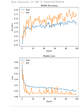
```
# Plot Numbers
# ------------
# Plot the
# Prime Numbers
# Fibonacci Numbers

import matplotlib
import matplotlib.pyplot as plt
import numpy as np

fig = plt.figure(1)
ax = fig.add_subplot(111)
ax.set_aspect('equal')
ax.grid(True, linestyle='-')
ax.axhline(0, color='lightgrey')
ax.axvline(0, color='lightgrey')

# Prime Numbers
x = [2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97, 101, 103, 107, 109, 113, 127, 131, 137, 139, 149, 151, 157, 163, 167, 173, 179, 181, 191, 193, 197, 199, 211, 223, 227, 229, 233, 239, 241, 251, 257, 263, 269, 271, 277, 281, 283, 293, 307, 311, 313, 317, 331, 337, 347, 349, 353, 359, 367, 373, 379, 383, 389, 397, 401, 409, 419, 421, 431, 433, 439, 443, 449, 457, 461, 463, 467, 479, 487, 491, 499, 503, 509, 521, 523, 541, 547, 557, 563, 569, 571, 577, 587, 593, 599, 601, 607, 613, 617, 619, 631, 641, 643, 647, 653, 659, 661, 673, 677, 683, 691, 701, 709, 719, 727, 733, 739, 743, 751, 757, 761, 769, 773, 787, 797, 809, 811, 821, 823, 827, 829, 839, 853, 857, 859, 863, 877, 881, 883, 887, 907, 911, 919, 929, 937, 941, 947, 953, 967, 971, 977, 983, 991, 997]
y = [0, 0, 0, 
```

```
[1] "Plot of Model Count for Binary Variable"
Warning message:
In ggsave(paste0(path_to_save, "Binary_Variable_Count.pdf"),
    plot = .Last.value, width = 8, height = 6, dpi = 300)
cannot open file '/home/jupyter-ubuntu/Binary_Variable_Count.pdf': No such file or directory
```

Seaborn Confusion Matrix with labels for <class.origin.sequential.SequentialDataset object at 0x7f8f41d27ba0>

```
Accuracy of Model: 0.5000000000000000
Precision of Model: 0.5000000000000000
```




```
[ 0.0000 - 0.0000 ]
[ 0.0000 - 0.0000 ]
[ 0.0000 - 0.0000 ]
```

```
Epoch 20/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4511 - accuracy: 0.8176 - val_loss: 0.5001 - val
Epoch 21/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4501 - accuracy: 0.8176 - val_loss: 0.5000 - val
Epoch 22/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4491 - accuracy: 0.8176 - val_loss: 0.4999 - val
Epoch 23/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4481 - accuracy: 0.8176 - val_loss: 0.4998 - val
Epoch 24/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4471 - accuracy: 0.8176 - val_loss: 0.4997 - val
Epoch 25/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4462 - accuracy: 0.8176 - val_loss: 0.4996 - val
Epoch 26/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4452 - accuracy: 0.8176 - val_loss: 0.4995 - val
Epoch 27/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4442 - accuracy: 0.8176 - val_loss: 0.4994 - val
Epoch 28/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4432 - accuracy: 0.8176 - val_loss: 0.4993 - val
Epoch 29/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4423 - accuracy: 0.8176 - val_loss: 0.4992 - val
Epoch 30/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4413 - accuracy: 0.8176 - val_loss: 0.4991 - val
Epoch 31/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4403 - accuracy: 0.8176 - val_loss: 0.4990 - val
Epoch 32/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4393 - accuracy: 0.8176 - val_loss: 0.4989 - val
Epoch 33/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4384 - accuracy: 0.8176 - val_loss: 0.4988 - val
Epoch 34/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4374 - accuracy: 0.8176 - val_loss: 0.4987 - val
Epoch 35/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4364 - accuracy: 0.8176 - val_loss: 0.4986 - val
Epoch 36/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4354 - accuracy: 0.8176 - val_loss: 0.4985 - val
Epoch 37/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4345 - accuracy: 0.8176 - val_loss: 0.4984 - val
Epoch 38/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4335 - accuracy: 0.8176 - val_loss: 0.4983 - val
Epoch 39/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4325 - accuracy: 0.8176 - val_loss: 0.4982 - val
Epoch 40/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4315 - accuracy: 0.8176 - val_loss: 0.4981 - val
Epoch 41/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4306 - accuracy: 0.8176 - val_loss: 0.4980 - val
Epoch 42/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4296 - accuracy: 0.8176 - val_loss: 0.4979 - val
Epoch 43/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4286 - accuracy: 0.8176 - val_loss: 0.4978 - val
Epoch 44/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4276 - accuracy: 0.8176 - val_loss: 0.4977 - val
Epoch 45/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4267 - accuracy: 0.8176 - val_loss: 0.4976 - val
Epoch 46/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4257 - accuracy: 0.8176 - val_loss: 0.4975 - val
Epoch 47/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4247 - accuracy: 0.8176 - val_loss: 0.4974 - val
