==========

1️⃣ Import Libraries

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pip install tensorflow

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.datasets import load_breast_cancer
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
import tensorflow as tf
from tensorflow.keras import layers, models
```

```
# ================================================
# 2️⃣ Load Dataset
# ================================================
data = load_breast_cancer()
df = pd.DataFrame(data.data, columns=data.feature_names)
df['target'] = data.target

print("✅ Dataset Loaded Successfully!")
print(df.head())
```

```
✅ Dataset Loaded Successfully!
   mean radius  mean texture  mean perimeter  mean area  mean smoothness  \
0        17.99         10.38          122.80     1001.0          0.11840
1        20.57         17.77          132.90     1326.0          0.08474
2        19.69         21.25          130.00     1203.0          0.10960
3        11.42         20.38           77.58      386.1          0.14250
4        20.29         14.34          135.10     1297.0          0.10030

   mean compactness  mean concavity  mean concave points  mean symmetry  \
0           0.27760          0.3001              0.14710         0.2419
1           0.07864          0.0869              0.07017         0.1812
2           0.15990          0.1974              0.12790         0.2069
3           0.28390          0.2414              0.10520         0.2597
4           0.13280          0.1980              0.10430         0.1809

   mean fractal dimension  ...  worst texture  worst perimeter  worst area  \
0                 0.07871  ...          17.33           184.60      2019.0
1                 0.05667  ...          23.41           158.80      1956.0
2                 0.05999  ...          25.53           152.50      1709.0
3                 0.09744  ...          26.50            98.87       567.7
4                 0.05883  ...          16.67           152.20      1575.0

   worst smoothness  worst compactness  worst concavity  worst concave points  \
0            0.1622             0.6656           0.7119                0.2654
1            0.1238             0.1866           0.2416                0.1860
2            0.1444             0.4245           0.4504                0.2430
3            0.2098             0.8663           0.6869                0.2575
4            0.1374             0.2050           0.4000                0.1625

   worst symmetry  worst fractal dimension  target
0          0.4601                  0.11890       0
1          0.2750                  0.08902       0
2          0.3613                  0.08758       0
3          0.6638                  0.17300       0
4          0.2364                  0.07678       0

