Neural Networks

Perceptron and Adaline

INTRODUCTION

The project focuses on the implementation and evaluation of Perceptron and Adaline, two fundamental neural network models, for pattern recognition tasks. The goal is to develop "A Detectors" and "E Detectors" that can identify patterns resembling the letters 'A' and 'E' in a set of training and test patterns. This project offers an opportunity to explore the behaviour and performance of these neural networks in pattern classification.

Project Components:

1. Perceptron Training for A and E Detection:

- The project begins by creating a set of 25 training patterns for 'A' and 'E' detection. These patterns are transformed into column vectors, with 'ON' pixels represented as '1' and 'OFF' pixels as '-1'. These patterns will be used to train a Perceptron.

- For the 'A' detector, first five target patterns (t1, t2, t3, t4, t5) are labelled as '+1,' and for the 'E' detector, the corresponding five targets patterns (t6, t7, t8, t9, t10) are labelled as '+1' and all the remaining corresponding targets of other vowels are labelled as -1. The project tracks the training process, including the number of patterns prompting weight changes during each epoch.

2. Adaline Training for A and E Detection:

- The project then applies the Adaline (Widrow-Hoff) training algorithm to create 'A' and 'E Detectors. Different values of the learning rate (alpha) are tested, and the progression of training is observed.

- Instead of monitoring pattern changes, the Mean Squared Error (MSE) for each epoch is calculated and plotted as a learning curve.

- The final values of bias and weights are recorded for analysis.

3. Testing with Three Test Sets:

- The project evaluates the trained detectors using three test sets (TSET 1, TSET 2, TSET 3) of varying noise levels.

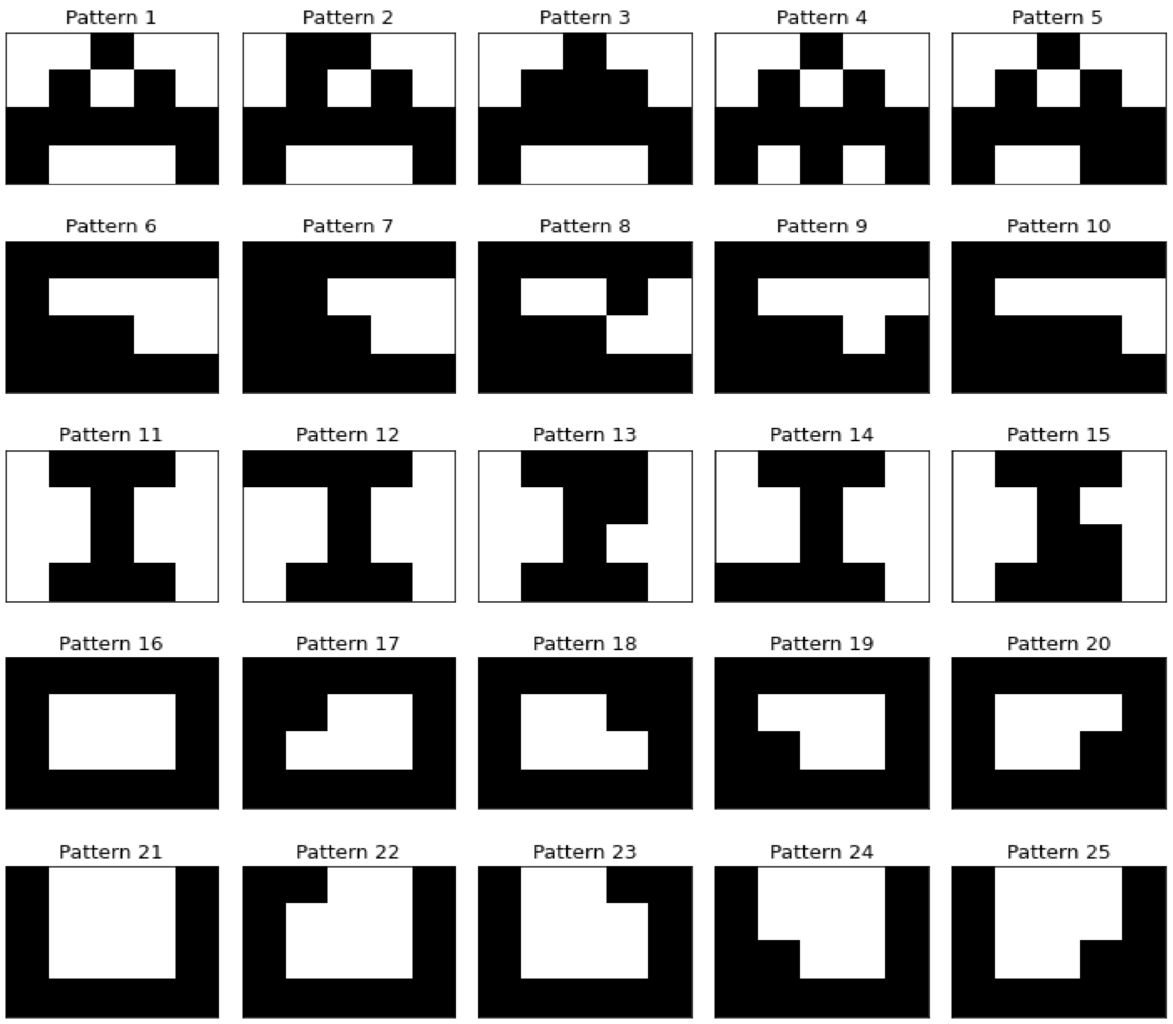
- Patterns are classified as 'HIT' or 'MISS' for each set, and the Hit Ratio (accuracy) is calculated for assessing detector performance.

Objectives:

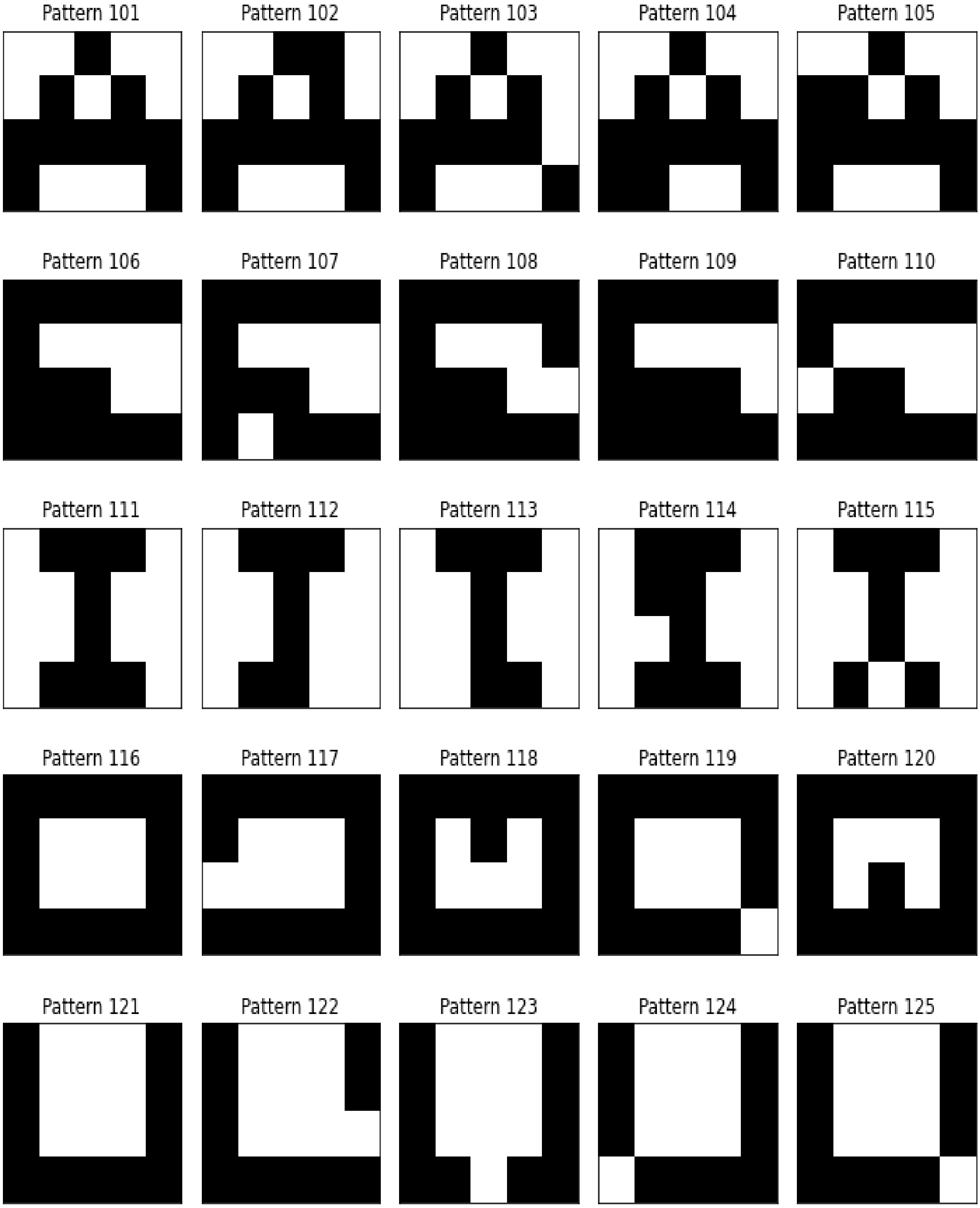
The primary objectives of this project are to:

- Implement Perceptrons and Adaline for 'A' and 'E' pattern detection.
- Analyse the impact of different learning rates (alpha) on training.
- Observe how the detectors perform on progressively more challenging test sets.
- Assess the differences between Perceptrons and Adaline in terms of training and testing.

