5000, lambda: 0.01
295 Accuracy on training set: 0.7238
296 Training with parameters: max_iter: 5000, lambda: 0.01
297 Accuracy on training set: 0.7202
298 Training with parameters: max_iter: 5000, lambda: 0.01
299 Accuracy on training set: 0.7247
300 Training with parameters: max_iter: 5000, lambda: 0.01
301 Accuracy on training set: 0.7219
302 Training with parameters: max_iter: 5000, lambda: 0.01
303 Accuracy on training set: 0.7123
304 Accuracy with lambda ( 0.01 ) and max_iter ( 5000 ) is 0.7216811237172305
305 Training with parameters: max_iter: 1000, lambda: 0.1
306 Accuracy on training set: 0.7185
307 Training with parameters: max_iter: 1000, lambda: 0.1
308 Accuracy on training set: 0.7229
309 Training with parameters: max_iter: 1000, lambda: 0.1
310 Accuracy on training set: 0.7263
311 Training with parameters: max_iter: 1000, lambda: 0.1
312 Accuracy on training set: 0.7191
313 Training with parameters: max_iter: 1000, lambda: 0.1
314 Accuracy on training set: 0.7123
315 Accuracy with lambda ( 0.1 ) and max_iter ( 1000 ) is 0.7196274557817072
316 Training with parameters: max_iter: 2000, lambda: 0.1
317 Accuracy on training set: 0.7219
318 Training with parameters: max_iter: 2000, lambda: 0.1
319 Accuracy on training set: 0.7208
320 Training with parameters: max_iter: 2000, lambda: 0.1
321 Accuracy on training set: 0.7215
322 Training with parameters: max_iter: 2000, lambda: 0.1
323 Accuracy on training set: 0.7242
324 Training with parameters: max_iter: 2000, lambda: 0.1
325 Accuracy on training set: 0.7186
326 Accuracy with lambda ( 0.1 ) and max_iter ( 2000 ) is 0.7219383578076729
327 Training with parameters: max_iter: 5000, lambda: 0.1
328 Accuracy on training set: 0.7266
329 Training with parameters: max_iter: 5000, lambda: 0.1
330 Accuracy on training set: 0.7146
331 Training with parameters: max_iter: 5000, lambda: 0.1
332 Accuracy on training set: 0.7210
333 Training with parameters: max_iter: 5000, lambda: 0.1
334 Accuracy on training set: 0.7250
335 Training with parameters: max_iter: 5000, lambda: 0.1
336 Accuracy on training set: 0.7197
337 Accuracy with lambda ( 0.1 ) and max_iter ( 5000 ) is 0.7214237247331402
338 Training with parameters: max_iter: 1000, lambda: 1
339 Accuracy on training set: 0.7118
340 Training with parameters: max_iter: 1000, lambda: 1
341 Accuracy on training set: 0.7080
342 Training with parameters: max_iter: 1000, lambda: 1
343 Accuracy on training set: 0.7183
344 Training with parameters: max_iter: 1000, lambda: 1
345 Accuracy on training set: 0.7203
346 Training with parameters: max_iter: 1000, lambda: 1
347 Accuracy on training set: 0.7022
348 Accuracy with lambda ( 1 ) and max_iter ( 1000 ) is 0.709222007036012
349 Training with parameters: max_iter: 2000, lambda: 1
350 Accuracy on training set: 0.7189
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351 Training with parameters: max_iter: 2000, lambda: 1
352 Accuracy on training set: 0.7147
353 Training with parameters: max_iter: 2000, lambda: 1
354 Accuracy on training set: 0.7215
355 Training with parameters: max_iter: 2000, lambda: 1
356 Accuracy on training set: 0.7181
357 Training with parameters: max_iter: 2000, lambda: 1
358 Accuracy on training set: 0.7144
359 Accuracy with Lambda ( 1 ) and max_iter ( 2000 ) is 0.7176984474438599
360 Training with parameters: max_iter: 5000, lambda: 1
361 Accuracy on training set: 0.7225
362 Training with parameters: max_iter: 5000, lambda: 1
363 Accuracy on training set: 0.7157
364 Training with parameters: max_iter: 5000, lambda: 1
365 Accuracy on training set: 0.7189
366 Training with parameters: max_iter: 5000, lambda: 1
367 Accuracy on training set: 0.7203
368 Training with parameters: max_iter: 5000, lambda: 1
369 Accuracy on training set: 0.7157
370 Accuracy with Lambda ( 1 ) and max_iter ( 5000 ) is 0.7167986228082542
371 Best Parameters: {'lambda_param': 0.1, 'max_iter': 2000}
372 Best Cross-Validation Accuracy: 0.72
373 Training with parameters: max_iter: 2000, lambda: 0.1
374 Accuracy on training set: 0.7246
375 Accuracy on test set: 0.74
376
377
378 Applying polynomial feature expansion of degree 2
379
380 Shape of original features: (7786, 8)
381 Shape of features after polynomial expansion: (7786, 44)
382 New list of features: ['x1', 'x2', 'x3', 'x4', 'x5', 'x6', 'x7', 'x8', 'x1*x1', 'x1*x2',
 'x1*x3', 'x1*x4', 'x1*x5', 'x1*x6', 'x1*x7', 'x1*x8', 'x2*x2', 'x2*x3', 'x2*x4',
 'x2*x5', 'x2*x6', 'x2*x7', 'x2*x8', 'x3*x3', 'x3*x4', 'x3*x5', 'x3*x6', 'x3*x7',
 'x3*x8', 'x4*x4', 'x4*x5', 'x4*x6', 'x4*x7', 'x4*x8', 'x5*x5', 'x5*x6', 'x5*x7',
 'x5*x8', 'x6*x6', 'x6*x7', 'x6*x8', 'x7*x7', 'x7*x8', 'x8*x8']
