CS 519 Project 1 Report

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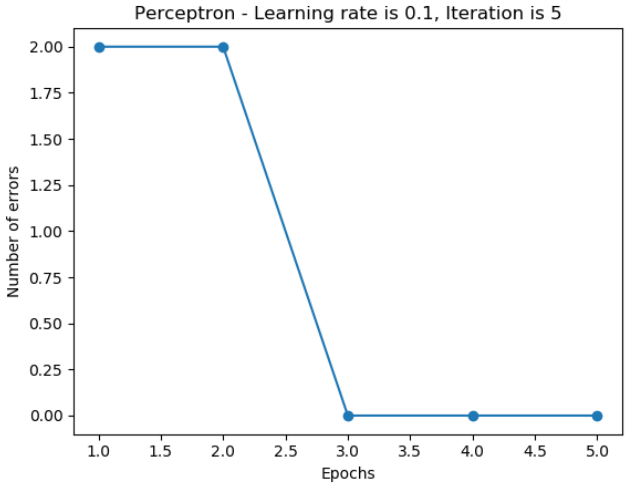
In this project, I designed three classifiers, Perceptron, Adaline and SGD to classify two data sets, iris (https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data) and ecoli (http://archive.ics.uci.edu/ml/machine-learning-databases/ecoli/ecoli.data) from UCI machine learning repository.

1. Binary classification
   (1) For iris data set, the class “Iris-setosa” is labeled as 1 and other two are labeled as -1.
      (a) Preceptron

      Learning rate is 0.1, Iteration is 5

      The error of each iteration is ['2.00', '2.00', '0.00', '0.00', '0.00'].

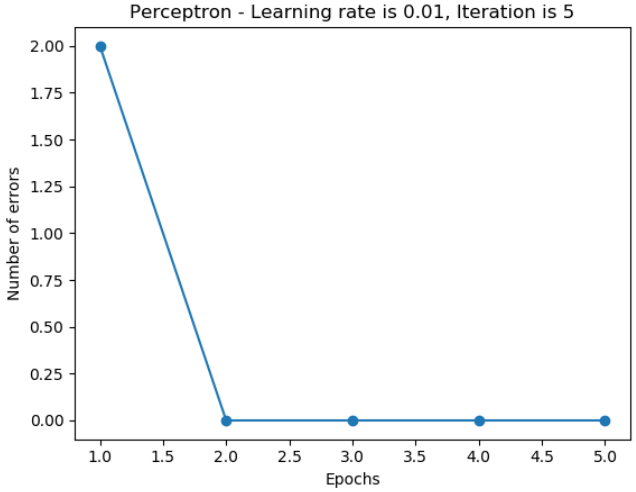
      The accuracy is 100.00%.



      Learning rate is 0.01, Iteration is 5

      The error of each iteration is ['2.00', '0.00', '0.00', '0.00', '0.00'].

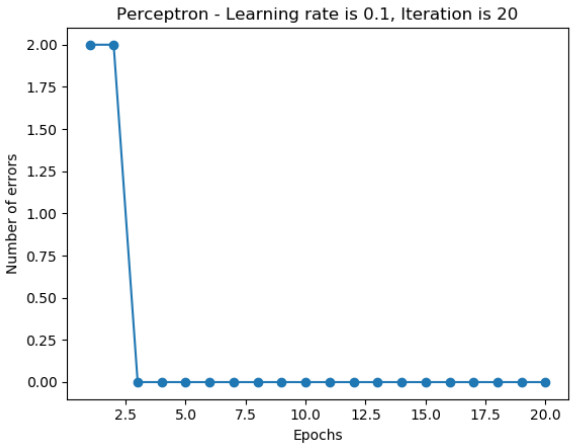
      The accuracy is 100.00%.



Learning rate is 0.1, Iteration is 20

The error of each iteration is ['2.00', '2.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00', '0.00'].

The accuracy is 100.00%.