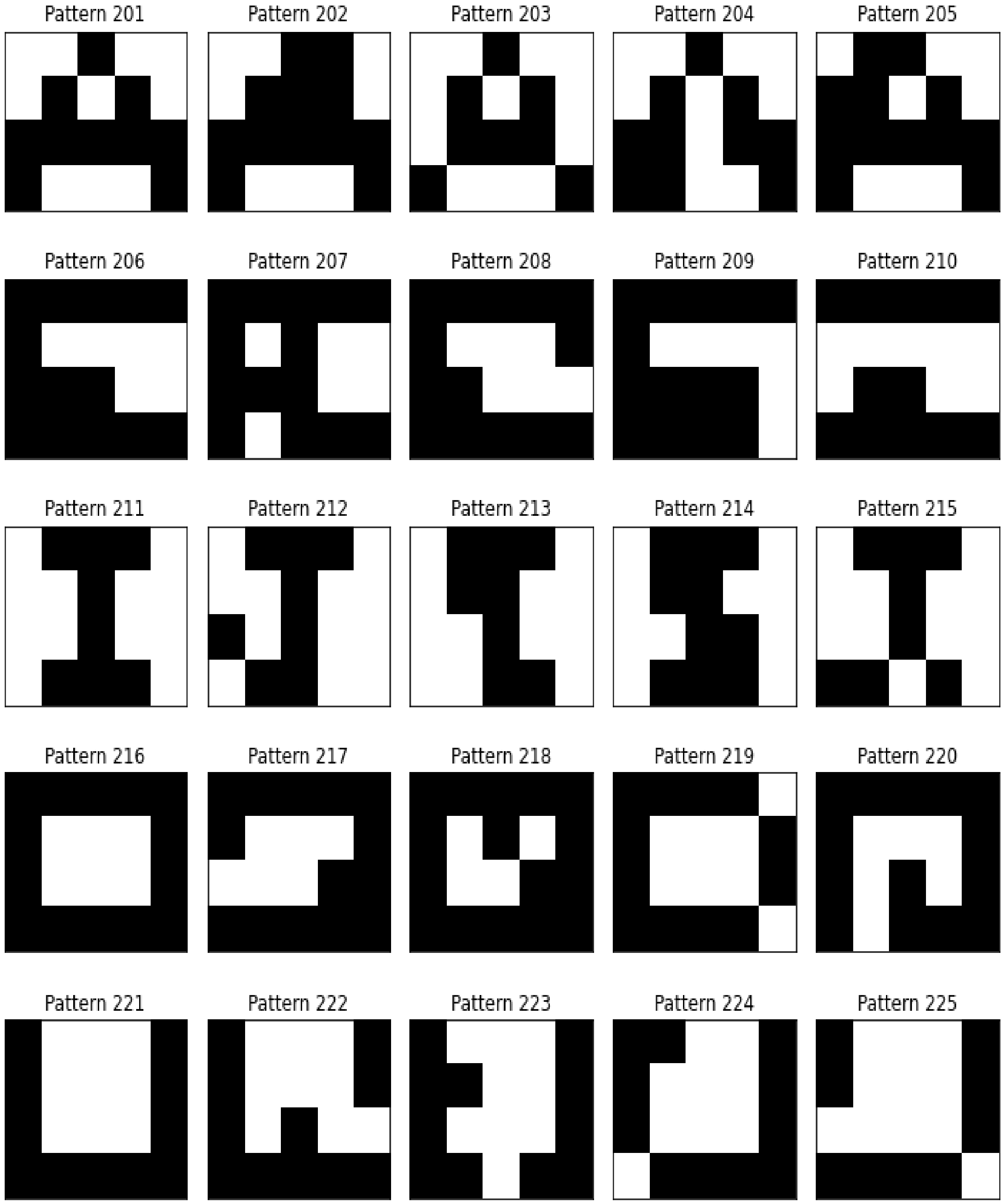
PATTERN FIGURES OF TRAINING SET:



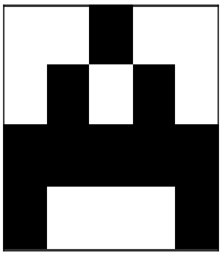
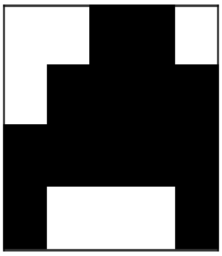
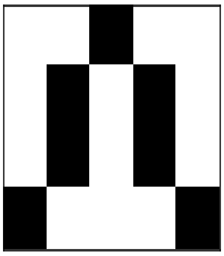
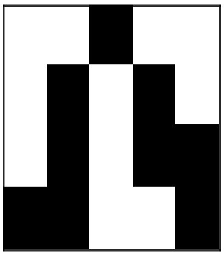
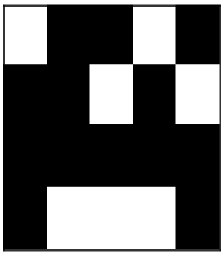
PATTERN FIGURES OF TEST SET 1:

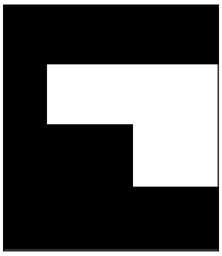
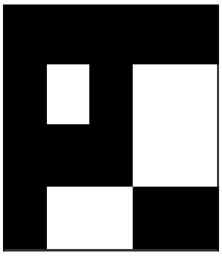
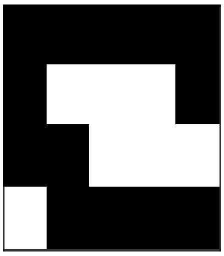
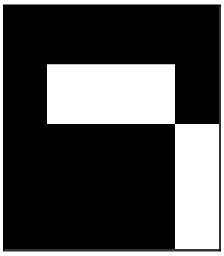
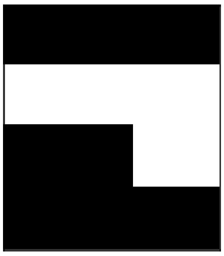


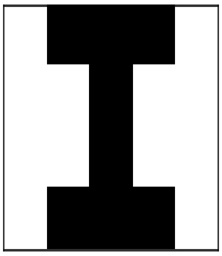
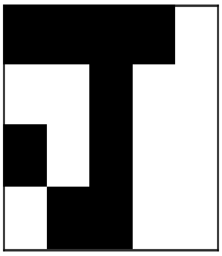
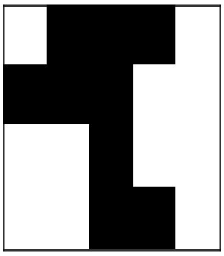
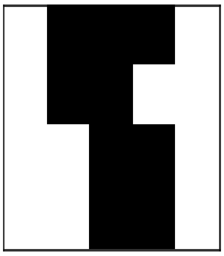
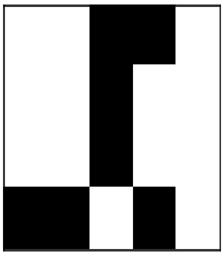
PATTERN FIGURES OF TEST SET 2:

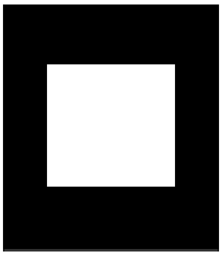
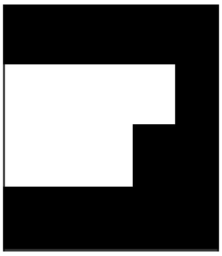
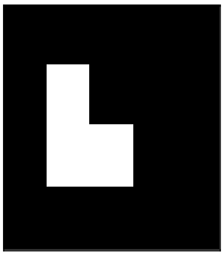
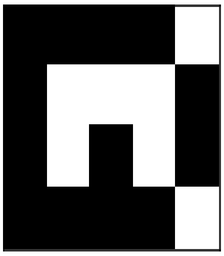
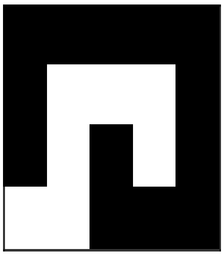


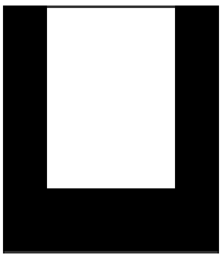
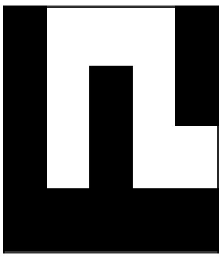
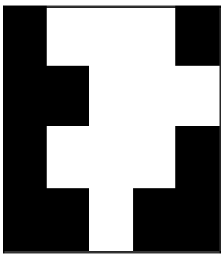
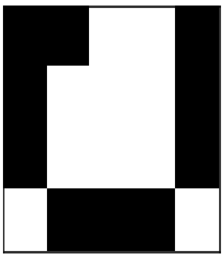
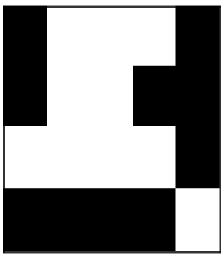
PATTERN FIGURES OF TEST SET 3:

Pattern 301

Pattern 302

Pattern 303

Pattern 304

Pattern 305


Pattern 306

Pattern 307

Pattern 308

Pattern 309

Pattern 310


Pattern 311

Pattern 312

Pattern 313

Pattern 314

Pattern 315


Pattern 316

Pattern 317

Pattern 318

Pattern 319

Pattern 320


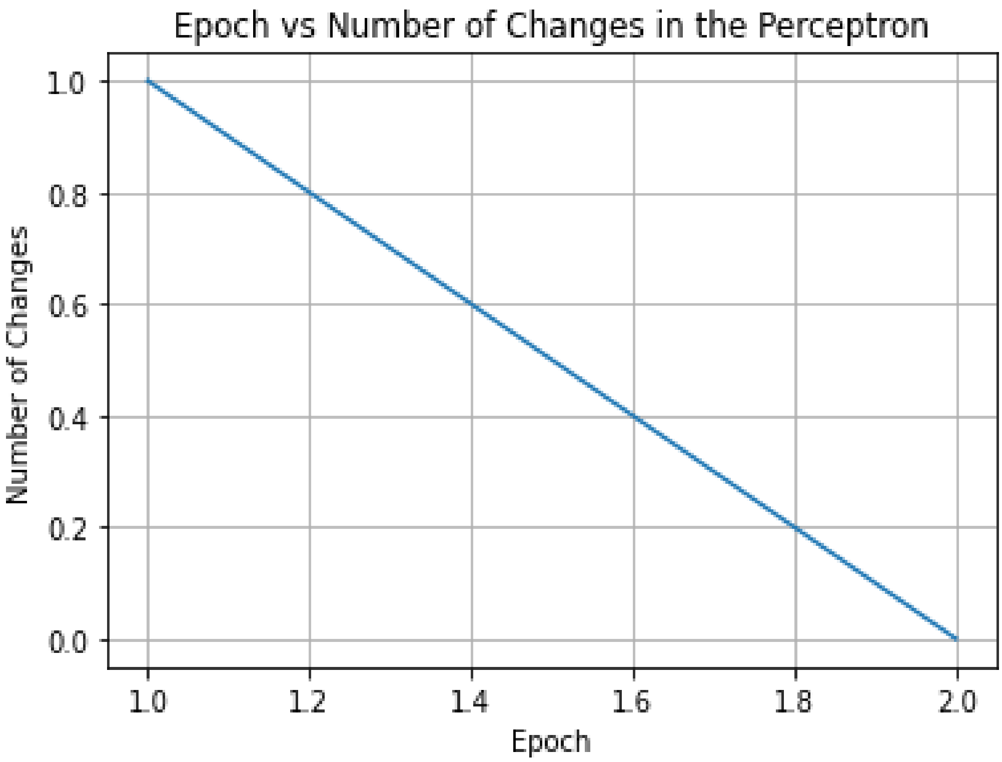
Pattern 321

Pattern 322

Pattern 323

Pattern 324

Pattern 325


PART I: PERCEPTRON

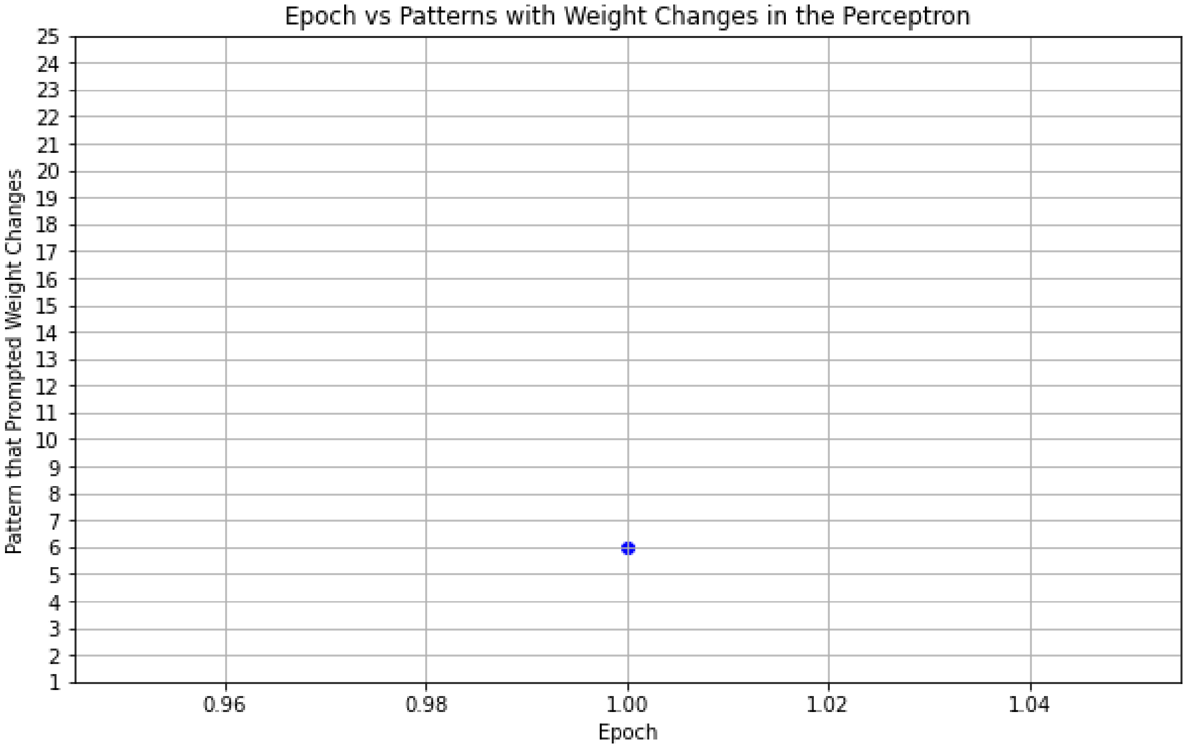
I.1 PERCEPTRON "A DETECTOR"

Number of the 25 training patterns that prompted a change of weights ($e \neq 0$) in each epoch of training and plotting these numbers, from epoch 1 to the last epoch trained.

```
patterns that changed in epoch 1: [6]
Number of Changes in weights in epoch 1: 1
patterns that changed in epoch 2: []
Number of Changes in weights in epoch 2: 0
Training complete in epoch 2.
Number of Changes in weights in each epoch: [1, 0]
weights: [-2 -2 -2 -2 -2 2 -2 -2 -2 2 -2 -2 -2 2 2 -2 -2 2 2 -2]
bias: -2
```



Plotting the pattern numbers that prompted Weight changes in each epoch.



A TABLE of trained final weights and bias for A perceptron.

```
weights: [-2 -2 -2 -2 -2  2 -2 -2 -2  2 -2 -2 -2  2  2 -2 -2  2  2 -2]
bias: -2
```

b	-2
W1	-2
W2	-2
W3	-2
W4	-2
W5	-2
W6	2
W7	-2
W8	-2
W9	-2
W10	2
W11	-2
W12	-2
W13	-2

W14	2
W15	2
W16	-2
W17	-2
W18	2
W19	2
W20	-2

Results for TSET1 with 'A' Detector Perceptron:

```
Perceptron outputs for the test set_1_A:
[1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in TSET1

P101	HIT
P102	HIT
P103	HIT
P104	HIT
P105	HIT
P106	HIT
P107	HIT
P108	HIT
P109	HIT
P110	HIT
P111	HIT
P112	HIT
P113	HIT
P114	HIT
P115	HIT
P116	HIT
P117	HIT
P118	HIT
P119	HIT
P120	HIT
P121	HIT
P122	HIT
P123	HIT
P124	HIT
P125	HIT

Results for TSET2 with 'A' Detector Perceptron:

```
Perceptron outputs for the test set_2_A:
[1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1
, -1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 24
Number of attempted classifications: 25
Hit Ratio: 0.96
Accuracy: 96.00%
```

Patterns classified incorrectly in TSET2: pt205

P201	HIT
P202	HIT
P203	HIT
P204	HIT
P205	MISS
P206	HIT
P207	HIT
P208	HIT
P209	HIT
P210	HIT
P211	HIT
P212	HIT
P213	HIT
P214	HIT
P215	HIT
P216	HIT
P217	HIT
P218	HIT
P219	HIT
P220	HIT
P221	HIT
P222	HIT
P223	HIT
P224	HIT
P225	HIT

Results for TSET3 with 'A' Detector Perceptron:

```
Perceptron outputs for the test set_3_A:
[1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, 1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 23
Number of attempted classifications: 25
Hit Ratio: 0.92
Accuracy: 92.00%
```

Patterns classified incorrectly in TSET3: pt305, pt314

P301	HIT
P302	HIT
P303	HIT
P304	HIT
P305	MISS
P306	HIT
P307	HIT
P308	HIT
P309	HIT
P310	HIT
P311	HIT
P312	HIT
P313	HIT
P314	MISS
P315	HIT
P316	HIT
P317	HIT
P318	HIT
P319	HIT
P320	HIT
P321	HIT
P322	HIT
P323	HIT
P324	HIT
P325	HIT

Results for Testing 'A' detector Perceptron with 25 Training Patterns

```
Perceptron outputs for the training_patterns:
[1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in 25 training patterns.

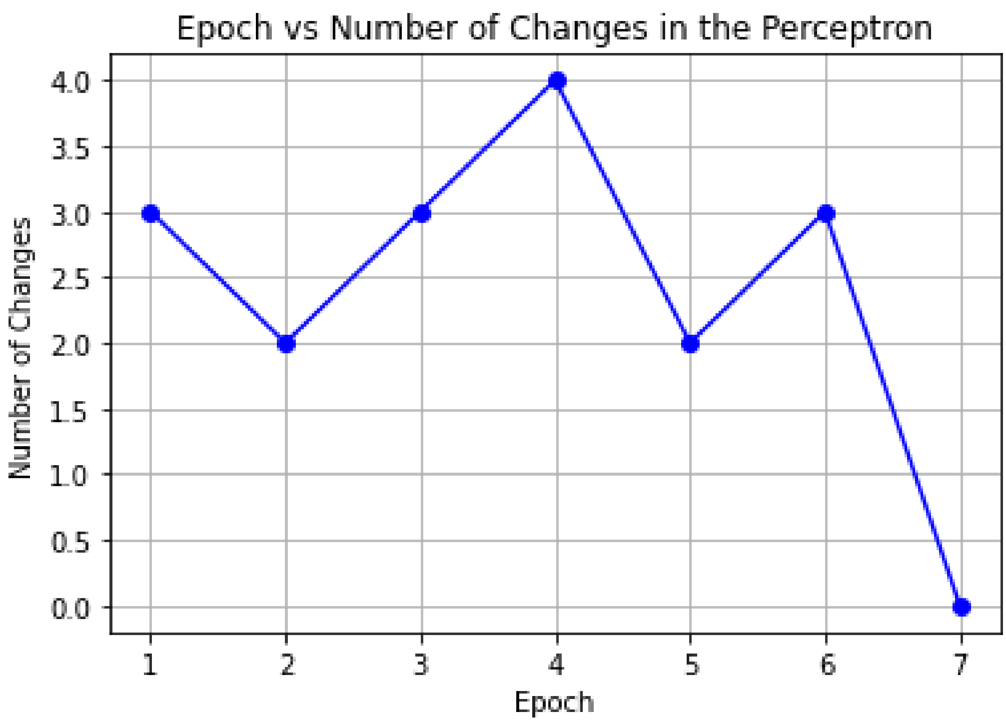
P1	HIT
P2	HIT
P3	HIT
P4	HIT
P5	HIT
P6	HIT
P7	HIT
P8	HIT
P9	HIT

P10	HIT
P11	HIT
P12	HIT
P13	HIT
P14	HIT
P15	HIT
P16	HIT
P17	HIT
P18	HIT
P19	HIT
P20	HIT
P21	HIT
P22	HIT
P23	HIT
P24	HIT
P25	HIT

I.2 PERCEPTRON "E DETECTOR"

Number of the 25 training patterns that prompted a change of weights ($e \neq 0$) in each epoch of training and plotting these numbers, from epoch 1 to the last epoch trained.

```
patterns that changed in epoch 1: [1, 11, 16]
Number of Changes in weights in epoch 1: 3
patterns that changed in epoch 2: [6, 19]
Number of Changes in weights in epoch 2: 2
patterns that changed in epoch 3: [6, 12, 24]
Number of Changes in weights in epoch 3: 3
patterns that changed in epoch 4: [1, 6, 12, 24]
Number of Changes in weights in epoch 4: 4
patterns that changed in epoch 5: [9, 19]
Number of Changes in weights in epoch 5: 2
patterns that changed in epoch 6: [2, 9, 12]
Number of Changes in weights in epoch 6: 3
patterns that changed in epoch 7: []
Number of Changes in weights in epoch 7: 0
Training complete in 7 epochs.
Number of Changes in weights in each epoch: [3, 2, 3, 4, 2, 3, 0]
weights:[  2  14   2   2   2   2   6  -2  -6  -2   6  -2   6   2   2  -
2  14  -6
 -10   2]
bias:-14
```



Plotting the pattern numbers that prompted Weight changes in each epoch.

