Aryan Patel ABI Project

In [235…
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import sklearn.preprocessing
import sklearn.pipeline
```

Reading in the data

In [236…
```
training_data = pd.read_csv('/Users/aryanpatel/abiprojecttrain.csv')

test_data = pd.read_csv('/Users/aryanpatel/abiprojecttest.csv')



training_data.head()
```

Out[236]:

	SalePrice	LotFrontage	LotArea	Street	LotShape	YearBuilt	BsmtUnfSF	TotalBsmtSF
0	163990	65	8461	Pave	Reg	2005	728	728
1	412500	110	13688	Pave	IR1	2003	556	1572
2	126000	60	8160	Pave	Reg	1940	444	756
3	280000	109	14154	Pave	Reg	2006	1063	1063
4	105000	51	6120	Pave	Reg	1931	506	715

5 rows × 24 columns

In [237…
```
trainview = training_data.shape
testview = test_data.shape


print(trainview,testview)
```

```
(901, 24) (226, 24)
```

In [238…
```
#checking if null values
navalues = training_data.isna().sum()
print(navalues)
```

```
SalePrice       0
LotFrontage     0
LotArea         0
Street          0
LotShape        0
YearBuilt       0
BsmtUnfSF       0
TotalBsmtSF     0
CentralAir      0
X1stFlrSF       0
X2ndFlrSF       0
GrLivArea       0
BsmtFullBath    0
BsmtHalfBath    0
FullBath        0
HalfBath        0
BedroomAbvGr    0
KitchenAbvGr    0
TotRmsAbvGrd    0
Fireplaces      0
GarageYrBlt     0
GarageCars      0
GarageArea      0
WoodDeckSF      0
dtype: int64
```

In [239…

```
for i, (col_name, dtype) in enumerate(training_data.dtypes.items()):
    print(f"Column {i}: {col_name} - {dtype}")
```

```
Column 0: SalePrice - int64
Column 1: LotFrontage - int64
Column 2: LotArea - int64
Column 3: Street - object
Column 4: LotShape - object
Column 5: YearBuilt - int64
Column 6: BsmtUnfSF - int64
Column 7: TotalBsmtSF - int64
Column 8: CentralAir - object
Column 9: X1stFlrSF - int64
Column 10: X2ndFlrSF - int64
Column 11: GrLivArea - int64
Column 12: BsmtFullBath - int64
Column 13: BsmtHalfBath - int64
Column 14: FullBath - int64
Column 15: HalfBath - int64
Column 16: BedroomAbvGr - int64
Column 17: KitchenAbvGr - int64
Column 18: TotRmsAbvGrd - int64
Column 19: Fireplaces - int64
Column 20: GarageYrBlt - int64
Column 21: GarageCars - int64
Column 22: GarageArea - int64
Column 23: WoodDeckSF - int64
```

In [240…
```
#sklearn preprocessing on training data
from sklearn.compose import ColumnTransformer
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler, OneHotEncoder, FunctionTra
from sklearn.compose import make_column_selector as selector

X_train = training_data.drop(columns=['SalePrice'])
y_train = training_data['SalePrice']


X_test = test_data.drop(columns=['SalePrice'])
y_test = test_data['SalePrice']





numerical_features = selector(dtype_include=np.int64)
categorical_features = selector(dtype_include=object)


numerical_transformer = Pipeline(steps=[
    ('scaler', StandardScaler())
])

categorical_transformer = Pipeline(steps=[
    ('onehot', OneHotEncoder())
])

preprocessor = ColumnTransformer(
    transformers=[
        ('num', numerical_transformer, numerical_features),
        ('cat', categorical_transformer, categorical_features)
    ])


pipeline = Pipeline(steps=[
    ('preprocessor', preprocessor)
])


X_train_processed = pipeline.fit_transform(X_train)


X_test_processed = pipeline.transform(X_test)


y_train_processed = np.log1p(y_train)
y_test_processed = np.log1p(y_test)
```

In [241…
```
X_train_processed
```

Out[241]:
```
array([[-0.23492683, -0.18862751,  1.04590173, ...,  1.        ,
         0.        ,  1.        ],
       [ 1.66023998,  0.41400605,  0.98098096, ...,  0.        ,
         0.        ,  1.        ],
       [-0.44550092, -0.22333053, -1.06402334, ...,  1.        ,
         1.        ,  0.        ],
       ...,
       [ 0.18622135, -0.12648489,  1.07836211, ...,  1.        ,
         0.        ,  1.        ],
       [-0.8666491 ,  0.54901349,  1.07836211, ...,  0.        ,
         0.        ,  1.        ],
       [-0.31915647, -0.18413111,  1.01344134, ...,  1.        ,
         0.        ,  1.        ]])
```

1st Model Simple multiple linear regression.

In [242…
```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error


linear_regression = LinearRegression()


linear_regression.fit(X_train_processed, y_train_processed)


y_train_pred = linear_regression.predict(X_train_processed)
y_test_pred = linear_regression.predict(X_test_processed)


train_mse = mean_squared_error(y_train_processed, y_train_pred)
test_mse = mean_squared_error(y_test_processed, y_test_pred)

print("Training MSE (Regular Regression) is :", train_mse)
print("Test MSE (Regular Regression) is  :", test_mse)

residual_model0_test = y_test_processed - y_test_pred
```

```
Training MSE (Regular Regression) is : 0.02462790457299441
Test MSE (Regular Regression) is  : 0.06428908586018621
```

2nd model elastic net regression

In [243…

```
from sklearn.linear_model import ElasticNet
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import mean_squared_error

#tried many values for all params but this resulted in best from my testing
param_grid = {
    'alpha': [ 0.1, 0.5, 1.0, 10, 100],
    'l1_ratio': [ 0.1, 0.5, 0.9, 0.99]
}


elastic_net = ElasticNet(max_iter=10000)


grid_search = GridSearchCV(elastic_net, param_grid, cv=10, scoring='neg_mean

grid_search.fit(X_train_processed, y_train_processed)


best_elastic_net = grid_search.best_estimator_


print("Best Hyperparameters are :")
print(grid_search.best_params_)


best_elastic_net.fit(X_train_processed, y_train_processed)


y_train_pred = best_elastic_net.predict(X_train_processed)
y_test_pred = best_elastic_net.predict(X_test_processed)


train_mse_elastic = mean_squared_error(y_train_processed, y_train_pred)
test_mse_elastic = mean_squared_error(y_test_processed, y_test_pred)

print("Training MSE (Elastic Net) is :", train_mse_elastic)
print("Test MSE (Elastic Net) is :", test_mse_elastic)

residual_model1_test = y_test_processed - y_test_pred
```

```
Best Hyperparameters are :
{'alpha': 0.1, 'l1_ratio': 0.1}
Training MSE (Elastic Net) is : 0.027969114268482042
Test MSE (Elastic Net) is : 0.05836975904396832
```

In [244…