Epoch 48/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4237 - accuracy: 0.8176 - val_loss: 0.4973 - val
Epoch 49/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4228 - accuracy: 0.8176 - val_loss: 0.4972 - val
Epoch 50/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4218 - accuracy: 0.8176 - val_loss: 0.4971 - val
Epoch 51/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4208 - accuracy: 0.8176 - val_loss: 0.4970 - val
Epoch 52/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4198 - accuracy: 0.8176 - val_loss: 0.4969 - val
Epoch 53/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4189 - accuracy: 0.8176 - val_loss: 0.4968 - val
Epoch 54/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4179 - accuracy: 0.8176 - val_loss: 0.4967 - val
Epoch 55/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4169 - accuracy: 0.8176 - val_loss: 0.4966 - val
Epoch 56/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4159 - accuracy: 0.8176 - val_loss: 0.4965 - val
Epoch 57/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4150 - accuracy: 0.8176 - val_loss: 0.4964 - val
Epoch 58/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4140 - accuracy: 0.8176 - val_loss: 0.4963 - val
Epoch 59/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4130 - accuracy: 0.8176 - val_loss: 0.4962 - val
Epoch 60/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4120 - accuracy: 0.8176 - val_loss: 0.4961 - val
Epoch 61/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4111 - accuracy: 0.8176 - val_loss: 0.4960 - val
Epoch 62/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4101 - accuracy: 0.8176 - val_loss: 0.4959 - val
Epoch 63/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4091 - accuracy: 0.8176 - val_loss: 0.4958 - val
Epoch 64/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4081 - accuracy: 0.8176 - val_loss: 0.4957 - val
Epoch 65/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4072 - accuracy: 0.8176 - val_loss: 0.4956 - val
Epoch 66/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4062 - accuracy: 0.8176 - val_loss: 0.4955 - val
Epoch 67/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4052 - accuracy: 0.8176 - val_loss: 0.4954 - val
Epoch 68/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4042 - accuracy: 0.8176 - val_loss: 0.4953 - val
Epoch 69/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4033 - accuracy: 0.8176 - val_loss: 0.4952 - val
Epoch 70/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4023 - accuracy: 0.8176 - val_loss: 0.4951 - val
Epoch 71/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4013 - accuracy: 0.8176 - val_loss: 0.4950 - val
Epoch 72/20
1/1 [==============================] - 1s 1ms/step - loss: 0.4003 - accuracy: 0.8176 - val_loss: 0.4949 - val
Epoch 73/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3994 - accuracy: 0.8176 - val_loss: 0.4948 - val
Epoch 74/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3984 - accuracy: 0.8176 - val_loss: 0.4947 - val
Epoch 75/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3974 - accuracy: 0.8176 - val_loss: 0.4946 - val
Epoch 76/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3964 - accuracy: 0.8176 - val_loss: 0.4945 - val
Epoch 77/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3955 - accuracy: 0.8176 - val_loss: 0.4944 - val
Epoch 78/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3945 - accuracy: 0.8176 - val_loss: 0.4943 - val
Epoch 79/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3935 - accuracy: 0.8176 - val_loss: 0.4942 - val
Epoch 80/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3925 - accuracy: 0.8176 - val_loss: 0.4941 - val
Epoch 81/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3916 - accuracy: 0.8176 - val_loss: 0.4940 - val
Epoch 82/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3906 - accuracy: 0.8176 - val_loss: 0.4939 - val
Epoch 83/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3896 - accuracy: 0.8176 - val_loss: 0.4938 - val
Epoch 84/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3886 - accuracy: 0.8176 - val_loss: 0.4937 - val
Epoch 85/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3877 - accuracy: 0.8176 - val_loss: 0.4936 - val
Epoch 86/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3867 - accuracy: 0.8176 - val_loss: 0.4935 - val
Epoch 87/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3857 - accuracy: 0.8176 - val_loss: 0.4934 - val
Epoch 88/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3847 - accuracy: 0.8176 - val_loss: 0.4933 - val
Epoch 89/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3838 - accuracy: 0.8176 - val_loss: 0.4932 - val
Epoch 90/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3828 - accuracy: 0.8176 - val_loss: 0.4931 - val