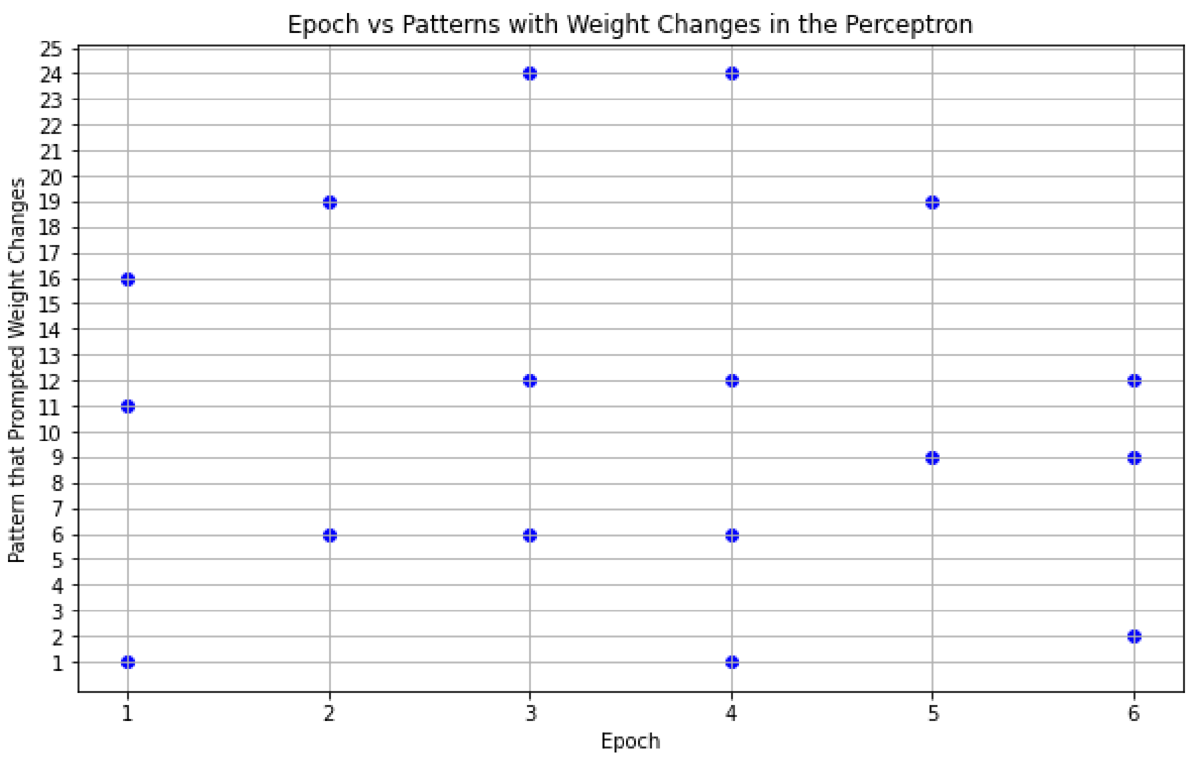


TABLE of trained final weights and bias for E perceptron.

```
weights:[  2  14   2   2   2   2   6  -2  -6  -2   6  -2   6   2   2  -
2  14  -6 -10   2]
bias:-14
```

b	-14
W1	2
W2	14
W3	2
W4	2
W5	2
W6	2
W7	6
W8	-2
W9	-6
W10	-2
W11	6
W12	-2
W13	6
W14	2
W15	2
W16	-2
W17	14
W18	-6
W19	-10
W20	2

Results for TSET1 with 'E' Detector Perceptron:

```
Perceptron outputs for the test set_1_E:
[-1, -1, -1, -1, -1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, 1, -1, -1, -1]
Number of correct classficitaions: 24
Number of attempted classifications: 25
Hit Ratio: 0.96
Accuracy: 96.00%
```

Patterns classified incorrectly in TSET1: pt122

P101	HIT
P102	HIT
P103	HIT
P104	HIT
P105	HIT
P106	HIT
P107	HIT
P108	HIT
P109	HIT
P110	HIT
P111	HIT
P112	HIT
P113	HIT
P114	HIT
P115	HIT
P116	HIT
P117	HIT
P118	HIT
P119	HIT
P120	HIT
P121	HIT
P122	MISS
P123	HIT
P124	HIT
P125	HIT

Results for TSET2 with 'E' Detector Perceptron:

```
Perceptron outputs for the test set_2_E:
[-1, -1, -1, -1, 1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
1, -1, 1, -1, -1, -1]
Number of correct classficitaions: 22
Number of attempted classifications: 25
Hit Ratio: 0.88
Accuracy: 88.00%
```

Patterns classified incorrectly in TSET2: pt205, pt220, pt222

P201	HIT
P202	HIT
P203	HIT
P204	HIT
P205	MISS
P206	HIT
P207	HIT
P208	HIT
P209	HIT

P210	HIT
P211	HIT
P212	HIT
P213	HIT
P214	HIT
P215	HIT
P216	HIT
P217	HIT
P218	HIT
P219	HIT
P220	MISS
P221	HIT
P222	MISS
P223	HIT
P224	HIT
P225	HIT

Results for TSET3 with 'E' Detector Perceptron:

```
Perceptron outputs for the test set_3_E:
[-1, -1, -1, -1, 1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, 1, 1, -1, -1]
Number of correct classficitaions: 22
Number of attempted classifications: 25
Hit Ratio: 0.88
Accuracy: 88.00%
```

Patterns classified incorrectly in TSET3: pt305, pt322, pt323

P301	HIT
P302	HIT
P303	HIT
P304	HIT
P305	MISS
P306	HIT
P307	HIT
P308	HIT
P309	HIT
P310	HIT
P311	HIT
P312	HIT
P313	HIT
P314	HIT
P315	HIT
P316	HIT
P317	HIT
P318	HIT
P319	HIT
P320	HIT

