

pulsar1

October 8, 2022

1 Pulsar Emission Data Analysis

2 All Imports that may or may not be needed and used for the notebook

```
[ ]: #currently including any and all Imports that maybe needed for the project.
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
from sklearn.model_selection import train_test_split
from sklearn import linear_model
from sklearn.metrics import r2_score, mean_squared_error
from sklearn.linear_model import LogisticRegression, LinearRegression
from sklearn.metrics import confusion_matrix, accuracy_score
from sklearn.feature_selection import RFE
import datetime as dt
from sklearn.cluster import KMeans
from sklearn.metrics import pairwise_distances
from scipy.cluster.hierarchy import linkage, dendrogram, cut_tree
from scipy.spatial.distance import pdist
from sklearn.feature_extraction.text import TfidfVectorizer
import matplotlib.dates as mdates
from scipy.stats import pearsonr
from scipy import stats
import statistics
import math
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
from statsmodels.tsa.stattools import acf, pacf
from statsmodels.tsa.tsatools import lagmat
from numpy import array
from sklearn.model_selection import train_test_split
from keras.models import Sequential
from keras.layers import LSTM
from keras.layers import Dense
from keras.layers import Bidirectional
```

3 Section for extracting from a tar file.

Currently implemented for original TAR File structure.

```
[ ]: #This is also found in the main file under tarunzip.py
import tarfile
import os
import sys

#tar = tarfile.open("pulseTarFile.tar")
#tar.extractall('./Data')
#tar.close()
```

3.1 Beginning of Exploration

3.1.1 Examining the data

In this section we are determining the total integrity of the data to determine if further comprehensive data cleaning and uniforming processes are needed.

```
[ ]: colnames = ['Pulse Number', 'Brightness', 'Uncertainty']
pulsar = pd.read_csv("Data/J0437-4715.pulses", sep = ' ', header = None, names_
↳ colnames)
```

```
[ ]: pulsar.shape
```

```
[ ]: (27000, 3)
```

```
[ ]: pulsar.head(25)
```

```
[ ]:
      Pulse Number  Brightness  Uncertainty
0                1    0.598393    0.056431
1                2    0.590859    0.055182
2                3    0.449643    0.063632
3                4    0.682860    0.056269
4                5    0.490026    0.046830
5                6    0.586071    0.052649
6                7    0.150353    0.056483
7                8    0.384684    0.052567
8                9    0.429094    0.055569
9               10    0.995865    0.075811
10              11    0.670907    0.049539
11              12    0.465406    0.047461
12              13    0.242442    0.050653
13              14    0.500057    0.050163
14              15    0.658159    0.050743
15              16    0.404870    0.056679
16              17    0.595339    0.065296
17              18    0.230061    0.051813
18              19    0.423335    0.049558
```

19	20	0.208840	0.049900
20	21	0.297223	0.048826
21	22	0.749683	0.071350
22	23	0.387574	0.054314
23	24	0.466527	0.045075
24	25	1.333974	0.092806

```
[ ]: pulsar.describe()
```

```
[ ]:
      Pulse Number    Brightness    Uncertainty
count    27000.00000    27000.000000    27000.000000
mean     13500.50000         0.536400         0.062556
std       7794.37297         0.413764         0.056313
min         1.00000        -5.114133         0.015426
25%       6750.75000         0.296443         0.052381
50%      13500.50000         0.423816         0.056856
75%      20250.25000         0.643723         0.063111
max       27000.00000        18.722410         3.049559
```

```
[ ]: nullBoolBrightness = pd.isnull(pulsar["Brightness"])

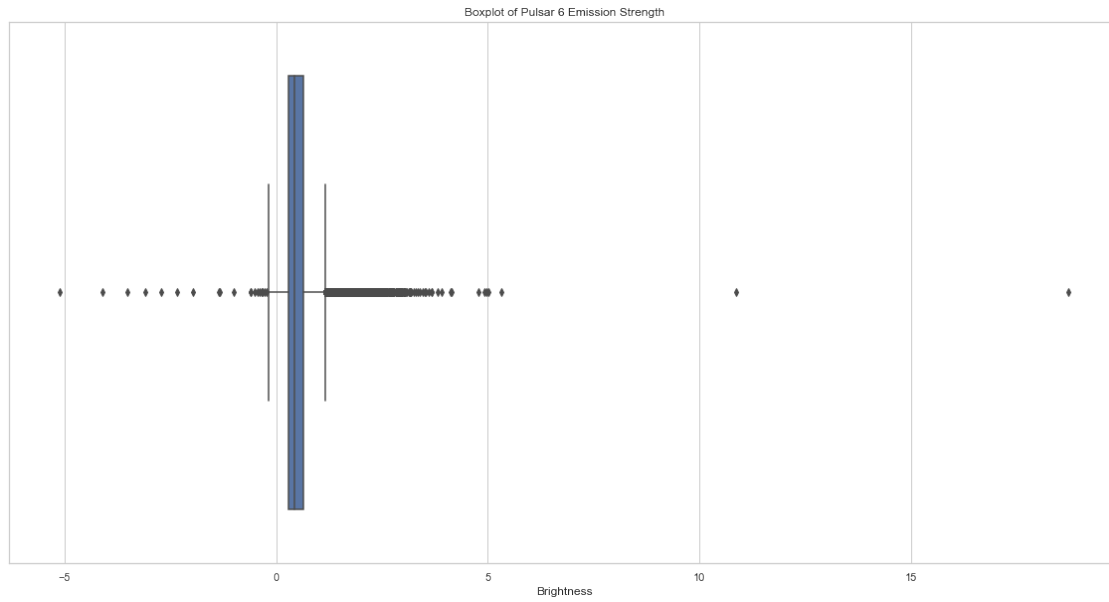
pulsar[nullBoolBrightness]
```

```
[ ]: Empty DataFrame
Columns: [Pulse Number, Brightness, Uncertainty]
Index: []
```

```
[ ]: pulsar["Brightness"].describe()
```

```
[ ]: count    27000.000000
      mean         0.536400
      std         0.413764
      min        -5.114133
      25%         0.296443
      50%         0.423816
      75%         0.643723
      max         18.722410
      Name: Brightness, dtype: float64
```

```
[ ]: plt.figure(figsize=(20,10))
      sns.set_theme(style="whitegrid")
      ax = sns.boxplot(x=pulsar["Brightness"]).set_title("Boxplot of Pulsar 6_
      ↪Emission Strength")
```



```
[ ]: medianpulse6 = pulsar["Brightness"].median()
print("Median of Pulsar6: ", medianpulse6)
pulsar['Binary'] = np.where(pulsar['Brightness'] > medianpulse6, 1, 0)
```

