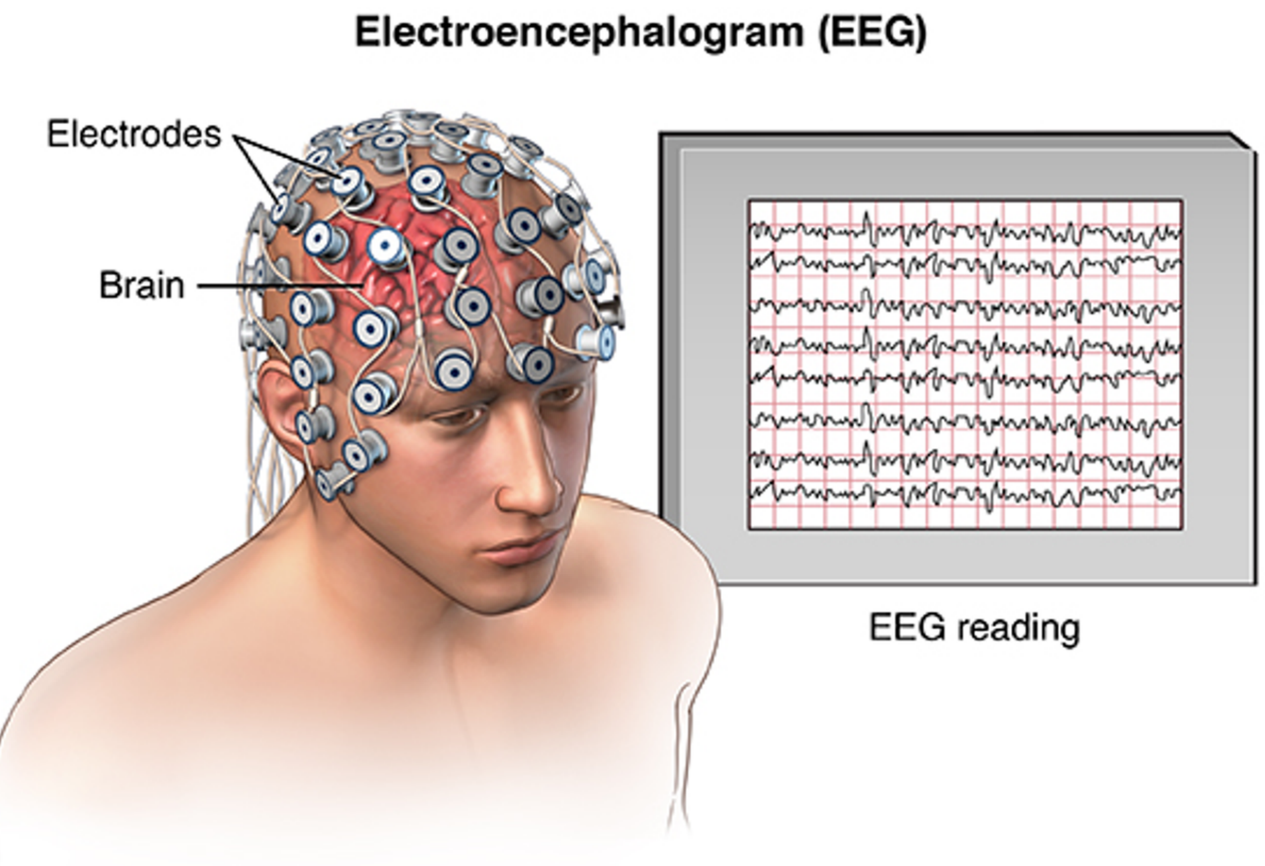
# EPILEPTIC SEIZURE RECOGNITION

Onur KARASOY
onkarasoy@gmail.com

According to the World Health Organization (WHO), epilepsy is a common neurological disorder that affects people of all ages. It is estimated that about 50 million people worldwide have epilepsy.

Epilepsy is a condition where a person **has seizures.** Seizures happen when there is a sudden burst of electrical activity in the brain. It can make a person's body shake or make them lose consciousness.