P321	HIT
P322	MISS
P323	MISS
P324	HIT
P325	HIT

Results for Testing 'E' detector Perceptron with 25 Training Patterns

```
Perceptron outputs for the training_patterns :
[-1, -1, -1, -1, -1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in 25 training patterns.

P1	HIT
P2	HIT
P3	HIT
P4	HIT
P5	HIT
P6	HIT
P7	HIT
P8	HIT
P9	HIT
P10	HIT
P11	HIT
P12	HIT
P13	HIT
P14	HIT
P15	HIT
P16	HIT
P17	HIT
P18	HIT
P19	HIT
P20	HIT
P21	HIT
P22	HIT
P23	HIT
P24	HIT
P25	HIT

I.3 COMMENTS:

The comments and observations based on all the above results are discussed below:

- The perceptron, a simple binary classifier, is effective in learning and classifying patterns when they are linearly separable, as observed. The speed and efficiency of training are influenced by the separability of patterns.
- It's worth noting that the performance of perceptrons may degrade when patterns are not linearly separable. It would be interesting to explore scenarios where more complex neural network architectures might be necessary.

The notable key differences between the "A Detector" and "E Detector" are

I). Training Process Duration:

- The "A Detector" required only two epochs to complete its training, indicating that patterns resembling the letter 'A' are highly linearly separable. The majority of patterns were correctly classified in the first epoch.
- In contrast, the "E Detector" underwent seven epochs to complete its training. This suggests that patterns resembling the letter 'E' are less linearly separable, and the training process was more protracted.

II). Pattern Changes during Training:

- In the "A Detector," only one pattern prompted a weight change in epoch 1, while the following epochs had no pattern changes. This indicates that most "A" patterns are quite distinct from the others, making training easier.
- The "E Detector" experienced pattern changes in every epoch of training, and the number of patterns changing weight was higher than in the "A Detector." The need for constant pattern changes implies that "E" patterns are not as easily separable.

III). Testing Accuracy:

- The "A Detector" demonstrated high accuracy in all three test sets: 100% accuracy in Test Set 1, 96% accuracy in Test Set 2, and 92% accuracy in Test Set 3.
- The "E Detector" also performed well in Test Set 1 with 96% accuracy but faced more challenges in Test Sets 2 and 3, achieving 88% accuracy. This suggests that the "E Detector" is less robust in classifying 'E' patterns in noisier or more complex scenarios.

IV). Pattern Numbers:

- The "A Detector" showed that patterns across all epochs did not change, indicating that the detector was consistently accurate in recognizing 'A' patterns in the training set.
- In contrast, the "E Detector" underwent constant changes in patterns during training, reflecting the need for adjustments in the model's weights to correctly classify 'E' patterns.

PART II: ADALINE:

II.1 ADALINE “A DETECTOR”

Results of Mean Square Error in each epoch of training and final value of the BIAS and 4 of the 20 weights in the network at the end of each epoch.

All the observations are listed when ALPHA = 0.1, 0.01, 0.001

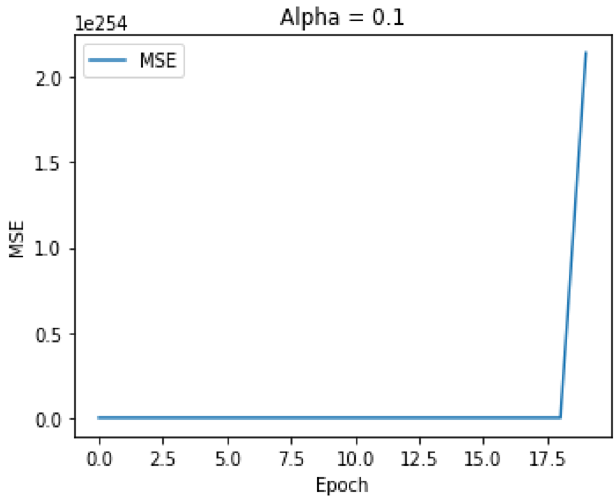
```
OBSERVATIONS FOR ALPHA_1: 0.1
Epoch 1: MSE = 1882263820279.4207
Epoch 2: MSE = 1.03379380188956e+25
Epoch 3: MSE = 5.678317000573412e+37
Epoch 4: MSE = 3.1189279487043548e+50
Epoch 5: MSE = 1.7131328786732566e+63
Epoch 6: MSE = 9.409721251209038e+75
Epoch 7: MSE = 5.1684755530480135e+88
Epoch 8: MSE = 2.838887447279345e+101
Epoch 9: MSE = 1.5593150931259472e+114
Epoch 10: MSE = 8.564846633777523e+126
Epoch 11: MSE = 4.704411454972366e+139
Epoch 12: MSE = 2.5839910606681996e+152
Epoch 13: MSE = 1.4193082100750023e+165
Epoch 14: MSE = 7.7958311305666335e+177
Epoch 15: MSE = 4.282014476129916e+190
Epoch 16: MSE = 2.3519811636111482e+203
Epoch 17: MSE = 1.2918721841831072e+216
Epoch 18: MSE = 7.095863547238703e+228
Epoch 19: MSE = 3.8975434332824216e+241
Epoch 20: MSE = 2.1408028372014423e+254
OBSERVATIONS FOR ALPHA_2: 0.01
Epoch 1: MSE = 0.17213 ; W1 = -0.1087, W2 = -0.1033, W3 = -0.0042, W4 =
-0.0096; bias = -0.0649
Epoch 2: MSE = 0.04212 ; W1 = -0.0846, W2 = -0.0810, W3 = 0.0003, W4 =
-0.0057; bias = -0.0907
Epoch 3: MSE = 0.02748 ; W1 = -0.0705, W2 = -0.0706, W3 = 0.0029, W4 =
-0.0021; bias = -0.1066
Epoch 4: MSE = 0.02206 ; W1 = -0.0619, W2 = -0.0668, W3 = 0.0046, W4 =
0.0011; bias = -0.1174
Epoch 5: MSE = 0.01952 ; W1 = -0.0563, W2 = -0.0663, W3 = 0.0058, W4 =
0.0040; bias = -0.1255
Epoch 6: MSE = 0.01793 ; W1 = -0.0522, W2 = -0.0674, W3 = 0.0066, W4 =
0.0065; bias = -0.1321
Epoch 7: MSE = 0.01675 ; W1 = -0.0489, W2 = -0.0693, W3 = 0.0073, W4 =
0.0088; bias = -0.1377
Epoch 8: MSE = 0.01578 ; W1 = -0.0461, W2 = -0.0715, W3 = 0.0079, W4 =
0.0108; bias = -0.1428
Epoch 9: MSE = 0.01495 ; W1 = -0.0435, W2 = -0.0738, W3 = 0.0085, W4 =
0.0126; bias = -0.1475
Epoch 10: MSE = 0.01422 ; W1 = -0.0410, W2 = -0.0760, W3 = 0.0091, W4 =
0.0142; bias = -0.1520
Epoch 11: MSE = 0.01357 ; W1 = -0.0387, W2 = -0.0782, W3 = 0.0098, W4 =
0.0157; bias = -0.1562
Epoch 12: MSE = 0.01298 ; W1 = -0.0365, W2 = -0.0802, W3 = 0.0105, W4 =
0.0171; bias = -0.1603
Epoch 13: MSE = 0.01243 ; W1 = -0.0343, W2 = -0.0822, W3 = 0.0112, W4 =
0.0184; bias = -0.1642
```

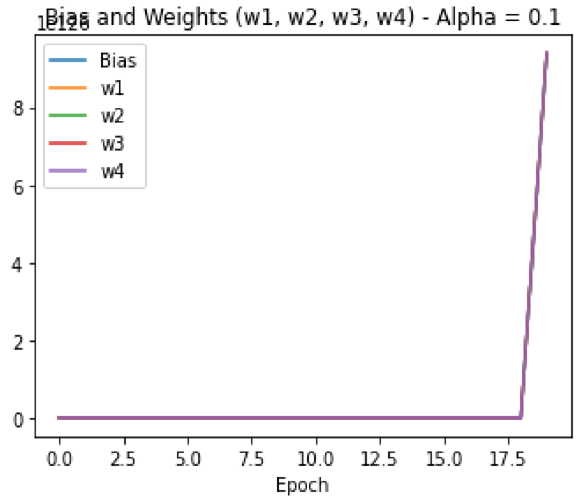
Epoch 14: MSE = 0.01192 ; W1 = -0.0323, W2 = -0.0840, W3 = 0.0119, W4 = 0.0196; bias = -0.1680
Epoch 15: MSE = 0.01145 ; W1 = -0.0303, W2 = -0.0858, W3 = 0.0127, W4 = 0.0207; bias = -0.1717
Epoch 16: MSE = 0.01102 ; W1 = -0.0284, W2 = -0.0874, W3 = 0.0136, W4 = 0.0218; bias = -0.1752
Epoch 17: MSE = 0.01060 ; W1 = -0.0265, W2 = -0.0891, W3 = 0.0144, W4 = 0.0227; bias = -0.1786
Epoch 18: MSE = 0.01022 ; W1 = -0.0248, W2 = -0.0906, W3 = 0.0153, W4 = 0.0236; bias = -0.1819
Epoch 19: MSE = 0.00986 ; W1 = -0.0231, W2 = -0.0920, W3 = 0.0162, W4 = 0.0244; bias = -0.1851
Epoch 20: MSE = 0.00952 ; W1 = -0.0216, W2 = -0.0935, W3 = 0.0172, W4 = 0.0252; bias = -0.1882
OBSERVATIONS FOR ALPHA_3: 0.001
Epoch 1: MSE = 0.73711 ; W1 = -0.0289, W2 = -0.0256, W3 = -0.0069, W4 = -0.0102; bias = -0.0241
Epoch 2: MSE = 0.36113 ; W1 = -0.0471, W2 = -0.0412, W3 = -0.0093, W4 = -0.0152; bias = -0.0405
Epoch 3: MSE = 0.18950 ; W1 = -0.0583, W2 = -0.0506, W3 = -0.0093, W4 = -0.0171; bias = -0.0519
Epoch 4: MSE = 0.10877 ; W1 = -0.0651, W2 = -0.0560, W3 = -0.0079, W4 = -0.0174; bias = -0.0601
Epoch 5: MSE = 0.06935 ; W1 = -0.0690, W2 = -0.0590, W3 = -0.0060, W4 = -0.0168; bias = -0.0660
Epoch 6: MSE = 0.04919 ; W1 = -0.0711, W2 = -0.0605, W3 = -0.0040, W4 = -0.0157; bias = -0.0706
Epoch 7: MSE = 0.03831 ; W1 = -0.0721, W2 = -0.0610, W3 = -0.0020, W4 = -0.0146; bias = -0.0742
Epoch 8: MSE = 0.03208 ; W1 = -0.0724, W2 = -0.0611, W3 = -0.0002, W4 = -0.0134; bias = -0.0771
Epoch 9: MSE = 0.02827 ; W1 = -0.0722, W2 = -0.0608, W3 = 0.0013, W4 = -0.0124; bias = -0.0797
Epoch 10: MSE = 0.02578 ; W1 = -0.0718, W2 = -0.0604, W3 = 0.0026, W4 = -0.0115; bias = -0.0819
Epoch 11: MSE = 0.02405 ; W1 = -0.0712, W2 = -0.0599, W3 = 0.0037, W4 = -0.0107; bias = -0.0839
Epoch 12: MSE = 0.02277 ; W1 = -0.0705, W2 = -0.0594, W3 = 0.0047, W4 = -0.0101; bias = -0.0857
Epoch 13: MSE = 0.02177 ; W1 = -0.0698, W2 = -0.0590, W3 = 0.0054, W4 = -0.0095; bias = -0.0875
Epoch 14: MSE = 0.02097 ; W1 = -0.0690, W2 = -0.0585, W3 = 0.0060, W4 = -0.0091; bias = -0.0891
Epoch 15: MSE = 0.02028 ; W1 = -0.0683, W2 = -0.0581, W3 = 0.0065, W4 = -0.0087; bias = -0.0906
Epoch 16: MSE = 0.01969 ; W1 = -0.0676, W2 = -0.0577, W3 = 0.0069, W4 = -0.0084; bias = -0.0921
Epoch 17: MSE = 0.01918 ; W1 = -0.0669, W2 = -0.0574, W3 = 0.0072, W4 = -0.0081; bias = -0.0935
Epoch 18: MSE = 0.01871 ; W1 = -0.0662, W2 = -0.0572, W3 = 0.0075, W4 = -0.0079; bias = -0.0948
Epoch 19: MSE = 0.01829 ; W1 = -0.0656, W2 = -0.0569, W3 = 0.0077, W4 = -0.0077; bias = -0.0961
Epoch 20: MSE = 0.01790 ; W1 = -0.0649, W2 = -0.0567, W3 = 0.0079, W4 = -0.0076; bias = -0.0973
Final Weights for alpha = 0.01: ['-0.0216', '-0.0935', '0.0172', '0.025
2', '-0.0364', '0.0852', '0.0532', '-0.2989', '0.0303', '-0.0514', '0.0