Median of Pulsar6: 0.42381595

```
[ ]: pulsar
```

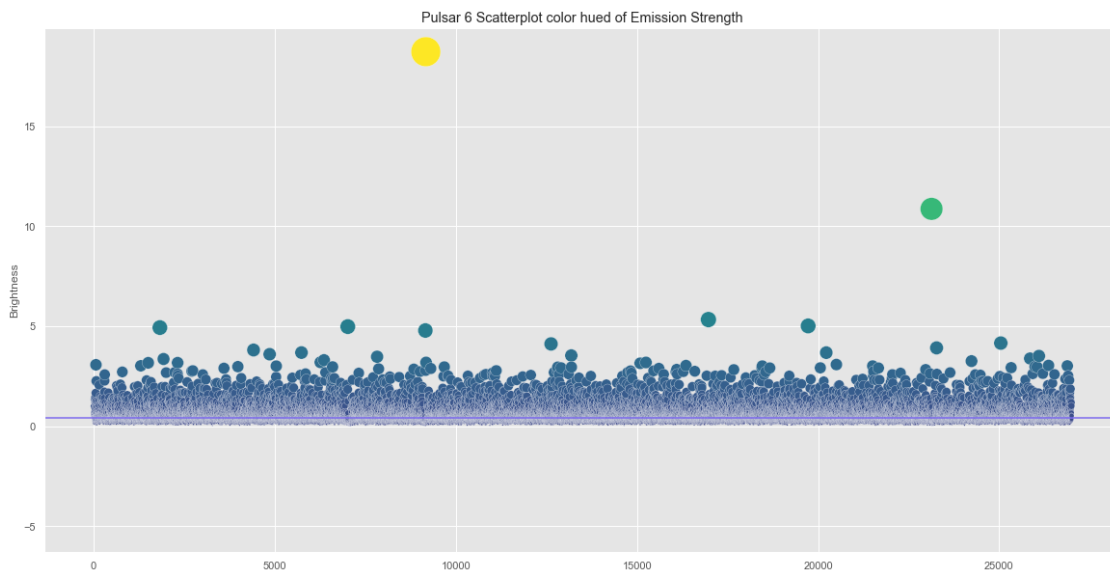
```
[ ]:
      Pulse Number  Brightness  Uncertainty  Binary
0                1    0.598393    0.056431      1
1                2    0.590859    0.055182      1
2                3    0.449643    0.063632      1
3                4    0.682860    0.056269      1
4                5    0.490026    0.046830      1
...            ...      ...      ...      ...
26995           26996    0.539079    0.063854      1
26996           26997    0.324070    0.054332      0
26997           26998    0.291341    0.058106      0
26998           26999    0.346267    0.058064      0
26999           27000    0.513315    0.064349      1
```

[27000 rows x 4 columns]

```
[ ]: plt.figure(figsize=(20,10))
sns.set_style("darkgrid", {"axes.facecolor": ".75"})
strength = pulsar.Brightness.values
plt.style.use('ggplot')
```

```
ax = sns.scatterplot(data=pulsar["Brightness"], s= strength*50, c=strength,
    cmap="viridis", marker="o").set_title('Pulsar 6 Scatterplot color hue of Emission Strength')
ax= plt.axhline( y=0.42381595, ls='-',c='mediumslateblue')
```

c:\Users\oxlay\anaconda3\lib\site-packages\matplotlib\collections.py:1003:
RuntimeWarning: invalid value encountered in sqrt
scale = np.sqrt(self._sizes) * dpi / 72.0 * self._factor



```
[ ]: print(len(pulsar[(pulsar.Brightness > 0.42381595)]))
print(len(pulsar[(pulsar.Brightness < 0.42381595)]))
```

13500
13500

```
[ ]: #plt.figure(figsize=(20,10))
#sns.set_style("darkgrid", {"axes.facecolor": ".75"})
#strength = pulsar.Brightness.values
#ax = plt.axhline( y=0.65829515, ls='-',c='mediumslateblue')
#ax = sns.swarmplot(data=pulsar["Brightness"], c="blue").set_title('Pulsar 6 Swarm plot of Emission Strength')
```