# EEG (Electroencephalogram)

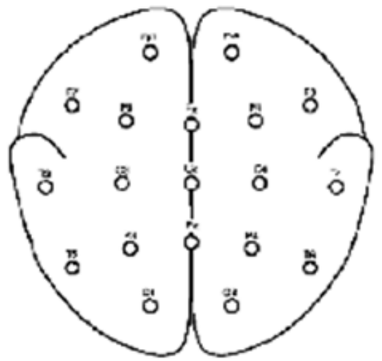
EEG is a test that measures and records the electrical activity of the brain.

# DATASET

***The Bonn dataset is collected under the supervision of the University of Bonn**

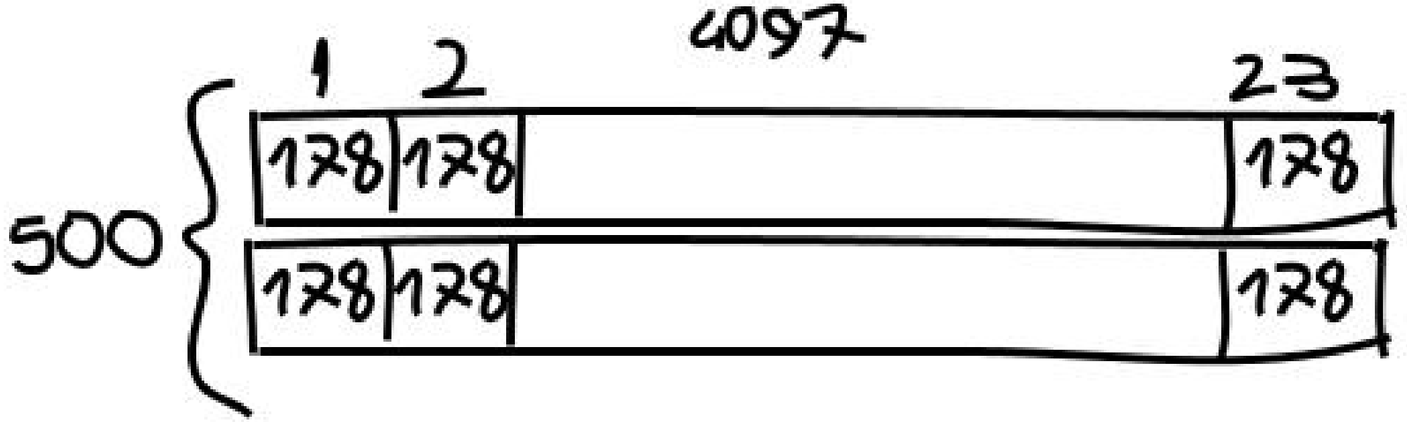
| | Set A | Set B | Set C | Set D | Set E |
|---|---|---|---|---|---|
| **Individuals** | Healthy | Healthy | Epileptic | Epileptic | Epileptic |
| **Situation** | Eyes Open | Eyes Closed | Interictal | Interictal | Ictal |
| **Electrode Type** | Surface | Surface | Intracranial | Intracranial | Intracranial |
| **Electrode Placement** | International 10-20 System | International 10-20 System | Opposite the Epileptogenic Zone | Epileptogenic Zone | Opposite the Epileptogenic Zone |
| **Duration** | 23.6 sec | 23.6 sec | 23.6 sec | 23.6 sec | 23.6 sec |

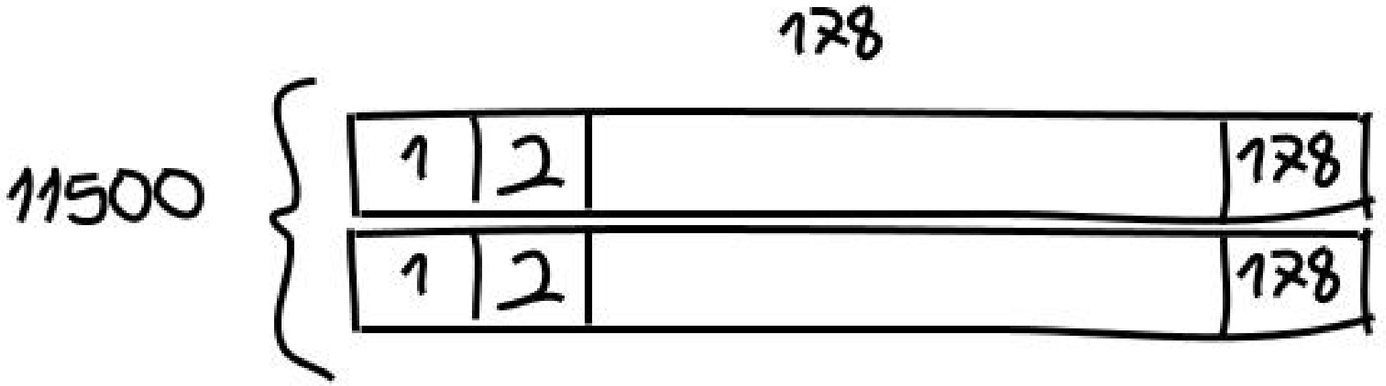
*Intracranial Scheme of intracranial electrodes implanted for presurgical evaluation of epilepsy patients.*