```
#checking coef of the elastic net model
print("Coefficients:")
for i, coef in enumerate(best_elastic_net.coef_):
    print(f"Feature {i}: {coef}")
```

```
Coefficients:
Feature 0: 0.012009936379842032
Feature 1: 0.00915587177911959
Feature 2: 0.06871359699411492
Feature 3: -0.0
Feature 4: 0.07209034881414104
Feature 5: 0.027057832403221745
Feature 6: 0.01473509275927689
Feature 7: 0.09133413203771718
Feature 8: 0.023115725619931318
Feature 9: 0.0
Feature 10: 0.03089444644838244
Feature 11: 0.016131089285058575
Feature 12: -0.005068347350476139
Feature 13: -0.04120539122186395
Feature 14: 0.024635013991695466
Feature 15: 0.04700034380389149
Feature 16: 0.028394537079765143
Feature 17: 0.029396977086362894
Feature 18: 0.026853033978358063
Feature 19: 0.008634288309406574
Feature 20: -0.0
Feature 21: 0.0
Feature 22: 0.0
Feature 23: 0.0
Feature 24: -0.0
Feature 25: -0.0
Feature 26: -0.0
Feature 27: 0.0
```

Third model SVM (poly)

In [245…
```
from sklearn.svm import SVR
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import mean_squared_error

#tried large range of param but these resulted in best mse from what I have
param_grid = {
    'C': [0.01,0.1, 1, 10],
    'epsilon': [0.01,0.1, 0.5, 1.0]
}


svm_model = SVR(kernel='poly',degree=3)


grid_search = GridSearchCV(svm_model, param_grid, cv=5, scoring='neg_mean_sq
grid_search.fit(X_train_processed, y_train_processed)


best_svm_model = grid_search.best_estimator_


best_svm_model.fit(X_train_processed, y_train_processed)


y_train_pred_svm = best_svm_model.predict(X_train_processed)
y_test_pred_svm = best_svm_model.predict(X_test_processed)


train_mse_svm = mean_squared_error(y_train_processed, y_train_pred_svm)
test_mse_svm = mean_squared_error(y_test_processed, y_test_pred_svm)

print("Training MSE (SVM):", train_mse_svm)
print("Test MSE (SVM):", test_mse_svm)
print("Best hyperparameters:", grid_search.best_params_)

residual_model2_test = y_test_processed - y_test_pred_svm
```

```
Training MSE (SVM): 0.009404704464279212
Test MSE (SVM): 0.02839727450036488
Best hyperparameters: {'C': 1, 'epsilon': 0.1}
```

Model 4 # neural network

In [246…
```
from sklearn.model_selection import train_test_split

# Creating validation data for neural network from full training data
X_train_nn, X_valid_nn, y_train_nn, y_valid_nn = train_test_split(X_train_pr
```

In [247…
```
x_train_processed_view = X_train_processed.shape

print(x_train_processed_view)
```

```
(901, 28)
```

In [248…

```python
import tensorflow as tf



tf.keras.backend.clear_session()
tf.random.set_seed(42)

ann_model = tf.keras.Sequential([
    tf.keras.layers.Dense(70, activation="relu", input_shape=(28,)),
    tf.keras.layers.Dense(35, activation="relu", kernel_initializer="he_norm
    tf.keras.layers.Dropout(0.001),
    tf.keras.layers.Dense(20, activation="relu", kernel_initializer="he_norm
    tf.keras.layers.Dense(1)
])

ann_model.summary()
```

```
/Users/aryanpatel/anaconda3/lib/python3.11/site-packages/keras/src/layers/co
re/dense.py:88: UserWarning: Do not pass an `input_shape`/`input_dim` argume
nt to a layer. When using Sequential models, prefer using an `Input(shape)`
object as the first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

```
Model: "sequential"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━
┃ Layer (type)                    ┃ Output Shape           ┃     Para
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━
│ dense (Dense)                   │ (None, 70)             │       2,
├─────────────────────────────────┼────────────────────────┼────────
│ dense_1 (Dense)                 │ (None, 35)             │       2,
├─────────────────────────────────┼────────────────────────┼────────
│ dropout (Dropout)               │ (None, 35)             │
├─────────────────────────────────┼────────────────────────┼────────
│ dense_2 (Dense)                 │ (None, 20)             │
├─────────────────────────────────┼────────────────────────┼────────
│ dense_3 (Dense)                 │ (None, 1)              │
└─────────────────────────────────┴────────────────────────┴────────

 Total params: 5,256 (20.53 KB)
 Trainable params: 5,256 (20.53 KB)
 Non-trainable params: 0 (0.00 B)
```

In [249…

```python
tf.random.set_seed(42)
optimizer = tf.keras.optimizers.Adam(learning_rate=0.001)
ann_model.compile(loss='mean_squared_error', optimizer=optimizer)

tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir="logs")
```

