

# REPORT

## ➤ Assumptions:-

- 1) I didn't take every point, instead took 1000 points per parameter to investigate the splits since my laptop was taking too long.

## ➤ Approach:-

- 1) I separated the train set from the val set. I then applied PCA on the train set.
- 2) I then pre-computed each split and found out which samples were misclassified. I then calculated the weighted mis-classification error for each of the splits, took the minimum for each of the 300 trees and found the val accuracy and test accuracy for the best split.
- 3) For regression, I first took the mean as the base model and then applied gradient boosting by taking the best split based on the minimum ssr. Then, I again found val mse for each of the 300 trees and mse for the best split.

## ➤ Result:-

### 1) AdaBoost.M1 :

```
Accuracy till 1 Stumps -> 99.55%
Accuracy till 2 Stumps -> 99.55%
Accuracy till 3 Stumps -> 99.55%
Accuracy till 4 Stumps -> 99.55%
Accuracy till 5 Stumps -> 99.55%
Accuracy till 6 Stumps -> 99.6%
Accuracy till 7 Stumps -> 99.55%
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Accuracy till 8 Stumps -> 99.6%  
Accuracy till 9 Stumps -> 99.6%  
Accuracy till 10 Stumps -> 99.5%  
Accuracy till 11 Stumps -> 99.6%  
Accuracy till 12 Stumps -> 99.5%  
Accuracy till 13 Stumps -> 99.5%  
Accuracy till 14 Stumps -> 99.5%  
Accuracy till 15 Stumps -> 99.5%  
Accuracy till 16 Stumps -> 99.6%  
Accuracy till 17 Stumps -> 99.5%  
Accuracy till 18 Stumps -> 99.5%  
Accuracy till 19 Stumps -> 99.5%  
Accuracy till 20 Stumps -> 99.5%  
Accuracy till 21 Stumps -> 99.5%  
Accuracy till 22 Stumps -> 99.6%  
Accuracy till 23 Stumps -> 99.5%  
Accuracy till 24 Stumps -> 99.5%  
Accuracy till 25 Stumps -> 99.5%  
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Accuracy till 30 Stumps -> 99.5%  
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Accuracy till 33 Stumps -> 99.6%  
Accuracy till 34 Stumps -> 99.5%  
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Accuracy till 55 Stumps -> 99.55%  
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Accuracy till 193 Stumps -> 99.7%  
Accuracy till 194 Stumps -> 99.7%  
Accuracy till 195 Stumps -> 99.7%

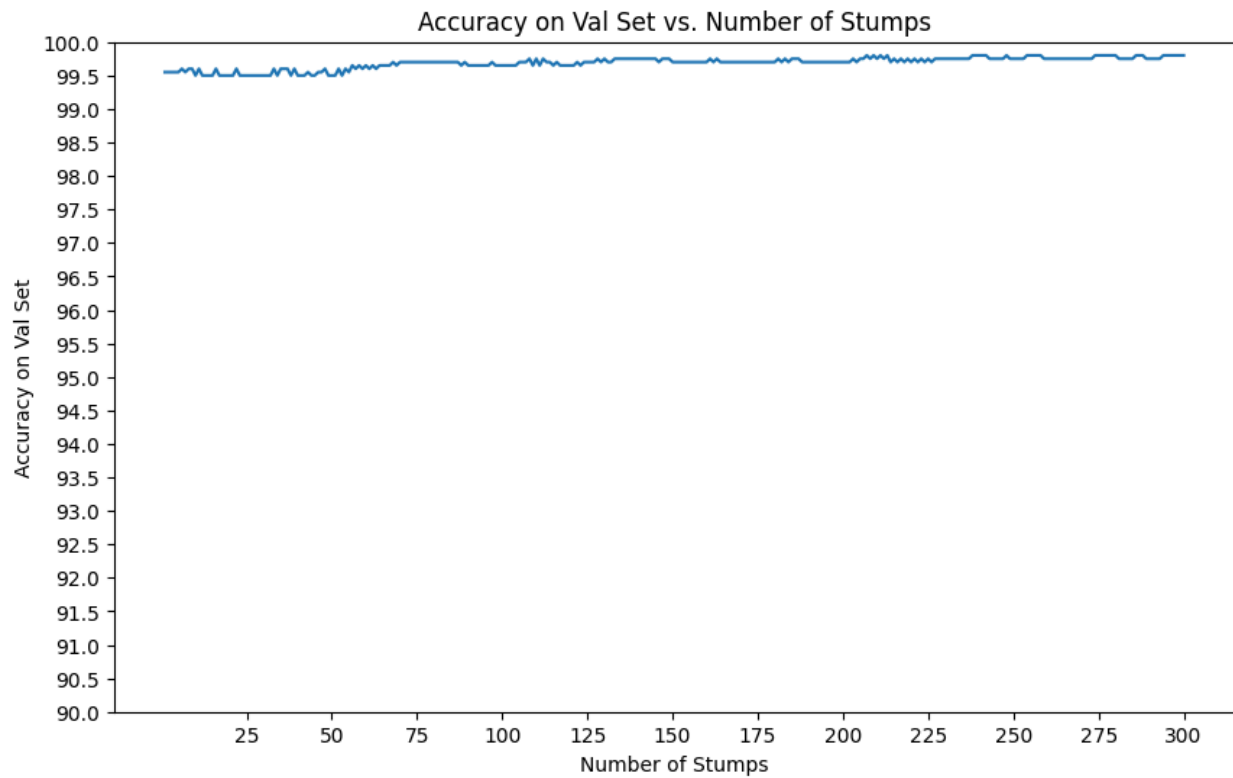
Accuracy till 196 Stumps -> 99.7%  
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Accuracy till 253 Stumps -> 99.75%  
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Accuracy till 272 Stumps -> 99.75%  
Accuracy till 273 Stumps -> 99.75%  
