HW2-3 Report
Differential Privacy Classifier

3. Task (a): Naive Bayes Classifier to predict the classes for records

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Console ✕   Problems   Debug Shell   History
<terminated> hw2_3_classifier [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdl
Enter full path for the dataset file
iris.data.txt
|
Training :
Scores : [100.0, 40.0, 90.0]
Accuracy = 76.66666666666667%

Prediction :

Data : [5.1, 3.5, 1.4, 0.2]       Prediction: Iris-setosa
Data : [4.9, 3.0, 1.4, 0.2]       Prediction: Iris-setosa
Data : [4.7, 3.2, 1.3, 0.2]       Prediction: Iris-setosa
Data : [4.6, 3.1, 1.5, 0.2]       Prediction: Iris-setosa
Data : [5.0, 3.6, 1.4, 0.2]       Prediction: Iris-setosa
Data : [5.4, 3.9, 1.7, 0.4]       Prediction: Iris-setosa
Data : [4.6, 3.4, 1.4, 0.3]       Prediction: Iris-setosa
Data : [5.0, 3.4, 1.5, 0.2]       Prediction: Iris-setosa
Data : [4.4, 2.9, 1.4, 0.2]       Prediction: Iris-setosa
Data : [4.9, 3.1, 1.5, 0.1]       Prediction: Iris-setosa

Data : [7.0, 3.2, 4.7, 1.4]       Prediction: Iris-virginica
Data : [6.4, 3.2, 4.5, 1.5]       Prediction: Iris-virginica
Data : [6.9, 3.1, 4.9, 1.5]       Prediction: Iris-virginica
Data : [5.5, 2.3, 4.0, 1.3]       Prediction: Iris-versicolor
Data : [6.5, 2.8, 4.6, 1.5]       Prediction: Iris-virginica
Data : [5.7, 2.8, 4.5, 1.3]       Prediction: Iris-versicolor
Data : [6.3, 3.3, 4.7, 1.6]       Prediction: Iris-virginica
Data : [4.9, 2.4, 3.3, 1.0]       Prediction: Iris-versicolor
Data : [6.6, 2.9, 4.6, 1.3]       Prediction: Iris-virginica
Data : [5.2, 2.7, 3.9, 1.4]       Prediction: Iris-versicolor

Data : [6.3, 3.3, 6.0, 2.5]       Prediction: Iris-virginica
Data : [5.8, 2.7, 5.1, 1.9]       Prediction: Iris-virginica
Data : [7.1, 3.0, 5.9, 2.1]       Prediction: Iris-virginica
Data : [6.3, 2.9, 5.6, 1.8]       Prediction: Iris-virginica
Data : [6.5, 3.0, 5.8, 2.2]       Prediction: Iris-virginica
Data : [7.6, 3.0, 6.6, 2.1]       Prediction: Iris-virginica
Data : [4.9, 2.5, 4.5, 1.7]       Prediction: Iris-versicolor
Data : [7.3, 2.9, 6.3, 1.8]       Prediction: Iris-virginica
Data : [6.7, 2.5, 5.8, 1.8]       Prediction: Iris-virginica
Data : [7.2, 3.6, 6.1, 2.5]       Prediction: Iris-virginica
```

3. Task (c): Prove ε-differential privacy for your designed algorithm.

- Using sequential composition for the queries (mean, standard deviation, and probability)
- The privacy budget for each query is $\frac{\varepsilon}{3}$
- Therefore, the designed algorithm satisfies ε-differential privacy as

$$\frac{\varepsilon}{3} + \frac{\varepsilon}{3} + \frac{\varepsilon}{3} = \varepsilon$$

3. Task (d)

- For $\varepsilon = 0.5$

```
Console    Problems    Debug Shell    History
<terminated> hw2_3_dpclassifier [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java  (0
Enter full path for the dataset file
iris.data.txt
Enter epsilon value
0.5
Scores : [90.0, 10.0, 100.0]
Accuracy = 66.66666666666667%