```
153', '-0.1373', '-0.0320', '0.0654', '0.0579', '-0.1641', '-0.0935', '
-0.0153', '0.0865', '0.0172']
Final Bias for alpha = 0.01: -0.1882
```

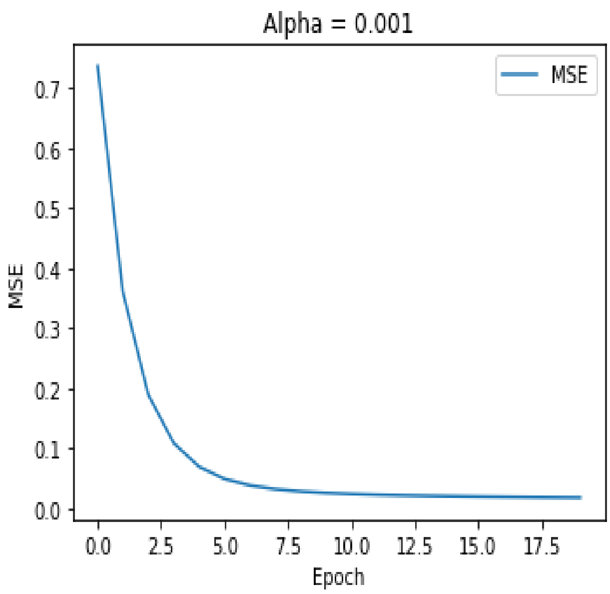
The plots of MSE vs. epoch (the "Learning Curve") and the plots of the 4 weights and the bias for the 3 values of alpha

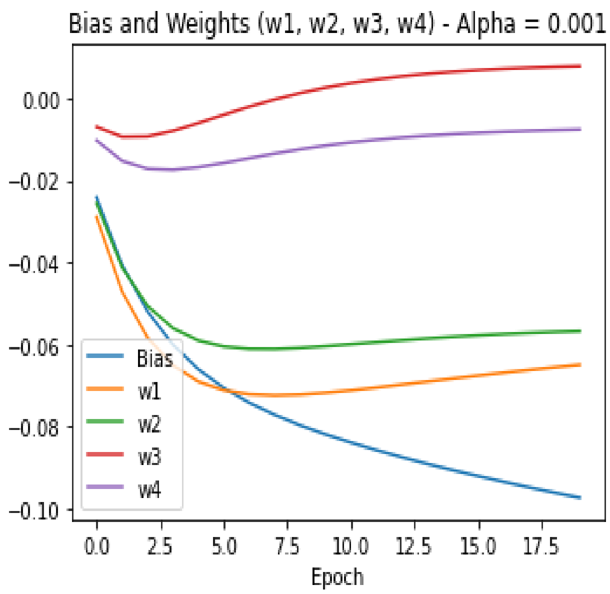
a) ALPHA = 0.1 which ended up being "too small"



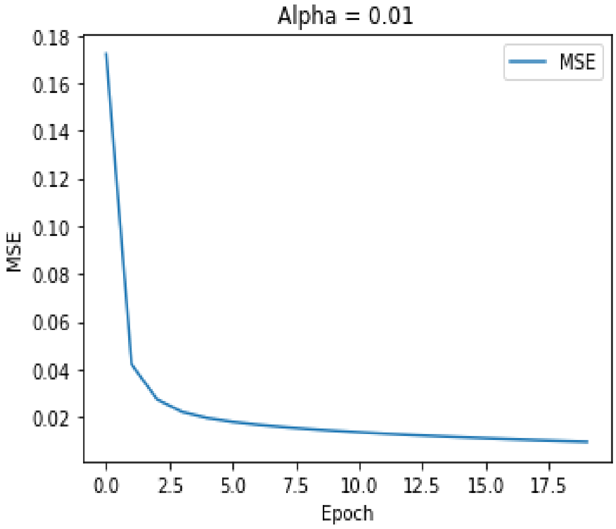


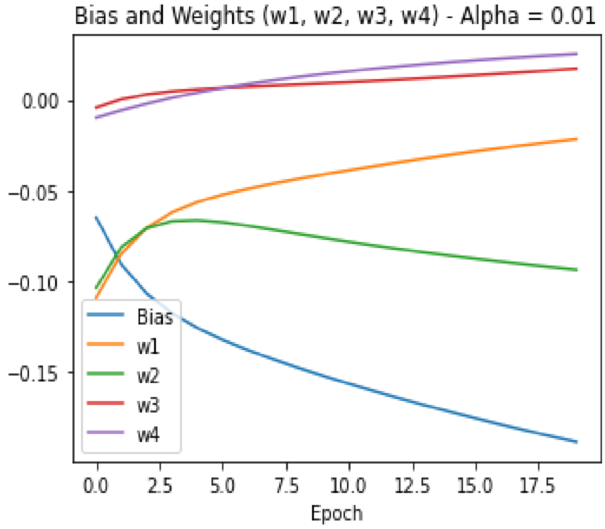
b) ALPHA = 0.001 which ended up being "too large"





c) when "ALPHA **= 0.01"** I got the "best trained weights", converging at a reasonable speed.





<u>Observation of the above values of plots:</u>

- The primary goal in training Adaline is to minimize the cost or loss function, typically represented by the MSE. By using alpha = 0.01, I was able to train the model to reach a minimum MSE, indicating that the model has successfully learned and can make more accurate predictions.
- With an alpha value of 0.01, the training process reached a reasonably low Mean Squared Error (MSE) quickly. This indicates that the Adaline model efficiently adjusted its weights to minimize the error with relatively few training epochs.
- While achieving a low MSE is important, it's also essential to find a balance with training time. Alpha = 0.01 found this balance, allowing the model to converge efficiently without prolonging the training process unnecessarily.
- In summary, an alpha value of 0.01 is considered the best choice for training 'A' Adaline detector because it enabled reasonable speed of convergence and a low MSE.

Final and best trained weights when Alpha = 0.01 for 'A' Detector Adaline

```
[-0.02156626 -0.09345598  0.01715754  0.02519263 -0.03635294  0.0852304
  0.05317853 -0.29885377  0.03025028 -0.05136438  0.01531267 -0.1372949
6
 -0.0319741   0.06539273  0.05787763 -0.16411643 -0.09345598 -0.0153126
7
  0.08650757  0.01715754]
```

```
-0.18824024664617364
```

b	-0.18824024664617364
W1	-0.02156626
W2	-0.09345598
W3	0.01715754
W4	0.02519263
W5	-0.03635294
W6	0.0852304
W7	0.05317853
W8	-0.29885377
W9	0.03025028
W10	-0.05136438
W11	0.01531267
W12	-0.13729496
W13	-0.0319741
W14	0.06539273
W15	0.05787763
W16	-0.16411643
W17	-0.09345598
W18	-0.01531267
W19	0.08650757
W20	0.01715754

Results for TSET1 with 'A' Detector Adaline:

```
Adaline outputs for the test set_1_A:
[1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in TSET1

P101	HIT
P102	HIT
P103	HIT
P104	HIT

P105	HIT
P106	HIT
P107	HIT
P108	HIT
P109	HIT
P110	HIT
P111	HIT
P112	HIT
P113	HIT
P114	HIT
P115	HIT
P116	HIT
P117	HIT
P118	HIT
P119	HIT
P120	HIT
P121	HIT
P122	HIT
P123	HIT
P124	HIT
P125	HIT

Results for TSET2 with 'A' Detector Adaline:

```
Adaline outputs for the test set_2_A:
[1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in TSET2

P201	HIT
P202	HIT
P203	HIT
P204	HIT
P205	HIT
P206	HIT
P207	HIT
P208	HIT
P209	HIT
P210	HIT
P211	HIT
P212	HIT
P213	HIT

P214	HIT
P215	HIT
P216	HIT
P217	HIT
P218	HIT
P219	HIT
P220	HIT
P221	HIT
P222	HIT
P223	HIT
P224	HIT
P225	HIT

Results for TSET3 with 'A' Detector Adaline:

```
Adaline outputs for the test set_3_A:
[1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in TSET3

P301	HIT
P302	HIT
P303	HIT
P304	HIT
P305	HIT
P306	HIT
P307	HIT
P308	HIT
P309	HIT
P310	HIT
P311	HIT
P312	HIT
P313	HIT
P314	HIT
P315	HIT
P316	HIT
P317	HIT
P318	HIT
P319	HIT
P320	HIT
P321	HIT
P322	HIT