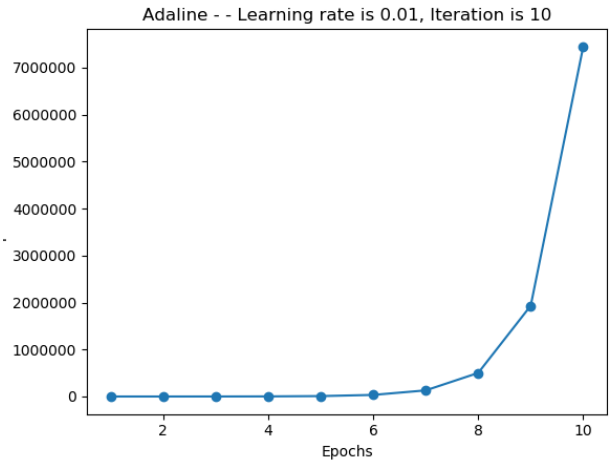
Analysis: The performance of Preceptron is good for iris. Error converges to 0 after 2 or 3 iterations. Learning rate doesn't affect the result much.

(b) Adaline,

Learning rate is 0.1, Iteration is 10

The sum of squared error of each iteration is ['52.76', '33242.57', '26746934.66', '21886724329.49', '17938253632251.62', '14704342255692962.00', '12053618605524316160.00', '9880750282428678930432.00', '8099579383182574831534080.00', '6639494507337461892256890880.00'].

The accuracy is 6.67%.

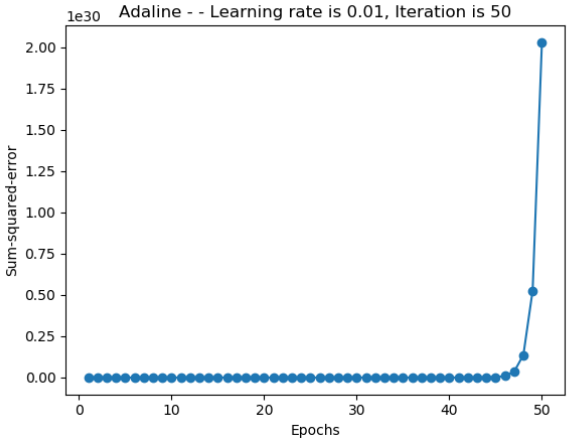


Learning rate is 0.01, Iteration is 50

The sum of squared error of each iteration is ['52.76', '157.34', '594.20', '2277.88', '8766.46', '33771.93', '130136.96', '501504.23', '1932662.89', '7447998.29', '28702751.67', '110613371.36', '426276860.59', '1642766722.52',

'6330821041.72', '24397435476.92', '94021747595.65', '362336813231.82', '1396357434140.39', '5381219938707.88', '20737905152930.36', '79918813025764.36', '307987553629312.94', '1186908683941435.00', '4574055696130965.00', '17627291631089364.00', '67931269509967184.00', '261790493617119488.00', '1008876516553829504.00', '3887963277774380544.00', '14983259300114319360.00', '57741815756802482176.00', '222522831655665369088.00', '857548554008230100992.00', '3304782331817338339328.00', '12735822606946204123136.00', '4908074456643729463705 6.00', '1891451821794397257728 00.00', '7289192586160960291471 36.00', '2809076495944681426780160.00', '1082549358765783473402 6752.00', '4171880387935466548101 1200.00', '1607740638365307720318 32064.00', '6195839093868269010147 08224.00', '2387724808408048461198 393344.00', '9201707265654287322063044608.00', '3546112864624768420830773 2480.00', '1366585143997529582845936 27136.00', '5266484816163236701515032 82176.00', '2029574406007745215710686609408.00'].

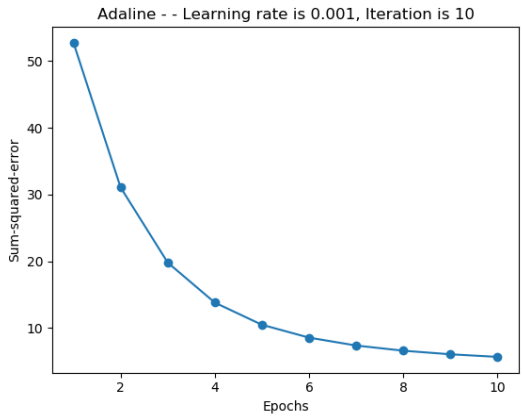
The accuracy is 6.67%.



Learning rate is 0.001, Iteration is 10

The sum of squared error of each iteration is ['52.76', '31.07', '19.81', '13.81', '10.50', '8.57', '7.39', '6.61', '6.08', '5.69'].