Accuracy till 274 Stumps -> 99.8%  
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Accuracy till 280 Stumps -> 99.8%  
Accuracy till 281 Stumps -> 99.75%  
Accuracy till 282 Stumps -> 99.75%  
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Accuracy till 285 Stumps -> 99.75%  
Accuracy till 286 Stumps -> 99.8%  
Accuracy till 287 Stumps -> 99.8%  
Accuracy till 288 Stumps -> 99.8%  
Accuracy till 289 Stumps -> 99.75%

Accuracy till 290 Stumps -> 99.75%  
Accuracy till 291 Stumps -> 99.75%  
Accuracy till 292 Stumps -> 99.75%  
Accuracy till 293 Stumps -> 99.75%  
Accuracy till 294 Stumps -> 99.8%  
Accuracy till 295 Stumps -> 99.8%  
Accuracy till 296 Stumps -> 99.8%  
Accuracy till 297 Stumps -> 99.8%  
Accuracy till 298 Stumps -> 99.8%  
Accuracy till 299 Stumps -> 99.8%  
Accuracy till 300 Stumps -> 99.8%

Best Accuracy -> 99.8% on Stump 300

Accuracy for Test Set -> 99.76%



## 2) Gradient Boosting :

MSE On Stump 1 -> 0.24175189513446496



MSE On Stump 2 -> 0.2322257814460403  
MSE On Stump 3 -> 0.22289595970562923  
MSE On Stump 4 -> 0.2137624299132286  
MSE On Stump 5 -> 0.20482519206883093  
MSE On Stump 6 -> 0.19608424617243508  
MSE On Stump 7 -> 0.18753959222404906  
MSE On Stump 8 -> 0.17919123022367425  
MSE On Stump 9 -> 0.1710391601712967  
MSE On Stump 10 -> 0.16308338206692963  
MSE On Stump 11 -> 0.15532389591056958  
MSE On Stump 12 -> 0.14776070170221198  
MSE On Stump 13 -> 0.14039379944185978  
MSE On Stump 14 -> 0.13322318912951434  
MSE On Stump 15 -> 0.12624887076517893  
MSE On Stump 16 -> 0.11947084434884303  
MSE On Stump 17 -> 0.11288910988052155  
MSE On Stump 18 -> 0.10650366736020148  
MSE On Stump 19 -> 0.10031451678788755  
MSE On Stump 20 -> 0.09432165816357833  
MSE On Stump 21 -> 0.08852509148727983  
MSE On Stump 22 -> 0.08292481675898229  
MSE On Stump 23 -> 0.07752083397869819  
MSE On Stump 24 -> 0.07231314314641339  
MSE On Stump 25 -> 0.06730174426213927  
MSE On Stump 26 -> 0.06248663732586625  
MSE On Stump 27 -> 0.05786782233760301  
MSE On Stump 28 -> 0.0534452992973469  
MSE On Stump 29 -> 0.049219068205092385  
MSE On Stump 30 -> 0.04518912906084595  
MSE On Stump 31 -> 0.041355481864606955  
MSE On Stump 32 -> 0.037718126616373325  
MSE On Stump 33 -> 0.034277063316145606  
MSE On Stump 34 -> 0.031032291963925637  
MSE On Stump 35 -> 0.02798381255971055  
MSE On Stump 36 -> 0.02513162510350038  
MSE On Stump 37 -> 0.022475729595297173  
MSE On Stump 38 -> 0.020016126035100577  