In [250…

```
tf.random.set_seed(42)
history = ann_model.fit(X_train_nn, y_train_nn, epochs=500,
                        validation_data=(X_valid_nn, y_valid_nn),
                        callbacks=[tensorboard_callback])
```

```
Epoch 1/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 135.8865 - val_loss: 94.4918
Epoch 2/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 75.0217 - val_loss: 19.7875
Epoch 3/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 15.0995 - val_loss: 8.4906
Epoch 4/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 9.0276 - val_loss: 7.3393
Epoch 5/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 7.1921 - val_loss: 6.1159
Epoch 6/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 6.0626 - val_loss: 5.5420
Epoch 7/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 5.3429 - val_loss: 5.0790
Epoch 8/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 4.8309 - val_loss: 4.7204
Epoch 9/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 4.4587 - val_loss: 4.4249
Epoch 10/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 4.1340 - val_loss: 4.1709
Epoch 11/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 3.8795 - val_loss: 3.9637
Epoch 12/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 3.6638 - val_loss: 3.7702
Epoch 13/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 3.4717 - val_loss: 3.6229
Epoch 14/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 3.3473 - val_loss: 3.4721
Epoch 15/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 3.1963 - val_loss: 3.3444
Epoch 16/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 3.0701 - val_loss: 3.2171
Epoch 17/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 2.9589 - val_loss: 3.1103
Epoch 18/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 2.8393 - val_loss: 3.0081
Epoch 19/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 2.7480 - val_loss: 2.9278
Epoch 20/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 2.6516 - val_loss: 2.8357
Epoch 21/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 2.5595 - val_loss: 2.7551
Epoch 22/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 2.4777 - val_loss: 2.6795
Epoch 23/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 2.4193 - val_loss: 2.6035
Epoch 24/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 2.3299 - val_loss: 2.5249
```

```
Epoch 25/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 2.2429 - val_loss: 2.4531
Epoch 26/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 2.1851 - val_loss: 2.3768
Epoch 27/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 2.1146 - val_loss: 2.3139
Epoch 28/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 2.0527 - val_loss: 2.2424
Epoch 29/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.9853 - val_loss: 2.1848
Epoch 30/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.9334 - val_loss: 2.1290
Epoch 31/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.8908 - val_loss: 2.0790
Epoch 32/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.8400 - val_loss: 2.0123
Epoch 33/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.7687 - val_loss: 1.9529
Epoch 34/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.7256 - val_loss: 1.8996
Epoch 35/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.6939 - val_loss: 1.8462
Epoch 36/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6221 - val_loss: 1.7897
Epoch 37/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.5770 - val_loss: 1.7452
Epoch 38/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.5315 - val_loss: 1.7066
Epoch 39/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.4883 - val_loss: 1.6506
Epoch 40/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.4479 - val_loss: 1.6058
Epoch 41/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.4058 - val_loss: 1.5621
Epoch 42/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.3715 - val_loss: 1.5159
Epoch 43/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.3272 - val_loss: 1.4765
Epoch 44/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.3072 - val_loss: 1.4415
Epoch 45/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.2597 - val_loss: 1.4014
Epoch 46/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.2213 - val_loss: 1.3656
Epoch 47/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.2040 - val_loss: 1.3295
Epoch 48/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.1715 - val_loss: 1.2948
Epoch 49/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.1440 - val_loss: 1.2578
Epoch 50/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.1129 - val_loss: 1.2264
Epoch 51/500
```