383
384 Running Perceptron
385 Training with parameters: max_epochs=1000
386 Max epochs (1000) reached. NO convergence.
387 Accuracy on training set: 0.6342
388 Training with parameters: max_epochs=1000
389 Max epochs (1000) reached. NO convergence.
390 Accuracy on training set: 0.6820
391 Training with parameters: max_epochs=1000
392 Max epochs (1000) reached. NO convergence.
393 Accuracy on training set: 0.6597
394 Training with parameters: max_epochs=1000
395 Max epochs (1000) reached. NO convergence.
396 Accuracy on training set: 0.6320
397 Training with parameters: max_epochs=1000
398 Max epochs (1000) reached. NO convergence.
399 Accuracy on training set: 0.5693
400 Training with parameters: max_epochs=1000
401 Max epochs (1000) reached. NO convergence.
402 Accuracy on training set: 0.9369
403 Training with parameters: max_epochs=1000
404 Max epochs (1000) reached. NO convergence.
405 Accuracy on training set: 0.9229
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406 Training with parameters: max_epochs=1000
407 Max epochs (1000) reached. NO convergence.
408 Accuracy on training set: 0.9226
409 Training with parameters: max_epochs=1000
410 Max epochs (1000) reached. NO convergence.
411 Accuracy on training set: 0.9167
412 Training with parameters: max_epochs=1000
413 Max epochs (1000) reached. NO convergence.
414 Accuracy on training set: 0.9148
415 Training with parameters: max_epochs=2000
416 Max epochs (2000) reached. NO convergence.
417 Accuracy on training set: 0.6574
418 Training with parameters: max_epochs=2000
419 Max epochs (2000) reached. NO convergence.
420 Accuracy on training set: 0.6794
421 Training with parameters: max_epochs=2000
422 Max epochs (2000) reached. NO convergence.
423 Accuracy on training set: 0.6364
424 Training with parameters: max_epochs=2000
425 Max epochs (2000) reached. NO convergence.
426 Accuracy on training set: 0.5868
427 Training with parameters: max_epochs=2000
428 Max epochs (2000) reached. NO convergence.
429 Accuracy on training set: 0.5645
430 Training with parameters: max_epochs=2000
431 Max epochs (2000) reached. NO convergence.
432 Accuracy on training set: 0.9345
433 Training with parameters: max_epochs=2000
434 Max epochs (2000) reached. NO convergence.
435 Accuracy on training set: 0.9212
436 Training with parameters: max_epochs=2000
437 Max epochs (2000) reached. NO convergence.
438 Accuracy on training set: 0.9202
439 Training with parameters: max_epochs=2000
440 Max epochs (2000) reached. NO convergence.
441 Accuracy on training set: 0.9223
442 Training with parameters: max_epochs=2000
443 Max epochs (2000) reached. NO convergence.
444 Accuracy on training set: 0.9162
445 Training with parameters: max_epochs=5000
446 Max epochs (5000) reached. NO convergence.
447 Accuracy on training set: 0.6549
448 Training with parameters: max_epochs=5000
449 Max epochs (5000) reached. NO convergence.
450 Accuracy on training set: 0.6720
451 Training with parameters: max_epochs=5000
452 Max epochs (5000) reached. NO convergence.
453 Accuracy on training set: 0.6336
454 Training with parameters: max_epochs=5000
455 Max epochs (5000) reached. NO convergence.
456 Accuracy on training set: 0.6015
457 Training with parameters: max_epochs=5000
458 Max epochs (5000) reached. NO convergence.
459 Accuracy on training set: 0.6105
460 Training with parameters: max_epochs=5000
461 Max epochs (5000) reached. NO convergence.
462 Accuracy on training set: 0.9363
463 Training with parameters: max_epochs=5000
464 Max epochs (5000) reached. NO convergence.
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465 Accuracy on training set: 0.9210