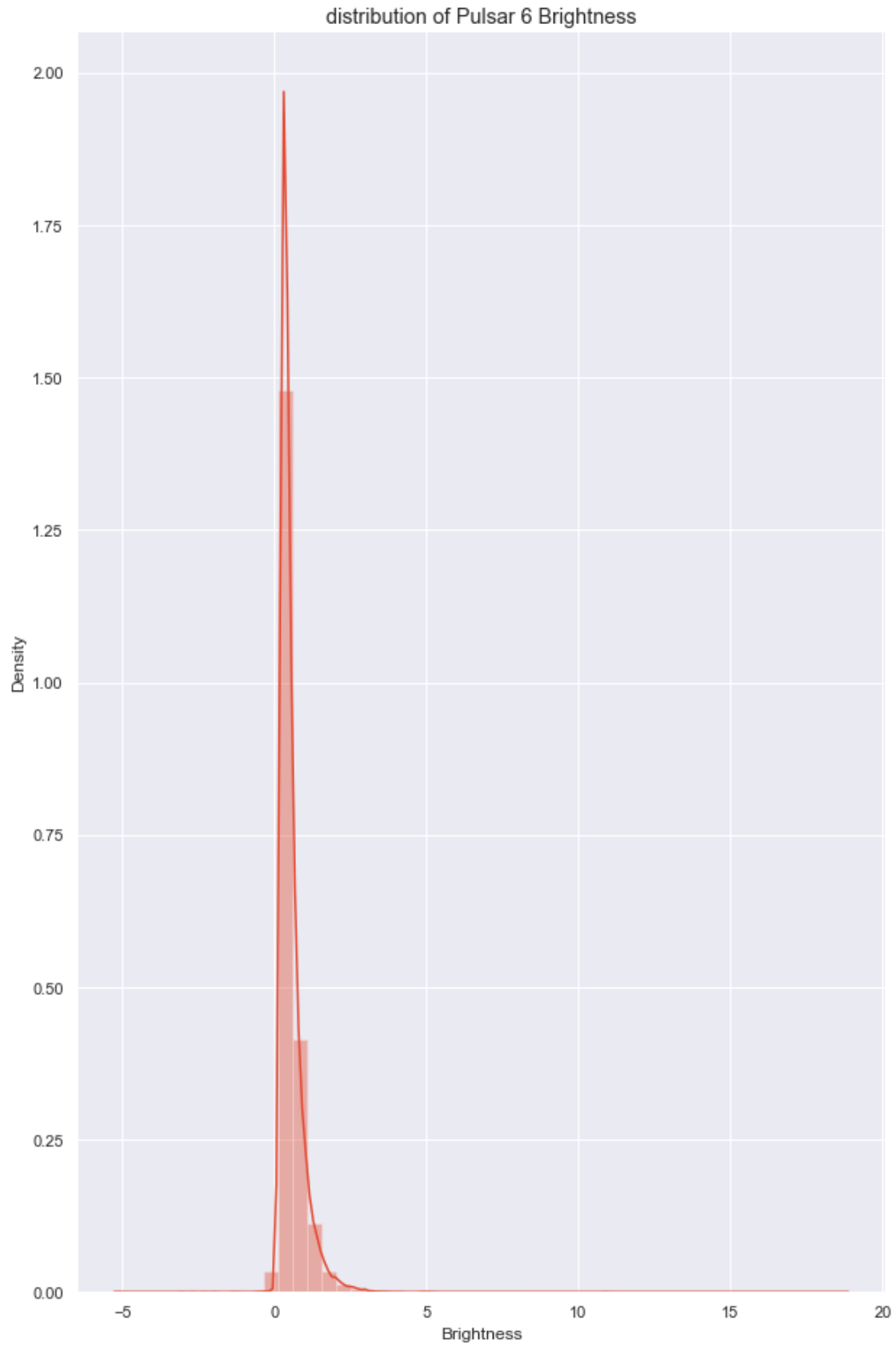
```
[ ]: plt.figure(figsize=(10, 16))
with sns.axes_style('darkgrid'):
    sns.distplot(pulsar.Brightness)
plt.title("distribution of Pulsar 6 Brightness")
```

c:\Users\oxlay\anaconda3\lib\site-packages\seaborn\distributions.py:2619:
FutureWarning: `distplot` is a deprecated function and will be removed in a

future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).

```
warnings.warn(msg, FutureWarning)
```

```
[ ]: Text(0.5, 1.0, 'distribution of Pulsar 6 Brightness')
```