Prediction :
Data : [5.1, 3.5, 1.4, 0.2]      Prediction: Iris-setosa
Data : [4.9, 3.0, 1.4, 0.2]      Prediction: Iris-virginica
Data : [4.7, 3.2, 1.3, 0.2]      Prediction: Iris-versicolor
Data : [4.6, 3.1, 1.5, 0.2]      Prediction: Iris-versicolor
Data : [5.0, 3.6, 1.4, 0.2]      Prediction: Iris-versicolor
Data : [5.4, 3.9, 1.7, 0.4]      Prediction: Iris-versicolor
Data : [4.6, 3.4, 1.4, 0.3]      Prediction: Iris-versicolor
Data : [5.0, 3.4, 1.5, 0.2]      Prediction: Iris-setosa
Data : [4.4, 2.9, 1.4, 0.2]      Prediction: Iris-versicolor
Data : [4.9, 3.1, 1.5, 0.1]      Prediction: Iris-versicolor


Data : [7.0, 3.2, 4.7, 1.4]      Prediction: Iris-setosa
Data : [6.4, 3.2, 4.5, 1.5]      Prediction: Iris-setosa
Data : [6.9, 3.1, 4.9, 1.5]      Prediction: Iris-virginica
Data : [5.5, 2.3, 4.0, 1.3]      Prediction: Iris-versicolor
Data : [6.5, 2.8, 4.6, 1.5]      Prediction: Iris-setosa
Data : [5.7, 2.8, 4.5, 1.3]      Prediction: Iris-virginica
Data : [6.3, 3.3, 4.7, 1.6]      Prediction: Iris-versicolor
Data : [4.9, 2.4, 3.3, 1.0]      Prediction: Iris-setosa
Data : [6.6, 2.9, 4.6, 1.3]      Prediction: Iris-setosa
Data : [5.2, 2.7, 3.9, 1.4]      Prediction: Iris-setosa


Data : [6.3, 3.3, 6.0, 2.5]      Prediction: Iris-virginica
Data : [5.8, 2.7, 5.1, 1.9]      Prediction: Iris-versicolor
Data : [7.1, 3.0, 5.9, 2.1]      Prediction: Iris-setosa
Data : [6.3, 2.9, 5.6, 1.8]      Prediction: Iris-versicolor
Data : [6.5, 3.0, 5.8, 2.2]      Prediction: Iris-versicolor
Data : [7.6, 3.0, 6.6, 2.1]      Prediction: Iris-versicolor
Data : [4.9, 2.5, 4.5, 1.7]      Prediction: Iris-versicolor
Data : [7.3, 2.9, 6.3, 1.8]      Prediction: Iris-versicolor
Data : [6.7, 2.5, 5.8, 1.8]      Prediction: Iris-setosa
Data : [7.2, 3.6, 6.1, 2.5]      Prediction: Iris-setosa


Precision for Class1:    0.25
Recall for Class1:       0.16666666666666666

Precision for Class2:    0.2222222222222222
Recall for Class2:       0.13333333333333333

Precision for Class3:    0.25
Recall for Class3:       0.07142857142857142
```

- For $\varepsilon = 1$

```
Console    Problems    Debug Shell    History
<terminated> hw2_3_dpclassifier [Java Application] /Library/Java/JavaVirtualMachines/jdk-12
Enter full path for the dataset file
iris.data.txt
Enter epsilon value
1
Scores : [40.0, 40.0, 20.0]
Accuracy = 33.333333333333336%

Prediction :
Data : [5.1, 3.5, 1.4, 0.2]      Prediction: Iris-virginica
Data : [4.9, 3.0, 1.4, 0.2]      Prediction: Iris-virginica
Data : [4.7, 3.2, 1.3, 0.2]      Prediction: Iris-virginica
Data : [4.6, 3.1, 1.5, 0.2]      Prediction: Iris-virginica
Data : [5.0, 3.6, 1.4, 0.2]      Prediction: Iris-virginica
Data : [5.4, 3.9, 1.7, 0.4]      Prediction: Iris-virginica
Data : [4.6, 3.4, 1.4, 0.3]      Prediction: Iris-virginica
Data : [5.0, 3.4, 1.5, 0.2]      Prediction: Iris-setosa
Data : [4.4, 2.9, 1.4, 0.2]      Prediction: Iris-virginica
Data : [4.9, 3.1, 1.5, 0.1]      Prediction: Iris-virginica