[5 rows x 31 columns]
```

==========

3️⃣ Basic EDA

```
==================================================
```

```
print("\nDataset Info:")
print(df.info())
```

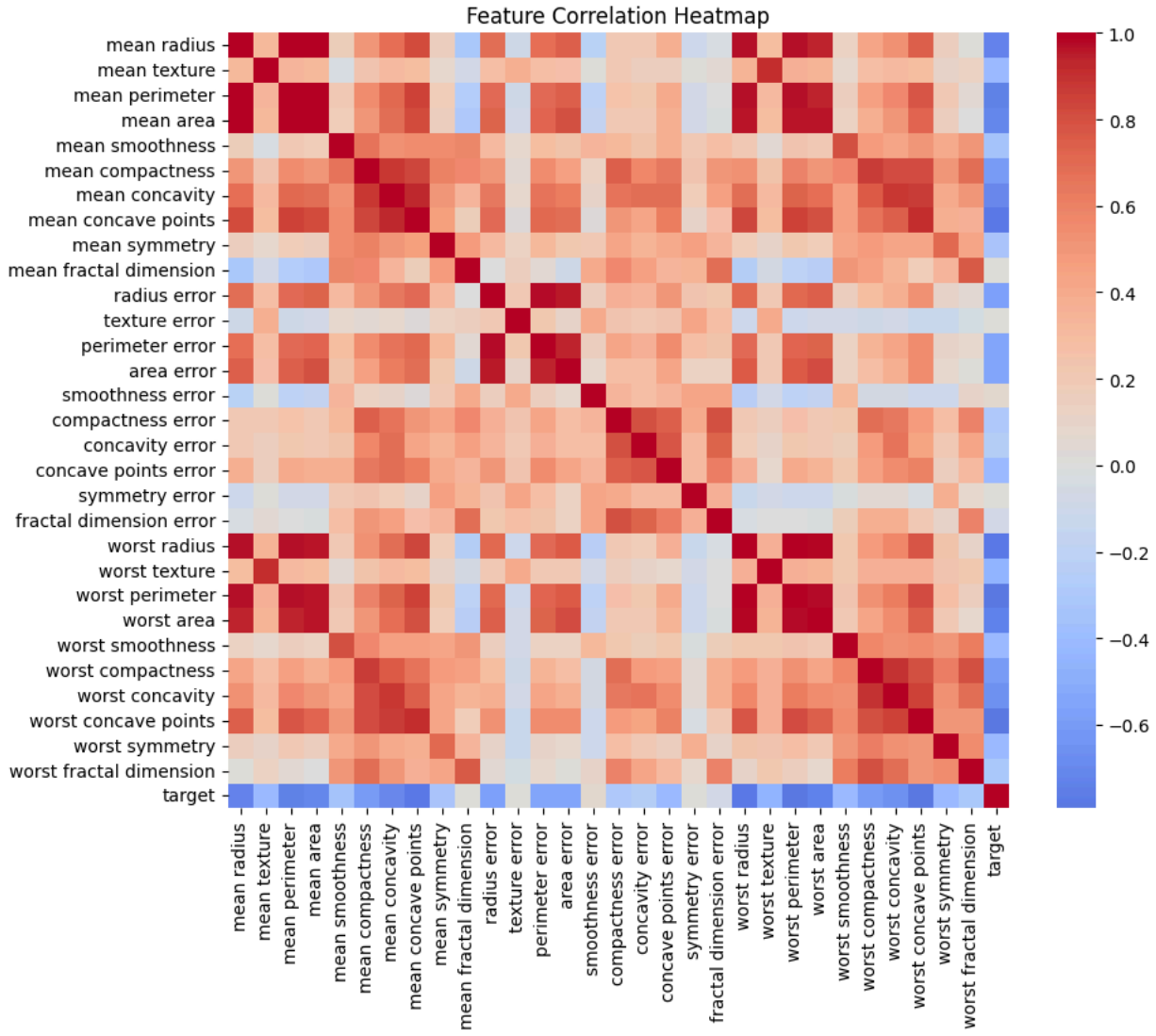
```
Dataset Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 569 entries, 0 to 568
Data columns (total 31 columns):
 #   Column                   Non-Null Count  Dtype  
---  ------                   --------------  -----  
 0   mean radius              569 non-null    float64
 1   mean texture             569 non-null    float64
 2   mean perimeter           569 non-null    float64
 3   mean area                569 non-null    float64
 4   mean smoothness          569 non-null    float64
 5   mean compactness         569 non-null    float64
 6   mean concavity           569 non-null    float64
 7   mean concave points      569 non-null    float64
 8   mean symmetry            569 non-null    float64
 9   mean fractal dimension   569 non-null    float64
 10  radius error             569 non-null    float64
 11  texture error            569 non-null    float64
 12  perimeter error          569 non-null    float64
 13  area error               569 non-null    float64
 14  smoothness error         569 non-null    float64
 15  compactness error        569 non-null    float64
 16  concavity error          569 non-null    float64
 17  concave points error     569 non-null    float64
 18  symmetry error           569 non-null    float64
 19  fractal dimension error  569 non-null    float64
 20  worst radius             569 non-null    float64
 21  worst texture            569 non-null    float64
 22  worst perimeter          569 non-null    float64
 23  worst area               569 non-null    float64
 24  worst smoothness         569 non-null    float64
 25  worst compactness        569 non-null    float64
 26  worst concavity          569 non-null    float64
 27  worst concave points     569 non-null    float64
 28  worst symmetry           569 non-null    float64
 29  worst fractal dimension  569 non-null    float64
 30  target                   569 non-null    int64  
dtypes: float64(30), int64(1)
memory usage: 137.9 KB
None
```

```
print("\nClass Distribution:")
print(df['target'].value_counts())
```

```
Class Distribution:
target
1    357
0    212
Name: count, dtype: int64
```

```
# Visualize class balance
sns.countplot(x='target', data=df)
plt.title("Target Class Distribution (0 = Malignant, 1 = Benign)")
plt.show()
```


```
# Correlation heatmap (top features)
plt.figure(figsize=(10, 8))
sns.heatmap(df.corr(), cmap='coolwarm', center=0)
plt.title("Feature Correlation Heatmap")
plt.show()
```




```
# Check for missing values
print("\nMissing Values:")
print(df.isnull().sum().sum())
```

```
Missing Values:
0
```

==========

4 Preprocessing

==========

```
X = df.drop('target', axis=1)
y = df['target']
```

```
# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

```
# Scale features
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)

print("\n✅ Data Preprocessing Completed!")
```

```
✅ Data Preprocessing Completed!
```

==========

5 Build TensorFlow Model

==========

```
model = models.Sequential([
    layers.Dense(32, activation='relu', input_shape=(X_train.shape[1],)),
    layers.Dense(16, activation='relu'),
    layers.Dense(1, activation='sigmoid')  # sigmoid → binary output between 0 and 1
])

model.compile(optimizer='adam',
              loss='binary_crossentropy',
              metrics=['accuracy'])

model.summary()
```

```
/usr/local/lib/python3.12/dist-packages/keras/src/layers/core/dense.py:93: UserWarning: Do not pass an `input_shape`/`input_dim`
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Model: "sequential"
```

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 32)	992
dense_1 (Dense)	(None, 16)	528
dense_2 (Dense)	(None, 1)	17

```
Total params: 1,537 (6.00 KB)
Trainable params: 1,537 (6.00 KB)
Non-trainable params: 0 (0.00 B)
```

==========

6 Train Model

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```
history = model.fit(X_train_scaled, y_train, epochs=30, batch_size=16, validation_split=0.2, verbos
```