P323	HIT
P324	HIT
P325	HIT

Results for testing 'A' detector Adaline with 25 Training Patterns

```
Adaline outputs for the training_patterns_A_Ada:
[1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in 25 training patterns.

P1	HIT
P2	HIT
P3	HIT
P4	HIT
P5	HIT
P6	HIT
P7	HIT
P8	HIT
P9	HIT
P10	HIT
P11	HIT
P12	HIT
P13	HIT
P14	HIT
P15	HIT
P16	HIT
P17	HIT
P18	HIT
P19	HIT
P20	HIT
P21	HIT
P22	HIT
P23	HIT
P24	HIT
P25	HIT

II.2 ADALINE "E DETECTOR"

Results of Mean Square Error in each epoch of training and final value of the BIAS and 4 of the 20 weights in the network at the end of each epoch.

All the observations are listed when ALPHA = 0.1, 0.001, 0.0001

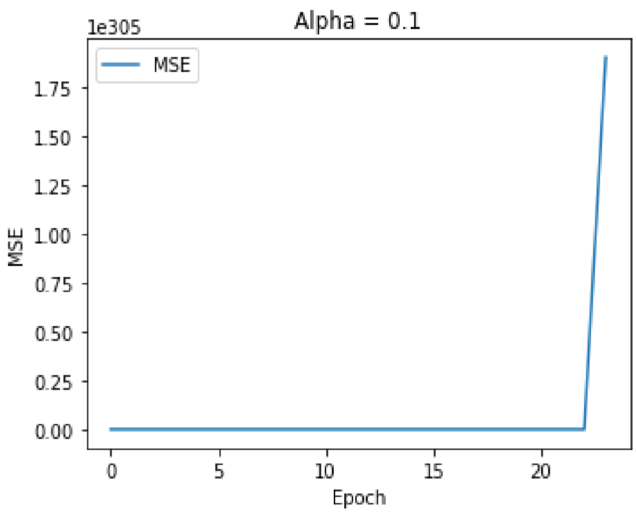
```
OBSERVATIONS FOR ALPHA_1: 0.1
Epoch 1: MSE = 1834573856139.0762
Epoch 2: MSE = 1.0076264680312522e+25
Epoch 3: MSE = 5.534587734272418e+37
Epoch 4: MSE = 3.039981805742235e+50
Epoch 5: MSE = 1.6697701478320317e+63
Epoch 6: MSE = 9.17154287346224e+75
Epoch 7: MSE = 5.03765136710406e+88
Epoch 8: MSE = 2.7670296750087875e+101
Epoch 9: MSE = 1.5198457901187845e+114
Epoch 10: MSE = 8.348053678659813e+126
Epoch 11: MSE = 4.5853336354827683e+139
Epoch 12: MSE = 2.518585212555193e+152
Epoch 13: MSE = 1.3833827540520647e+165
Epoch 14: MSE = 7.598503456101463e+177
Epoch 15: MSE = 4.173628347127212e+190
Epoch 16: MSE = 2.2924479380155425e+203
Epoch 17: MSE = 1.2591723822580094e+216
Epoch 18: MSE = 6.916253416048374e+228
Epoch 19: MSE = 3.798889015435801e+241
Epoch 20: MSE = 2.0866149464841795e+254
Epoch 21: MSE = 1.1461145395930183e+267
Epoch 22: MSE = 6.295260848580686e+279
Epoch 23: MSE = 3.4577965624400424e+292
Epoch 24: MSE = 1.899263168724422e+305
Epoch 25: MSE = inf
OBSERVATIONS FOR ALPHA_2: 0.001
Epoch 1: MSE = 0.95807 ; W1 = 0.0041, W2 = 0.0084, W3 = -0.0102, W4 = -
0.0141; bias = -0.0303
Epoch 2: MSE = 0.83701 ; W1 = 0.0109, W2 = 0.0193, W3 = -0.0172, W4 = -
0.0247; bias = -0.0563
Epoch 3: MSE = 0.74164 ; W1 = 0.0192, W2 = 0.0316, W3 = -0.0221, W4 = -
0.0329; bias = -0.0791
Epoch 4: MSE = 0.66149 ; W1 = 0.0281, W2 = 0.0443, W3 = -0.0256, W4 = -
0.0393; bias = -0.0994
Epoch 5: MSE = 0.59199 ; W1 = 0.0373, W2 = 0.0571, W3 = -0.0280, W4 = -
0.0445; bias = -0.1178
Epoch 6: MSE = 0.53090 ; W1 = 0.0463, W2 = 0.0697, W3 = -0.0297, W4 = -
0.0487; bias = -0.1345
Epoch 7: MSE = 0.47695 ; W1 = 0.0550, W2 = 0.0818, W3 = -0.0309, W4 = -
0.0523; bias = -0.1499
Epoch 8: MSE = 0.42923 ; W1 = 0.0634, W2 = 0.0934, W3 = -0.0318, W4 = -
0.0553; bias = -0.1642
Epoch 9: MSE = 0.38702 ; W1 = 0.0713, W2 = 0.1046, W3 = -0.0325, W4 = -
0.0579; bias = -0.1775
Epoch 10: MSE = 0.34970 ; W1 = 0.0787, W2 = 0.1151, W3 = -0.0329, W4 =
-0.0602; bias = -0.1898
```

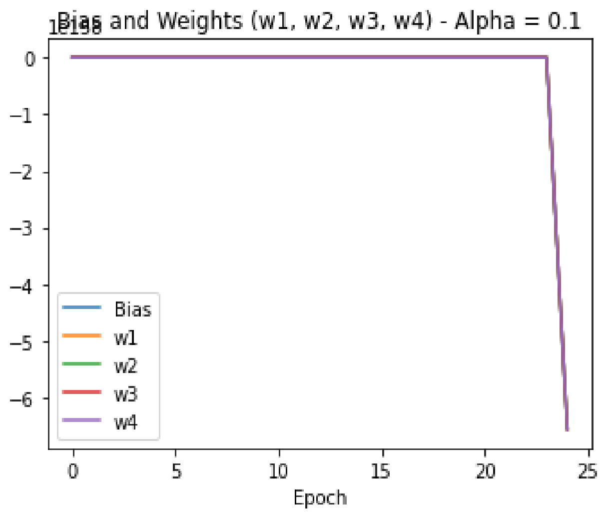
Epoch 11: MSE = 0.31671 ; W1 = 0.0857, W2 = 0.1251, W3 = -0.0332, W4 = -0.0621; bias = -0.2014
Epoch 12: MSE = 0.28756 ; W1 = 0.0923, W2 = 0.1346, W3 = -0.0334, W4 = -0.0638; bias = -0.2122
Epoch 13: MSE = 0.26179 ; W1 = 0.0984, W2 = 0.1435, W3 = -0.0336, W4 = -0.0653; bias = -0.2223
Epoch 14: MSE = 0.23901 ; W1 = 0.1041, W2 = 0.1520, W3 = -0.0337, W4 = -0.0666; bias = -0.2319
Epoch 15: MSE = 0.21887 ; W1 = 0.1094, W2 = 0.1600, W3 = -0.0337, W4 = -0.0678; bias = -0.2409
Epoch 16: MSE = 0.20105 ; W1 = 0.1144, W2 = 0.1676, W3 = -0.0337, W4 = -0.0688; bias = -0.2494
Epoch 17: MSE = 0.18528 ; W1 = 0.1190, W2 = 0.1747, W3 = -0.0337, W4 = -0.0697; bias = -0.2574
Epoch 18: MSE = 0.17132 ; W1 = 0.1233, W2 = 0.1815, W3 = -0.0337, W4 = -0.0704; bias = -0.2649
Epoch 19: MSE = 0.15894 ; W1 = 0.1273, W2 = 0.1879, W3 = -0.0337, W4 = -0.0711; bias = -0.2721
Epoch 20: MSE = 0.14797 ; W1 = 0.1310, W2 = 0.1940, W3 = -0.0336, W4 = -0.0717; bias = -0.2788
Epoch 21: MSE = 0.13824 ; W1 = 0.1344, W2 = 0.1998, W3 = -0.0336, W4 = -0.0722; bias = -0.2852
Epoch 22: MSE = 0.12959 ; W1 = 0.1376, W2 = 0.2052, W3 = -0.0335, W4 = -0.0726; bias = -0.2913
Epoch 23: MSE = 0.12190 ; W1 = 0.1405, W2 = 0.2104, W3 = -0.0335, W4 = -0.0729; bias = -0.2970
Epoch 24: MSE = 0.11505 ; W1 = 0.1432, W2 = 0.2153, W3 = -0.0334, W4 = -0.0732; bias = -0.3025
Epoch 25: MSE = 0.10895 ; W1 = 0.1458, W2 = 0.2200, W3 = -0.0333, W4 = -0.0734; bias = -0.3077
OBSERVATIONS FOR ALPHA_3: 0.0001
Epoch 1: MSE = 0.99668 ; W1 = 0.0006, W2 = 0.0010, W3 = -0.0010, W4 = -0.0014; bias = -0.0030
Epoch 2: MSE = 0.98212 ; W1 = 0.0012, W2 = 0.0020, W3 = -0.0020, W4 = -0.0028; bias = -0.0060
Epoch 3: MSE = 0.96799 ; W1 = 0.0018, W2 = 0.0030, W3 = -0.0029, W4 = -0.0041; bias = -0.0089
Epoch 4: MSE = 0.95425 ; W1 = 0.0025, W2 = 0.0041, W3 = -0.0038, W4 = -0.0054; bias = -0.0118
Epoch 5: MSE = 0.94088 ; W1 = 0.0031, W2 = 0.0051, W3 = -0.0047, W4 = -0.0067; bias = -0.0146
Epoch 6: MSE = 0.92787 ; W1 = 0.0038, W2 = 0.0062, W3 = -0.0055, W4 = -0.0079; bias = -0.0174
Epoch 7: MSE = 0.91520 ; W1 = 0.0045, W2 = 0.0073, W3 = -0.0064, W4 = -0.0091; bias = -0.0202
Epoch 8: MSE = 0.90283 ; W1 = 0.0053, W2 = 0.0085, W3 = -0.0071, W4 = -0.0103; bias = -0.0229
Epoch 9: MSE = 0.89077 ; W1 = 0.0060, W2 = 0.0096, W3 = -0.0079, W4 = -0.0114; bias = -0.0256
Epoch 10: MSE = 0.87900 ; W1 = 0.0068, W2 = 0.0108, W3 = -0.0086, W4 = -0.0125; bias = -0.0282
Epoch 11: MSE = 0.86749 ; W1 = 0.0076, W2 = 0.0119, W3 = -0.0094, W4 = -0.0136; bias = -0.0308
Epoch 12: MSE = 0.85624 ; W1 = 0.0084, W2 = 0.0131, W3 = -0.0100, W4 = -0.0146; bias = -0.0334
Epoch 13: MSE = 0.84524 ; W1 = 0.0092, W2 = 0.0143, W3 = -0.0107, W4 = -0.0157; bias = -0.0360

```
Epoch 14: MSE = 0.83447 ; W1 = 0.0100, W2 = 0.0155, W3 = -0.0114, W4 =
-0.0167; bias = -0.0385
Epoch 15: MSE = 0.82392 ; W1 = 0.0108, W2 = 0.0167, W3 = -0.0120, W4 =
-0.0177; bias = -0.0410
Epoch 16: MSE = 0.81358 ; W1 = 0.0117, W2 = 0.0180, W3 = -0.0126, W4 =
-0.0186; bias = -0.0434
Epoch 17: MSE = 0.80345 ; W1 = 0.0125, W2 = 0.0192, W3 = -0.0132, W4 =
-0.0195; bias = -0.0458
Epoch 18: MSE = 0.79351 ; W1 = 0.0134, W2 = 0.0204, W3 = -0.0137, W4 =
-0.0205; bias = -0.0482
Epoch 19: MSE = 0.78376 ; W1 = 0.0143, W2 = 0.0217, W3 = -0.0143, W4 =
-0.0214; bias = -0.0506
Epoch 20: MSE = 0.77419 ; W1 = 0.0152, W2 = 0.0229, W3 = -0.0148, W4 =
-0.0222; bias = -0.0530
Epoch 21: MSE = 0.76480 ; W1 = 0.0160, W2 = 0.0242, W3 = -0.0153, W4 =
-0.0231; bias = -0.0553
Epoch 22: MSE = 0.75557 ; W1 = 0.0169, W2 = 0.0255, W3 = -0.0158, W4 =
-0.0239; bias = -0.0576
Epoch 23: MSE = 0.74650 ; W1 = 0.0178, W2 = 0.0268, W3 = -0.0163, W4 =
-0.0247; bias = -0.0598
Epoch 24: MSE = 0.73758 ; W1 = 0.0187, W2 = 0.0280, W3 = -0.0168, W4 =
-0.0255; bias = -0.0621
Epoch 25: MSE = 0.72882 ; W1 = 0.0197, W2 = 0.0293, W3 = -0.0172, W4 =
-0.0263; bias = -0.0643
Final Weights for alpha = 0.001: ['0.1458', '0.2200', '-0.0333', '-0.07
34', '0.0462', '0.0640', '0.2684', '-0.0543', '-0.1099', '-0.0208', '0.
1298', '-0.0941', '0.1021', '0.0210', '0.0053', '-0.0929', '0.2200', '-
0.1298', '-0.2839', '-0.0333']
Final Bias for alpha = 0.001: -0.3077
```

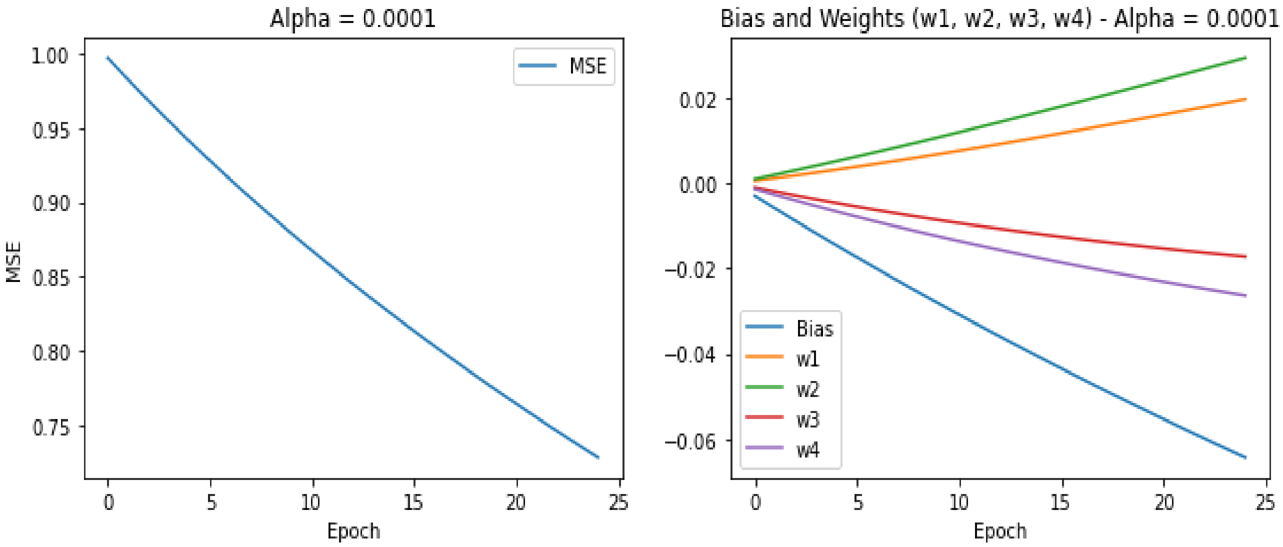
The plots of MSE vs. epoch (the "Learning Curve") and the plots of the 4 weights and the bias for the 3 values of alpha

a) ALPHA = 0.1 which ended up being "too small"

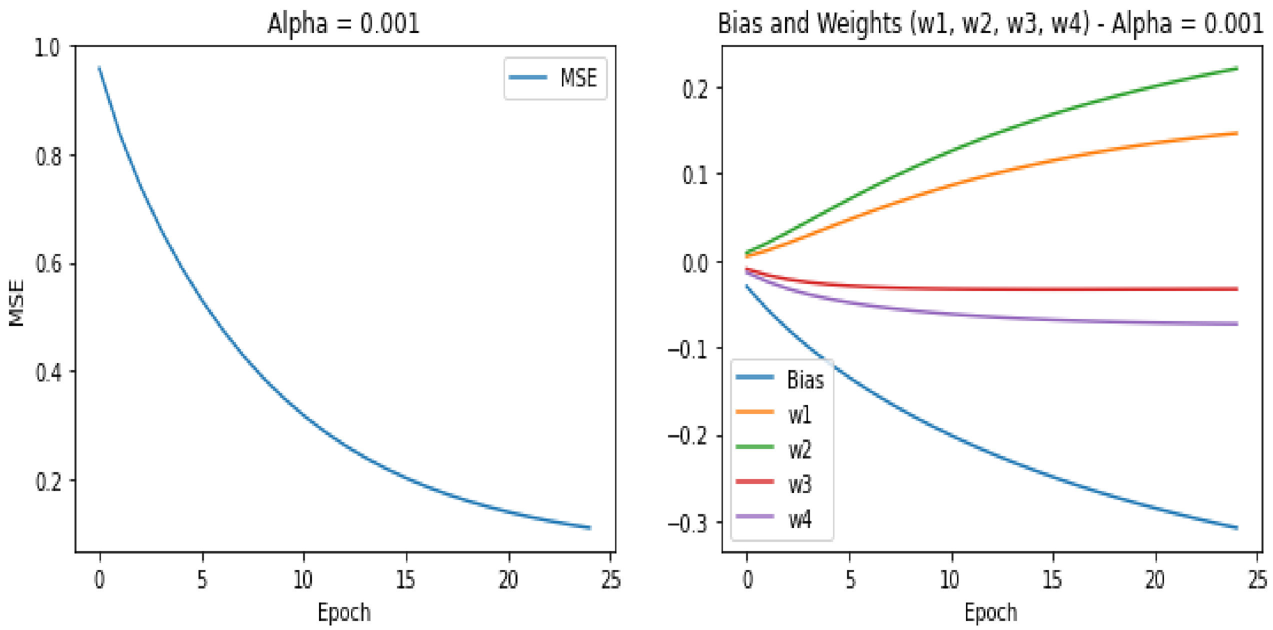




b) ALPHA = 0.0001 which ended up being "too large"



c) when "ALPHA = 0.001" I got the "best trained weights" for the Adaline 'E' Detector



<u>Observation of the above values of plots:</u>

Observing the MSE values for different alpha values (0.1, 0.001, and 0.0001) provides valuable insights into the effectiveness of the Adaline training process for ‘E’ detector. Here's a summary of why alpha = 0.001 is considered the best choice compared to alpha = 0.1 and alpha = 0.0001:

Alpha = 0.1:

- The MSE values for alpha = 0.1 increase dramatically with each epoch.

- This indicates that the learning rate is too high, causing the model to overshoot the optimal weights.

- The model's weights and bias are diverging instead of converging, making it unstable.

- After 25 epochs, the MSE reaches infinity, which means the weights have become extremely large and unstable.

Alpha = 0.001:

- The MSE values for alpha = 0.001 decrease consistently with each epoch.

- This indicates that the learning rate is appropriate for stable convergence.

- The model's weights and bias are converging at a reasonable speed, resulting in effective learning.

- After 25 epochs, the MSE reaches a low value, indicating that the model has successfully learned and is making accurate predictions.

- The final weights and bias for alpha = 0.001 are provided, reflecting meaningful values for prediction.

Alpha = 0.0001:

- The MSE values for alpha = 0.0001 decrease more slowly compared to alpha = 0.001.

- While this learning rate is less prone to overshooting, it converges very slowly.

- After 25 epochs, the MSE is relatively high compared to alpha = 0.001, indicating that the model has not learned as effectively.

In summary, alpha = 0.001 is considered the best choice because it strikes a balance between a stable learning process and a reasonably fast convergence. The MSE consistently decreases, and the final weights and bias are meaningful for accurate predictions. In contrast, alpha = 0.1 leads to instability, while alpha = 0.0001 converges too slowly, resulting in a higher MSE after 25 epochs.

Final and best trained weights when Alpha = 0.001 for 'E' Detector Adaline