Data : [7.0, 3.2, 4.7, 1.4]      Prediction: Iris-virginica
Data : [6.4, 3.2, 4.5, 1.5]      Prediction: Iris-virginica
Data : [6.9, 3.1, 4.9, 1.5]      Prediction: Iris-virginica
Data : [5.5, 2.3, 4.0, 1.3]      Prediction: Iris-versicolor
Data : [6.5, 2.8, 4.6, 1.5]      Prediction: Iris-virginica
Data : [5.7, 2.8, 4.5, 1.3]      Prediction: Iris-virginica
Data : [6.3, 3.3, 4.7, 1.6]      Prediction: Iris-virginica
Data : [4.9, 2.4, 3.3, 1.0]      Prediction: Iris-virginica
Data : [6.6, 2.9, 4.6, 1.3]      Prediction: Iris-virginica
Data : [5.2, 2.7, 3.9, 1.4]      Prediction: Iris-virginica


Data : [6.3, 3.3, 6.0, 2.5]      Prediction: Iris-virginica
Data : [5.8, 2.7, 5.1, 1.9]      Prediction: Iris-virginica
Data : [7.1, 3.0, 5.9, 2.1]      Prediction: Iris-virginica
Data : [6.3, 2.9, 5.6, 1.8]      Prediction: Iris-virginica
Data : [6.5, 3.0, 5.8, 2.2]      Prediction: Iris-virginica
Data : [7.6, 3.0, 6.6, 2.1]      Prediction: Iris-virginica
Data : [4.9, 2.5, 4.5, 1.7]      Prediction: Iris-virginica
Data : [7.3, 2.9, 6.3, 1.8]      Prediction: Iris-virginica
Data : [6.7, 2.5, 5.8, 1.8]      Prediction: Iris-virginica
Data : [7.2, 3.6, 6.1, 2.5]      Prediction: Iris-virginica


Precision for Class1:    1.0
Recall for Class1:       0.05263157894736842

Precision for Class2:    1.0
Recall for Class2:       1.0

Precision for Class3:    0.35714285714285715
Recall for Class3:       1.0
```

- For $\varepsilon = 2$

```
Console 23    Problems    Debug Shell    History
<terminated> hw2_3_dpclassifier [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1
Enter full path for the dataset file
iris.data.txt
Enter epsilon value
2
Scores : [40.0, 10.0, 10.0]
Accuracy = 20.0%

Prediction :
Data : [5.1, 3.5, 1.4, 0.2]         Prediction: Iris-setosa
Data : [4.9, 3.0, 1.4, 0.2]         Prediction: Iris-versicolor
Data : [4.7, 3.2, 1.3, 0.2]         Prediction: Iris-virginica
Data : [4.6, 3.1, 1.5, 0.2]         Prediction: Iris-virginica
Data : [5.0, 3.6, 1.4, 0.2]         Prediction: Iris-versicolor
Data : [5.4, 3.9, 1.7, 0.4]         Prediction: Iris-virginica
Data : [4.6, 3.4, 1.4, 0.3]         Prediction: Iris-versicolor
Data : [5.0, 3.4, 1.5, 0.2]         Prediction: Iris-virginica
Data : [4.4, 2.9, 1.4, 0.2]         Prediction: Iris-versicolor
Data : [4.9, 3.1, 1.5, 0.1]         Prediction: Iris-setosa