*International 10-20 system*

# DATASET


4097
1
2
23
128
128
128
500
128
128
128


128
11500
1
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128
1
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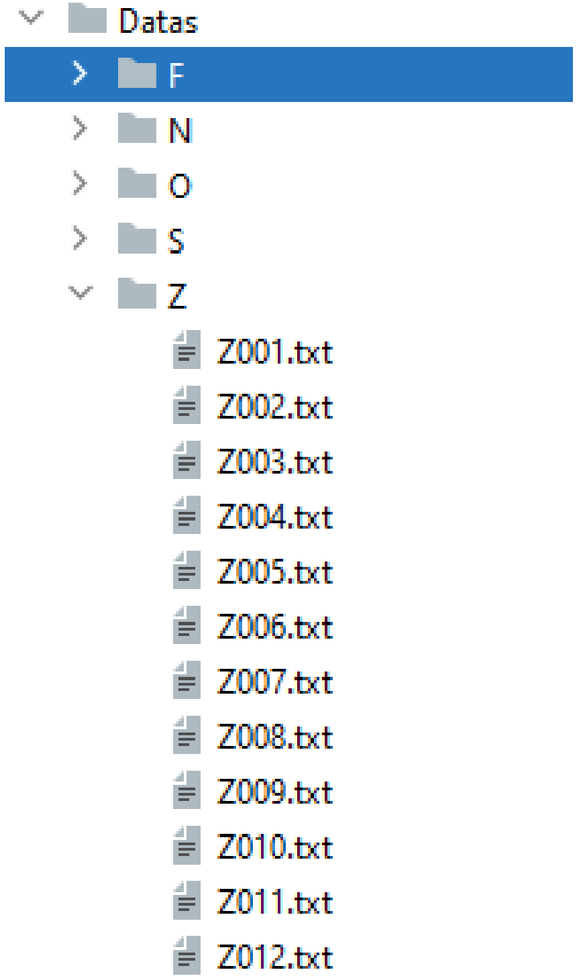
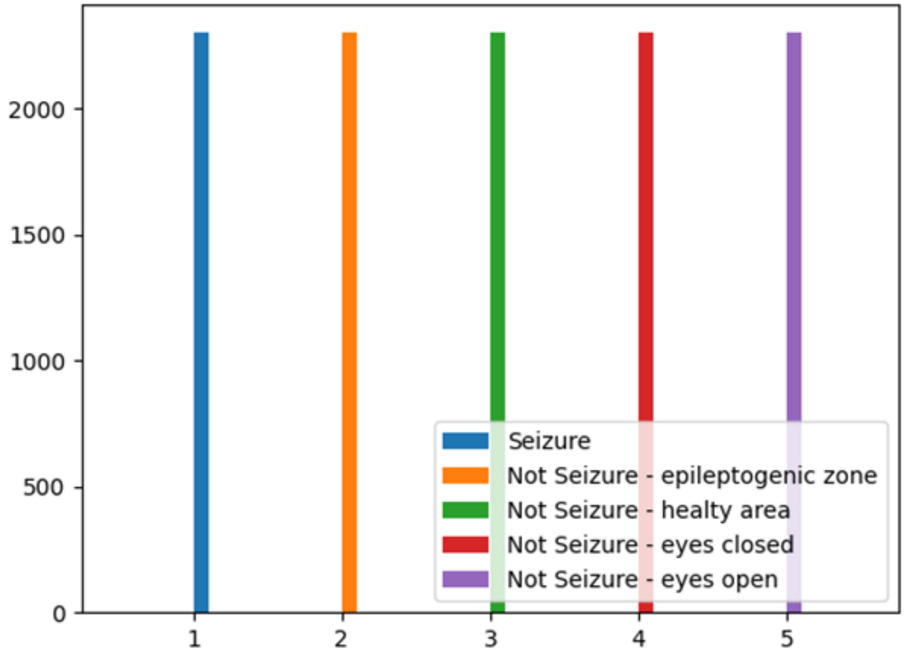

