MODEL no.4: Regression Model: Predicting house pricing in California

Initialize Notebook

```python
import datetime
print(f"Notebook last run (end-to-end): {datetime.datetime.now()}")
```

```
Notebook last run (end-to-end): 2025-09-12 01:03:04.124393
```

1. Import libraries

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import tensorflow as tf
from sklearn.datasets import fetch_california_housing
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler

print(tf.__version__)
```

```
2.20.0
```

1. Load datasets

```python
cal = fetch_california_housing(as_frame=True)
X = cal.frame.drop(columns=["MedHouseVal"])
y = cal.frame["MedHouseVal"]
```

1. Quick data exploration

```python
print("Dataset shape:", X.shape)
print("Feature names:", list(X.columns))
print("Target (y) summary:\n", y.describe())
```

```
Dataset shape: (20640, 8)
Feature names: ['MedInc', 'HouseAge', 'AveRooms', 'AveBedrms',
'Population', 'AveOccup', 'Latitude', 'Longitude']
Target (y) summary:
 count    20640.000000
mean         2.068558
std          1.153956
min          0.149990
25%          1.196000
50%          1.797000
75%          2.647250
max          5.000010
Name: MedHouseVal, dtype: float64
```

1. Train, Validation, Test Splitting (using split() and shape() to display)

```
X_train_full, X_test, y_train_full, y_test = train_test_split(X, y,
test_size=0.15, random_state=42)
X_train, X_val, y_train, y_val = train_test_split(X_train_full,
y_train_full, test_size=0.15, random_state=42)
print("Train / Val / Test shapes:", X_train.shape, X_val.shape,
X_test.shape)

Train / Val / Test shapes: (14912, 8) (2632, 8) (3096, 8)
```

4.1 Preprocessing

```
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_val_scaled   = scaler.transform(X_val)
X_test_scaled  = scaler.transform(X_test)
```

1. Building the model

```
tf.random.set_seed(42)

inputs = tf.keras.Input(shape=(X_train_scaled.shape[1],),
name="features")

x = tf.keras.layers.Dense(128, activation='relu')(inputs)
x = tf.keras.layers.BatchNormalization()(x)
x = tf.keras.layers.Dropout(0.2)(x)
x = tf.keras.layers.Dense(64, activation='relu')(x)
x = tf.keras.layers.BatchNormalization()(x)
x = tf.keras.layers.Dropout(0.15)(x)
x = tf.keras.layers.Dense(32, activation='relu')(x)

outputs = tf.keras.layers.Dense(1, activation='linear',
name='prediction')(x)  # regression output
model = tf.keras.Model(inputs=inputs, outputs=outputs,
name="california_housing_model")
```
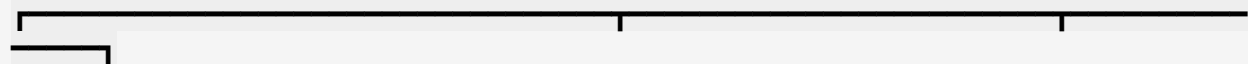
1. Compile the model

```
model.compile(
    optimizer=tf.keras.optimizers.Adam(learning_rate=1e-3),
    loss='mse',
    metrics=[tf.keras.metrics.MeanAbsoluteError(name='mae')]
)

model.summary()

Model: "california_housing_model"
```

Layer (type)	Output Shape	Param #
features (InputLayer)	(None, 8)	0
dense_3 (Dense)	(None, 128)	1,152
batch_normalization_2 (BatchNormalization)	(None, 128)	512
dropout_2 (Dropout)	(None, 128)	0
dense_4 (Dense)	(None, 64)	8,256
batch_normalization_3 (BatchNormalization)	(None, 64)	256
dropout_3 (Dropout)	(None, 64)	0
dense_5 (Dense)	(None, 32)	2,080
prediction (Dense)	(None, 1)	33

Total params: 12,289 (48.00 KB)

Trainable params: 11,905 (46.50 KB)

Non-trainable params: 384 (1.50 KB)

1. Training the model