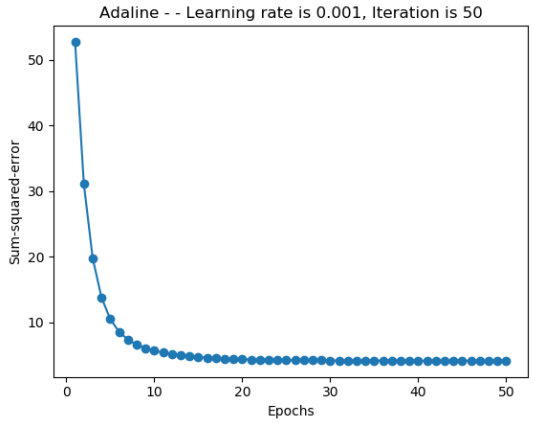
The accuracy is 100.00%.



Learning rate is 0.001, Iteration is 50

The sum of squared error of each iteration is ['52.76', '31.07', '19.81', '13.81', '10.50', '8.57', '7.39', '6.61', '6.08', '5.69', '5.39', '5.16', '4.98', '4.83', '4.72', '4.62', '4.54', '4.48', '4.42', '4.38', '4.35', '4.32', '4.29', '4.27', '4.25', '4.24', '4.23', '4.22', '4.21', '4.20', '4.19', '4.19', '4.18', '4.18', '4.17', '4.17', '4.17', '4.16', '4.16', '4.16', '4.16', '4.15', '4.15', '4.15', '4.15', '4.14', '4.14', '4.14', '4.14'].

The accuracy is 100.00%.



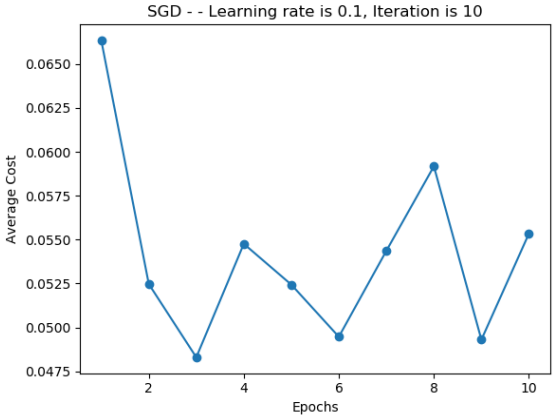
Analysis: The performance of Adaline is good for iris. Learning rate affects the result much more than iterations. When eta=0.01, error never converges, but when eta=0.001, error converges to 4.15 after about 20 iterations.

(c) SGD

Learning rate is 0.1, Iteration is 10

The sum of squared error of each iteration is ['0.07', '0.05', '0.05', '0.05', '0.05', '0.05', '0.05', '0.06', '0.05', '0.06'].

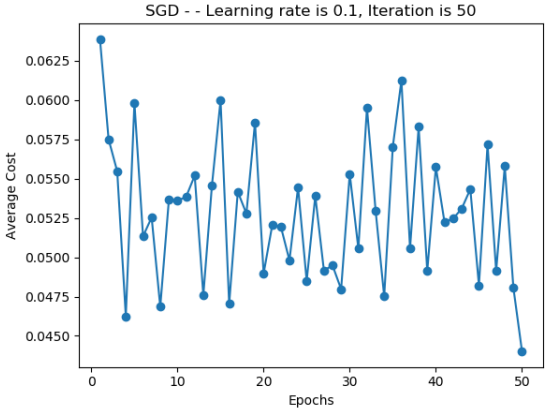
The accuracy is 100.00%.



Learning rate is 0.1, Iteration is 50

The sum of squared error of each iteration is ['0.06', '0.06', '0.06', '0.05', '0.06', '0.05', '0.05', '0.05', '0.05', '0.05', '0.05', '0.06', '0.05', '0.05', '0.06', '0.05', '0.05', '0.05', '0.06', '0.05', '0.05', '0.05', '0.05', '0.05', '0.05', '0.05', '0.05', '0.05', '0.05', '0.06', '0.05', '0.06', '0.05', '0.05', '0.06', '0.06', '0.05', '0.06', '0.05', '0.06', '0.05', '0.05', '0.05', '0.05', '0.05', '0.06', '0.05', '0.06', '0.05', '0.04'].