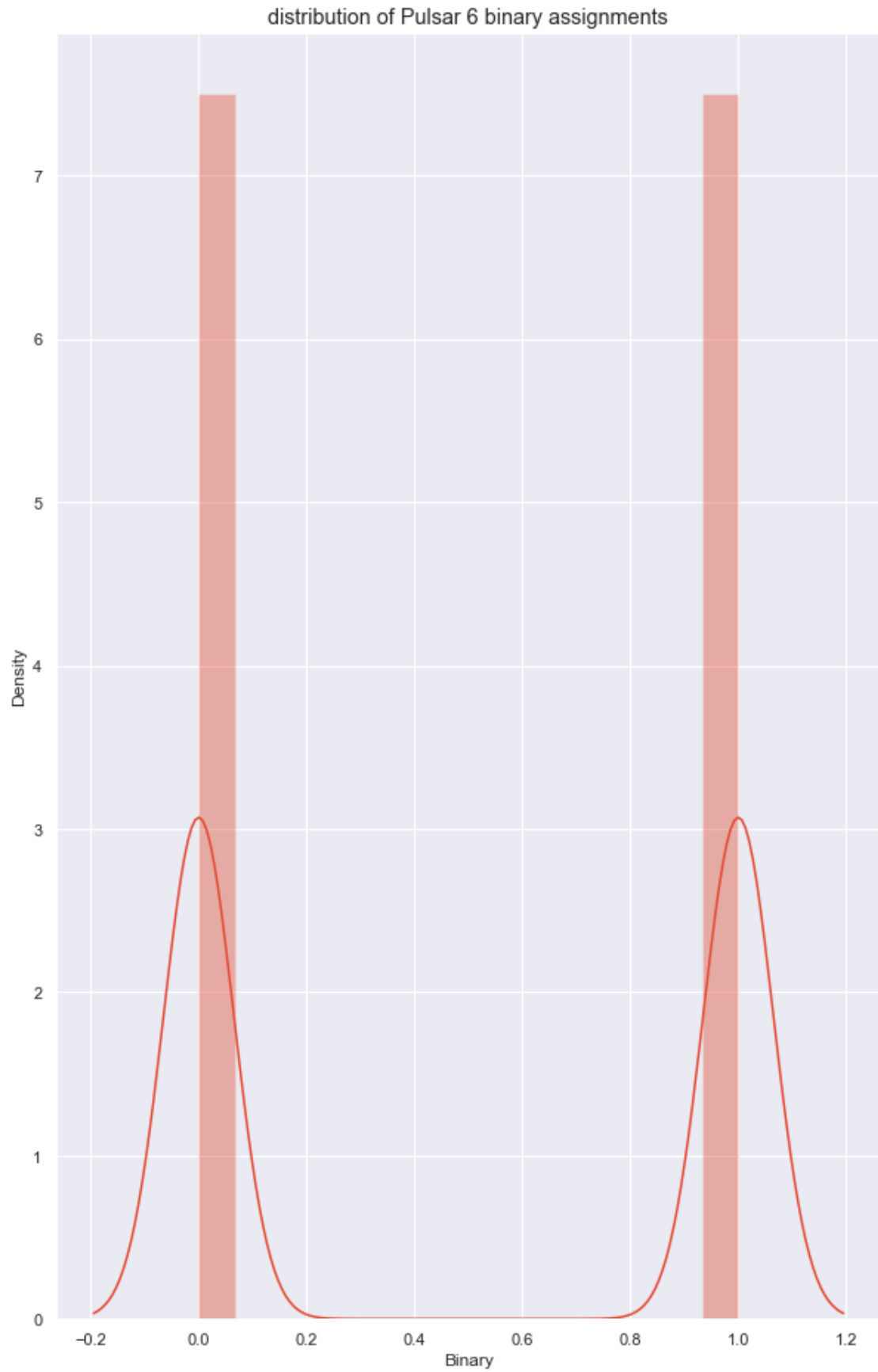


```
[ ]: plt.figure(figsize=(10, 16))
      with sns.axes_style('darkgrid'):
          sns.distplot(pulsar.Binary)
      plt.title("distribution of Pulsar 6 binary assignments")
```

```
c:\Users\oxlay\anaconda3\lib\site-packages\seaborn\distributions.py:2619:
FutureWarning: `distplot` is a deprecated function and will be removed in a
future version. Please adapt your code to use either `displot` (a figure-level
function with similar flexibility) or `histplot` (an axes-level function for
histograms).
```

```
warnings.warn(msg, FutureWarning)
```

```
[ ]: Text(0.5, 1.0, 'distribution of Pulsar 6 binary assignments')
```

3.2 Binary Classification

```
[ ]: X = pulsar[['Brightness', 'Uncertainty']]
     y = pulsar['Binary']
```

```
[ ]: X.head()
```

```
[ ]:      Brightness  Uncertainty
     0      0.598393      0.056431
     1      0.590859      0.055182
     2      0.449643      0.063632
     3      0.682860      0.056269
     4      0.490026      0.046830
```

```
[ ]: y.head()
```

```
[ ]: 0      1
     1      1
     2      1
     3      1
     4      1
     Name: Binary, dtype: int32
```

```
[ ]: from sklearn.model_selection import train_test_split

     X_train, X_test, y_train, y_test = train_test_split(X, y , test_size=0.20)
```

```
[ ]: from sklearn.preprocessing import StandardScaler

     train_scaler = StandardScaler()
     X_train = train_scaler.fit_transform(X_train)

     test_scaler = StandardScaler()
     X_test = test_scaler.fit_transform(X_test)
```

```
[ ]: model = LogisticRegression()

     model.fit(X_train, y_train)
```

```
[ ]: LogisticRegression()
```

```
[ ]: predictions = model.predict(X_test)
```

```
[ ]: from sklearn.metrics import confusion_matrix
```

```

cm = confusion_matrix(y_test, predictions)

TN, FP, FN, TP = confusion_matrix(y_test, predictions).ravel()

print('True Positive(TP) = ', TP)
print('False Positive(FP) = ', FP)
print('True Negative(TN) = ', TN)
print('False Negative(FN) = ', FN)

```

```

True Positive(TP) = 2602
False Positive(FP) = 0
True Negative(TN) = 2665
False Negative(FN) = 133

```

```

[ ]: accuracy = (TP + TN) / (TP + FP + TN + FN)

print("Accuracy of the model is ", accuracy)