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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.0735 - val_loss: 1.1939
Epoch 52/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.0362 - val_loss: 1.1638
Epoch 53/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.0239 - val_loss: 1.1290
Epoch 54/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.9928 - val_loss: 1.1025
Epoch 55/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.9637 - val_loss: 1.0724
Epoch 56/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.9288 - val_loss: 1.0448
Epoch 57/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.9086 - val_loss: 1.0189
Epoch 58/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.8814 - val_loss: 0.9954
Epoch 59/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.8589 - val_loss: 0.9700
Epoch 60/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.8414 - val_loss: 0.9455
Epoch 61/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.8254 - val_loss: 0.9168
Epoch 62/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.8045 - val_loss: 0.8924
Epoch 63/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.7751 - val_loss: 0.8740
Epoch 64/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.7546 - val_loss: 0.8544
Epoch 65/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.7459 - val_loss: 0.8273
Epoch 66/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.7154 - val_loss: 0.8118
Epoch 67/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.6965 - val_loss: 0.7833
Epoch 68/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.6785 - val_loss: 0.7717
Epoch 69/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.6617 - val_loss: 0.7458
Epoch 70/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.6736 - val_loss: 0.7284
Epoch 71/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.6288 - val_loss: 0.7084
Epoch 72/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.6184 - val_loss: 0.6981
Epoch 73/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.6107 - val_loss: 0.6910
Epoch 74/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.5800 - val_loss: 0.6605
Epoch 75/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.5688 - val_loss: 0.6402
Epoch 76/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.5456 - val_loss: 0.6244
Epoch 77/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.5484 - val_loss: 0.6103
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Epoch 78/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.5243 - val_loss: 0.5933
Epoch 79/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.5083 - val_loss: 0.5766
Epoch 80/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4935 - val_loss: 0.5661
Epoch 81/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4879 - val_loss: 0.5517
Epoch 82/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4655 - val_loss: 0.5380
Epoch 83/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4666 - val_loss: 0.5235
Epoch 84/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4433 - val_loss: 0.5144
Epoch 85/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4384 - val_loss: 0.5008
Epoch 86/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4405 - val_loss: 0.4959
Epoch 87/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4344 - val_loss: 0.4800
Epoch 88/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4182 - val_loss: 0.4741
Epoch 89/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4169 - val_loss: 0.4514
Epoch 90/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4150 - val_loss: 0.4573
Epoch 91/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.4088 - val_loss: 0.4332
Epoch 92/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3817 - val_loss: 0.4365
Epoch 93/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.3800 - val_loss: 0.4125
Epoch 94/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3573 - val_loss: 0.4049
Epoch 95/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3486 - val_loss: 0.3951
Epoch 96/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3320 - val_loss: 0.4026
Epoch 97/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3374 - val_loss: 0.3841
Epoch 98/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.3263 - val_loss: 0.3711
Epoch 99/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3086 - val_loss: 0.3722
Epoch 100/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3150 - val_loss: 0.3500
Epoch 101/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3006 - val_loss: 0.3571
Epoch 102/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3330 - val_loss: 0.3414
Epoch 103/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.3121 - val_loss: 0.3460
Epoch 104/500
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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3210 - val_loss: 0.3289
Epoch 105/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.3142 - val_loss: 0.3445
Epoch 106/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2899 - val_loss: 0.3094
Epoch 107/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2671 - val_loss: 0.3127
Epoch 108/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2613 - val_loss: 0.2974
Epoch 109/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2469 - val_loss: 0.2971
Epoch 110/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.2521 - val_loss: 0.2882
Epoch 111/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2432 - val_loss: 0.2959
Epoch 112/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.2309 - val_loss: 0.2756
Epoch 113/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2204 - val_loss: 0.2715
Epoch 114/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2196 - val_loss: 0.2650
Epoch 115/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2130 - val_loss: 0.2583
Epoch 116/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2170 - val_loss: 0.2620
Epoch 117/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2145 - val_loss: 0.2504
Epoch 118/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1996 - val_loss: 0.2475
Epoch 119/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1981 - val_loss: 0.2715
Epoch 120/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2082 - val_loss: 0.2384
Epoch 121/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1941 - val_loss: 0.2335
Epoch 122/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1974 - val_loss: 0.2484
Epoch 123/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2039 - val_loss: 0.2265
Epoch 124/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1930 - val_loss: 0.2299
Epoch 125/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1983 - val_loss: 0.2334
Epoch 126/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1835 - val_loss: 0.2160
Epoch 127/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1748 - val_loss: 0.2107
Epoch 128/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1753 - val_loss: 0.2084
Epoch 129/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1719 - val_loss: 0.2155
Epoch 130/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.1761 - val_loss: 0.2040
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Epoch 131/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1591 - val_loss: 0.2021
Epoch 132/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.1611 - val_loss: 0.1978
Epoch 133/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.1578 - val_loss: 0.1923
Epoch 134/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1507 - val_loss: 0.1890
Epoch 135/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1598 - val_loss: 0.1846
Epoch 136/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1566 - val_loss: 0.1875
Epoch 137/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1874 - val_loss: 0.1923
Epoch 138/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1709 - val_loss: 0.1841
Epoch 139/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1610 - val_loss: 0.1907
Epoch 140/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.1671 - val_loss: 0.2076
Epoch 141/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2089 - val_loss: 0.1946
Epoch 142/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1782 - val_loss: 0.2015
Epoch 143/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.2193 - val_loss: 0.2368
Epoch 144/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1932 - val_loss: 0.1688
Epoch 145/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1565 - val_loss: 0.1671
Epoch 146/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1263 - val_loss: 0.1648
Epoch 147/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1241 - val_loss: 0.1587
Epoch 148/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1221 - val_loss: 0.1637
Epoch 149/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.1295 - val_loss: 0.1590
Epoch 150/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1188 - val_loss: 0.1562
Epoch 151/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1190 - val_loss: 0.1608
Epoch 152/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1150 - val_loss: 0.1784
Epoch 153/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1278 - val_loss: 0.1411
Epoch 154/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1370 - val_loss: 0.1459
Epoch 155/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1182 - val_loss: 0.1615
Epoch 156/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1197 - val_loss: 0.1503
Epoch 157/500
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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1053 - val_loss: 0.1550
Epoch 158/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1185 - val_loss: 0.1369
Epoch 159/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1126 - val_loss: 0.1458
Epoch 160/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1082 - val_loss: 0.1489
Epoch 161/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1068 - val_loss: 0.1972
Epoch 162/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1531 - val_loss: 0.1404
Epoch 163/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1150 - val_loss: 0.1443