Data : [7.0, 3.2, 4.7, 1.4]         Prediction: Iris-virginica
Data : [6.4, 3.2, 4.5, 1.5]         Prediction: Iris-setosa
Data : [6.9, 3.1, 4.9, 1.5]         Prediction: Iris-virginica
Data : [5.5, 2.3, 4.0, 1.3]         Prediction: Iris-versicolor
Data : [6.5, 2.8, 4.6, 1.5]         Prediction: Iris-virginica
Data : [5.7, 2.8, 4.5, 1.3]         Prediction: Iris-versicolor
Data : [6.3, 3.3, 4.7, 1.6]         Prediction: Iris-versicolor
Data : [4.9, 2.4, 3.3, 1.0]         Prediction: Iris-setosa
Data : [6.6, 2.9, 4.6, 1.3]         Prediction: Iris-versicolor
Data : [5.2, 2.7, 3.9, 1.4]         Prediction: Iris-virginica


Data : [6.3, 3.3, 6.0, 2.5]         Prediction: Iris-virginica
Data : [5.8, 2.7, 5.1, 1.9]         Prediction: Iris-virginica
Data : [7.1, 3.0, 5.9, 2.1]         Prediction: Iris-virginica
Data : [6.3, 2.9, 5.6, 1.8]         Prediction: Iris-setosa
Data : [6.5, 3.0, 5.8, 2.2]         Prediction: Iris-versicolor
Data : [7.6, 3.0, 6.6, 2.1]         Prediction: Iris-setosa
Data : [4.9, 2.5, 4.5, 1.7]         Prediction: Iris-setosa
Data : [7.3, 2.9, 6.3, 1.8]         Prediction: Iris-virginica
Data : [6.7, 2.5, 5.8, 1.8]         Prediction: Iris-virginica
Data : [7.2, 3.6, 6.1, 2.5]         Prediction: Iris-virginica


Precision for Class1:    0.5
Recall for Class1:       0.14285714285714285

Precision for Class2:    0.5
Recall for Class2:       0.4

Precision for Class3:    0.42857142857142855
Recall for Class3:       0.5
```

- For $\varepsilon = 4$

```
Console 23    Problems    Debug Shell    History
<terminated> hw2_3_dpclassifier [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.
Enter full path for the dataset file
iris.data.txt
Enter epsilon value
4
Scores : [90.0, 30.0, 40.0]
Accuracy = 53.333333333333336%

Prediction :
Data : [5.1, 3.5, 1.4, 0.2]         Prediction: Iris-setosa
Data : [4.9, 3.0, 1.4, 0.2]         Prediction: Iris-virginica
Data : [4.7, 3.2, 1.3, 0.2]         Prediction: Iris-versicolor
Data : [4.6, 3.1, 1.5, 0.2]         Prediction: Iris-setosa
Data : [5.0, 3.6, 1.4, 0.2]         Prediction: Iris-setosa
Data : [5.4, 3.9, 1.7, 0.4]         Prediction: Iris-setosa
Data : [4.6, 3.4, 1.4, 0.3]         Prediction: Iris-setosa
Data : [5.0, 3.4, 1.5, 0.2]         Prediction: Iris-setosa
Data : [4.4, 2.9, 1.4, 0.2]         Prediction: Iris-versicolor
Data : [4.9, 3.1, 1.5, 0.1]         Prediction: Iris-setosa


Data : [7.0, 3.2, 4.7, 1.4]         Prediction: Iris-versicolor
Data : [6.4, 3.2, 4.5, 1.5]         Prediction: Iris-versicolor
Data : [6.9, 3.1, 4.9, 1.5]         Prediction: Iris-versicolor
Data : [5.5, 2.3, 4.0, 1.3]         Prediction: Iris-versicolor
Data : [6.5, 2.8, 4.6, 1.5]         Prediction: Iris-virginica
Data : [5.7, 2.8, 4.5, 1.3]         Prediction: Iris-versicolor
Data : [6.3, 3.3, 4.7, 1.6]         Prediction: Iris-versicolor
Data : [4.9, 2.4, 3.3, 1.0]         Prediction: Iris-setosa
Data : [6.6, 2.9, 4.6, 1.3]         Prediction: Iris-setosa
Data : [5.2, 2.7, 3.9, 1.4]         Prediction: Iris-virginica