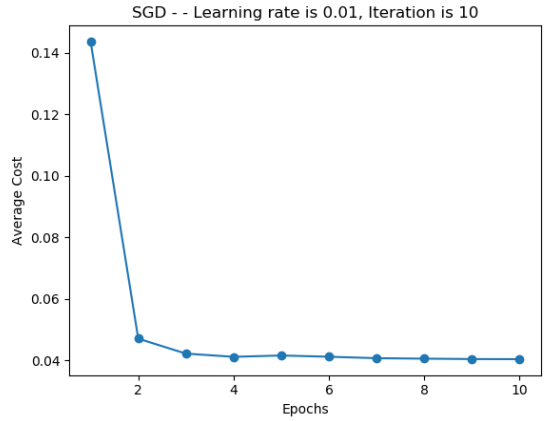
The accuracy is 100.00%.



Learning rate is 0.01, Iteration is 10

The sum of squared error of each iteration is ['0.14', '0.05', '0.04', '0.04', '0.04', '0.04', '0.04', '0.04', '0.04', '0.04'].

The accuracy is 100.00%.



Analysis: The performance of SGD is good for iris. Learning rate and iteration do not affect the result much. Error converges to 0.05 after about 4 iterations.

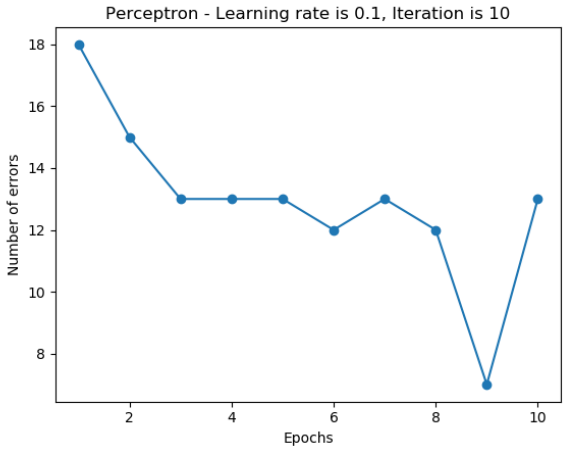
(2) For ecoli data set, the class “cp” is labeled as 1 and other seven classes are labeled as -1.

(a) Preceptron

Learning rate is 0.1, Iteration is 10

The error of each iteration is ['18.00', '15.00', '13.00', '13.00', '13.00', '12.00', '13.00', '12.00', '7.00', '13.00'].

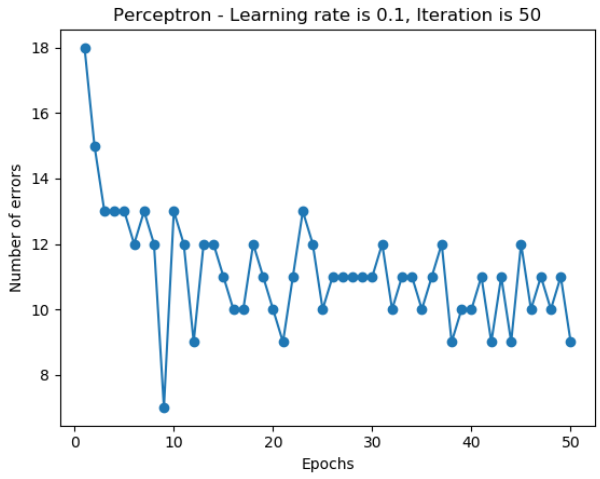
The accuracy is 91.09%.



Learning rate is 0.1, Iteration is 50

The error of each iteration is ['18.00', '15.00', '13.00', '13.00', '13.00', '12.00', '13.00', '12.00', '7.00', '13.00', '12.00', '9.00', '12.00', '12.00', '11.00', '10.00', '10.00', '12.00', '11.00', '10.00', '9.00', '11.00', '13.00', '12.00', '10.00', '11.00', '11.00', '11.00', '11.00', '11.00', '12.00', '10.00', '11.00', '11.00', '10.00', '11.00', '12.00', '9.00', '10.00', '10.00', '11.00', '9.00', '11.00', '9.00', '12.00', '10.00', '11.00', '10.00', '11.00', '9.00'].