```

Accuracy of the model is 0.9753703703703703

3.3 Bidirectional LSTM Model

```

[ ]: brightness_list = list(pulsar['Brightness'])
brightness_list[:10]

```

```

[ ]: [0.5983928,
      0.5908588,
      0.4496432,
      0.6828599,
      0.4900255,
      0.5860711,
      0.1503529,
      0.3846841,
      0.4290943,
      0.9958652]

```

```

[ ]: def split_list(blist, steps):
      X, y = list(), list()
      for i in range(len(blist)):
          # find the end of this pattern
          end_ix = i + steps
          # check if we are beyond the sequence
          if end_ix > len(blist)-1:
              break
          # gather input and output parts of the pattern
          list_x, list_y = blist[i:end_ix], blist[end_ix]
          X.append(list_x)
          y.append(list_y)

```

```
return array(X), array(y)
```

```
[ ]: X, y = split_list(brightness_list, 100)
      X = X.reshape((X.shape[0], X.shape[1], 1))
      X[:1]
```

```
[ ]: array([[0.5983928 ],
            [0.5908588 ],
            [0.4496432 ],
            [0.6828599 ],
            [0.4900255 ],
            [0.5860711 ],
            [0.1503529 ],
            [0.3846841 ],
            [0.4290943 ],
            [0.9958652 ],
            [0.6709066 ],
            [0.4654059 ],
            [0.2424418 ],
            [0.5000568 ],
            [0.6581591 ],
            [0.4048701 ],
            [0.5953394 ],
            [0.2300607 ],
            [0.4233346 ],
            [0.2088396 ],
            [0.2972227 ],
            [0.7496831 ],
            [0.3875735 ],
            [0.4665271 ],
            [1.333974  ],
            [0.8959215 ],
            [0.2351233 ],
            [0.323191  ],
            [0.2703888 ],
            [0.4753427 ],
            [0.3990772 ],
            [0.4934571 ],
            [0.2208065 ],
            [0.4939765 ],
            [0.2345259 ],
            [0.1164145 ],
            [0.3152364 ],
            [1.210627  ],
            [1.430717  ],
            [0.7304184 ],
            [0.5940009 ]],
```

[0.4075853],
[1.311816],
[1.194411],
[0.2275558],
[0.6375001],
[1.059504],
[0.2311127],
[0.6227987],
[0.572595],
[1.228927],
[0.2702216],
[0.3170902],
[1.137008],
[1.117319],
[0.1729182],
[0.4553044],
[0.9010122],
[1.659878],
[0.5816137],
[0.4834241],
[0.167261],
[0.6253759],
[0.2243756],
[0.5025026],
[3.067179],
[1.248391],
[0.2737925],
[0.5757317],
[0.2450731],
[0.3890404],
[0.544409],
[0.9333154],
[0.2085643],
[0.4490108],
[0.9996381],
[2.256221],
[0.7781707],
[0.4173896],
[0.2555327],
[0.5819737],
[0.6653123],
[0.2847919],
[0.5221179],
[1.18983],
[0.281626],
[0.07158104],
[0.3005017],

```

[0.4125063 ],
[0.2417494 ],
[0.3217806 ],
[0.5198837 ],
[0.4372924 ],
[0.2454122 ],
[0.5387975 ],
[0.8243877 ],
[0.230281  ],
[0.3229915 ],
[0.5854581 ],
[0.5464478 ]]])

```

```
[ ]: X_train, X_test, y_train, y_test = train_test_split(X, y , test_size=0.20)
```

```
[ ]: model = Sequential()
model.add(Bidirectional(LSTM(50, activation='relu'), input_shape=(100, 1)))
model.add(Dense(8, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam',
↳metrics=['accuracy'])
```

```
[ ]: history = model.fit(X_train, y_train, epochs=1, verbose=1, batch_size=10)
```

```

2152/2152 [=====] - 34s 15ms/step - loss: nan -
accuracy: 0.0000e+00

```

```
[ ]: y_pred = model.predict(X_test, verbose=0)
y_pred[:10]
```

```
[ ]: array([[nan],
          [nan],
          [nan],
          [nan],
          [nan],
          [nan],
          [nan],
          [nan],
          [nan],
          [nan]], dtype=float32)
```

```
[ ]: model.evaluate(X_test, y_test)
```

```

169/169 [=====] - 2s 8ms/step - loss: nan - accuracy:
0.0000e+00

```

```
[ ]: [nan, 0.0]
```

3.4 ML Evaluation.

3.4.1 Logistic Regression

This model appears to have gained some insight in the data and accurately defined a majority of the data. The accuracy of the model is >95% which indicates that it was able to determine a trend and apply it in a useful manner in the predictions during evaluation. Further, the confusion matrix further supports the high accuracy and likely usefulness of the model with only 3 false assignments. However, in analysis this is only to determine if there is a correlation between binary assignment and the emission strength x error in measurement. This doesn't aid us in our overall randomness determination, but it does determine that uncertainty has a role in the binary assignment and the overall trust of emission strength.

3.4.2 Bidirectional LSTM

This model is very error prone as the loss value is consistently at 60% or higher at every epoch during training and at exactly 63.07% in evaluation with a 0% accuracy this indicates that there is either a great error in the formation of the model, data used or trend being obtained. Alternatively it could indicate that there is no trend there to predict. Likely this indicates that the model is not valuable for any meaningful analysis.

