CS 519 Project 1 Report

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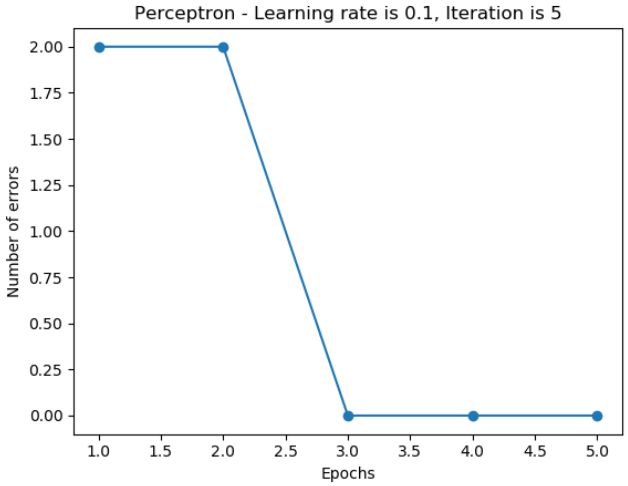
In this project, I designed three classifiers, Perceptron, Adaline and SGD to classify two data sets, iris (https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data) and ecoli (http://archive.ics.uci.edu/ml/machine-learning-databases/ecoli/ecoli.data) from UCI machine learning repository.

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'].

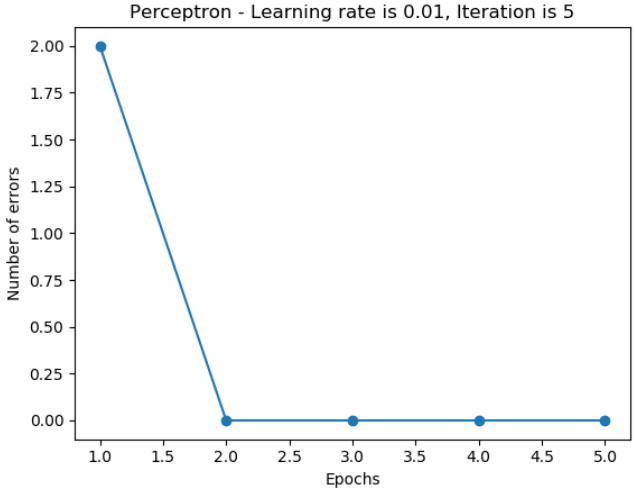
      The accuracy is 100.00%.



      Learning rate is 0.01, Iteration is 5

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

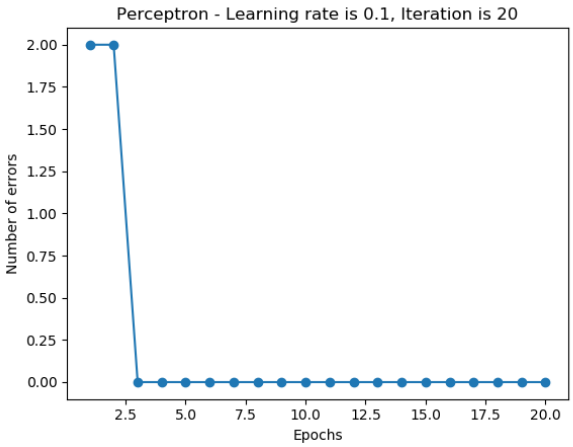
      The accuracy is 100.00%.



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%.



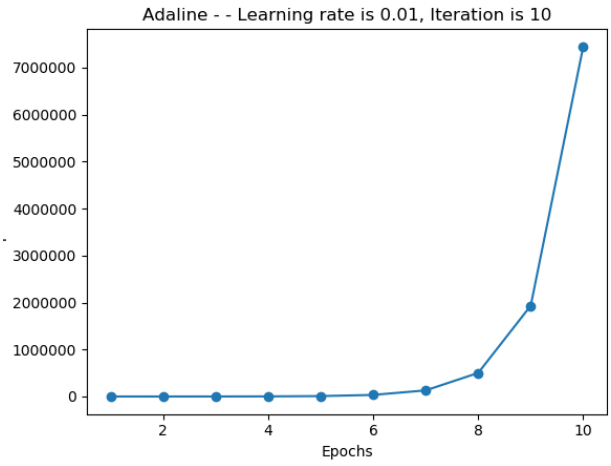
Analysis: The performance of Preceptron is good for iris. Error converges to 0 after 2 or 3 iterations. Learning rate doesn't affect the result much.