```
history = model.fit(
    X_train_scaled, y_train,
    validation_data=(X_val_scaled, y_val),
    epochs=300,
    batch_size=32,
    verbose=1
)
```

```
Epoch 1/300
466/466 ─────────────────── 1s 839us/step - loss: 0.7911 - mae:
0.6554 - val_loss: 0.5662 - val_mae: 0.5230
Epoch 2/300
466/466 ─────────────────── 0s 625us/step - loss: 0.5262 - mae:
0.5325 - val_loss: 0.4213 - val_mae: 0.4511
Epoch 3/300
466/466 ─────────────────── 0s 625us/step - loss: 0.4645 - mae:
0.4965 - val_loss: 0.3788 - val_mae: 0.4314
Epoch 4/300
466/466 ─────────────────── 0s 624us/step - loss: 0.4374 - mae:
0.4778 - val_loss: 0.3599 - val_mae: 0.4211
Epoch 5/300
466/466 ─────────────────── 0s 628us/step - loss: 0.4172 - mae:
0.4662 - val_loss: 0.3592 - val_mae: 0.4192
Epoch 6/300
466/466 ─────────────────── 0s 624us/step - loss: 0.3979 - mae:
0.4519 - val_loss: 0.3447 - val_mae: 0.4143
Epoch 7/300
466/466 ─────────────────── 0s 632us/step - loss: 0.3829 - mae:
0.4467 - val_loss: 0.3393 - val_mae: 0.4032
Epoch 8/300
466/466 ─────────────────── 0s 625us/step - loss: 0.3738 - mae:
0.4375 - val_loss: 0.3323 - val_mae: 0.3982
Epoch 9/300
466/466 ─────────────────── 0s 624us/step - loss: 0.3661 - mae:
0.4331 - val_loss: 0.3297 - val_mae: 0.4030
Epoch 10/300
466/466 ─────────────────── 0s 626us/step - loss: 0.3586 - mae:
0.4272 - val_loss: 0.3390 - val_mae: 0.4127
Epoch 11/300
466/466 ─────────────────── 0s 657us/step - loss: 0.3530 - mae:
0.4232 - val_loss: 0.3315 - val_mae: 0.4026
Epoch 12/300
466/466 ─────────────────── 0s 642us/step - loss: 0.3507 - mae:
0.4206 - val_loss: 0.3240 - val_mae: 0.3955
Epoch 13/300
466/466 ─────────────────── 0s 628us/step - loss: 0.3417 - mae:
0.4155 - val_loss: 0.3188 - val_mae: 0.3927
Epoch 14/300
```

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466/466 ──────────────── 0s 650us/step - loss: 0.3394 - mae:
0.4130 - val_loss: 0.3164 - val_mae: 0.3912
Epoch 15/300
466/466 ──────────────── 0s 776us/step - loss: 0.3336 - mae:
0.4098 - val_loss: 0.3067 - val_mae: 0.3906
Epoch 16/300
466/466 ──────────────── 0s 648us/step - loss: 0.3341 - mae:
0.4079 - val_loss: 0.3110 - val_mae: 0.3870
Epoch 17/300
466/466 ──────────────── 0s 640us/step - loss: 0.3291 - mae:
0.4059 - val_loss: 0.3066 - val_mae: 0.3903
Epoch 18/300
466/466 ──────────────── 0s 633us/step - loss: 0.3234 - mae:
0.3999 - val_loss: 0.3176 - val_mae: 0.3872
Epoch 19/300
466/466 ──────────────── 0s 647us/step - loss: 0.3178 - mae:
0.3981 - val_loss: 0.3094 - val_mae: 0.3823
Epoch 20/300
466/466 ──────────────── 0s 624us/step - loss: 0.3232 - mae:
0.4003 - val_loss: 0.3073 - val_mae: 0.3915
Epoch 21/300
466/466 ──────────────── 0s 624us/step - loss: 0.3150 - mae:
0.3968 - val_loss: 0.3130 - val_mae: 0.3891
Epoch 22/300
466/466 ──────────────── 0s 650us/step - loss: 0.3143 - mae:
0.3960 - val_loss: 0.3111 - val_mae: 0.3911
Epoch 23/300
466/466 ──────────────── 0s 645us/step - loss: 0.3100 - mae:
0.3931 - val_loss: 0.3056 - val_mae: 0.3885
Epoch 24/300
466/466 ──────────────── 0s 640us/step - loss: 0.3051 - mae:
0.3886 - val_loss: 0.3082 - val_mae: 0.3894
Epoch 25/300
466/466 ──────────────── 0s 625us/step - loss: 0.3065 - mae:
0.3893 - val_loss: 0.3109 - val_mae: 0.3976
Epoch 26/300