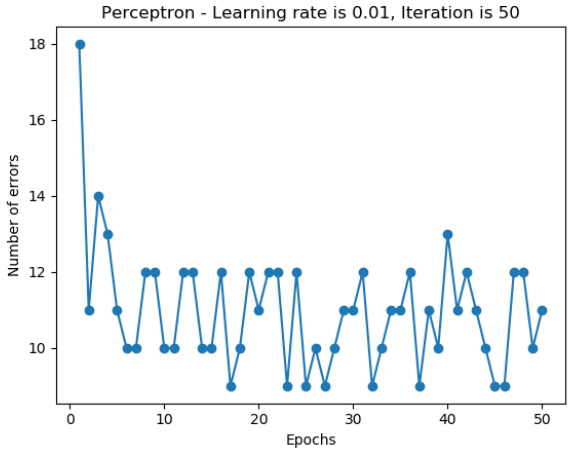
The accuracy is 88.12%.



Learning rate is 0.01, Iteration is 50

The error of each iteration is ['18.00', '11.00', '14.00', '13.00', '11.00', '10.00', '10.00', '12.00', '12.00', '10.00', '10.00', '12.00', '12.00', '10.00', '10.00', '12.00', '9.00', '10.00', '12.00', '11.00', '12.00', '12.00', '9.00', '12.00', '9.00', '10.00', '9.00', '10.00', '11.00', '11.00', '12.00', '9.00', '10.00', '11.00', '11.00', '12.00', '9.00', '11.00', '10.00', '13.00', '11.00', '12.00', '11.00', '10.00', '9.00', '9.00', '12.00', '12.00', '10.00', '11.00'].

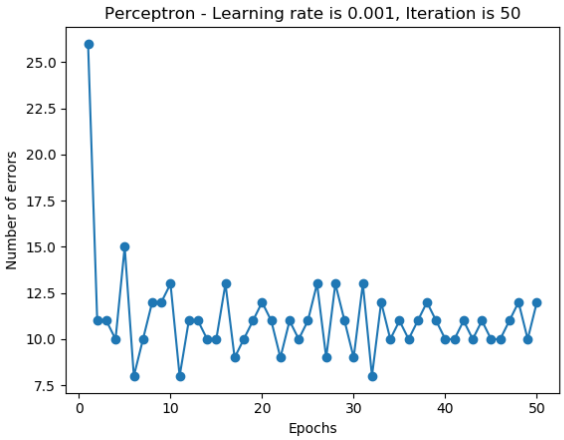
The accuracy is 89.11%.



Learning rate is 0.001, Iteration is 50

The error of each iteration is ['26.00', '11.00', '11.00', '10.00', '15.00', '8.00', '10.00', '12.00', '12.00', '13.00', '8.00', '11.00', '11.00', '10.00', '10.00', '13.00', '9.00', '10.00', '11.00', '12.00', '11.00', '9.00', '11.00', '10.00', '11.00', '13.00', '9.00', '13.00', '11.00', '9.00', '13.00', '8.00', '12.00', '10.00', '11.00', '10.00', '11.00', '12.00', '11.00', '10.00', '10.00', '11.00', '10.00', '11.00', '10.00', '10.00', '11.00', '12.00', '10.00', '12.00'].

The accuracy is 92.08%.



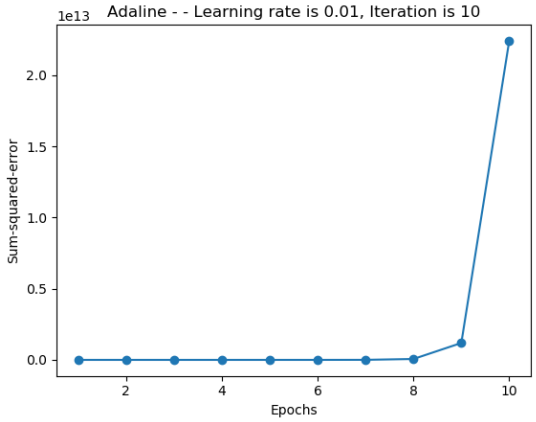
Analysis: The performance of Perceptron is good for ecoli. Learning rate and iteration are both important. Number of errors converges to 10 after about 10 iterations.

(b) Adaline

Learning rate is 0.01, Iteration is 10

The sum of squared error of each iteration is ['117.24', '1477.37', '26544.34', '496266.98', '9346384.36', '176362220.14', '3329730804.66', '62875927399.21', '1187356365177.85', '22422506654294.20'].

The accuracy is 9.90%.