(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%.

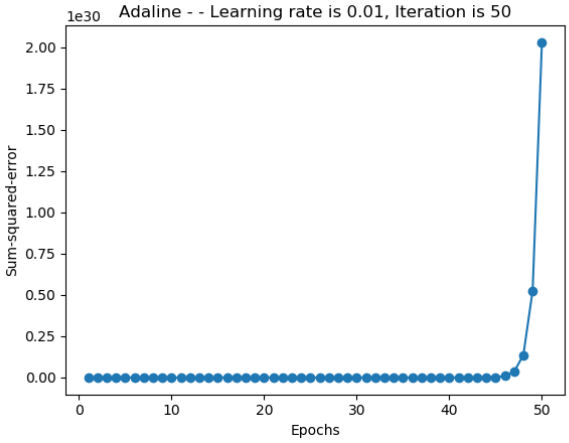


Learning rate is 0.01, Iteration is 50

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'].

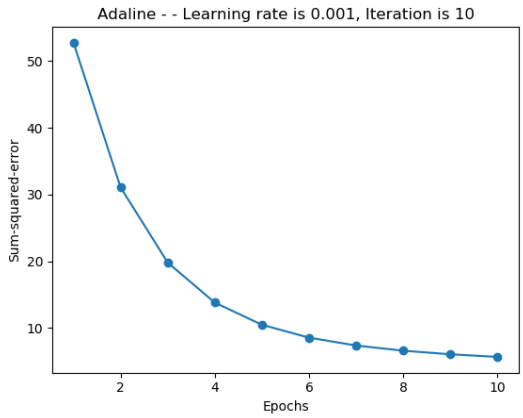
The accuracy is 6.67%.



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'].

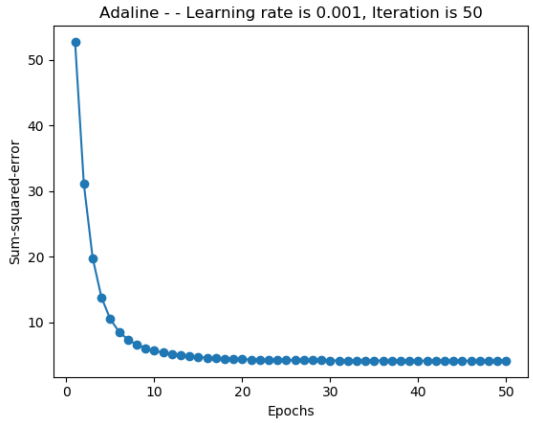
The accuracy is 100.00%.



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%.



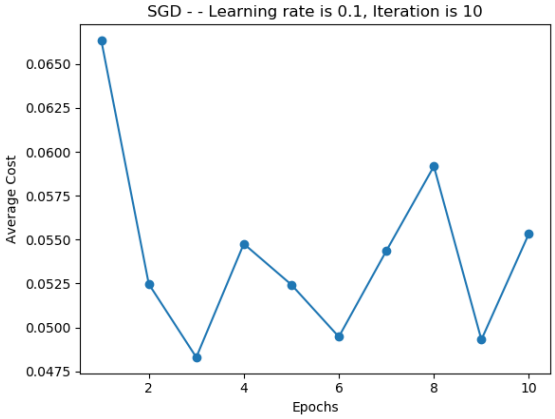
Analysis: The performance of Adaline is good for iris. Learning rate affect the result much more than iterations. When eta=0.01, error never converges, but when eta=0.001, error converges to 4.15 after about 20 iterations.

(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'].