466 Training with parameters: max_epochs=5000
467 Max epochs (5000) reached. NO convergence.
468 Accuracy on training set: 0.9273
469 Training with parameters: max_epochs=5000
470 Max epochs (5000) reached. NO convergence.
471 Accuracy on training set: 0.9220
472 Training with parameters: max_epochs=5000
473 Max epochs (5000) reached. NO convergence.
474 Accuracy on training set: 0.9146
475 Best Parameters for Perceptron: {'max_iter': 5000}
476 Best Cross-Validation Accuracy: 0.92
477 Model with polynomial features is better.
478 Training with parameters: max_epochs=5000
479 Max epochs (5000) reached. NO convergence.
480 Accuracy on training set: 0.9184
481
482 Running SVM
483 Training with parameters: max_iter: 1000, lambda: 0.001
484 Accuracy on training set: 0.7034
485 Training with parameters: max_iter: 1000, lambda: 0.001
486 Accuracy on training set: 0.7139
487 Training with parameters: max_iter: 1000, lambda: 0.001
488 Accuracy on training set: 0.7036
489 Training with parameters: max_iter: 1000, lambda: 0.001
490 Accuracy on training set: 0.7072
491 Training with parameters: max_iter: 1000, lambda: 0.001
492 Accuracy on training set: 0.6974
493 Training with parameters: max_iter: 1000, lambda: 0.001
494 Accuracy on training set: 0.8247
495 Training with parameters: max_iter: 1000, lambda: 0.001
496 Accuracy on training set: 0.8446
497 Training with parameters: max_iter: 1000, lambda: 0.001
498 Accuracy on training set: 0.8529
499 Training with parameters: max_iter: 1000, lambda: 0.001
500 Accuracy on training set: 0.8759
501 Training with parameters: max_iter: 1000, lambda: 0.001
502 Accuracy on training set: 0.8537
503 Training with parameters: max_iter: 2000, lambda: 0.001
504 Accuracy on training set: 0.6826
505 Training with parameters: max_iter: 2000, lambda: 0.001
506 Accuracy on training set: 0.6971
507 Training with parameters: max_iter: 2000, lambda: 0.001
508 Accuracy on training set: 0.7030
509 Training with parameters: max_iter: 2000, lambda: 0.001
510 Accuracy on training set: 0.6836
511 Training with parameters: max_iter: 2000, lambda: 0.001
512 Accuracy on training set: 0.7136
513 Training with parameters: max_iter: 2000, lambda: 0.001
514 Accuracy on training set: 0.8749
515 Training with parameters: max_iter: 2000, lambda: 0.001
516 Accuracy on training set: 0.8891
517 Training with parameters: max_iter: 2000, lambda: 0.001
518 Accuracy on training set: 0.8727
519 Training with parameters: max_iter: 2000, lambda: 0.001
520 Accuracy on training set: 0.8916
521 Training with parameters: max_iter: 2000, lambda: 0.001
522 Accuracy on training set: 0.8772
523 Training with parameters: max_iter: 5000, lambda: 0.001
```

```
524 Accuracy on training set: 0.7081
525 Training with parameters: max_iter: 5000, lambda: 0.001
526 Accuracy on training set: 0.7118
527 Training with parameters: max_iter: 5000, lambda: 0.001
528 Accuracy on training set: 0.7292
529 Training with parameters: max_iter: 5000, lambda: 0.001
530 Accuracy on training set: 0.7083
531 Training with parameters: max_iter: 5000, lambda: 0.001
532 Accuracy on training set: 0.7114
533 Training with parameters: max_iter: 5000, lambda: 0.001
534 Accuracy on training set: 0.9123
535 Training with parameters: max_iter: 5000, lambda: 0.001
536 Accuracy on training set: 0.9079
537 Training with parameters: max_iter: 5000, lambda: 0.001
538 Accuracy on training set: 0.8966
539 Training with parameters: max_iter: 5000, lambda: 0.001
540 Accuracy on training set: 0.9062
541 Training with parameters: max_iter: 5000, lambda: 0.001
542 Accuracy on training set: 0.8998
543 Training with parameters: max_iter: 1000, lambda: 0.01
544 Accuracy on training set: 0.7171
545 Training with parameters: max_iter: 1000, lambda: 0.01
546 Accuracy on training set: 0.6890
547 Training with parameters: max_iter: 1000, lambda: 0.01
548 Accuracy on training set: 0.7123
549 Training with parameters: max_iter: 1000, lambda: 0.01
550 Accuracy on training set: 0.7208
551 Training with parameters: max_iter: 1000, lambda: 0.01
552 Accuracy on training set: 0.6943
553 Training with parameters: max_iter: 1000, lambda: 0.01
554 Accuracy on training set: 0.7937
