4.4. Implement the delta training rule for a two-input linear unit. Train it to fit the target 
concept —2 + + 2x2 > O. Plot the error E as a function of the number of training 
iterations. Plot the decision surface after 5, 10, 50, 100, , iterations. 
(a) Try this using various constant values for and using a decaying learning rate 
of no/i for the ith iteration. Which works better? 
(b) Try incremental and batch learning. Which converges more quickly? Consider 
both number of weight updates and total execution time. 

Black line is the learned decision boundary.

Red line is the actual decision boundary.

In this linear learning, it seems a constant learning rate works better than a decay learning, as there is no fear for overfitting.

|  |  |
| --- | --- |
| incremental learning, 5 iterations, learning rate = 0.1, no decay | incremental learning, 5 iterations, learning rate = 0.2, no decay |
| incremental learning, 5 iterations, learning rate = 0.1, with decay | incremental learning, 5 iterations, learning rate = 0.2, with decay |
| incremental learning, 10 iterations, learning rate = 0.1, no decay | incremental learning,10 iterations, learning rate = 0.2, no decay |
| incremental learning, 10 iterations, learning rate = 0.1, with decay | incremental learning, 10 iterations, learning rate = 0.2, with decay |
| incremental learning, 50 iterations, learning rate = 0.1, no decay | incremental learning, 50 iterations, learning rate = 0.2, no decay |
| incremental learning, 50 iterations, learning rate = 0.1, with decay | incremental learning, 50 iterations, learning rate = 0.2, with decay |
| incremental learning, 100 iterations, learning rate = 0.1, no decay | incremental learning, 100 iterations, learning rate = 0.2, no decay |
| incremental learning, 100 iterations, learning rate = 0.1, with decay | incremental learning, 100 iterations, learning rate = 0.2, with decay |

Incremental Learning till convergence:

Incremental training: 15286 iterations till convergence. 1292600 milliseconds.



Batch Learning till convergence:

Batch training: 7 iterations till convergence. 478400 milliseconds.