Data : [6.3, 3.3, 6.0, 2.5]         Prediction: Iris-setosa
Data : [5.8, 2.7, 5.1, 1.9]         Prediction: Iris-setosa
Data : [7.1, 3.0, 5.9, 2.1]         Prediction: Iris-setosa
Data : [6.3, 2.9, 5.6, 1.8]         Prediction: Iris-versicolor
Data : [6.5, 3.0, 5.8, 2.2]         Prediction: Iris-setosa
Data : [7.6, 3.0, 6.6, 2.1]         Prediction: Iris-setosa
Data : [4.9, 2.5, 4.5, 1.7]         Prediction: Iris-virginica
Data : [7.3, 2.9, 6.3, 1.8]         Prediction: Iris-versicolor
Data : [6.7, 2.5, 5.8, 1.8]         Prediction: Iris-versicolor
Data : [7.2, 3.6, 6.1, 2.5]         Prediction: Iris-setosa


Precision for Class1:    0.7777777777777778
Recall for Class1:       0.5833333333333334

Precision for Class2:    0.75
Recall for Class2:       0.6

Precision for Class3:    0.25
Recall for Class3:       0.2
```

- For $\varepsilon = 8$


```
Console  Problems  Debug Shell  History
<terminated> hw2_3_dpclassifier [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.
Enter full path for the dataset file
iris.data.txt
Enter epsilon value
8
Scores : [50.0, 0.0, 60.0]
Accuracy = 36.666666666666664%

Prediction :
Data : [5.1, 3.5, 1.4, 0.2]      Prediction: Iris-setosa
Data : [4.9, 3.0, 1.4, 0.2]      Prediction: Iris-setosa
Data : [4.7, 3.2, 1.3, 0.2]      Prediction: Iris-setosa
Data : [4.6, 3.1, 1.5, 0.2]      Prediction: Iris-versicolor
Data : [5.0, 3.6, 1.4, 0.2]      Prediction: Iris-setosa
Data : [5.4, 3.9, 1.7, 0.4]      Prediction: Iris-setosa
Data : [4.6, 3.4, 1.4, 0.3]      Prediction: Iris-setosa
Data : [5.0, 3.4, 1.5, 0.2]      Prediction: Iris-setosa
Data : [4.4, 2.9, 1.4, 0.2]      Prediction: Iris-versicolor
Data : [4.9, 3.1, 1.5, 0.1]      Prediction: Iris-setosa


Data : [7.0, 3.2, 4.7, 1.4]      Prediction: Iris-versicolor
Data : [6.4, 3.2, 4.5, 1.5]      Prediction: Iris-versicolor
Data : [6.9, 3.1, 4.9, 1.5]      Prediction: Iris-virginica
Data : [5.5, 2.3, 4.0, 1.3]      Prediction: Iris-versicolor
Data : [6.5, 2.8, 4.6, 1.5]      Prediction: Iris-versicolor
Data : [5.7, 2.8, 4.5, 1.3]      Prediction: Iris-versicolor
Data : [6.3, 3.3, 4.7, 1.6]      Prediction: Iris-versicolor
Data : [4.9, 2.4, 3.3, 1.0]      Prediction: Iris-virginica
Data : [6.6, 2.9, 4.6, 1.3]      Prediction: Iris-versicolor
Data : [5.2, 2.7, 3.9, 1.4]      Prediction: Iris-versicolor


Data : [6.3, 3.3, 6.0, 2.5]      Prediction: Iris-setosa
Data : [5.8, 2.7, 5.1, 1.9]      Prediction: Iris-versicolor
Data : [7.1, 3.0, 5.9, 2.1]      Prediction: Iris-virginica
Data : [6.3, 2.9, 5.6, 1.8]      Prediction: Iris-virginica
Data : [6.5, 3.0, 5.8, 2.2]      Prediction: Iris-virginica
Data : [7.6, 3.0, 6.6, 2.1]      Prediction: Iris-setosa
Data : [4.9, 2.5, 4.5, 1.7]      Prediction: Iris-versicolor
Data : [7.3, 2.9, 6.3, 1.8]      Prediction: Iris-virginica
Data : [6.7, 2.5, 5.8, 1.8]      Prediction: Iris-virginica
Data : [7.2, 3.6, 6.1, 2.5]      Prediction: Iris-versicolor