```
[ 0.14576987  0.22000851 -0.03334498 -0.07340166  0.04617479  0.0640043
5
  0.26843078 -0.05431692 -0.10991542 -0.02079806  0.12980594 -0.0940562
7
  0.10212764  0.02104366  0.00526549 -0.09286934  0.22000851 -0.1298059
4
 -0.28391449 -0.03334498]
```

```
-0.30767040851265054
```

b	-0.30767040851265054
W1	0.14576987
W2	0.22000851
W3	-0.03334498
W4	-0.07340166
W5	0.04617479
W6	0.06400435
W7	0.26843078
W8	-0.05431692
W9	-0.10991542
W10	-0.02079806
W11	0.12980594
W12	-0.09405627
W13	0.10212764
W14	0.02104366
W15	0.00526549
W16	-0.09286934
W17	0.22000851
W18	-0.12980594
W19	-0.28391449
W20	-0.03334498

Results for TSET1 with 'E' Detector Adaline:

```
Adaline outputs for the test set_1_E:
[-1, -1, -1, -1, -1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
```

```
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in TSET1

P101	HIT
P102	HIT
P103	HIT
P104	HIT
P105	HIT
P106	HIT
P107	HIT
P108	HIT
P109	HIT
P110	HIT
P111	HIT
P112	HIT
P113	HIT
P114	HIT
P115	HIT
P116	HIT
P117	HIT
P118	HIT
P119	HIT
P120	HIT
P121	HIT
P122	HIT
P123	HIT
P124	HIT
P125	HIT

Results for TSET2 with 'E' Detector Adaline:

```
Adaline outputs for the test set_2_E:
[-1, -1, -1, -1, -1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in TSET2

P201	HIT
P202	HIT
P203	HIT
P204	HIT
P205	HIT
P206	HIT
P207	HIT
P208	HIT
P209	HIT
P210	HIT
P211	HIT
P212	HIT
P213	HIT
P214	HIT
P215	HIT
P216	HIT
P217	HIT
P218	HIT
P219	HIT
P220	HIT
P221	HIT
P222	HIT
P223	HIT
P224	HIT
P225	HIT

Results for TSET3 with 'E' Detector Adaline:

```
Adaline outputs for the test set_3_E:
[-1, -1, -1, -1, 1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 24
Number of attempted classifications: 25
Hit Ratio: 0.96
Accuracy: 96.00%
```

Patterns that classified incorrectly in TSET3: pt305

P301	HIT
P302	HIT
P303	HIT
P304	HIT
P305	MISS
P306	HIT
P307	HIT
P308	HIT
P309	HIT

P310	HIT
P311	HIT
P312	HIT
P313	HIT
P314	HIT
P315	HIT
P316	HIT
P317	HIT
P318	HIT
P319	HIT
P320	HIT
P321	HIT
P322	HIT
P323	HIT
P324	HIT
P325	HIT

Results for 'E' detector Adaline with 25 Training Patterns

```
Adaline outputs for the training_patterns_E_Ada:
[-1, -1, -1, -1, -1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1,
-1, -1, -1, -1, -1, -1]
Number of correct classficitaions: 25
Number of attempted classifications: 25
Hit Ratio: 1.0
Accuracy: 100.00%
```

There are no patterns classified incorrectly in 25 training patterns

P1	HIT
P2	HIT
P3	HIT
P4	HIT
P5	HIT
P6	HIT
P7	HIT
P8	HIT
P9	HIT
P10	HIT
P11	HIT
P12	HIT
P13	HIT
P14	HIT
P15	HIT
P16	HIT
P17	HIT
P18	HIT
P19	HIT

P20	HIT
P21	HIT
P22	HIT
P23	HIT
P24	HIT
P25	HIT

II.3 COMMENTS:

The comments, observations and notable key differences based on all the above results for both Adaline detectors are discussed below:

- The choice of learning rate (alpha) significantly impacts the training process of an Adaline model. It must strike a balance between stable convergence and a reasonably fast learning rate.
- Using a high learning rate can lead to overshooting, instability, and divergence, rendering the model ineffective. On the other hand, a very low learning rate might lead to slow convergence and less effective learning.
- In both 'E' and 'A' Detector Adaline cases, the learning rate was critical in determining the model's success. In 'E' Detector Adaline, alpha = 0.001 achieved the right balance, while in 'A' Detector Adaline, alpha = 0.01 was the best choice for my models.
- ‘A’ Detector Adaline achieved 100% accuracy in all the 3 Test Sets while ‘E’ detector Adaline achieved 100% accuracy in Test set 1 and Test set 2 but achieved a 96% accuracy in Test set 3.
- The primary goal is to minimize the cost or loss function (typically represented by the MSE) to ensure that the model has successfully learned and can make accurate predictions.
- In summary, the choice of learning rate is a key factor in Adaline training, and it must be selected carefully to achieve a balance between convergence speed and stability. The optimal learning rate leads to efficient learning and lower MSE values, ensuring the model's effectiveness.

CONCLUSION

- The Perceptron excelled when dealing with linearly separable patterns, while it struggled when patterns were not linearly separable.
- Adaline models proved to be more effective in various scenarios compared to the Perceptron by observing the accuracies.
- The importance of the learning rate in Adaline training was confirmed, and the right choice of alpha was crucial for convergence and stability.
- We know that the accuracy values indicate the model's ability to correctly classify patterns in different test sets. All Adaline models achieved higher accuracy compared to the Perceptron models, particularly in the 'A Detector' case, where Adaline achieved 100% accuracy in all test sets.
- These accuracy results reveal that both 'A Detector' and 'E Detector' Adaline models outperformed their Perceptron models in terms of accuracy.
- The slight drop in accuracy in the 'E Detector' Adaline model in Test Set 3 was **unexpected**. It may be due to the complexity of the 'E' patterns or the limited size of the training dataset. Using a larger training dataset might mitigate this.
- I expected for the best alpha value of Adaline ‘A’ detector will also be the best alpha choice for Adaline ‘E’ detector but the accuracy was more with alpha = 0.001
- In summary, these experiments emphasize the importance of understanding and selecting the right model and parameters for the given task. While Perceptrons and Adaline models are foundational building blocks in machine learning and illuminate the fundamental concepts of linearity, separability, and the role of learning rates in model training.
- The results obtained will be very useful for understanding the strengths and limitations of Perceptrons and Adaline in real-world applications.