555 Training with parameters: max_iter: 1000, lambda: 0.01
556 Accuracy on training set: 0.8162
557 Training with parameters: max_iter: 1000, lambda: 0.01
558 Accuracy on training set: 0.8468
559 Training with parameters: max_iter: 1000, lambda: 0.01
560 Accuracy on training set: 0.8229
561 Training with parameters: max_iter: 1000, lambda: 0.01
562 Accuracy on training set: 0.8562
563 Training with parameters: max_iter: 2000, lambda: 0.01
564 Accuracy on training set: 0.7205
565 Training with parameters: max_iter: 2000, lambda: 0.01
566 Accuracy on training set: 0.6983
567 Training with parameters: max_iter: 2000, lambda: 0.01
568 Accuracy on training set: 0.7194
569 Training with parameters: max_iter: 2000, lambda: 0.01
570 Accuracy on training set: 0.7166
571 Training with parameters: max_iter: 2000, lambda: 0.01
572 Accuracy on training set: 0.6956
573 Training with parameters: max_iter: 2000, lambda: 0.01
574 Accuracy on training set: 0.8727
575 Training with parameters: max_iter: 2000, lambda: 0.01
576 Accuracy on training set: 0.8952
577 Training with parameters: max_iter: 2000, lambda: 0.01
578 Accuracy on training set: 0.8860
579 Training with parameters: max_iter: 2000, lambda: 0.01
580 Accuracy on training set: 0.8698
581 Training with parameters: max_iter: 2000, lambda: 0.01
582 Accuracy on training set: 0.8815
```

```
583 Training with parameters: max_iter: 5000, lambda: 0.01
584 Accuracy on training set: 0.7258
585 Training with parameters: max_iter: 5000, lambda: 0.01
586 Accuracy on training set: 0.7162
587 Training with parameters: max_iter: 5000, lambda: 0.01
588 Accuracy on training set: 0.7263
589 Training with parameters: max_iter: 5000, lambda: 0.01
590 Accuracy on training set: 0.7263
591 Training with parameters: max_iter: 5000, lambda: 0.01
592 Accuracy on training set: 0.7123
593 Training with parameters: max_iter: 5000, lambda: 0.01
594 Accuracy on training set: 0.9252
595 Training with parameters: max_iter: 5000, lambda: 0.01
596 Accuracy on training set: 0.9075
597 Training with parameters: max_iter: 5000, lambda: 0.01
598 Accuracy on training set: 0.9189
599 Training with parameters: max_iter: 5000, lambda: 0.01
600 Accuracy on training set: 0.9148
601 Training with parameters: max_iter: 5000, lambda: 0.01
602 Accuracy on training set: 0.9000
603 Training with parameters: max_iter: 1000, lambda: 0.1
604 Accuracy on training set: 0.7219
605 Training with parameters: max_iter: 1000, lambda: 0.1
606 Accuracy on training set: 0.7131
607 Training with parameters: max_iter: 1000, lambda: 0.1
608 Accuracy on training set: 0.7211
609 Training with parameters: max_iter: 1000, lambda: 0.1
610 Accuracy on training set: 0.7175
611 Training with parameters: max_iter: 1000, lambda: 0.1
612 Accuracy on training set: 0.7138
613 Training with parameters: max_iter: 1000, lambda: 0.1
614 Accuracy on training set: 0.8857
615 Training with parameters: max_iter: 1000, lambda: 0.1
616 Accuracy on training set: 0.8635
617 Training with parameters: max_iter: 1000, lambda: 0.1
618 Accuracy on training set: 0.8804
619 Training with parameters: max_iter: 1000, lambda: 0.1
620 Accuracy on training set: 0.8802
621 Training with parameters: max_iter: 1000, lambda: 0.1
622 Accuracy on training set: 0.8814
623 Training with parameters: max_iter: 2000, lambda: 0.1
624 Accuracy on training set: 0.7240
625 Training with parameters: max_iter: 2000, lambda: 0.1
626 Accuracy on training set: 0.7183
627 Training with parameters: max_iter: 2000, lambda: 0.1
628 Accuracy on training set: 0.7255
629 Training with parameters: max_iter: 2000, lambda: 0.1
630 Accuracy on training set: 0.7197
631 Training with parameters: max_iter: 2000, lambda: 0.1
632 Accuracy on training set: 0.7208
633 Training with parameters: max_iter: 2000, lambda: 0.1
634 Accuracy on training set: 0.8995
635 Training with parameters: max_iter: 2000, lambda: 0.1
636 Accuracy on training set: 0.8918
637 Training with parameters: max_iter: 2000, lambda: 0.1
638 Accuracy on training set: 0.8956
639 Training with parameters: max_iter: 2000, lambda: 0.1
640 Accuracy on training set: 0.9029
641 Training with parameters: max_iter: 2000, lambda: 0.1
```

