Analysis For Exercise 3.2: Posterior Probabilities With LDA And QDA

Created: 09/17/2023 by Tom Lever (TSL2b@Virginia.edu)
Updated: 09/17/2023 by Tom Lever (TSL2b@Virginia.edu)

I completed this exercise myself.

2. Differences Between LDA And QDA

LDA1 and QDA1: Describe distinct source files
This is code for Linear Discriminant Analysis
This is code for Quadratic Discriminant Analysis

LDA{34,35} and QDA{34,35}: Define distinct classes
class LDA:
    """Creates a class for Linear Discriminant Analysis
class QDA:
    """Creates a class for Quadratic Discriminant Analysis

LDA{71,72} and QDA{71,72}: Initialize a mean covariance matrix versus initialize a dictionary for class-specific covariance matrices
        # compute the mean covariance matrix
        self.cov = np.zeros([self.num_cols, self.num_cols])
        # compute the covariance matrix of each class
        self.covs = dict()

LDA{74,75} and QDA74: Calculate mean covariance matrix versus calculate class-specific covariance matrix
            self.cov = self.cov + self.num_obs[name] * np.cov(np.transpose(self.data[self.data_labels == name, :]))
        self.cov = self.cov / self.num_rows
            self.covs[name] = np.cov(np.transpose(self.data[self.data_labels == name, :]))

LDA92 and QDA91: Construct multivariate Gaussian Probability Density Function with mean covariance matrix versus class-specific covariance matrix
            likelihoods[idx] = multivariate_gaussian_pdf(x, self.means[name], self.cov)
            likelihoods[idx] = multivariate_gaussian_pdf(x, self.means[name], self.covs[name])

LDA94: Remove of blank line

LDA{99,100} and QDA{97,98}: Change described model
        print('LDA Predicted Class: ' + self.class_names[indices_sorted[0]])
        print('LDA Class Likelihoods:')
        print('QDA Predicted Class: ' + self.class_names[indices_sorted[0]])

print('QDA Class Likelihoods:')

LDA112 and QDA110: Changed model name and constructor
model_lda = LDA('iris_data.csv')
model_qda = QDA('iris_data.csv')

LDA115 and QDA 113: Changed use of model
model_lda.compute_likelihoods(Iris_setosa_observation)
model_qda.compute_likelihoods(Iris_setosa_observation)

LDA{122,123} and QDA{120,121}: Changed use of model
model_lda.compute_probabilities(Iris_setosa_observation, uninformative_priors)
print(model_lda)
model_qda.compute_probabilities(Iris_setosa_observation, uninformative_priors)
print(model_qda)

3. In both Exercise3.2_Linear_Discriminant_Analysis.py and Exercise3.2_Quadratic_Discriminant_Analysis.py,

```
    def compute_probabilities(self, x, priors):
        likelihoods = self.compute_likelihoods(x)
        number_of_classes = len(priors)
        array_of_prior_probabilities = np.zeros(number_of_classes)
        index = 0
        for class_name in self.class_names:
            array_of_prior_probabilities[index] = priors[class_name]
            index += 1
        joint_probabilities = np.multiply(likelihoods,
array_of_prior_probabilities)
        total_and_marginal_probability = np.sum(joint_probabilities)
        posterior_probabilities = joint_probabilities /
total_and_marginal_probability
        indices_that_sort_posterior_probabilities =
np.argsort(posterior_probabilities)[::-1]
        print('LDA Predicted Class:' +
self.class_names[indices_that_sort_posterior_probabilities[0]])
        print('LDA Class Posterior Probabilities:')
        for index in range(0, len(indices_that_sort_posterior_probabilities)):
            print(self.class_names[indices_that_sort_posterior_probabilities[inde
x]] + ': ' +
str(posterior_probabilities[indices_that_sort_posterior_probabilities[index]]))
        return posterior_probabilities
```

4. Predicted Classes And Posterior Probabilities For Carl's Observations, LDA And QDA, And Uninformative Priors

Predicted Classes And Posterior Probabilities For Carl's Observations, LDA, And Uninformative Priors

Carl's First Observation:
LDA Predicted Class:Iris-versicolor
LDA Class Posterior Probabilities:
Iris-versicolor: 0.9999970568617268
Iris-virginica: 2.94313827322853e-06
Iris-setosa: 1.0221808316494076e-17

Carl's Second Observation:
LDA Predicted Class:Iris-versicolor
LDA Class Posterior Probabilities:
Iris-versicolor: 0.5602348418832768
Iris-virginica: 0.43976515811672334
Iris-setosa: 2.4269307963452403e-28

Predicted Classes And Posterior Probabilities For Carl's Observations, QDA, And Uninformative Priors

Carl's First Observation:
QDA Predicted Class:Iris-versicolor
QDA Class Posterior Probabilities:
Iris-versicolor: 0.9999701265523081
Iris-virginica: 2.9873447691956454e-05
Iris-setosa: 2.71126344764457e-52

Carl's Second Observation:
QDA Predicted Class:Iris-virginica
QDA Class Posterior Probabilities:
Iris-virginica: 0.5648248061588751
Iris-versicolor: 0.4351751938411249
Iris-setosa: 2.7265939261013007e-103

5. Predicted Classes And Posterior Probabilities For Carl's Observations, LDA And QDA, And Informative Priors

Predicted Classes And Posterior Probabilities For Carl's Observations, LDA, And Informative Priors

Carl's First Observation:
LDA Predicted Class:Iris-versicolor

LDA Class Posterior Probabilities:
Iris-versicolor: 0.9999896990918361
Iris-virginica: 1.0300908163807187e-05
Iris-setosa: 5.110866553279631e-18

Carl's Second Observation:
LDA Predicted Class:Iris-virginica
LDA Class Posterior Probabilities:
Iris-virginica: 0.7331468987640914
Iris-versicolor: 0.2668531012359085
Iris-setosa: 5.780022600099131e-29

Predicted Classes And Posterior Probabilities For Carl's Observations, QDA, And Informative Priors

Carl's First Observation:
QDA Predicted Class:Iris-versicolor
QDA Class Posterior Probabilities:
Iris-versicolor: 0.9998954507411951
Iris-virginica: 0.00010454925880481221
Iris-setosa: 1.355530487899472e-52

Carl's Second Observation:
QDA Predicted Class:Iris-virginica
QDA Class Posterior Probabilities:
Iris-virginica: 0.8195837457481516
Iris-versicolor: 0.18041625425184843
Iris-setosa: 5.651997976619851e-104