Epoch 164/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1167 - val_loss: 0.2093
Epoch 165/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.1534 - val_loss: 0.1384
Epoch 166/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.1149 - val_loss: 0.1406
Epoch 167/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.1156 - val_loss: 0.1390
Epoch 168/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1030 - val_loss: 0.1347
Epoch 169/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0929 - val_loss: 0.1340
Epoch 170/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0965 - val_loss: 0.1322
Epoch 171/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0983 - val_loss: 0.1292
Epoch 172/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0921 - val_loss: 0.1241
Epoch 173/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0902 - val_loss: 0.1241
Epoch 174/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1062 - val_loss: 0.1281
Epoch 175/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1106 - val_loss: 0.1311
Epoch 176/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0977 - val_loss: 0.1260
Epoch 177/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.1023 - val_loss: 0.1275
Epoch 178/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1080 - val_loss: 0.1284
Epoch 179/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1071 - val_loss: 0.1195
Epoch 180/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1199 - val_loss: 0.1203
Epoch 181/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1115 - val_loss: 0.1309
Epoch 182/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.1157 - val_loss: 0.1313
Epoch 183/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.1138 - val_loss: 0.1240
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Epoch 184/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0929 - val_loss: 0.1242
Epoch 185/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0902 - val_loss: 0.1300
Epoch 186/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0893 - val_loss: 0.1289
Epoch 187/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0823 - val_loss: 0.1187
Epoch 188/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0871 - val_loss: 0.1284
Epoch 189/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0905 - val_loss: 0.1085
Epoch 190/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0881 - val_loss: 0.1154
Epoch 191/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0905 - val_loss: 0.1232
Epoch 192/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0899 - val_loss: 0.1326
Epoch 193/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0944 - val_loss: 0.1366
Epoch 194/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1081 - val_loss: 0.1163
Epoch 195/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0942 - val_loss: 0.1136
Epoch 196/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0764 - val_loss: 0.1073
Epoch 197/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0763 - val_loss: 0.1129
Epoch 198/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0725 - val_loss: 0.1127
Epoch 199/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0740 - val_loss: 0.1127
Epoch 200/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0686 - val_loss: 0.1163
Epoch 201/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0748 - val_loss: 0.1160
Epoch 202/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0747 - val_loss: 0.1112
Epoch 203/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0736 - val_loss: 0.1043
Epoch 204/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0708 - val_loss: 0.1050
Epoch 205/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0782 - val_loss: 0.1066
Epoch 206/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0800 - val_loss: 0.1021
Epoch 207/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0707 - val_loss: 0.1050
Epoch 208/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0648 - val_loss: 0.1084
Epoch 209/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0693 - val_loss: 0.1050
Epoch 210/500
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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0698 - val_loss: 0.1167
Epoch 211/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0850 - val_loss: 0.1142
Epoch 212/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0723 - val_loss: 0.1008
Epoch 213/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0695 - val_loss: 0.1043
Epoch 214/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0790 - val_loss: 0.1019
Epoch 215/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0760 - val_loss: 0.1136
Epoch 216/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0723 - val_loss: 0.1010
Epoch 217/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0743 - val_loss: 0.1141
Epoch 218/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0977 - val_loss: 0.1206
Epoch 219/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0856 - val_loss: 0.1258
Epoch 220/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0917 - val_loss: 0.1116
Epoch 221/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0716 - val_loss: 0.1046
Epoch 222/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0842 - val_loss: 0.1057
Epoch 223/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0748 - val_loss: 0.0969
Epoch 224/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0859 - val_loss: 0.1011
Epoch 225/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0733 - val_loss: 0.0949
Epoch 226/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0687 - val_loss: 0.0963
Epoch 227/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0715 - val_loss: 0.0984
Epoch 228/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0709 - val_loss: 0.0930
Epoch 229/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0728 - val_loss: 0.0996
Epoch 230/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0656 - val_loss: 0.0986
Epoch 231/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0835 - val_loss: 0.1009
Epoch 232/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0729 - val_loss: 0.1240
Epoch 233/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0722 - val_loss: 0.1207
Epoch 234/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0717 - val_loss: 0.1381
Epoch 235/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0892 - val_loss: 0.1468
Epoch 236/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0803 - val_loss: 0.1351
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Epoch 237/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0860 - val_loss: 0.1250
Epoch 238/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0791 - val_loss: 0.1014
Epoch 239/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0872 - val_loss: 0.1089
Epoch 240/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0742 - val_loss: 0.1596
Epoch 241/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0926 - val_loss: 0.1696
Epoch 242/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1002 - val_loss: 0.1091
Epoch 243/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0860 - val_loss: 0.0929
Epoch 244/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0736 - val_loss: 0.1016
Epoch 245/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0706 - val_loss: 0.0964
Epoch 246/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.0709 - val_loss: 0.1338
Epoch 247/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0715 - val_loss: 0.1179
Epoch 248/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0841 - val_loss: 0.0849
Epoch 249/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0752 - val_loss: 0.1002
Epoch 250/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0718 - val_loss: 0.0987
Epoch 251/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0806 - val_loss: 0.1275
Epoch 252/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0715 - val_loss: 0.1024
Epoch 253/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0856 - val_loss: 0.0891
Epoch 254/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0695 - val_loss: 0.1137
Epoch 255/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0847 - val_loss: 0.0984
Epoch 256/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0743 - val_loss: 0.1175
Epoch 257/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0659 - val_loss: 0.0905
Epoch 258/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0743 - val_loss: 0.0844
Epoch 259/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0631 - val_loss: 0.0866
Epoch 260/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0574 - val_loss: 0.0896
Epoch 261/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0555 - val_loss: 0.1030
Epoch 262/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0591 - val_loss: 0.0924
Epoch 263/500
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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0562 - val_loss: 0.0850
Epoch 264/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0563 - val_loss: 0.0856
Epoch 265/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0548 - val_loss: 0.0849
Epoch 266/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0569 - val_loss: 0.0893
Epoch 267/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0572 - val_loss: 0.0880
Epoch 268/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0750 - val_loss: 0.0991
Epoch 269/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0592 - val_loss: 0.0956
Epoch 270/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0577 - val_loss: 0.0839
Epoch 271/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0519 - val_loss: 0.0848
Epoch 272/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0497 - val_loss: 0.0848
Epoch 273/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0546 - val_loss: 0.0884
Epoch 274/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0564 - val_loss: 0.0875
Epoch 275/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0504 - val_loss: 0.0867
Epoch 276/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0508 - val_loss: 0.1479