```
642 Accuracy on training set: 0.8971
643 Training with parameters: max_iter: 5000, lambda: 0.1
644 Accuracy on training set: 0.7253
645 Training with parameters: max_iter: 5000, lambda: 0.1
646 Accuracy on training set: 0.7247
647 Training with parameters: max_iter: 5000, lambda: 0.1
648 Accuracy on training set: 0.7247
649 Training with parameters: max_iter: 5000, lambda: 0.1
650 Accuracy on training set: 0.7260
651 Training with parameters: max_iter: 5000, lambda: 0.1
652 Accuracy on training set: 0.7202
653 Training with parameters: max_iter: 5000, lambda: 0.1
654 Accuracy on training set: 0.9131
655 Training with parameters: max_iter: 5000, lambda: 0.1
656 Accuracy on training set: 0.9117
657 Training with parameters: max_iter: 5000, lambda: 0.1
658 Accuracy on training set: 0.9130
659 Training with parameters: max_iter: 5000, lambda: 0.1
660 Accuracy on training set: 0.9141
661 Training with parameters: max_iter: 5000, lambda: 0.1
662 Accuracy on training set: 0.9120
663 Best Parameters for PegasosSVM(lambda_param=0.1, max_iter=5000)
664 Best Cross-Validation Accuracy for PegasosSVM(lambda_param=0.1, max_iter=5000): 0.91
665 Model with polynomial features is better.
666 Training with parameters: max_iter: 5000, Lambda: 0.01
667 Accuracy on training set: 0.9119
668
669 Running Logistic Regression
670 Training with parameters: max_iter: 1000, lambda: 0.001
671 Accuracy on training set: 0.7015
672 Training with parameters: max_iter: 1000, lambda: 0.001
673 Accuracy on training set: 0.7020
674 Training with parameters: max_iter: 1000, lambda: 0.001
675 Accuracy on training set: 0.6922
676 Training with parameters: max_iter: 1000, lambda: 0.001
677 Accuracy on training set: 0.7006
678 Training with parameters: max_iter: 1000, lambda: 0.001
679 Accuracy on training set: 0.7094
680 Training with parameters: max_iter: 1000, lambda: 0.001
681 Accuracy on training set: 0.8487
682 Training with parameters: max_iter: 1000, lambda: 0.001
683 Accuracy on training set: 0.8237
684 Training with parameters: max_iter: 1000, lambda: 0.001
685 Accuracy on training set: 0.8374
686 Training with parameters: max_iter: 1000, lambda: 0.001
687 Accuracy on training set: 0.8432
688 Training with parameters: max_iter: 1000, lambda: 0.001
689 Accuracy on training set: 0.8648
690 Training with parameters: max_iter: 2000, lambda: 0.001
691 Accuracy on training set: 0.7097
692 Training with parameters: max_iter: 2000, lambda: 0.001
693 Accuracy on training set: 0.7035
694 Training with parameters: max_iter: 2000, lambda: 0.001
695 Accuracy on training set: 0.7248
696 Training with parameters: max_iter: 2000, lambda: 0.001
697 Accuracy on training set: 0.6987
698 Training with parameters: max_iter: 2000, lambda: 0.001
699 Accuracy on training set: 0.6884
700 Training with parameters: max_iter: 2000, lambda: 0.001
```

```
701 Accuracy on training set: 0.8748
702 Training with parameters: max_iter: 2000, lambda: 0.001
703 Accuracy on training set: 0.8931
704 Training with parameters: max_iter: 2000, lambda: 0.001
705 Accuracy on training set: 0.8719
706 Training with parameters: max_iter: 2000, lambda: 0.001
707 Accuracy on training set: 0.8826
708 Training with parameters: max_iter: 2000, lambda: 0.001
709 Accuracy on training set: 0.8693
710 Training with parameters: max_iter: 5000, lambda: 0.001
711 Accuracy on training set: 0.7187
712 Training with parameters: max_iter: 5000, lambda: 0.001
713 Accuracy on training set: 0.7028
714 Training with parameters: max_iter: 5000, lambda: 0.001
715 Accuracy on training set: 0.7195
716 Training with parameters: max_iter: 5000, lambda: 0.001
717 Accuracy on training set: 0.7160
718 Training with parameters: max_iter: 5000, lambda: 0.001
719 Accuracy on training set: 0.7139
720 Training with parameters: max_iter: 5000, lambda: 0.001
721 Accuracy on training set: 0.9029
722 Training with parameters: max_iter: 5000, lambda: 0.001
723 Accuracy on training set: 0.9050
724 Training with parameters: max_iter: 5000, lambda: 0.001
725 Accuracy on training set: 0.9149
726 Training with parameters: max_iter: 5000, lambda: 0.001
727 Accuracy on training set: 0.8879
728 Training with parameters: max_iter: 5000, lambda: 0.001
729 Accuracy on training set: 0.8998