MSE On Stump 39 -> 0.017752814422910303  
MSE On Stump 40 -> 0.015685794758726113  
MSE On Stump 41 -> 0.013815067042547311  
MSE On Stump 42 -> 0.012140631274374834  
MSE On Stump 43 -> 0.010662487454208572  
MSE On Stump 44 -> 0.009380635582048685  
MSE On Stump 45 -> 0.0082950756578946  
MSE On Stump 46 -> 0.007405807681746914  
MSE On Stump 47 -> 0.0067128316536050805  
MSE On Stump 48 -> 0.006084925633395463  
MSE On Stump 49 -> 0.0055881398468222414  
MSE On Stump 50 -> 0.005158424225180261

MSE On Stump 51 -> 0.004857828680175759  
MSE On Stump 52 -> 0.004626303457102018  
MSE On Stump 53 -> 0.0045218981536659835  
MSE On Stump 54 -> 0.004488563329160397  
MSE On Stump 55 -> 0.004580348267292912  
MSE On Stump 56 -> 0.004488683286110981  
MSE On Stump 57 -> 0.00457862293235398  
MSE On Stump 58 -> 0.004488820711276209  
MSE On Stump 59 -> 0.004576915065629963  
MSE On Stump 60 -> 0.004488975604656615  
MSE On Stump 61 -> 0.00457522466712068  
MSE On Stump 62 -> 0.0044891479662517485  
MSE On Stump 63 -> 0.004573551736826315  
MSE On Stump 64 -> 0.00448933779606184  
MSE On Stump 65 -> 0.004571896274746851  
MSE On Stump 66 -> 0.004489545094086804  
MSE On Stump 67 -> 0.004570258280882429  
MSE On Stump 68 -> 0.004489769860326648  
MSE On Stump 69 -> 0.00456863775523257  
MSE On Stump 70 -> 0.004490012094781316  
MSE On Stump 71 -> 0.004567034697797832  
MSE On Stump 72 -> 0.004490271797450932  
MSE On Stump 73 -> 0.004565449108577967  
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MSE On Stump 75 -> 0.004563880987572867  
MSE On Stump 76 -> 0.0044908436074346855  
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MSE On Stump 82 -> 0.004491832334022467  
MSE On Stump 83 -> 0.004557783185702111  
MSE On Stump 84 -> 0.004492196845981388  
MSE On Stump 85 -> 0.004556302405771506  
MSE On Stump 86 -> 0.004492578826155241  
MSE On Stump 87 -> 0.004554839094055968  
MSE On Stump 88 -> 0.004492978274544099  
MSE On Stump 89 -> 0.004553393250555296  
MSE On Stump 90 -> 0.004493395191147743  
MSE On Stump 91 -> 0.004551964875269373  
MSE On Stump 92 -> 0.0044938295759662465  
MSE On Stump 93 -> 0.004550553968198519  
MSE On Stump 94 -> 0.0044942814289996615  
MSE On Stump 95 -> 0.004549160529342431  
MSE On Stump 96 -> 0.004494750750248002  
MSE On Stump 97 -> 0.004547784558701236  
MSE On Stump 98 -> 0.0044952375397112315  
MSE On Stump 99 -> 0.0045464260562748954

MSE On Stump 100 -> 0.0044957417973893595  
