Perceptron

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**General Introduction:**

This is a project trying to classify given inputs, which are handwriting data of 3 and 5, with 3 different types of perceptron algorithm: online perceptron, average perceptron and kernel perceptron. This report is to tell the difference of their performance of accuracy given different values such as iterations or dimension.

Part 1

a)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Train | 94.742 | 95.765 | 94.988 | 96.481 | 95.683 | 95.765 | 95.888 | 95.663 | 95.908 | 96.215 | 96.215 | 95.908 | 96.461 | 96.624 | 95.642 |
| Valid | 93.37 | 94.537 | 93.493 | 94.843 | 93.677 | 94.352 | 93.8 | 93.861 | 94.782 | 93.923 | 94.045 | 94.291 | 94.23 | 95.273 | 94.598 |

b) The accuracy did not reach 100%. The most probable reason is that the data was not linear separable. So the classification boundary swings left and right which caused the accuracy to fluctuate.

Part 2

b)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Train | 95.642 | 96.174 | 96.318 | 96.624 | 96.768 | 96.706 | 96.829 | 96.849 | 96.89 | 96.89 | 96.972 | 97.034 | 97.074 | 97.054 | 97.095 |
| Valid | 94.475 | 94.966 | 95.15 | 95.089 | 95.028 | 95.089 | 95.15 | 95.273 | 95.212 | 95.273 | 95.273 | 95.273 | 95.273 | 95.273 | 95.396 |

c) Comparing to the online perceptron, the accuracy of average perceptron was increasing more stably when the iterations grows. But it still won’t reach 100%.

Part 3

c)

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| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Train | 94.742 | 95.765 | 94.988 | 96.481 | 95.683 | 95.765 | 95.888 | 95.663 | 95.908 | 96.215 | 96.215 | 95.908 | 96.461 | 96.563 | 95.458 |
| Valid | 93.37 | 94.537 | 93.493 | 94.843 | 93.677 | 94.352 | 93.8 | 93.861 | 94.782 | 93.923 | 94.045 | 94.291 | 94.23 | 94.598 | 94.045 |

Best value in Training = 96.563

Best value in Valid = 94.843

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| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Train | 96.44 | 98.241 | 99.264 | 98.916 | 99.673 | 99.673 | 99.836 | 99.959 | 99.775 | 99.959 | 99.877 | 99.877 | 99.959 | 99.836 | 99.325 |
| Valid | 94.598 | 97.36 | 97.913 | 97.606 | 98.097 | 97.974 | 97.974 | 98.343 | 98.158 | 98.158 | 97.851 | 97.913 | 97.974 | 98.036 | 97.238 |

Best value in Training = 99.959

Best value in Valid = 98.343

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| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Train | 98.077 | 99.284 | 99.836 | 99.898 | 99.98 | 99.959 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Valid | 96.992 | 98.097 | 98.158 | 98.465 | 98.404 | 98.404 | 98.281 | 98.281 | 98.281 | 98.281 | 98.281 | 98.281 | 98.281 | 98.281 | 98.281 |

Best value in Training = 100

Best Value in Valid = 98.465

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| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Train | 98.793 | 99.611 | 99.939 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Valid | 96.317 | 97.238 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 | 97.729 |

Best value in Training = 100

Best value in Valid = 97.729

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| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Train | 96.706 | 99.243 | 98.936 | 99.038 | 99.755 | 99.795 | 99.857 | 99.898 | 99.898 | 99.898 | 99.918 | 99.918 | 99.939 | 99.959 | 99.959 |
| Valid | 94.966 | 96.44 | 96.133 | 96.501 | 96.562 | 96.562 | 96.562 | 96.562 | 96.562 | 96.562 | 96.562 | 96.562 | 96.562 | 96.562 | 96.562 |

Best value in Training = 99.939

Best Value in valid = 96.562

d)

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| --- | --- | --- | --- | --- | --- |
| p | 1 | 2 | 3 | 7 | 15 |
| train | 96.563 | 99.959 | 100 | 100 | 99.939 |
| valid | 94.843 | 98.343 | 98.465 | 97.729 | 96.562 |