4 Preliminary runs test

4.0.1 Math Logic

$$Z = \frac{R - \tilde{R}}{s_R}$$

$$\tilde{R} = \frac{2n_1n_2}{n_1 + n_2} + 1$$

$$s_R^2 = \frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1 + n_2)^2(n_1 + n_2 - 1)}$$

link to resource: <https://www.geeksforgeeks.org/runs-test-of-randomness-in-python/>

\$ Z_{\text{critical}} = 1.96 \$ as the confidence interval level of 95% thus this is a 2 tailed test. If the probability as corresponding to this confidence interval \$ H_{\text{null}} \$ will be rejected as it is not statistically significant as denoted by \$ |Z| > Z_{\text{critical}} \$

There is also code attempting to change it from a z-score probability to a P-score for ease of understanding and clarity.

5 FUNCTION CODE FOR RUNS TEST

```
[ ]: binaryData1 = pulsar['Binary'].tolist()
      print("pulsar6 original: ",binaryData1)
```

pulsar6 original: [1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0, 0,
0, 1, 0, 1, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
0, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 1, 0, 0, 1, 1, 0,
1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 1, 1, 0,
0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0,
0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 0,
0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1,
0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 1, 0, 0,
1, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0,
0, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0,
1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0,
0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0,
1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1,
1, 0, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0,
0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0,
1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 0,
1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 0, 1,
1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0, 1,
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0, 1, 0, 0, 1, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 1, 0, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0,
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1, 0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1,
1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1,
1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 0,
0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 0,
1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 1,
1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 1,
1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
1, 1, 1, 1, 1, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0,
0, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 1,
1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 1, 1,
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```

6 Below we begin autocorrelation and autocovariance analysis

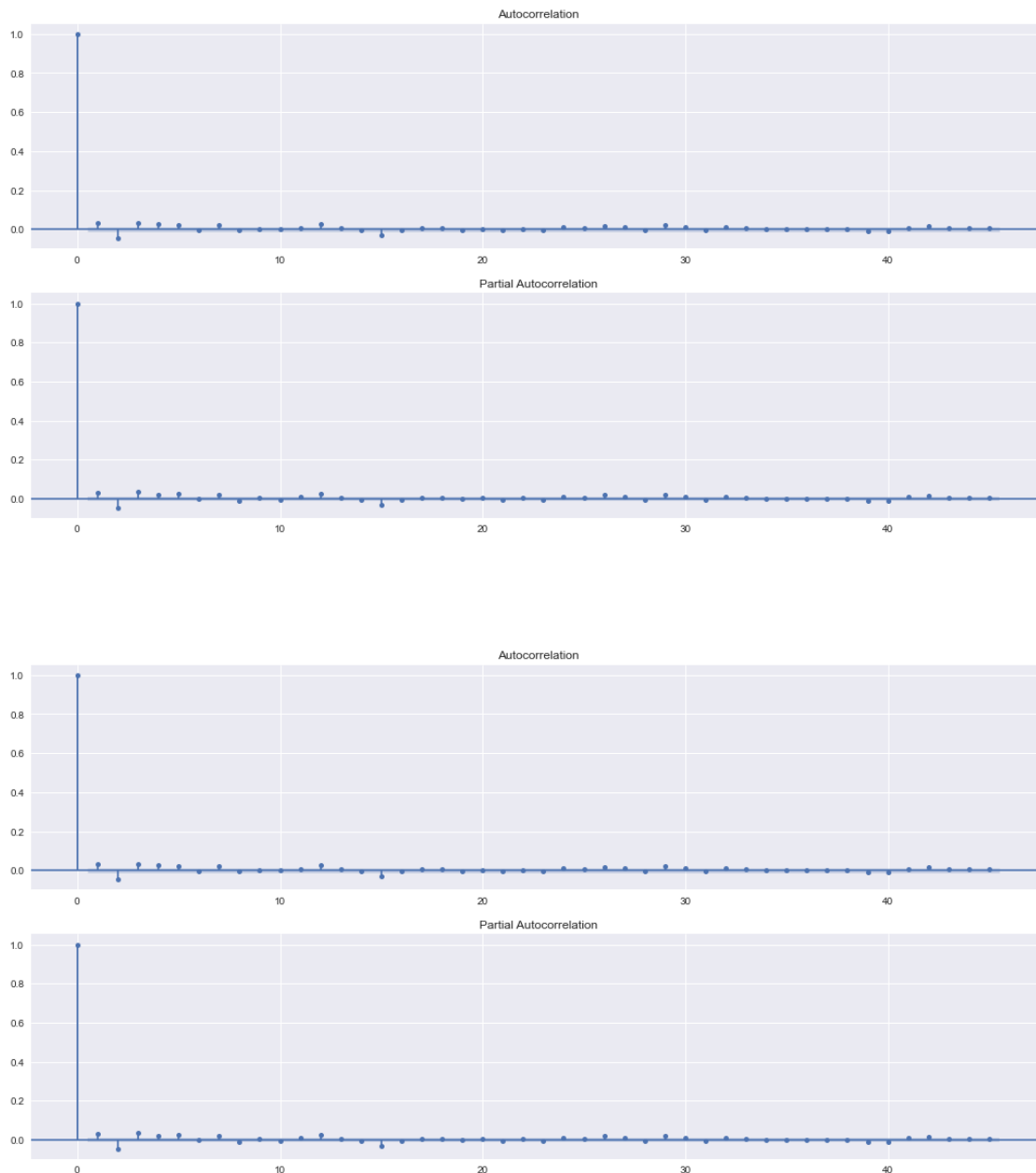
To get started with this I am playing around with guide from: <https://towardsdatascience.com/a-step-by-step-guide-to-calculating-autocorrelation-and-partial-autocorrelation-8c4342b784e8>

```
[ ]: plt.style.use("seaborn")
plt.rcParams["figure.figsize"] = (18, 9)

fig, ax = plt.subplots(2,1)

plot_acf(pulsar['Brightness'], ax=ax[0])
plot_pacf(pulsar['Brightness'], ax=ax[1], method="ols")
```

```
[ ]:
```



```
[ ]: acf(pulsar['Brightness'], nlags=10)
```

```
c:\Users\oxlay\anaconda3\lib\site-packages\statsmodels\tsa\stattools.py:667:
FutureWarning: fft=True will become the default after the release of the 0.12
release of statsmodels. To suppress this warning, explicitly set fft=False.
warnings.warn(
```

```
[ ]: array([ 1.00000000e+00,  3.02297520e-02, -4.45596588e-02,  3.11934730e-02,
           2.59222929e-02,  2.29438690e-02, -2.72483478e-03,  2.17140483e-02,
          -5.63815508e-03,  1.61127481e-03, -7.10167005e-04])
```

```
[ ]: acfpulsar = pd.DataFrame()
for lag in range(0,11):
    acfpulsar[f"B_lag_{lag}"] = pulsar['Brightness'].shift(lag)
```