Epoch 277/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0816 - val_loss: 0.0886
Epoch 278/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0668 - val_loss: 0.0838
Epoch 279/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0722 - val_loss: 0.0908
Epoch 280/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0611 - val_loss: 0.1087
Epoch 281/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0790 - val_loss: 0.0911
Epoch 282/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0678 - val_loss: 0.1236
Epoch 283/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0726 - val_loss: 0.1323
Epoch 284/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0720 - val_loss: 0.1257
Epoch 285/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0772 - val_loss: 0.0782
Epoch 286/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0669 - val_loss: 0.1052
Epoch 287/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0789 - val_loss: 0.0948
Epoch 288/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0691 - val_loss: 0.0844
Epoch 289/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0567 - val_loss: 0.1192
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Epoch 290/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0617 - val_loss: 0.0951
Epoch 291/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.0665 - val_loss: 0.0725
Epoch 292/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0520 - val_loss: 0.0904
Epoch 293/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0536 - val_loss: 0.0829
Epoch 294/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0490 - val_loss: 0.0827
Epoch 295/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0472 - val_loss: 0.0902
Epoch 296/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0511 - val_loss: 0.0872
Epoch 297/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0479 - val_loss: 0.0753
Epoch 298/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0471 - val_loss: 0.0755
Epoch 299/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0442 - val_loss: 0.0777
Epoch 300/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0613 - val_loss: 0.0824
Epoch 301/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0626 - val_loss: 0.0791
Epoch 302/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0554 - val_loss: 0.0810
Epoch 303/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0649 - val_loss: 0.0812
Epoch 304/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0557 - val_loss: 0.0821
Epoch 305/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0486 - val_loss: 0.0912
Epoch 306/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0543 - val_loss: 0.0806
Epoch 307/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0543 - val_loss: 0.0791
Epoch 308/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0571 - val_loss: 0.0856
Epoch 309/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0480 - val_loss: 0.0843
Epoch 310/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0612 - val_loss: 0.1209
Epoch 311/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0607 - val_loss: 0.1151
Epoch 312/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0641 - val_loss: 0.0843
Epoch 313/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0567 - val_loss: 0.0988
Epoch 314/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0666 - val_loss: 0.0801
Epoch 315/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0724 - val_loss: 0.0896
Epoch 316/500
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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0617 - val_loss: 0.1338
Epoch 317/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.0783 - val_loss: 0.1361
Epoch 318/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0853 - val_loss: 0.1020
Epoch 319/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0833 - val_loss: 0.1216
Epoch 320/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0856 - val_loss: 0.2157
Epoch 321/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1153 - val_loss: 0.0735
Epoch 322/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0875 - val_loss: 0.0943
Epoch 323/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0676 - val_loss: 0.0906
Epoch 324/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0589 - val_loss: 0.0986
Epoch 325/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0578 - val_loss: 0.0773
Epoch 326/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0476 - val_loss: 0.0751
Epoch 327/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0478 - val_loss: 0.1060
Epoch 328/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0514 - val_loss: 0.0872
Epoch 329/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0455 - val_loss: 0.0734
Epoch 330/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0528 - val_loss: 0.0789
Epoch 331/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0456 - val_loss: 0.0835
Epoch 332/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0403 - val_loss: 0.0784
Epoch 333/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0394 - val_loss: 0.0838
Epoch 334/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0476 - val_loss: 0.0818
Epoch 335/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0440 - val_loss: 0.0743
Epoch 336/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0443 - val_loss: 0.0767
Epoch 337/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0420 - val_loss: 0.0832
Epoch 338/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0479 - val_loss: 0.0770
Epoch 339/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0493 - val_loss: 0.0780
Epoch 340/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0501 - val_loss: 0.0775
Epoch 341/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0534 - val_loss: 0.0796
Epoch 342/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0523 - val_loss: 0.0828
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Epoch 343/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0573 - val_loss: 0.0851
Epoch 344/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0504 - val_loss: 0.0975
Epoch 345/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0530 - val_loss: 0.1334
Epoch 346/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0664 - val_loss: 0.0943
Epoch 347/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0626 - val_loss: 0.0797
Epoch 348/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0590 - val_loss: 0.0810
Epoch 349/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0553 - val_loss: 0.0968
Epoch 350/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0680 - val_loss: 0.0793
Epoch 351/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0574 - val_loss: 0.1175
Epoch 352/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0699 - val_loss: 0.1002
Epoch 353/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0631 - val_loss: 0.0691
Epoch 354/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0455 - val_loss: 0.0798
Epoch 355/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0568 - val_loss: 0.0791
Epoch 356/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0467 - val_loss: 0.0822
Epoch 357/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0478 - val_loss: 0.0852
Epoch 358/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0558 - val_loss: 0.2329
Epoch 359/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.1643 - val_loss: 0.1272
Epoch 360/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.1095 - val_loss: 0.0966
Epoch 361/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0887 - val_loss: 0.1265
Epoch 362/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0878 - val_loss: 0.0767
Epoch 363/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0514 - val_loss: 0.0809
Epoch 364/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0426 - val_loss: 0.0851
Epoch 365/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0420 - val_loss: 0.1046
Epoch 366/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0543 - val_loss: 0.0752
Epoch 367/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0409 - val_loss: 0.0846
Epoch 368/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.0400 - val_loss: 0.0854
Epoch 369/500
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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0465 - val_loss: 0.0792
Epoch 370/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0380 - val_loss: 0.0739
Epoch 371/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0406 - val_loss: 0.1145
Epoch 372/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0685 - val_loss: 0.0687
Epoch 373/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0487 - val_loss: 0.0793
Epoch 374/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0410 - val_loss: 0.0886
Epoch 375/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0425 - val_loss: 0.0875
Epoch 376/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0496 - val_loss: 0.0670
Epoch 377/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0407 - val_loss: 0.0844
Epoch 378/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0462 - val_loss: 0.0966
Epoch 379/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0441 - val_loss: 0.0776
Epoch 380/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0442 - val_loss: 0.0698
Epoch 381/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0376 - val_loss: 0.0806
Epoch 382/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0432 - val_loss: 0.0718
Epoch 383/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0423 - val_loss: 0.0870
Epoch 384/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0443 - val_loss: 0.0828
Epoch 385/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0622 - val_loss: 0.0756
Epoch 386/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0403 - val_loss: 0.0877
Epoch 387/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0425 - val_loss: 0.0874
Epoch 388/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0534 - val_loss: 0.0783
Epoch 389/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0469 - val_loss: 0.0784