Datas
F
N
O
S
Z
Z001.txt
Z002.txt
Z003.txt
Z004.txt
Z005.txt
Z006.txt
Z007.txt
Z008.txt
Z009.txt
Z010.txt
Z011.txt
Z012.txt

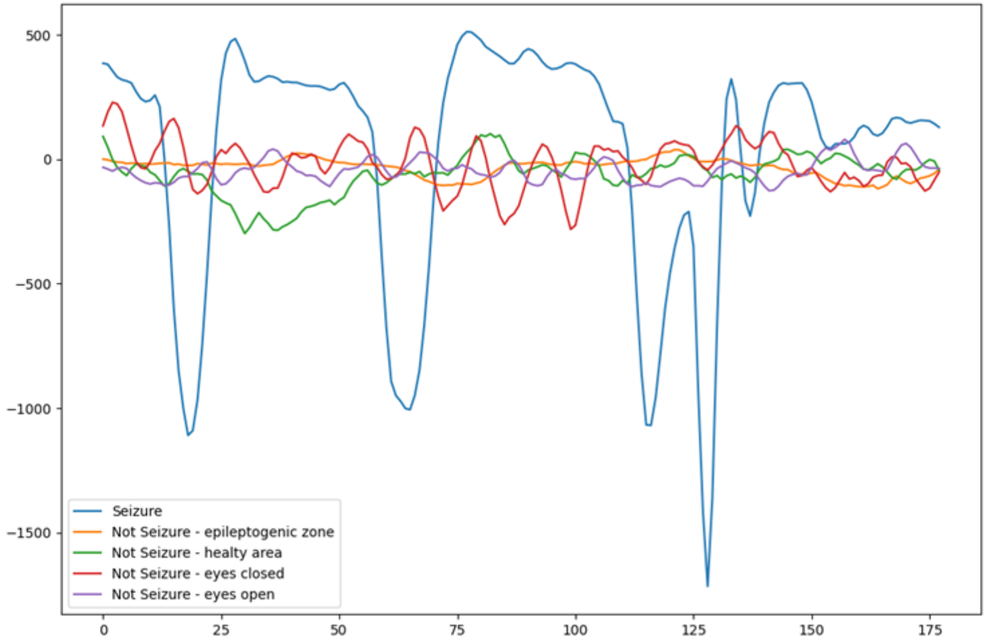
# DATASET

**11500 rows 180 columns**

| | Unnamed | X1 | X2 | X3 | X4 | X5 | ... | X174 | X175 | X176 | X177 | X178 | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11495 | X22.V1.114 | -22 | -22 | -23 | -26 | -36 | ... | -1 | -18 | -37 | -47 | -48 | 2 |
| 11496 | X19.V1.354 | -47 | -11 | 28 | 77 | 141 | ... | 27 | 48 | 77 | 117 | 170 | 1 |
| 11497 | X8.V1.28 | 14 | 6 | -13 | -16 | 10 | ... | -67 | -30 | -2 | -1 | -8 | 5 |
| 11498 | X10.V1.932 | -40 | -25 | -9 | -12 | -2 | ... | 116 | 86 | 68 | 59 | 55 | 3 |
| 11499 | X16.V1.210 | 29 | 41 | 57 | 72 | 74 | ... | 5 | 4 | -2 | 2 | 20 | 4 |