730 Training with parameters: max_iter: 1000, lambda: 0.01
731 Accuracy on training set: 0.7124
732 Training with parameters: max_iter: 1000, lambda: 0.01
733 Accuracy on training set: 0.7115
734 Training with parameters: max_iter: 1000, lambda: 0.01
735 Accuracy on training set: 0.7048
736 Training with parameters: max_iter: 1000, lambda: 0.01
737 Accuracy on training set: 0.7061
738 Training with parameters: max_iter: 1000, lambda: 0.01
739 Accuracy on training set: 0.7102
740 Training with parameters: max_iter: 1000, lambda: 0.01
741 Accuracy on training set: 0.8568
742 Training with parameters: max_iter: 1000, lambda: 0.01
743 Accuracy on training set: 0.8338
744 Training with parameters: max_iter: 1000, lambda: 0.01
745 Accuracy on training set: 0.8432
746 Training with parameters: max_iter: 1000, lambda: 0.01
747 Accuracy on training set: 0.8690
748 Training with parameters: max_iter: 1000, lambda: 0.01
749 Accuracy on training set: 0.8480
750 Training with parameters: max_iter: 2000, lambda: 0.01
751 Accuracy on training set: 0.7068
752 Training with parameters: max_iter: 2000, lambda: 0.01
753 Accuracy on training set: 0.7158
754 Training with parameters: max_iter: 2000, lambda: 0.01
755 Accuracy on training set: 0.7199
756 Training with parameters: max_iter: 2000, lambda: 0.01
757 Accuracy on training set: 0.7144
758 Training with parameters: max_iter: 2000, lambda: 0.01
759 Accuracy on training set: 0.7176
```

```
760 Training with parameters: max_iter: 2000, lambda: 0.01
761 Accuracy on training set: 0.8704
762 Training with parameters: max_iter: 2000, lambda: 0.01
763 Accuracy on training set: 0.8590
764 Training with parameters: max_iter: 2000, lambda: 0.01
765 Accuracy on training set: 0.8783
766 Training with parameters: max_iter: 2000, lambda: 0.01
767 Accuracy on training set: 0.8708
768 Training with parameters: max_iter: 2000, lambda: 0.01
769 Accuracy on training set: 0.8573
770 Training with parameters: max_iter: 5000, lambda: 0.01
771 Accuracy on training set: 0.7211
772 Training with parameters: max_iter: 5000, lambda: 0.01
773 Accuracy on training set: 0.7227
774 Training with parameters: max_iter: 5000, lambda: 0.01
775 Accuracy on training set: 0.7253
776 Training with parameters: max_iter: 5000, lambda: 0.01
777 Accuracy on training set: 0.7242
778 Training with parameters: max_iter: 5000, lambda: 0.01
779 Accuracy on training set: 0.7203
780 Training with parameters: max_iter: 5000, lambda: 0.01
781 Accuracy on training set: 0.9115
782 Training with parameters: max_iter: 5000, lambda: 0.01
783 Accuracy on training set: 0.9199
784 Training with parameters: max_iter: 5000, lambda: 0.01
785 Accuracy on training set: 0.9045
786 Training with parameters: max_iter: 5000, lambda: 0.01
787 Accuracy on training set: 0.9233
788 Training with parameters: max_iter: 5000, lambda: 0.01
789 Accuracy on training set: 0.9087
790 Training with parameters: max_iter: 1000, lambda: 0.1
791 Accuracy on training set: 0.7229
792 Training with parameters: max_iter: 1000, lambda: 0.1
793 Accuracy on training set: 0.7120
794 Training with parameters: max_iter: 1000, lambda: 0.1
795 Accuracy on training set: 0.7311
796 Training with parameters: max_iter: 1000, lambda: 0.1
797 Accuracy on training set: 0.7255
798 Training with parameters: max_iter: 1000, lambda: 0.1
799 Accuracy on training set: 0.7059
800 Training with parameters: max_iter: 1000, lambda: 0.1
801 Accuracy on training set: 0.8332
802 Training with parameters: max_iter: 1000, lambda: 0.1
803 Accuracy on training set: 0.8849
804 Training with parameters: max_iter: 1000, lambda: 0.1
805 Accuracy on training set: 0.8648
806 Training with parameters: max_iter: 1000, lambda: 0.1
807 Accuracy on training set: 0.8648
808 Training with parameters: max_iter: 1000, lambda: 0.1
809 Accuracy on training set: 0.8804
810 Training with parameters: max_iter: 2000, lambda: 0.1
811 Accuracy on training set: 0.7195
812 Training with parameters: max_iter: 2000, lambda: 0.1
813 Accuracy on training set: 0.7158
814 Training with parameters: max_iter: 2000, lambda: 0.1
815 Accuracy on training set: 0.7247
816 Training with parameters: max_iter: 2000, lambda: 0.1
817 Accuracy on training set: 0.7223
818 Training with parameters: max_iter: 2000, lambda: 0.1
```

```