Epoch 390/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0528 - val_loss: 0.0847
Epoch 391/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0527 - val_loss: 0.1048
Epoch 392/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0532 - val_loss: 0.1728
Epoch 393/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0935 - val_loss: 0.0804
Epoch 394/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0813 - val_loss: 0.0824
Epoch 395/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0569 - val_loss: 0.0753
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Epoch 396/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0739 - val_loss: 0.1312
Epoch 397/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0626 - val_loss: 0.0888
Epoch 398/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0628 - val_loss: 0.0716
Epoch 399/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0385 - val_loss: 0.0694
Epoch 400/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0475 - val_loss: 0.0823
Epoch 401/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0426 - val_loss: 0.1081
Epoch 402/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0579 - val_loss: 0.0663
Epoch 403/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0423 - val_loss: 0.0790
Epoch 404/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0367 - val_loss: 0.1120
Epoch 405/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0623 - val_loss: 0.0860
Epoch 406/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0457 - val_loss: 0.0673
Epoch 407/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0539 - val_loss: 0.1150
Epoch 408/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0546 - val_loss: 0.0796
Epoch 409/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0422 - val_loss: 0.0822
Epoch 410/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0493 - val_loss: 0.0725
Epoch 411/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0375 - val_loss: 0.0905
Epoch 412/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0450 - val_loss: 0.0761
Epoch 413/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0403 - val_loss: 0.0808
Epoch 414/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0384 - val_loss: 0.0729
Epoch 415/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0369 - val_loss: 0.0712
Epoch 416/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.0397 - val_loss: 0.0816
Epoch 417/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0369 - val_loss: 0.0775
Epoch 418/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0363 - val_loss: 0.0780
Epoch 419/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0514 - val_loss: 0.0705
Epoch 420/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0488 - val_loss: 0.0720
Epoch 421/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0404 - val_loss: 0.0735
Epoch 422/500
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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0416 - val_loss: 0.0872
Epoch 423/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0578 - val_loss: 0.0822
Epoch 424/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0389 - val_loss: 0.0836
Epoch 425/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0431 - val_loss: 0.0732
Epoch 426/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0377 - val_loss: 0.0753
Epoch 427/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0367 - val_loss: 0.0693
Epoch 428/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0358 - val_loss: 0.0684
Epoch 429/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0362 - val_loss: 0.0695
Epoch 430/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0367 - val_loss: 0.0746
Epoch 431/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0418 - val_loss: 0.0837
Epoch 432/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0475 - val_loss: 0.0718
Epoch 433/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0339 - val_loss: 0.0740
Epoch 434/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0427 - val_loss: 0.0652
Epoch 435/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0416 - val_loss: 0.0621
Epoch 436/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0323 - val_loss: 0.0697
Epoch 437/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0354 - val_loss: 0.0694
Epoch 438/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0385 - val_loss: 0.0668
Epoch 439/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0391 - val_loss: 0.0719
Epoch 440/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0384 - val_loss: 0.0686
Epoch 441/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0359 - val_loss: 0.0699
Epoch 442/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0420 - val_loss: 0.0770
Epoch 443/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0377 - val_loss: 0.1001
Epoch 444/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0531 - val_loss: 0.1103
Epoch 445/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0547 - val_loss: 0.1378
Epoch 446/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0620 - val_loss: 0.1884
Epoch 447/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0792 - val_loss: 0.1174
Epoch 448/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0643 - val_loss: 0.0915
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Epoch 449/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0530 - val_loss: 0.0679
Epoch 450/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0438 - val_loss: 0.0756
Epoch 451/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0398 - val_loss: 0.0797
Epoch 452/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0512 - val_loss: 0.0745
Epoch 453/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0410 - val_loss: 0.0697
Epoch 454/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0385 - val_loss: 0.0883
Epoch 455/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0438 - val_loss: 0.1095
Epoch 456/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0504 - val_loss: 0.1006
Epoch 457/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 0.0525 - val_loss: 0.0661
Epoch 458/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0375 - val_loss: 0.0658
Epoch 459/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0405 - val_loss: 0.0734
Epoch 460/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0464 - val_loss: 0.0778
Epoch 461/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0431 - val_loss: 0.1107
Epoch 462/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0475 - val_loss: 0.1175
Epoch 463/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0544 - val_loss: 0.1012
Epoch 464/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0554 - val_loss: 0.0760
Epoch 465/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0568 - val_loss: 0.0689
Epoch 466/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0443 - val_loss: 0.0742
Epoch 467/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0443 - val_loss: 0.0727
Epoch 468/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0447 - val_loss: 0.1047
Epoch 469/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0405 - val_loss: 0.1012
Epoch 470/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.0484 - val_loss: 0.0748
Epoch 471/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0456 - val_loss: 0.0916
Epoch 472/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0549 - val_loss: 0.0778
Epoch 473/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0395 - val_loss: 0.0675
Epoch 474/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0425 - val_loss: 0.0854
Epoch 475/500
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22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0391 - val_loss: 0.1319
Epoch 476/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0628 - val_loss: 0.0674
Epoch 477/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0388 - val_loss: 0.0710
Epoch 478/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0378 - val_loss: 0.0663
Epoch 479/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0489 - val_loss: 0.0953
Epoch 480/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0477 - val_loss: 0.0846
Epoch 481/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0406 - val_loss: 0.0901
Epoch 482/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0433 - val_loss: 0.0735
Epoch 483/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0347 - val_loss: 0.0716
Epoch 484/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0318 - val_loss: 0.0820
Epoch 485/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0342 - val_loss: 0.0741
Epoch 486/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0373 - val_loss: 0.0718
Epoch 487/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0399 - val_loss: 0.0740
Epoch 488/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0354 - val_loss: 0.0813
Epoch 489/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0306 - val_loss: 0.0924
Epoch 490/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0360 - val_loss: 0.0839
Epoch 491/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0481 - val_loss: 0.0688
Epoch 492/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0352 - val_loss: 0.0690
Epoch 493/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0392 - val_loss: 0.0826
Epoch 494/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0417 - val_loss: 0.0684
Epoch 495/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0375 - val_loss: 0.0786
Epoch 496/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0462 - val_loss: 0.0732
Epoch 497/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0419 - val_loss: 0.0861
Epoch 498/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0397 - val_loss: 0.0771
Epoch 499/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0418 - val_loss: 0.0802
Epoch 500/500
22/22 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0390 - val_loss: 0.0664
```

In [251…
```
tf.random.set_seed(42)
y_test_pred = ann_model.predict(X_test_processed)
nnmse = mean_squared_error(y_test_processed, y_test_pred, squared=True)