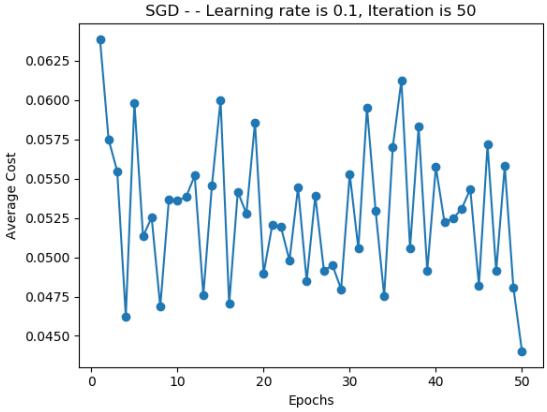
The accuracy is 100.00%.



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'].

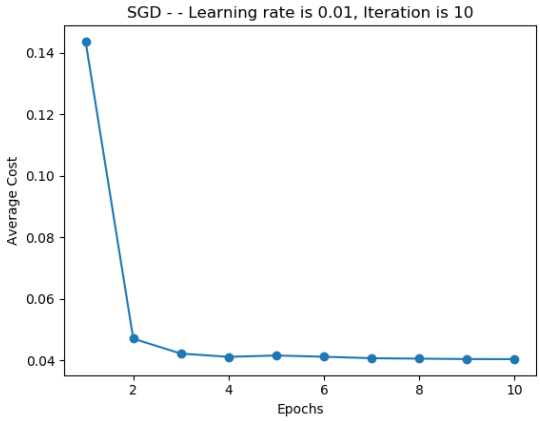
The accuracy is 100.00%.



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.

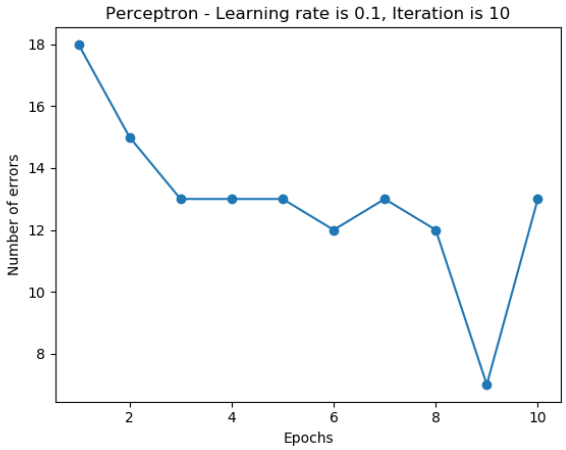
(2) For ecoli data set, the class “cp” is labeled as 1 and other two are labeled as -1.

(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'].

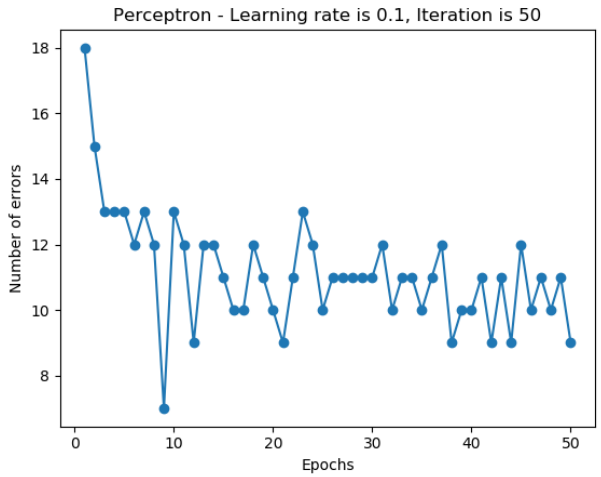
The accuracy is 91.09%.



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'].

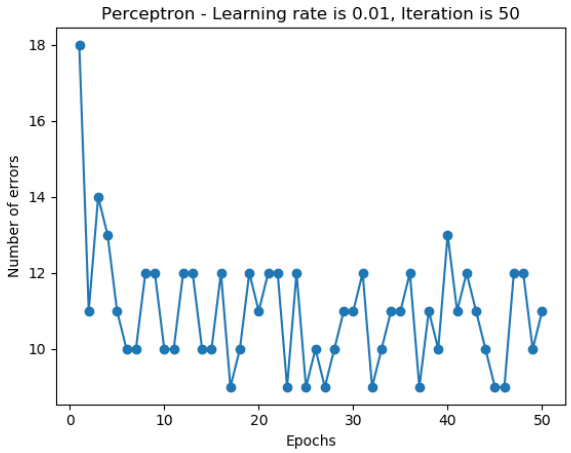
The accuracy is 88.12%.