Epoch 91/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3818 - accuracy: 0.8176 - val_loss: 0.4930 - val
Epoch 92/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3808 - accuracy: 0.8176 - val_loss: 0.4929 - val
Epoch 93/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3799 - accuracy: 0.8176 - val_loss: 0.4928 - val
Epoch 94/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3789 - accuracy: 0.8176 - val_loss: 0.4927 - val
Epoch 95/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3779 - accuracy: 0.8176 - val_loss: 0.4926 - val
Epoch 96/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3769 - accuracy: 0.8176 - val_loss: 0.4925 - val
Epoch 97/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3760 - accuracy: 0.8176 - val_loss: 0.4924 - val
Epoch 98/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3750 - accuracy: 0.8176 - val_loss: 0.4923 - val
Epoch 99/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3740 - accuracy: 0.8176 - val_loss: 0.4922 - val
Epoch 100/20
1/1 [==============================] - 1s 1ms/step - loss: 0.3730 - accuracy: 0.8176 - val_loss: 0.4921 - val
```

```
# Plot
# Create confusion matrix
cm = confusion_matrix(y_test, y_pred)
plt.figure(figure=(6,6))
sns.heatmap(cm, annot=True, fmt='d')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()
print("\nClassification Report:")
print(classification_report(y_test, y_pred))
```

```
Confusion Matrix
```



```
Classification Report:
              precision    recall  f1-score   support

           0       0.82      1.00      0.90       164
           1       0.00      0.00      0.00        36

    accuracy                           0.82       200
   macro avg       0.41      0.50      0.45       200
weighted avg       0.67      0.82      0.74       200
```

```
# Plot accuracy
plt.figure(figure=(12,5))
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Validation'], loc='upper left')
plt.show()
# Plot loss
plt.figure(figure=(12,5))
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Validation'], loc='upper left')
plt.show
```

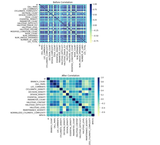
```
Model Accuracy
```

```
Model Loss
```

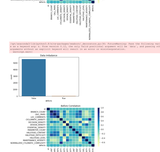
```
# Save model
model.save('ann_model.h5')
# Load model
loaded_model = tf.keras.models.load_model('ann_model.h5')
```

```
# Create a new data point (example)
new_data = np.array([[1, 0, 0, 0
```

```
Epoch 1/5
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 -
Epoch 2/5
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 -
Epoch 3/5
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 -
Epoch 4/5
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 -
Epoch 5/5
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 -
Epoch 1/5
1/1 [==============================] - ETA: 0s - loss: 0.7000 - accuracy: 0.4000 - val_loss: 0.6931 -
Epoch 2/5
1/1 [==============================] - ETA: 0s - loss: 0.7000 - accuracy: 0.4000 - val_loss: 0.6931 -
Epoch 3/5
1/1 [==============================] - ETA: 0s - loss: 0.7000 - accuracy: 0.4000 - val_loss: 0.6931 -
Epoch 4/5
1/1 [==============================] - ETA: 0s - loss: 0.7000 - accuracy: 0.4000 - val_loss: 0.6931 -
Epoch 5/5
1/1 [==============================] - ETA: 0s - loss: 0.7000 - accuracy: 0.4000 - val_loss: 0.6931 -
```




```
corrplot 0.92 loaded
Warning messages:
1: In .Deprecated("cut_number") :
  'cut_number' is deprecated; use 'ggplot2::cut_number()' instead
2: In .Deprecated("cut_number") :
  'cut_number' is deprecated; use 'ggplot2::cut_number()' instead
```




```
```

```
Epoch 1/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 2/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 3/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 4/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 5/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 6/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 7/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 8/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 9/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 10/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 11/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 12/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 13/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 14/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 15/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 16/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 17/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 18/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 19/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
Epoch 20/20
1/1 [==============================] - ETA: 0s - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - v
```

```
# Image Classification Models
# Image Classification Models
# Image Classification Models
```