acfpulsar

```
[ ]:      B_lag_0  B_lag_1  B_lag_2  B_lag_3  B_lag_4  B_lag_5  B_lag_6  \
0      0.598393      NaN      NaN      NaN      NaN      NaN      NaN
1      0.590859  0.598393      NaN      NaN      NaN      NaN      NaN
2      0.449643  0.590859  0.598393      NaN      NaN      NaN      NaN
3      0.682860  0.449643  0.590859  0.598393      NaN      NaN      NaN
4      0.490026  0.682860  0.449643  0.590859  0.598393      NaN      NaN
...
26995  0.539079  0.396929  1.014446  0.659313  1.173766  0.606806  0.500412
26996  0.324070  0.539079  0.396929  1.014446  0.659313  1.173766  0.606806
26997  0.291341  0.324070  0.539079  0.396929  1.014446  0.659313  1.173766
26998  0.346267  0.291341  0.324070  0.539079  0.396929  1.014446  0.659313
26999  0.513315  0.346267  0.291341  0.324070  0.539079  0.396929  1.014446
```

```
      B_lag_7  B_lag_8  B_lag_9  B_lag_10
0      NaN      NaN      NaN      NaN
1      NaN      NaN      NaN      NaN
2      NaN      NaN      NaN      NaN
3      NaN      NaN      NaN      NaN
4      NaN      NaN      NaN      NaN
...
26995  0.409631  0.698172  0.262350  0.447577
26996  0.500412  0.409631  0.698172  0.262350
26997  0.606806  0.500412  0.409631  0.698172
26998  1.173766  0.606806  0.500412  0.409631
26999  0.659313  1.173766  0.606806  0.500412
```

[27000 rows x 11 columns]

```
[ ]: acfpulsar.corr()["B_lag_0"].values
```

```
[ ]: array([ 1.00000000e+00,  3.02297663e-02, -4.45598682e-02,  3.11938480e-02,
           2.59227920e-02,  2.29443159e-02, -2.72489307e-03,  2.17154085e-02,
```

```
-5.63853223e-03, 1.61145686e-03, -7.10263111e-04])
```

6.0.1 Getting every 5th as per the auto correlation

6.0.2 Creating a new set of discrete 100 sets and examining them specifically

6.0.3 Further Random testing to move into extensive testing

Getting every 5th as per the auto correlation

```
[ ]: held5ths = pulsar[pulsar.index % 5 == 0]
held5ths
```

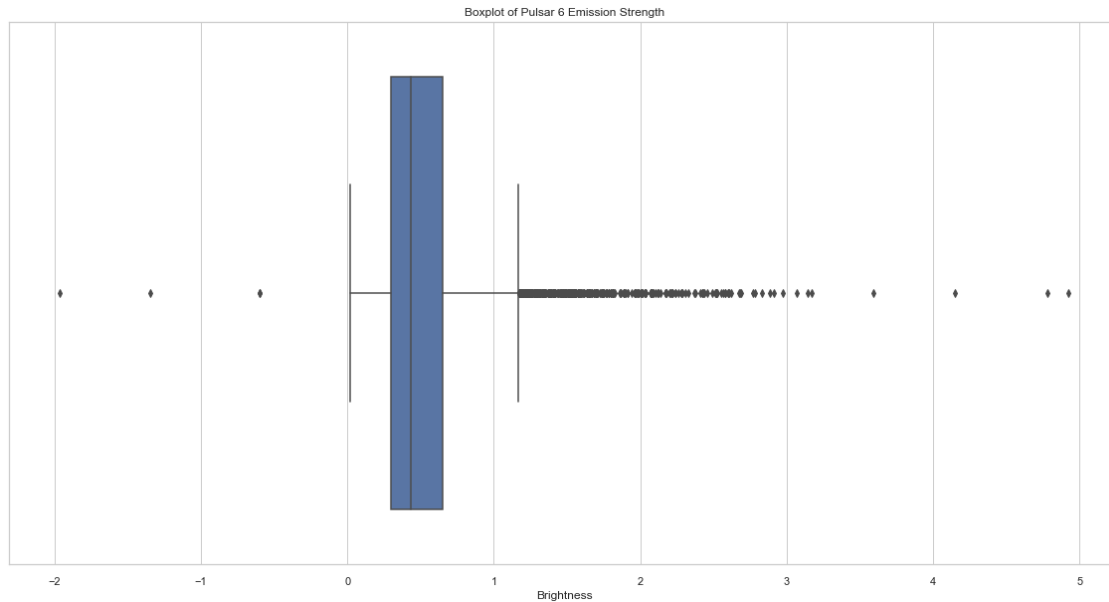
```
[ ]:
      Pulse Number  Brightness  Uncertainty  Binary
0           1      0.598393      0.056431      1
5           6      0.586071      0.052649      1
10          11      0.670907      0.049539      1
15          16      0.404870      0.056679      0
20          21      0.297223      0.048826      0
...
26975       26976      0.384184      0.070075      0
26980       26981      0.317133      0.055033      0
26985       26986      0.447577      0.054011      1
26990       26991      0.606806      0.043464      1
26995       26996      0.539079      0.063854      1
```