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'].

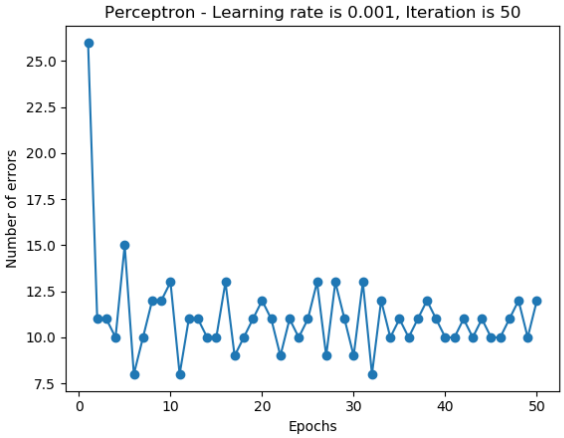
The accuracy is 89.11%.



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%.



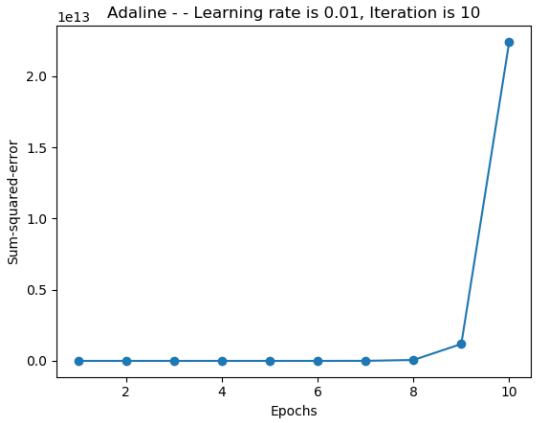
Analysis: The performance of Perceptron is good for ecoli. Learning rate and iteration are both important. Number of error converges to 10 after about 10 iterations.

(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', '151008169571563776.00', '2851715698030168576.00', '53853263249086087168.00', '1016992680971587813376.00', '19205412151574791192576.00', '3626848680038960306585 60.00', '6849127343786266120421376.00', '1293424388878725876411269 12.00', '2442569054152819253190852608.00', '4612672867195567408457082 4704.00', '8710808377611936223778884812 80.00', '1644993798089526125849847057 6128.00', '3106490785296555125131430215 02464.00', '5866456767399788263396298207 526912.00', '1107851829680738385817153768 08132608.00', '2092124301243190698248930475 192090624.00', '3950874994820997381109501826 9069803520.00', '7461035281424865233882029597 02404890624.00', '1408980227003836425895676983 7160882765824.00', '2660790634552063439869468600 67548198600704.00', '5024773708836942874389953365 275579238055936.00', '9489040775006115421184917765 093784503608 9344.00', '1791959201493477309100223559 83406226663381 4016.00', '3384027802130584612869914927 722407365447778 3040.00', '6390571925995071489849432731 741136254858648 61696.00', '1206828428407231184330929447 604130633691514 978304.00', '2279036794324301155786935463 156357477261249 35806976.00',

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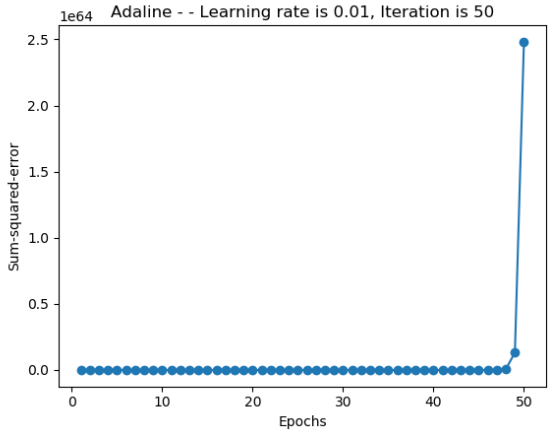
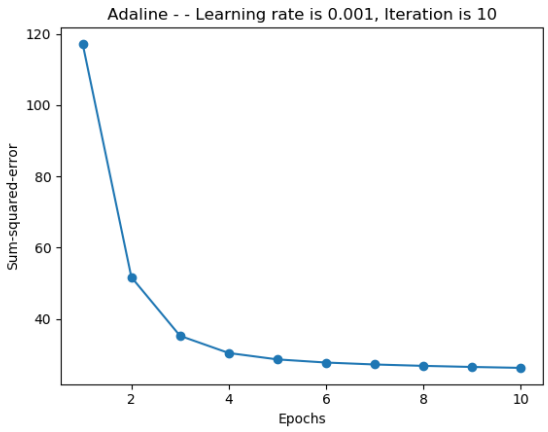
.00',
'24826482378688448333598424287728221669987083328023578730890788 86
4.00'].
The accuracy is 9.90%.