Precision for Class1:   1.0
Recall for Class1:      0.6666666666666666

Precision for Class2:   0.8
Recall for Class2:      0.8

Precision for Class3:   0.7142857142857143
Recall for Class3:      0.7142857142857143
```

- For $\varepsilon = 16$


```
Console  Problems  Debug Shell  History
<terminated> hw2_3_dpclassifier [Java Application] /Library/Java/JavaVirtualMachines/jdk-12
Enter full path for the dataset file
iris.data.txt
Enter epsilon value
16
Scores : [60.0, 30.0, 70.0]
Accuracy = 53.333333333333336%

Prediction :
Data : [5.1, 3.5, 1.4, 0.2]      Prediction: Iris-setosa
Data : [4.9, 3.0, 1.4, 0.2]      Prediction: Iris-setosa
Data : [4.7, 3.2, 1.3, 0.2]      Prediction: Iris-virginica
Data : [4.6, 3.1, 1.5, 0.2]      Prediction: Iris-setosa
Data : [5.0, 3.6, 1.4, 0.2]      Prediction: Iris-setosa
Data : [5.4, 3.9, 1.7, 0.4]      Prediction: Iris-setosa
Data : [4.6, 3.4, 1.4, 0.3]      Prediction: Iris-setosa
Data : [5.0, 3.4, 1.5, 0.2]      Prediction: Iris-setosa
Data : [4.4, 2.9, 1.4, 0.2]      Prediction: Iris-setosa
Data : [4.9, 3.1, 1.5, 0.1]      Prediction: Iris-setosa


Data : [7.0, 3.2, 4.7, 1.4]      Prediction: Iris-virginica
Data : [6.4, 3.2, 4.5, 1.5]      Prediction: Iris-virginica
Data : [6.9, 3.1, 4.9, 1.5]      Prediction: Iris-virginica
Data : [5.5, 2.3, 4.0, 1.3]      Prediction: Iris-versicolor
Data : [6.5, 2.8, 4.6, 1.5]      Prediction: Iris-versicolor
Data : [5.7, 2.8, 4.5, 1.3]      Prediction: Iris-versicolor
Data : [6.3, 3.3, 4.7, 1.6]      Prediction: Iris-virginica
Data : [4.9, 2.4, 3.3, 1.0]      Prediction: Iris-versicolor
Data : [6.6, 2.9, 4.6, 1.3]      Prediction: Iris-virginica
Data : [5.2, 2.7, 3.9, 1.4]      Prediction: Iris-versicolor


Data : [6.3, 3.3, 6.0, 2.5]      Prediction: Iris-virginica
Data : [5.8, 2.7, 5.1, 1.9]      Prediction: Iris-virginica
Data : [7.1, 3.0, 5.9, 2.1]      Prediction: Iris-virginica
Data : [6.3, 2.9, 5.6, 1.8]      Prediction: Iris-virginica
Data : [6.5, 3.0, 5.8, 2.2]      Prediction: Iris-virginica
Data : [7.6, 3.0, 6.6, 2.1]      Prediction: Iris-virginica
Data : [4.9, 2.5, 4.5, 1.7]      Prediction: Iris-virginica
Data : [7.3, 2.9, 6.3, 1.8]      Prediction: Iris-virginica
Data : [6.7, 2.5, 5.8, 1.8]      Prediction: Iris-versicolor
Data : [7.2, 3.6, 6.1, 2.5]      Prediction: Iris-virginica


Precision for Class1:   1.0
Recall for Class1:      0.6

Precision for Class2:   1.0
Recall for Class2:      1.0

Precision for Class3:   0.6
Recall for Class3:      1.0
```