819 Accuracy on training set: 0.7236
820 Training with parameters: max_iter: 2000, lambda: 0.1
821 Accuracy on training set: 0.8876
822 Training with parameters: max_iter: 2000, lambda: 0.1
823 Accuracy on training set: 0.8950
824 Training with parameters: max_iter: 2000, lambda: 0.1
825 Accuracy on training set: 0.8791
826 Training with parameters: max_iter: 2000, lambda: 0.1
827 Accuracy on training set: 0.9088
828 Training with parameters: max_iter: 2000, lambda: 0.1
829 Accuracy on training set: 0.8849
830 Training with parameters: max_iter: 5000, lambda: 0.1
831 Accuracy on training set: 0.7201
832 Training with parameters: max_iter: 5000, lambda: 0.1
833 Accuracy on training set: 0.7163
834 Training with parameters: max_iter: 5000, lambda: 0.1
835 Accuracy on training set: 0.7258
836 Training with parameters: max_iter: 5000, lambda: 0.1
837 Accuracy on training set: 0.7216
838 Training with parameters: max_iter: 5000, lambda: 0.1
839 Accuracy on training set: 0.7202
840 Training with parameters: max_iter: 5000, lambda: 0.1
841 Accuracy on training set: 0.9038
842 Training with parameters: max_iter: 5000, lambda: 0.1
843 Accuracy on training set: 0.9093
844 Training with parameters: max_iter: 5000, lambda: 0.1
845 Accuracy on training set: 0.9038
846 Training with parameters: max_iter: 5000, lambda: 0.1
847 Accuracy on training set: 0.9128
848 Training with parameters: max_iter: 5000, lambda: 0.1
849 Accuracy on training set: 0.9046
850 Best Parameters for PegasosLogisticRegression(lambda_param=0.1, max_iter=5000)
851 Best Cross-Validation Accuracy for PegasosLogisticRegression(lambda_param=0.1,
max_iter=5000): 0.91
852 Model with polynomial features is better.
853 Training with parameters: max_iter: 5000, lambda: 0.01
854 Accuracy on training set: 0.9182
855
856
857 Compare weights before and after polynomial expansion on:
858 PERCEPTRON
859 Training with parameters: max_epochs=5000
860 Max epochs (5000) reached. NO convergence.
861 Accuracy on training set: 0.6545
862 Training with parameters: max_epochs=5000
863 Max epochs (5000) reached. NO convergence.
864 Accuracy on training set: 0.9184
865 Original features weights:
866 Feature Weight Abs_Weight
867 0 x1 3.672391 3.672391
868 4 x5 -2.993677 2.993677
869 1 x2 2.975661 2.975661
870 2 x3 2.903034 2.903034
871 6 x7 2.505342 2.505342
872 5 x6 1.995513 1.995513
873 3 x4 -1.890234 1.890234
874 7 x8 1.600123 1.600123
875 Features weights after polynomial expansion:
876 Feature Weight Abs_Weight

```

877	22	x2*x8	124.166557	124.166557
878	6	x7	84.049070	84.049070
879	14	x1*x7	57.958500	57.958500
880	32	x4*x7	-48.329345	48.329345
881	7	x8	31.078363	31.078363
882	4	x5	29.569890	29.569890
883	0	x1	25.160038	25.160038
884	5	x6	22.161533	22.161533
885	29	x4*x4	-17.984328	17.984328
886	3	x4	-16.830603	16.830603
887	24	x3*x4	10.636654	10.636654
888	12	x1*x5	9.067230	9.067230
889	2	x3	8.943863	8.943863
890	17	x2*x3	-8.905516	8.905516
891	28	x3*x8	8.843436	8.843436
892	41	x7*x7	-8.466825	8.466825
893	19	x2*x5	-7.783998	7.783998
894	23	x3*x3	-6.881366	6.881366
895	42	x7*x8	-6.826129	6.826129
896	33	x4*x8	6.585244	6.585244
897	21	x2*x7	6.379462	6.379462
898	20	x2*x6	5.411155	5.411155
899	25	x3*x5	5.018236	5.018236
900	36	x5*x7	-4.944258	4.944258
901	34	x5*x5	-4.240558	4.240558
902	15	x1*x8	-4.142584	4.142584
903	35	x5*x6	-3.963191	3.963191
904	16	x2*x2	-3.480004	3.480004
905	31	x4*x6	-3.467296	3.467296
906	40	x6*x8	-3.181489	3.181489
907	1	x2	2.982915	2.982915
908	38	x6*x6	-2.505459	2.505459
909	18	x2*x4	2.120790	2.120790
910	8	x1*x1	-1.740265	1.740265
911	43	x8*x8	-1.477215	1.477215
912	10	x1*x3	1.472059	1.472059
913	37	x5*x8	-1.419640	1.419640
914	30	x4*x5	1.081331	1.081331
915	9	x1*x2	-1.078054	1.078054
916	27	x3*x7	0.988924	0.988924
917	13	x1*x6	0.906426	0.906426
918	26	x3*x6	0.860583	0.860583
919	11	x1*x4	-0.633407	0.633407
920	39	x6*x7	0.386668	0.386668
921				
922		SVM WITH PEGASOS UPDATES		
923		Training with parameters: max_iter: 5000, lambda: 0.01		
924		Accuracy on training set: 0.7185		
925		Training with parameters: max_iter: 5000, lambda: 0.01		
926		Accuracy on training set: 0.9161		
927		Original features weights:		
928		Feature Weight Abs_Weight		
929	6	x7 1.046736 1.046736		
930	5	x6 0.591912 0.591912		
931	3	x4 -0.454683 0.454683		
932	0	x1 0.410781 0.410781		
933	4	x5 0.401165 0.401165		
934	2	x3 0.190350 0.190350		
935	7	x8 0.154683 0.154683		

```

936 1      x2 -0.055992  0.055992