466/466 ──────────────── 0s 652us/step - loss: 0.3055 - mae:
0.3896 - val_loss: 0.2981 - val_mae: 0.3802
Epoch 27/300
466/466 ──────────────── 0s 640us/step - loss: 0.3009 - mae:
0.3867 - val_loss: 0.2984 - val_mae: 0.3778
Epoch 28/300
466/466 ──────────────── 0s 644us/step - loss: 0.2990 - mae:
0.3844 - val_loss: 0.2990 - val_mae: 0.3822
Epoch 29/300
466/466 ──────────────── 0s 791us/step - loss: 0.2990 - mae:
0.3838 - val_loss: 0.3076 - val_mae: 0.3898
Epoch 30/300
466/466 ──────────────── 0s 662us/step - loss: 0.2973 - mae:
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0.3844 - val_loss: 0.2985 - val_mae: 0.3769
Epoch 31/300
466/466 ──────────────────── 0s 647us/step - loss: 0.2958 - mae:
0.3823 - val_loss: 0.3155 - val_mae: 0.3933
Epoch 32/300
466/466 ──────────────────── 0s 669us/step - loss: 0.2957 - mae:
0.3823 - val_loss: 0.2972 - val_mae: 0.3733
Epoch 33/300
466/466 ──────────────────── 0s 659us/step - loss: 0.2929 - mae:
0.3809 - val_loss: 0.3041 - val_mae: 0.3746
Epoch 34/300
466/466 ──────────────────── 0s 678us/step - loss: 0.2867 - mae:
0.3781 - val_loss: 0.3009 - val_mae: 0.3838
Epoch 35/300
466/466 ──────────────────── 0s 673us/step - loss: 0.2910 - mae:
0.3794 - val_loss: 0.3085 - val_mae: 0.3780
Epoch 36/300
466/466 ──────────────────── 0s 637us/step - loss: 0.2893 - mae:
0.3776 - val_loss: 0.2962 - val_mae: 0.3775
Epoch 37/300
466/466 ──────────────────── 0s 677us/step - loss: 0.2857 - mae:
0.3768 - val_loss: 0.2884 - val_mae: 0.3678
Epoch 38/300
466/466 ──────────────────── 0s 662us/step - loss: 0.2863 - mae:
0.3778 - val_loss: 0.3046 - val_mae: 0.3802
Epoch 39/300
466/466 ──────────────────── 0s 796us/step - loss: 0.2850 - mae:
0.3753 - val_loss: 0.3107 - val_mae: 0.3846
Epoch 40/300
466/466 ──────────────────── 0s 655us/step - loss: 0.2774 - mae:
0.3707 - val_loss: 0.3021 - val_mae: 0.3783
Epoch 41/300
466/466 ──────────────────── 0s 646us/step - loss: 0.2783 - mae:
0.3710 - val_loss: 0.3012 - val_mae: 0.3739
Epoch 42/300
466/466 ──────────────────── 0s 641us/step - loss: 0.2768 - mae:
0.3717 - val_loss: 0.3121 - val_mae: 0.3895
Epoch 43/300
466/466 ──────────────────── 0s 652us/step - loss: 0.2781 - mae:
0.3707 - val_loss: 0.3014 - val_mae: 0.3764
Epoch 44/300
466/466 ──────────────────── 0s 646us/step - loss: 0.2764 - mae:
0.3693 - val_loss: 0.2914 - val_mae: 0.3802
Epoch 45/300
466/466 ──────────────────── 0s 657us/step - loss: 0.2745 - mae:
0.3681 - val_loss: 0.2944 - val_mae: 0.3794
Epoch 46/300
466/466 ──────────────────── 0s 678us/step - loss: 0.2750 - mae:
0.3695 - val_loss: 0.2937 - val_mae: 0.3771
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Epoch 47/300
466/466 ──────────────── 0s 663us/step - loss: 0.2753 - mae:
0.3692 - val_loss: 0.2969 - val_mae: 0.3836
Epoch 48/300
466/466 ──────────────── 0s 807us/step - loss: 0.2707 - mae:
0.3657 - val_loss: 0.3111 - val_mae: 0.3865
Epoch 49/300
466/466 ──────────────── 0s 666us/step - loss: 0.2711 - mae:
0.3671 - val_loss: 0.2961 - val_mae: 0.3760
Epoch 50/300
466/466 ──────────────── 0s 662us/step - loss: 0.2705 - mae:
0.3671 - val_loss: 0.2961 - val_mae: 0.3819
Epoch 51/300
466/466 ──────────────── 0s 675us/step - loss: 0.2706 - mae:
0.3655 - val_loss: 0.3089 - val_mae: 0.3792
Epoch 52/300