**Every category has 2300 rows**




**One line data from diffrent categories**

# Pre-Processing

- **Checking Missing Data (No)**
- **Data cleaning. (Removed 1st column)**
- **Converting problem binary classification**

| | X1 | X2 | X3 | X4 | X5 | X6 | X7 | ... | X173 | X174 | X175 | X176 | X177 | X178 | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 135 | 190 | 229 | 223 | 192 | 125 | 55 | ... | -77 | -103 | -127 | -116 | -83 | -51 | 0 |
| 1 | 386 | 382 | 356 | 331 | 320 | 315 | 307 | ... | 152 | 157 | 156 | 154 | 143 | 129 | 1 |
| 2 | -32 | -39 | -47 | -37 | -32 | -36 | -57 | ... | 19 | -12 | -30 | -35 | -35 | -36 | 0 |
| 3 | -105 | -101 | -96 | -92 | -89 | -95 | -102 | ... | -77 | -85 | -77 | -72 | -69 | -65 | 0 |
| 4 | -9 | -65 | -98 | -102 | -78 | -48 | -16 | ... | -32 | -41 | -65 | -83 | -89 | -73 | 0 |

# Classification

Classical Machine Learning Algorithm Classification Performance (**PyCaret**)

```
clf1 = setup(data = eeg_data, target = 'y', numeric_imputation = 'mean', silent = True)
best_model = compare_models()
```

| | Model | Accuracy | AUC | Recall | Prec. | F1 | Kappa | MCC | TT (Sec) |
|---|---|---|---|---|---|---|---|---|---|
| **lightgbm** | Light Gradient Boosting Machine | 0.9725 | 0.9954 | 0.9024 | 0.9579 | 0.9291 | 0.9121 | 0.9129 | 2.413 |
| **rf** | Random Forest Classifier | 0.9720 | 0.9945 | 0.9217 | 0.9380 | 0.9296 | 0.9122 | 0.9124 | 7.397 |
| **et** | Extra Trees Classifier | 0.9712 | 0.9953 | 0.8968 | 0.9565 | 0.9256 | 0.9077 | 0.9086 | 1.541 |
| **gbc** | Gradient Boosting Classifier | 0.9615 | 0.9925 | 0.8546 | 0.9479 | 0.8984 | 0.8748 | 0.8769 | 16.314 |
| **nb** | Naive Bayes | 0.9575 | 0.9839 | 0.8863 | 0.9001 | 0.8930 | 0.8665 | 0.8667 | 0.035 |
| **ada** | Ada Boost Classifier | 0.9437 | 0.9755 | 0.8223 | 0.8886 | 0.8537 | 0.8189 | 0.8202 | 3.289 |
| **dt** | Decision Tree Classifier | 0.9365 | 0.8953 | 0.8266 | 0.8518 | 0.8389 | 0.7994 | 0.7996 | 1.801 |
| **qda** | Quadratic Discriminant Analysis | 0.9214 | 0.9602 | 0.8440 | 0.7814 | 0.8111 | 0.7616 | 0.7628 | 0.158 |
| **knn** | K Neighbors Classifier | 0.9181 | 0.9031 | 0.5960 | 0.9903 | 0.7436 | 0.6985 | 0.7307 | 2.533 |
| **lda** | Linear Discriminant Analysis | 0.8206 | 0.5242 | 0.1181 | 0.8798 | 0.2071 | 0.1685 | 0.2805 | 0.399 |
| **lr** | Logistic Regression | 0.8201 | 0.5247 | 0.1168 | 0.8727 | 0.2050 | 0.1663 | 0.2773 | 1.618 |
| **ridge** | Ridge Classifier | 0.8150 | 0.0000 | 0.0826 | 0.9093 | 0.1506 | 0.1218 | 0.2388 | 0.036 |
| **dummy** | Dummy Classifier | 0.8001 | 0.5000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.025 |
| **svm** | SVM - Linear Kernel | 0.7041 | 0.0000 | 0.4636 | 0.3330 | 0.3860 | 0.1993 | 0.2044 | 0.189 |