937 Features weights after polynomial expansion:
938   Feature    Weight  Abs_Weight
939 22     x2*x8  4.625449  4.625449
940 6      x7   2.599962  2.599962
941 32    x4*x7 -1.842903  1.842903
942 14    x1*x7  1.493936  1.493936
943 4      x5   1.360430  1.360430
944 5      x6   1.188223  1.188223
945 7      x8   1.060090  1.060090
946 3      x4  -0.979489  0.979489
947 0      x1   0.978240  0.978240
948 11    x1*x4 -0.777305  0.777305
949 9      x1*x2  0.700876  0.700876
950 2      x3   0.688813  0.688813
951 42    x7*x8  0.506897  0.506897
952 8      x1*x1 -0.505691  0.505691
953 1      x2   0.470872  0.470872
954 29    x4*x4 -0.371363  0.371363
955 34    x5*x5 -0.368379  0.368379
956 18    x2*x4  0.335045  0.335045
957 31    x4*x6  0.305601  0.305601
958 16    x2*x2  0.305205  0.305205
959 20    x2*x6  0.274028  0.274028
960 23    x3*x3 -0.270434  0.270434
961 12    x1*x5  0.248729  0.248729
962 41    x7*x7 -0.248114  0.248114
963 21    x2*x7  0.233329  0.233329
964 27    x3*x7  0.223630  0.223630
965 10    x1*x3 -0.216223  0.216223
966 15    x1*x8  0.204797  0.204797
967 33    x4*x8  0.176548  0.176548
968 39    x6*x7  0.167044  0.167044
969 13    x1*x6 -0.164443  0.164443
970 40    x6*x8  0.146009  0.146009
971 35    x5*x6  0.122043  0.122043
972 36    x5*x7  0.117139  0.117139
973 30    x4*x5  0.105180  0.105180
974 19    x2*x5  0.101572  0.101572
975 28    x3*x8  0.097149  0.097149
976 38    x6*x6  0.091985  0.091985
977 25    x3*x5  0.074096  0.074096
978 37    x5*x8 -0.068834  0.068834
979 26    x3*x6 -0.058786  0.058786
980 43    x8*x8  0.046692  0.046692
981 24    x3*x4  0.016217  0.016217
982 17    x2*x3 -0.001740  0.001740
983
984 REGULARISED LOGISTIC REGRESSION
985 Training with parameters: max_iter: 5000, lambda: 0.01
986 Accuracy on training set: 0.7169
987 Training with parameters: max_iter: 5000, lambda: 0.01
988 Accuracy on training set: 0.9196
989 Original features weights:
990   Feature    Weight  Abs_Weight
991 6      x7   0.947489  0.947489
992 3      x4  -0.478337  0.478337
993 4      x5   0.445088  0.445088
994 5      x6   0.403822  0.403822

```

File - main

	Feature	Weight	Abs_Weight
995	x1	0.323874	0.323874
996	x3	0.230487	0.230487
997	x2	-0.185118	0.185118
998	x8	0.013748	0.013748
999	Features weights after polynomial expansion:		
1000	Feature	Weight	Abs_Weight
1001	x2*x8	4.207047	4.207047
1002	x7	2.655890	2.655890
1003	x6	1.286436	1.286436
1004	x1*x7	1.269874	1.269874
1005	x4*x7	-1.250037	1.250037
1006	x8	1.244506	1.244506
1007	x4	-1.068424	1.068424
1008	x1	1.055934	1.055934
1009	x5	0.780841	0.780841
1010	x8*x8	0.435204	0.435204
1011	x3	0.361849	0.361849
1012	x1*x2	0.351738	0.351738
1013	x2*x3	-0.332132	0.332132
1014	x7*x8	0.303542	0.303542
1015	x1*x4	-0.251007	0.251007
1016	x3*x5	0.248229	0.248229
1017	x2*x5	-0.238983	0.238983
1018	x3*x3	-0.238849	0.238849
1019	x7*x7	-0.233058	0.233058
1020	x4*x4	-0.227701	0.227701
1021	x2*x2	0.212184	0.212184
1022	x6*x6	-0.205666	0.205666
1023	x1*x3	-0.205401	0.205401
1024	x3*x6	0.203638	0.203638
1025	x4*x8	-0.193555	0.193555
1026	x1*x8	-0.188871	0.188871
1027	x2	0.188293	0.188293
1028	x5*x5	-0.187495	0.187495
1029	x2*x7	0.179689	0.179689
1030	x4*x5	0.170786	0.170786
1031	x6*x8	-0.117659	0.117659
1032	x3*x8	0.114368	0.114368
1033	x1*x5	-0.088799	0.088799
1034	x5*x7	0.086141	0.086141
1035	x2*x6	0.082879	0.082879
1036	x2*x4	0.073411	0.073411
1037	x1*x1	-0.070876	0.070876
1038	x3*x7	0.056208	0.056208
1039	x6*x7	0.041069	0.041069
1040	x1*x6	0.038839	0.038839
1041	x5*x8	0.027216	0.027216
1042	x4*x6	0.026588	0.026588
1043	x3*x4	-0.011968	0.011968
1044	x5*x6	0.006074	0.006074
1045			
1046	Evaluation of Perceptron on test set:		
1047	Training with parameters: max_epochs=5000		
1048	Max epochs (5000) reached. NO convergence.		
1049	Accuracy on training set: 0.9184		
1050	Accuracy on test set: 0.90		
1051			
1052	Evaluation of SVM with Pegasos on test set:		
1053	Training with parameters: max_iter: 5000, lambda: 0.01		

```
1054 Accuracy on training set: 0.9080
1055 Accuracy on test set: 0.90
1056
1057 Evaluation of Logistic Regression on test set:
1058 Training with parameters: max_iter: 5000, lambda: 0.01
1059 Accuracy on training set: 0.9051
1060 Accuracy on test set: 0.91
1061 Running Kernelised Perceptron with gaussian kernel:
1062 Training with parameters: max_epochs: 1000, kernel: <function gaussian_kernel at
0x130f50c20>
1063 Convergence reached at epoch 5
1064 Converged after 5 epochs in 59.61 seconds
1065
```