466/466 ──────────────── 0s 653us/step - loss: 0.2721 - mae:
0.3660 - val_loss: 0.3164 - val_mae: 0.3911
Epoch 53/300
466/466 ──────────────── 0s 659us/step - loss: 0.2646 - mae:
0.3620 - val_loss: 0.2965 - val_mae: 0.3746
Epoch 54/300
466/466 ──────────────── 0s 643us/step - loss: 0.2665 - mae:
0.3648 - val_loss: 0.3156 - val_mae: 0.3908
Epoch 55/300
466/466 ──────────────── 0s 647us/step - loss: 0.2697 - mae:
0.3665 - val_loss: 0.3170 - val_mae: 0.3913
Epoch 56/300
466/466 ──────────────── 0s 649us/step - loss: 0.2649 - mae:
0.3631 - val_loss: 0.3036 - val_mae: 0.3784
Epoch 57/300
466/466 ──────────────── 0s 756us/step - loss: 0.2664 - mae:
0.3638 - val_loss: 0.3108 - val_mae: 0.3879
Epoch 58/300
466/466 ──────────────── 0s 639us/step - loss: 0.2641 - mae:
0.3631 - val_loss: 0.2920 - val_mae: 0.3809
Epoch 59/300
466/466 ──────────────── 0s 631us/step - loss: 0.2651 - mae:
0.3637 - val_loss: 0.2970 - val_mae: 0.3801
Epoch 60/300
466/466 ──────────────── 0s 632us/step - loss: 0.2576 - mae:
0.3567 - val_loss: 0.2927 - val_mae: 0.3723
Epoch 61/300
466/466 ──────────────── 0s 670us/step - loss: 0.2610 - mae:
0.3604 - val_loss: 0.2859 - val_mae: 0.3707
Epoch 62/300
466/466 ──────────────── 0s 653us/step - loss: 0.2600 - mae:
0.3581 - val_loss: 0.2901 - val_mae: 0.3798
Epoch 63/300
```

```
466/466 ──────────────── 0s 654us/step - loss: 0.2623 - mae:
0.3620 - val_loss: 0.2941 - val_mae: 0.3804
Epoch 64/300
466/466 ──────────────── 0s 656us/step - loss: 0.2614 - mae:
0.3602 - val_loss: 0.2940 - val_mae: 0.3765
Epoch 65/300
466/466 ──────────────── 0s 639us/step - loss: 0.2581 - mae:
0.3586 - val_loss: 0.3034 - val_mae: 0.3817
Epoch 66/300
466/466 ──────────────── 0s 640us/step - loss: 0.2553 - mae:
0.3546 - val_loss: 0.2966 - val_mae: 0.3811
Epoch 67/300
466/466 ──────────────── 0s 637us/step - loss: 0.2582 - mae:
0.3574 - val_loss: 0.3013 - val_mae: 0.3770
Epoch 68/300
466/466 ──────────────── 0s 648us/step - loss: 0.2576 - mae:
0.3588 - val_loss: 0.2990 - val_mae: 0.3783
Epoch 69/300
466/466 ──────────────── 0s 643us/step - loss: 0.2547 - mae:
0.3555 - val_loss: 0.2952 - val_mae: 0.3757
Epoch 70/300
466/466 ──────────────── 0s 633us/step - loss: 0.2583 - mae:
0.3578 - val_loss: 0.2975 - val_mae: 0.3785
Epoch 71/300
466/466 ──────────────── 0s 649us/step - loss: 0.2561 - mae:
0.3562 - val_loss: 0.3084 - val_mae: 0.3804
Epoch 72/300
466/466 ──────────────── 0s 637us/step - loss: 0.2554 - mae:
0.3551 - val_loss: 0.3028 - val_mae: 0.3807
Epoch 73/300
466/466 ──────────────── 0s 764us/step - loss: 0.2554 - mae:
0.3566 - val_loss: 0.2918 - val_mae: 0.3761
Epoch 74/300
466/466 ──────────────── 0s 663us/step - loss: 0.2531 - mae:
0.3538 - val_loss: 0.2840 - val_mae: 0.3690
Epoch 75/300
466/466 ──────────────── 0s 678us/step - loss: 0.2530 - mae:
0.3558 - val_loss: 0.2919 - val_mae: 0.3808
Epoch 76/300
466/466 ──────────────── 0s 669us/step - loss: 0.2499 - mae:
0.3523 - val_loss: 0.2974 - val_mae: 0.3791
Epoch 77/300
466/466 ──────────────── 0s 689us/step - loss: 0.2507 - mae:
0.3526 - val_loss: 0.3116 - val_mae: 0.3880
Epoch 78/300
466/466 ──────────────── 0s 683us/step - loss: 0.2539 - mae:
0.3549 - val_loss: 0.2997 - val_mae: 0.3821
Epoch 79/300
466/466 ──────────────── 0s 793us/step - loss: 0.2479 - mae:
```