Learning rate is 0.01, Iteration is 50

The sum of squared error of each iteration is ['117.24', '1477.37', '26544.34', '496266.98', '9346384.36', '176362220.14', '3329730804.66', '62875927399.21', '1187356365177.85', '22422506654294.20', '423437337901966.06', '7996403701048880.00', '1510081695715637776.00', '2851715698030168576.00', '53853263249086087168.00', '1016992680971587813376.00', '19205412151574791192576.00', '3626848680038960306585600.00', '6849127343786266120421376.00', '1293424388878725876411269120.00', '2442569054152819253190852608.00', '461267286719556740845708247040.00', '871080837761193622377888481280.00', '164499379808952612584984705761280.00', '3106490785296555125131430215024640.00', '5866456767399788263396298207526912.00', '1107851829680738385817153768081326080.00', '2092124301243190698248930475192090624.00', '3950874994820997381109501826906980352 0.00', '7461035281424865233882029597024048906240.00', '1408980227003836425895676983716088276582400.00', '2660790634552063439869468600675481986007040.00', '5024773708836942874389953365275579238055936.00', '9489040775006115421184917765093784503608934400.00', '1791959201493477309100223559834062266633814016.00', '3384027802130584612869914927722407365447778304 0.00', '6390571925995071489849432731741136254858648616960.00', '1206828428407231184330929447604130633369151497830400',

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.00',
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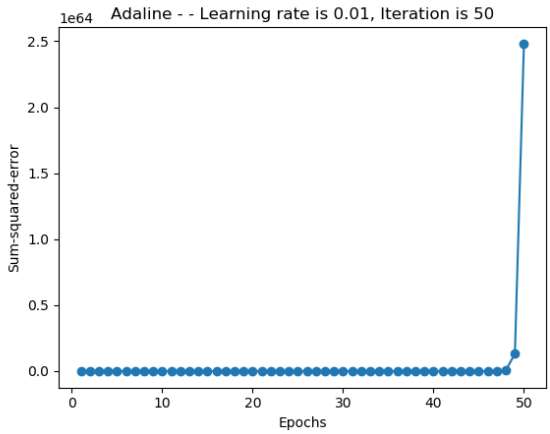
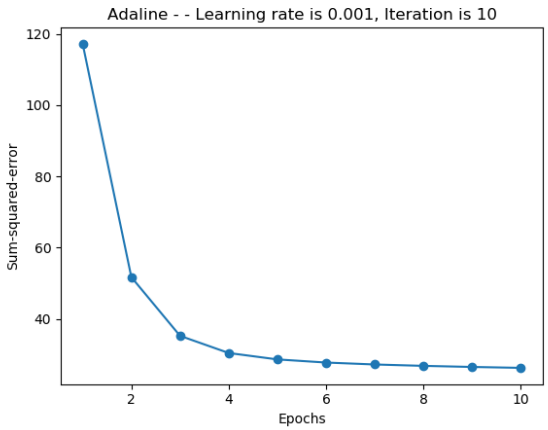
The accuracy is 9.90%.



Learning rate is 0.001, Iteration is 10

The sum of squared error of each iteration is ['117.24', '51.69', '35.21', '30.38', '28.59', '27.71', '27.16', '26.78', '26.47', '26.21'].

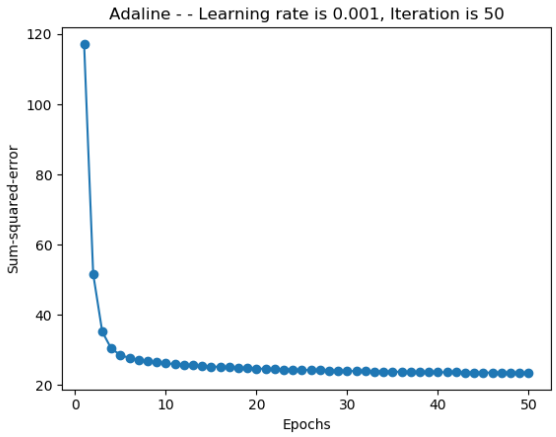
The accuracy is 93.07%.