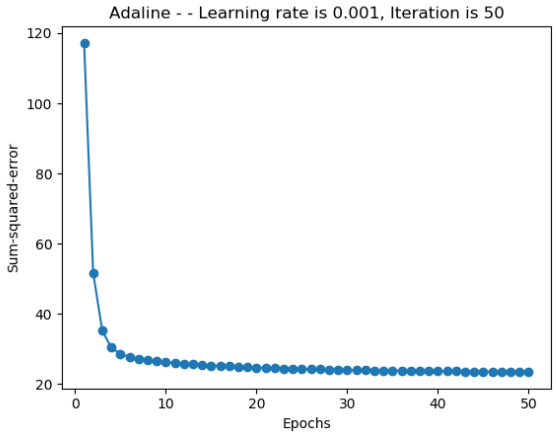
Learning rate is 0.001, Iteration is 10
The sum of squared error of each iteration is ['117.24', '51.69', '35.21', '30.38', '28.59', '27.71', '27.16', '26.78', '26.47', '26.21'].
The accuracy is 93.07%.



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%.



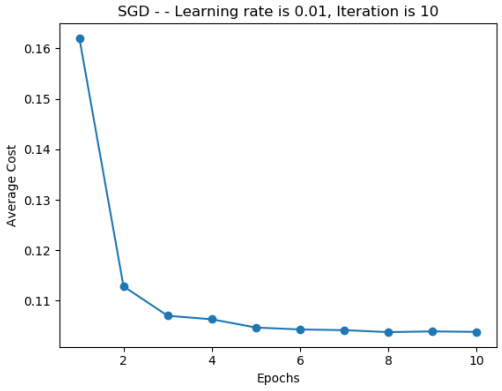
Analysis: Again, the performance of Adaline is good for ecoil. Learning rate affect the result much more than iterations. When eta=0.01, error never converges, but when eta=0.001, error converges to 23 after about 20 iterations.

(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%.

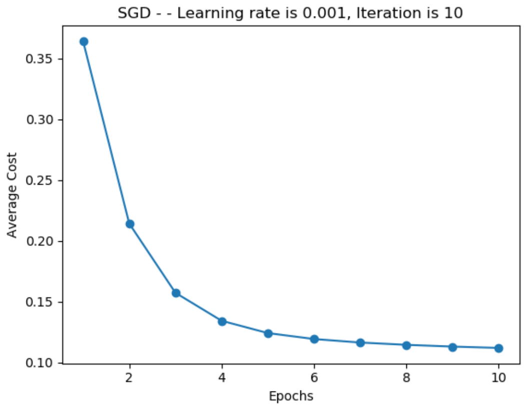


Learning rate is 0.001, Iteration is 10

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'].

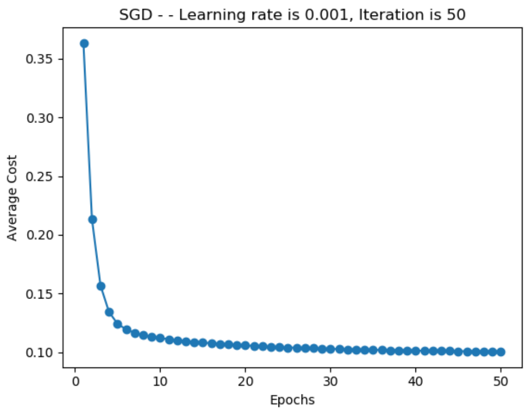
The accuracy is 93.07%.



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. Accuracy is about 71% and 81% respectively.