# Hyperparamteres

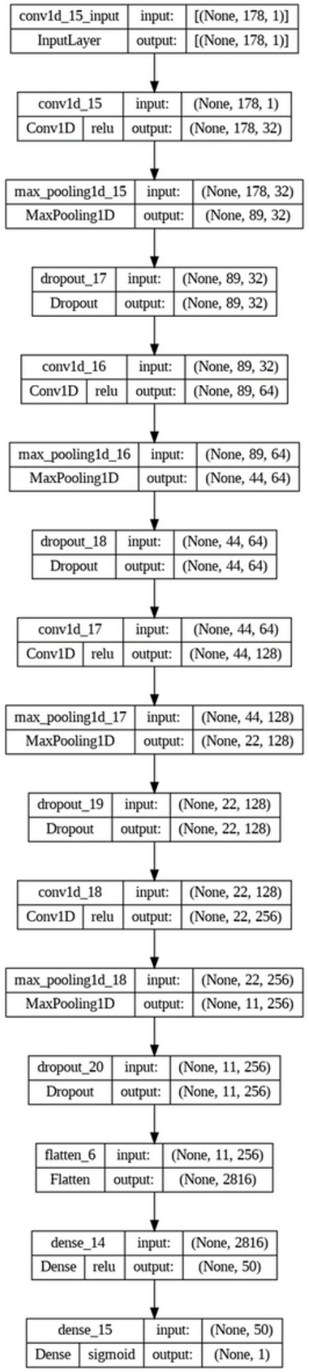
```
tune_model(best_model)
```

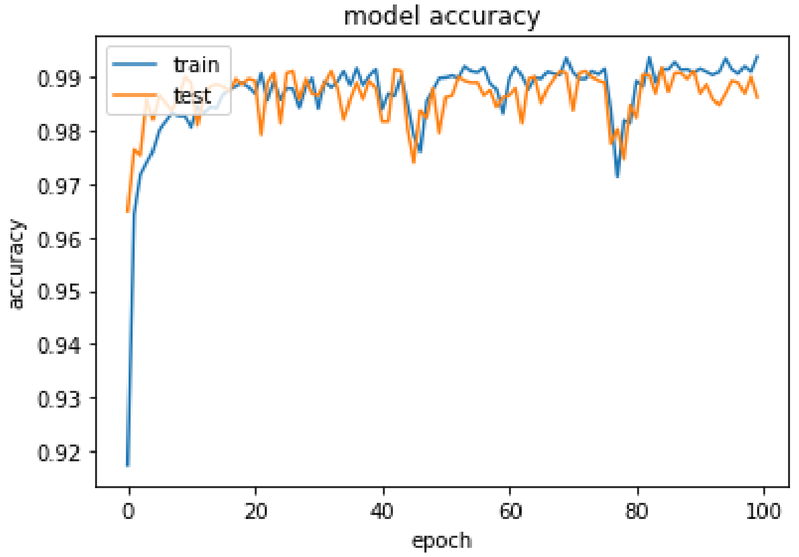
| Fold | Accuracy | AUC | Recall | Prec. | F1 | Kappa | MCC |
|---|---|---|---|---|---|---|---|
| 0 | 0.9789 | 0.9980 | 0.9379 | 0.9557 | 0.9467 | 0.9335 | 0.9336 |
| 1 | 0.9627 | 0.9866 | 0.8820 | 0.9281 | 0.9045 | 0.8813 | 0.8818 |
| 2 | 0.9752 | 0.9967 | 0.9379 | 0.9379 | 0.9379 | 0.9224 | 0.9224 |
| 3 | 0.9652 | 0.9954 | 0.8696 | 0.9524 | 0.9091 | 0.8876 | 0.8890 |
| 4 | 0.9789 | 0.9938 | 0.9255 | 0.9675 | 0.9460 | 0.9329 | 0.9333 |
| 5 | 0.9739 | 0.9949 | 0.8944 | 0.9730 | 0.9320 | 0.9159 | 0.9172 |
| 6 | 0.9776 | 0.9953 | 0.9379 | 0.9497 | 0.9438 | 0.9298 | 0.9298 |
| 7 | 0.9702 | 0.9960 | 0.8696 | 0.9790 | 0.9211 | 0.9028 | 0.9052 |
| 8 | 0.9839 | 0.9969 | 0.9379 | 0.9805 | 0.9587 | 0.9487 | 0.9491 |
| 9 | 0.9813 | 0.9966 | 0.9500 | 0.9560 | 0.9530 | 0.9413 | 0.9413 |
| Mean | 0.9748 | 0.9950 | 0.9143 | 0.9580 | 0.9353 | 0.9196 | 0.9203 |
| Std | 0.0065 | 0.0030 | 0.0301 | 0.0163 | 0.0174 | 0.0214 | 0.0210 |