```
Epoch 1/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - accuracy: 0.7708 - loss: 0.5553 - val_accuracy: 0.9560 - val_loss: 0.2828
Epoch 2/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9112 - loss: 0.3012 - val_accuracy: 0.9560 - val_loss: 0.1919
Epoch 3/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9483 - loss: 0.1892 - val_accuracy: 0.9670 - val_loss: 0.1530
Epoch 4/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9562 - loss: 0.1368 - val_accuracy: 0.9560 - val_loss: 0.1327
Epoch 5/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9643 - loss: 0.1175 - val_accuracy: 0.9560 - val_loss: 0.1197
Epoch 6/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9750 - loss: 0.1087 - val_accuracy: 0.9670 - val_loss: 0.1105
Epoch 7/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9867 - loss: 0.0758 - val_accuracy: 0.9670 - val_loss: 0.1048
Epoch 8/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.9880 - loss: 0.0706 - val_accuracy: 0.9670 - val_loss: 0.1006
Epoch 9/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9845 - loss: 0.0836 - val_accuracy: 0.9670 - val_loss: 0.0978
Epoch 10/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9939 - loss: 0.0516 - val_accuracy: 0.9670 - val_loss: 0.0939
Epoch 11/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9920 - loss: 0.0488 - val_accuracy: 0.9560 - val_loss: 0.0929
Epoch 12/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9871 - loss: 0.0571 - val_accuracy: 0.9560 - val_loss: 0.0924
Epoch 13/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9923 - loss: 0.0404 - val_accuracy: 0.9560 - val_loss: 0.0897
Epoch 14/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9938 - loss: 0.0369 - val_accuracy: 0.9560 - val_loss: 0.0901
Epoch 15/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9899 - loss: 0.0399 - val_accuracy: 0.9560 - val_loss: 0.0890
Epoch 16/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9910 - loss: 0.0335 - val_accuracy: 0.9560 - val_loss: 0.0870
Epoch 17/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9858 - loss: 0.0315 - val_accuracy: 0.9560 - val_loss: 0.0902
Epoch 18/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9968 - loss: 0.0180 - val_accuracy: 0.9670 - val_loss: 0.0883
Epoch 19/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9855 - loss: 0.0315 - val_accuracy: 0.9670 - val_loss: 0.0899
Epoch 20/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9921 - loss: 0.0301 - val_accuracy: 0.9670 - val_loss: 0.0897
Epoch 21/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9956 - loss: 0.0285 - val_accuracy: 0.9670 - val_loss: 0.0884
Epoch 22/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9908 - loss: 0.0315 - val_accuracy: 0.9670 - val_loss: 0.0910
Epoch 23/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9976 - loss: 0.0207 - val_accuracy: 0.9670 - val_loss: 0.0899
Epoch 24/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9938 - loss: 0.0258 - val_accuracy: 0.9670 - val_loss: 0.0919
Epoch 25/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9947 - loss: 0.0173 - val_accuracy: 0.9670 - val_loss: 0.0924
Epoch 26/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9925 - loss: 0.0208 - val_accuracy: 0.9670 - val_loss: 0.0914
Epoch 27/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9937 - loss: 0.0185 - val_accuracy: 0.9670 - val_loss: 0.0921
Epoch 28/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9962 - loss: 0.0155 - val_accuracy: 0.9670 - val_loss: 0.0930
Epoch 29/30
23/23 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.9902 - loss: 0.0181 - val_accuracy: 0.9670 - val_loss: 0.0963
```

==========

7 Evaluate Model

==========

```
loss, accuracy = model.evaluate(X_test_scaled, y_test)
print(f"\n✅ Test Accuracy: {accuracy*100:.2f}%")
```

```
4/4 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - accuracy: 0.9651 - loss: 0.1106

✅ Test Accuracy: 96.49%
```

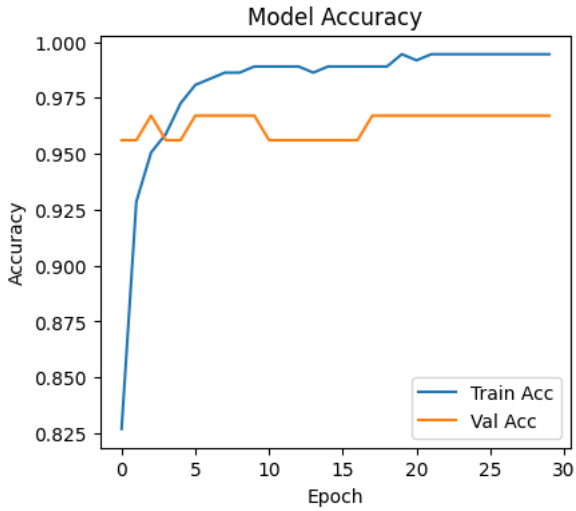
==========

8 Plot Training Results

==========

```
plt.figure(figsize=(10,4))
plt.subplot(1,2,1)
plt.plot(history.history['accuracy'], label='Train Acc')
plt.plot(history.history['val_accuracy'], label='Val Acc')
plt.title('Model Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x798d4de52f60>
```




```
plt.subplot(1,2,2)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Val Loss')
plt.title('Model Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()
```