Learning rate is 0.001, Iteration is 50

The sum of squared error of each iteration is ['117.24', '51.69', '35.21', '30.38', '28.59', '27.71', '27.16', '26.78', '26.47', '26.21', '25.99', '25.80', '25.62', '25.46', '25.31', '25.17', '25.05', '24.93', '24.83', '24.73', '24.63', '24.55', '24.46', '24.39', '24.32', '24.25', '24.19', '24.13', '24.08', '24.03', '23.98', '23.94', '23.90', '23.86', '23.82', '23.79', '23.76', '23.73', '23.70', '23.68', '23.65', '23.63', '23.61', '23.59', '23.57', '23.55', '23.54', '23.52', '23.51', '23.49'].

The accuracy is 95.05%.



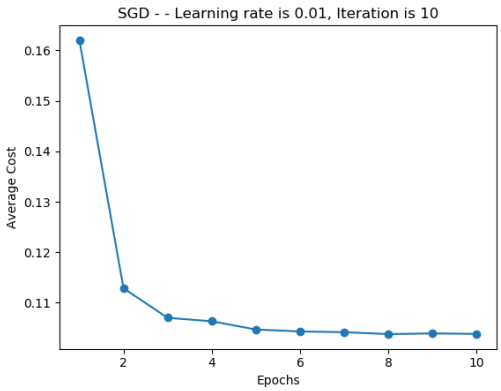
Analysis: Again, the performance of Adaline is good for ecoil. Learning rate affects the result much more than iterations. When eta=0.01, error never converges, but when eta=0.001, error converges to 23 after about 20 iterations.

(c) SGD

Learning rate is 0.01, Iteration is 10

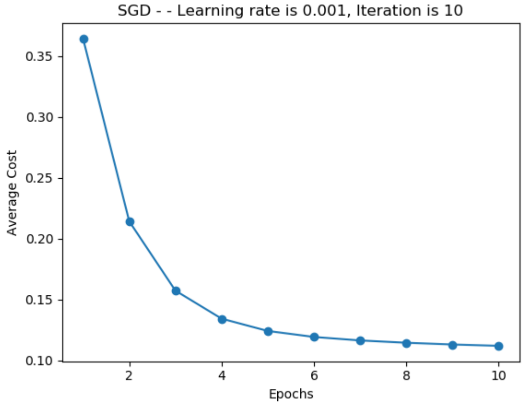
The sum of squared error of each iteration is ['0.16', '0.11', '0.11', '0.11', '0.10', '0.10', '0.10', '0.10', '0.10', '0.10'].

The accuracy is 94.06%.

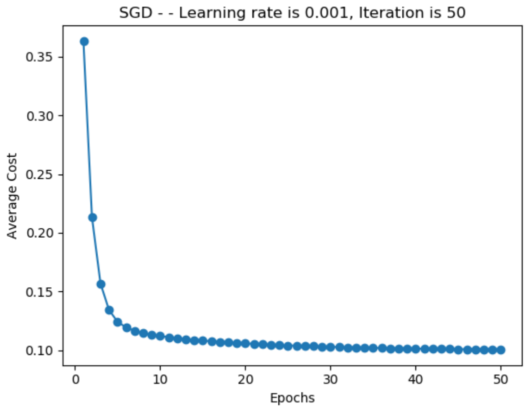


Learning rate is 0.001, Iteration is 10

The sum of squared error of each iteration is ['0.36', '0.21', '0.16', '0.13', '0.12', '0.12', '0.12', '0.11', '0.11', '0.11'].
The accuracy is 93.07%.



Learning rate is 0.001, Iteration is 50
The sum of squared error of each iteration is ['0.36', '0.21', '0.16', '0.13', '0.12', '0.12', '0.12', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.11', '0.10'].
The accuracy is 95.05%.



Analysis: The performance of SGD is good for ecoil. Learning rate and iteration do not affect the result much. Error converges to 0.1 after about 5 iterations.

2. One-vs-All
   (1) Iris and SGD
   Learning rate is 0.01, Iteration is 100
   The accuracy is 66.67%.

   Learning rate is 0.01, Iteration is 1000
   The accuracy is 71.11%.

   Learning rate is 0.001, Iteration is 1000

The accuracy is 71.11%.

(2) Ecoil and SGD
Learning rate is 0.01, Iteration is 100
The accuracy is 82.18%.

Learning rate is 0.01, Iteration is 1000
The accuracy is 80.20%.

Learning rate is 0.001, Iteration is 1000
The accuracy is 81.19%.

Analysis: The performance of SGD and One-vs-All is not very good for iris and ecoil. Learning rate and iteration do not affect the result much. Accuracies are about 71% and 81% respectively.