[5400 rows x 4 columns]

```
[ ]: medianheld5ths = held5ths["Brightness"].median()
medianheld5ths
```

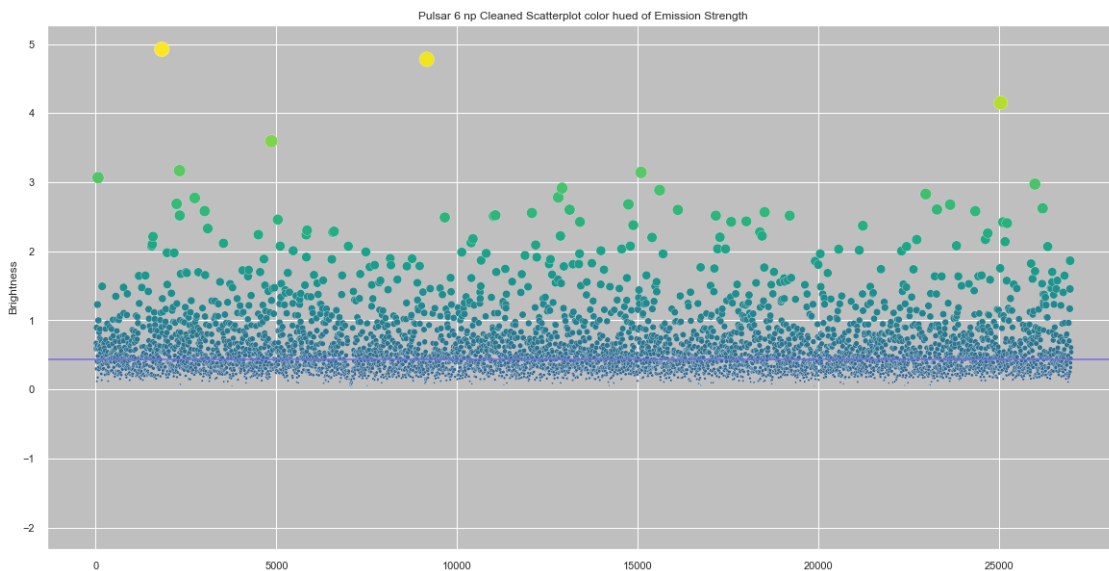
```
[ ]: 0.43021975
```

```
[ ]: plt.figure(figsize=(20,10))
sns.set_theme(style="whitegrid")
ax = sns.boxplot(x=held5ths["Brightness"]).set_title("Boxplot of Pulsar 6_
↳Emission Strength")
```



```
[ ]: plt.figure(figsize=(20,10))
sns.set_style("darkgrid", {"axes.facecolor": ".75"})
strength = held5ths.Brightness.values
ax = sns.scatterplot(data=held5ths["Brightness"], s= strength*50, c=strength,
                    cmap="viridis", marker="o").set_title('Pulsar 6 np Cleaned Scatterplot color
                    ↳hued of Emission Strength')
ax = plt.axhline( y=0.43021975, ls='-',c='mediumslateblue')
```

c:\Users\oxlay\anaconda3\lib\site-packages\matplotlib\collections.py:1003:
RuntimeWarning: invalid value encountered in sqrt
scale = np.sqrt(self._sizes) * dpi / 72.0 * self._factor




```
[ ]: #plt.figure(figsize=(20,10))
#sns.set_style("darkgrid", {"axes.facecolor": ".75"})
#strength = held5ths.Brightness.values
#ax = plt.axhline( y=0.6508051, ls='-',c='mediumslateblue')
#ax = sns.swarmplot(data=held5ths["Brightness"], c="blue").set_title('Pulsar 6
↳Swarm plot of Emission Strength')
```

```
[ ]: print(len(held5ths[(held5ths.Brightness > 0.43021975)]))
print(len(held5ths[(held5ths.Brightness < 0.43021975)]))
```

2700

2700

Randomness testing

```
[ ]: np.savetxt(r'every5thbinarypulsar1.txt', held5ths.Binary, fmt='%d',
↳delimiter='')
np.savetxt(r'allpulsar1.txt', pulsar.Binary, fmt='%d', delimiter='')
```

```
[ ]: pulsar.Binary
```

```
[ ]: 0      1
1      1
2      1
3      1
4      1
..
26995   1
26996   0
26997   0
26998   0
26999   1
Name: Binary, Length: 27000, dtype: int32
```