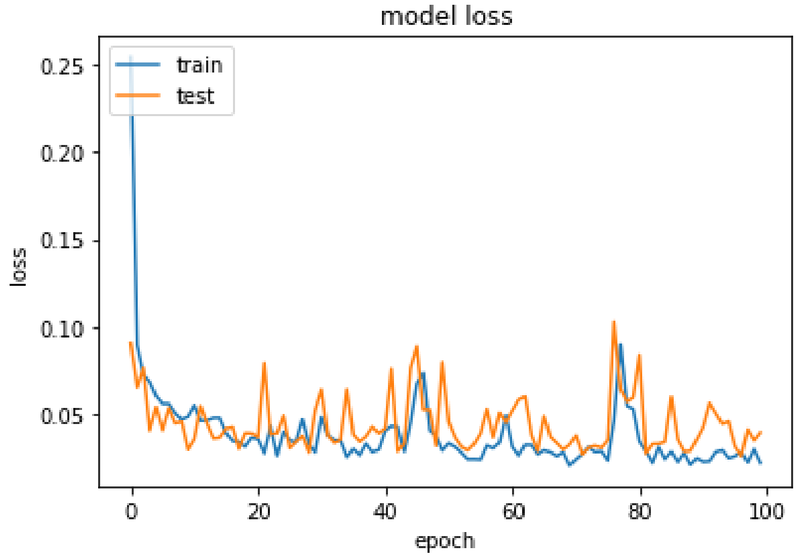
# CNN Model

| Layer (type) | Output Shape | Param # |
|---|---|---|
| conv1d (Conv1D) | (None, 178, 32) | 128 |
| max_pooling1d (MaxPooling1D) | (None, 89, 32) | 0 |
| dropout (Dropout) | (None, 89, 32) | 0 |
| conv1d_1 (Conv1D) | (None, 89, 64) | 10304 |
| max_pooling1d_1 (MaxPooling1D) | (None, 44, 64) | 0 |
| dropout_1 (Dropout) | (None, 44, 64) | 0 |
| conv1d_2 (Conv1D) | (None, 44, 128) | 57472 |
| max_pooling1d_2 (MaxPooling1D) | (None, 22, 128) | 0 |
| dropout_2 (Dropout) | (None, 22, 128) | 0 |
| conv1d_3 (Conv1D) | (None, 22, 256) | 295168 |
| max_pooling1d_3 (MaxPooling1D) | (None, 11, 256) | 0 |
| dropout_3 (Dropout) | (None, 11, 256) | 0 |
| flatten (Flatten) | (None, 2816) | 0 |
| dense (Dense) | (None, 50) | 140850 |
| dense_1 (Dense) | (None, 1) | 51 |

Total params: 503,973
Trainable params: 503,973
Non-trainable params: 0

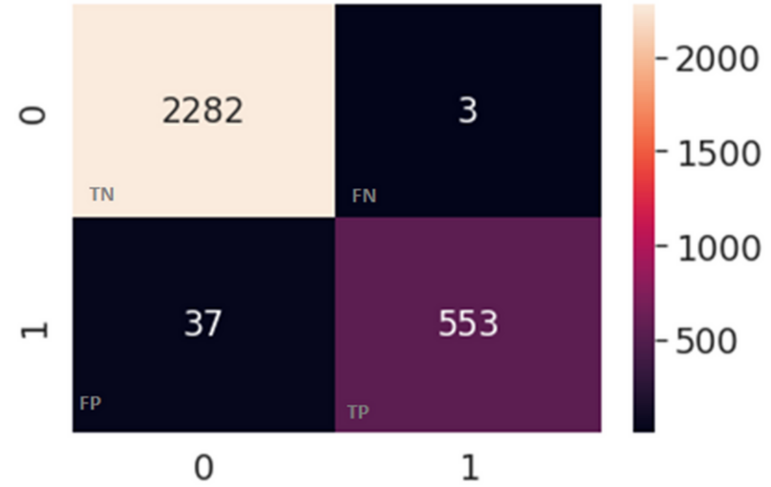


# CNN Classification Report

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| 0 | 0.98 | 1.00 | 0.99 | 2285 |
| 1 | 0.99 | 0.94 | 0.97 | 590 |
| accuracy | | | 0.99 | 2875 |
| macro avg | 0.99 | 0.97 | 0.98 | 2875 |
| weighted avg | 0.99 | 0.99 | 0.99 | 2875 |




Confusion Matrix

# THANKS

Onur KARASOY
onkarasoy@gmail.com