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0.3502 - val_loss: 0.3001 - val_mae: 0.3825
Epoch 80/300
466/466 ───────────────────── 0s 647us/step - loss: 0.2525 - mae:
0.3549 - val_loss: 0.3073 - val_mae: 0.3831
Epoch 81/300
466/466 ───────────────────── 0s 637us/step - loss: 0.2505 - mae:
0.3538 - val_loss: 0.2990 - val_mae: 0.3767
Epoch 82/300
466/466 ───────────────────── 0s 644us/step - loss: 0.2521 - mae:
0.3536 - val_loss: 0.3113 - val_mae: 0.3809
Epoch 83/300
466/466 ───────────────────── 0s 643us/step - loss: 0.2466 - mae:
0.3500 - val_loss: 0.2906 - val_mae: 0.3716
Epoch 84/300
466/466 ───────────────────── 0s 680us/step - loss: 0.2472 - mae:
0.3510 - val_loss: 0.3121 - val_mae: 0.3893
Epoch 85/300
466/466 ───────────────────── 0s 672us/step - loss: 0.2491 - mae:
0.3521 - val_loss: 0.3053 - val_mae: 0.3916
Epoch 86/300
466/466 ───────────────────── 0s 813us/step - loss: 0.2474 - mae:
0.3501 - val_loss: 0.3004 - val_mae: 0.3891
Epoch 87/300
466/466 ───────────────────── 0s 677us/step - loss: 0.2505 - mae:
0.3536 - val_loss: 0.3071 - val_mae: 0.3854
Epoch 88/300
466/466 ───────────────────── 0s 680us/step - loss: 0.2441 - mae:
0.3498 - val_loss: 0.3005 - val_mae: 0.3815
Epoch 89/300
466/466 ───────────────────── 0s 677us/step - loss: 0.2474 - mae:
0.3502 - val_loss: 0.3010 - val_mae: 0.3826
Epoch 90/300
466/466 ───────────────────── 0s 640us/step - loss: 0.2472 - mae:
0.3504 - val_loss: 0.3031 - val_mae: 0.3887
Epoch 91/300
466/466 ───────────────────── 0s 644us/step - loss: 0.2433 - mae:
0.3495 - val_loss: 0.3048 - val_mae: 0.3965
Epoch 92/300
466/466 ───────────────────── 0s 636us/step - loss: 0.2440 - mae:
0.3482 - val_loss: 0.3065 - val_mae: 0.3869
Epoch 93/300
466/466 ───────────────────── 0s 633us/step - loss: 0.2471 - mae:
0.3506 - val_loss: 0.3112 - val_mae: 0.3861
Epoch 94/300
466/466 ───────────────────── 0s 745us/step - loss: 0.2489 - mae:
0.3519 - val_loss: 0.3001 - val_mae: 0.3819
Epoch 95/300
466/466 ───────────────────── 0s 700us/step - loss: 0.2396 - mae:
0.3469 - val_loss: 0.3069 - val_mae: 0.3867
```