MSE On Stump 101 -> 0.004545085022063656  
MSE On Stump 102 -> 0.004496263523282243  
MSE On Stump 103 -> 0.004543761456067123  
MSE On Stump 104 -> 0.004496802717390194  
MSE On Stump 105 -> 0.004542455358285529  
MSE On Stump 106 -> 0.004497359379713033  
MSE On Stump 107 -> 0.004541166728718854  
MSE On Stump 108 -> 0.004497933510250726  
MSE On Stump 109 -> 0.004539895567367149  
MSE On Stump 110 -> 0.0044985251090033426  
MSE On Stump 111 -> 0.004538641874230279  
MSE On Stump 112 -> 0.004499134175970858  
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MSE On Stump 120 -> 0.004501745125989752  
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MSE On Stump 124 -> 0.00456084075688007  
MSE On Stump 125 -> 0.004533194204793959  
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MSE On Stump 127 -> 0.004533497062206807  
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MSE On Stump 148 -> 0.004561637590960112

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MSE On Stump 168 -> 0.004564022818724452  
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MSE On Stump 170 -> 0.004564342620004956  
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MSE On Stump 177 -> 0.004545726399881821  
MSE On Stump 178 -> 0.004565776081228269  
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MSE On Stump 180 -> 0.004566173010559222  
MSE On Stump 181 -> 0.0045469888844960945  
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MSE On Stump 192 -> 0.004568878524356936  
MSE On Stump 193 -> 0.00455114655298099  
MSE On Stump 194 -> 0.0045693834329585655  
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MSE On Stump 196 -> 0.0045699037671702684  
MSE On Stump 197 -> 0.0045526558473567924

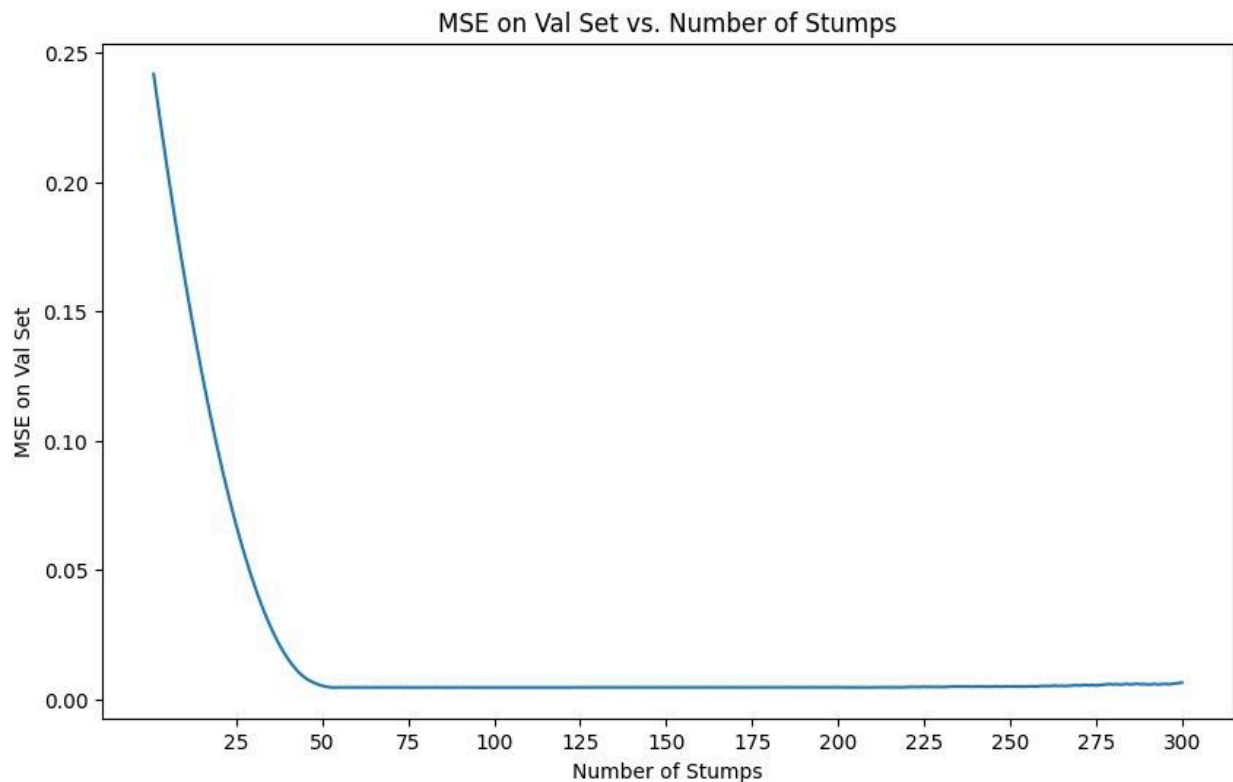
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MSE On Stump 295 -> 0.005911832094444817

MSE On Stump 296 -> 0.005749916382919909  
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MSE On Stump 299 -> 0.006215228988596472  
MSE On Stump 300 -> 0.006379964865599902

MSE for Test Set -> 0.003777288833824793

Smallest MSE for Stump 54 -> 0.004488563329160397



### ➤ Observations:-

For AdaBoost.M1, the accuracy improved as the number of trees increased, however, on running it again, it also started decreasing slightly after 100 stumps. But still, the test accuracy proved how strong the method was.

**For Gradient Boosting, the MSEs decreased exponentially as expected.**