y_test_pred1 = ann_model.predict(X_test_processed).ravel()

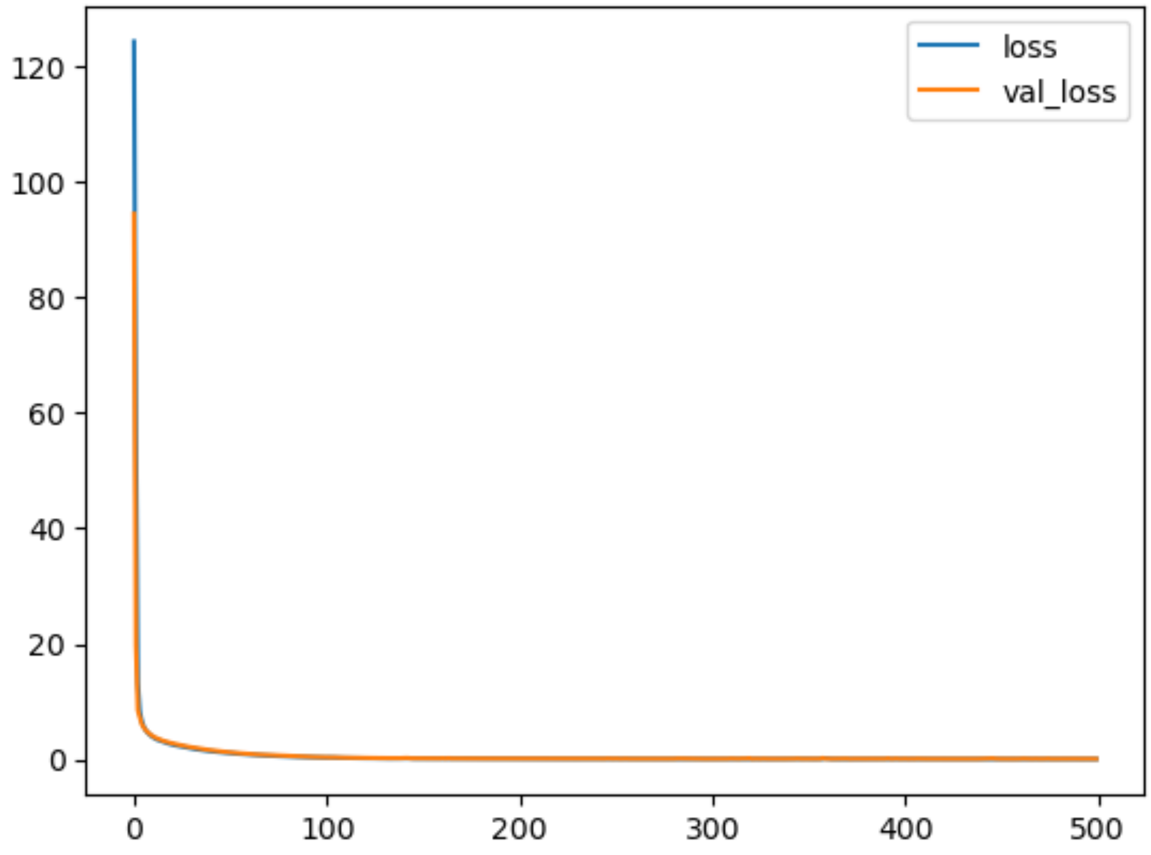

y_test_processed1 = y_test_processed.ravel()

residual_nn_test = y_test_processed1 - y_test_pred1
print("Test MSE (NN):", nnmse)
```

```
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step
Test MSE (NN): 0.06664396783777125
```

In [252…
```
pd.DataFrame(history.history).plot()
```

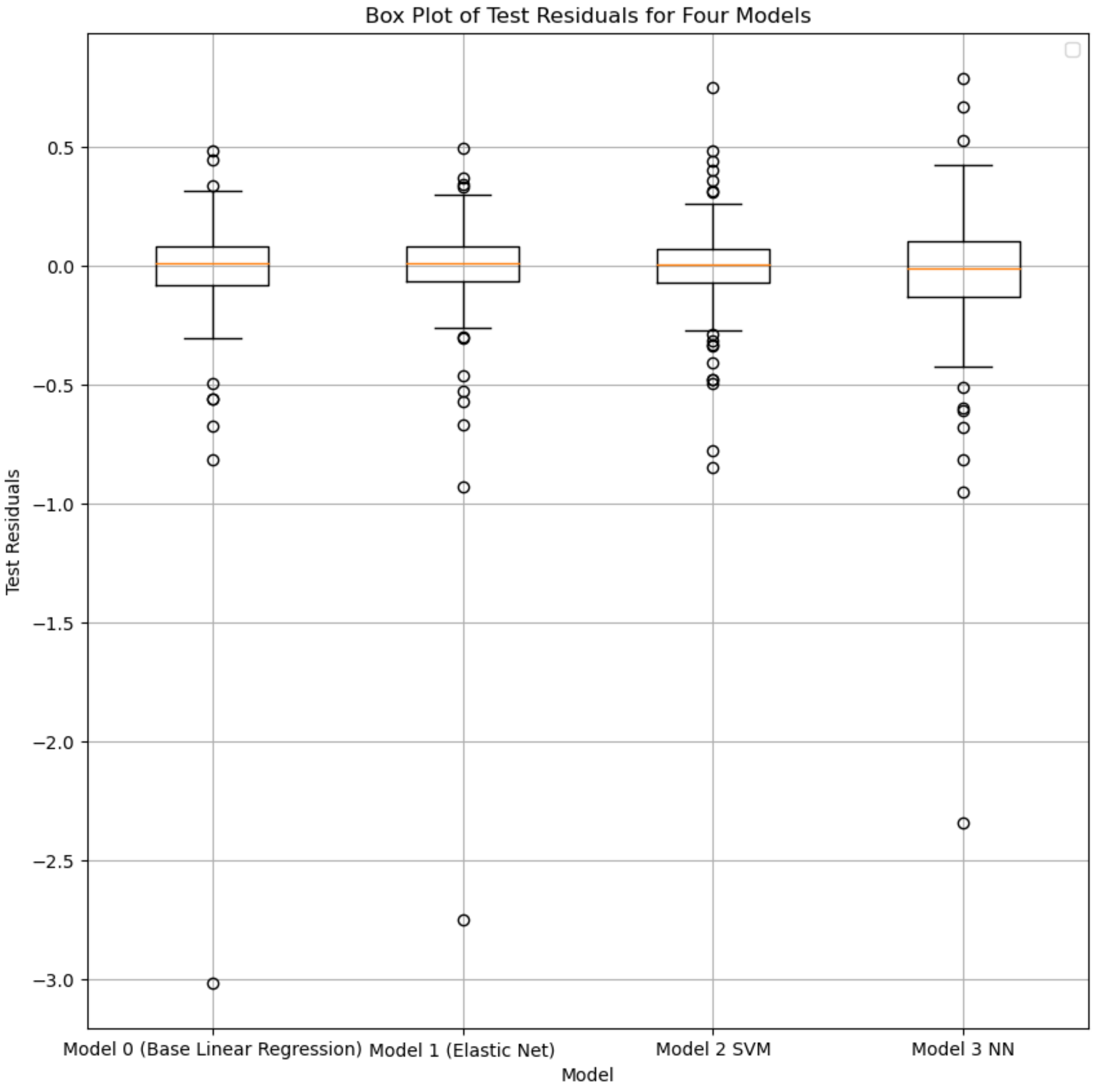
Out[252]:
```
<Axes: >
```



```
In [253…  residuals_data = [residual_model0_test, residual_model1_test, residual_model


          plt.figure(figsize=(10, 10))
          plt.boxplot(residuals_data, labels=['Model 0 (Base Linear Regression)', 'Mod
          plt.xlabel('Model')
          plt.ylabel('Test Residuals')
          plt.title('Box Plot of Test Residuals for Four Models')
          plt.grid(True)
          plt.legend()
          plt.show()
```

```
No artists with labels found to put in legend.  Note that artists whose labe
l start with an underscore are ignored when legend() is called with no argum
ent.
```



Order of best models in prediction accuracy based on residuals and test mse

1. SVM
2. Elastic Net / NN tied (as sometimes NN can have different accruacy each time trained sometimes it is below the test mse of Elastic net but does take around 1 min to compile so Elastic Net is the better option)
3. Base Regression.