```
Epoch 96/300
466/466 ──────────────── 0s 652us/step - loss: 0.2401 - mae:
0.3473 - val_loss: 0.2992 - val_mae: 0.3822
Epoch 97/300
466/466 ──────────────── 0s 668us/step - loss: 0.2402 - mae:
0.3476 - val_loss: 0.3199 - val_mae: 0.3878
Epoch 98/300
466/466 ──────────────── 0s 651us/step - loss: 0.2431 - mae:
0.3489 - val_loss: 0.3115 - val_mae: 0.3854
Epoch 99/300
466/466 ──────────────── 0s 666us/step - loss: 0.2426 - mae:
0.3482 - val_loss: 0.3083 - val_mae: 0.3904
Epoch 100/300
466/466 ──────────────── 0s 648us/step - loss: 0.2440 - mae:
0.3498 - val_loss: 0.3160 - val_mae: 0.3907
Epoch 101/300
466/466 ──────────────── 0s 660us/step - loss: 0.2427 - mae:
0.3477 - val_loss: 0.3138 - val_mae: 0.3882
Epoch 102/300
466/466 ──────────────── 0s 654us/step - loss: 0.2410 - mae:
0.3457 - val_loss: 0.3107 - val_mae: 0.3837
Epoch 103/300
466/466 ──────────────── 0s 780us/step - loss: 0.2385 - mae:
0.3462 - val_loss: 0.3084 - val_mae: 0.3847
Epoch 104/300
466/466 ──────────────── 0s 667us/step - loss: 0.2396 - mae:
0.3457 - val_loss: 0.3149 - val_mae: 0.3883
Epoch 105/300
466/466 ──────────────── 0s 669us/step - loss: 0.2416 - mae:
0.3467 - val_loss: 0.3273 - val_mae: 0.3930
Epoch 106/300
466/466 ──────────────── 0s 685us/step - loss: 0.2381 - mae:
0.3445 - val_loss: 0.3448 - val_mae: 0.4001
Epoch 107/300
466/466 ──────────────── 0s 800us/step - loss: 0.2392 - mae:
0.3457 - val_loss: 0.3152 - val_mae: 0.3886
Epoch 108/300
466/466 ──────────────── 0s 672us/step - loss: 0.2382 - mae:
0.3451 - val_loss: 0.3319 - val_mae: 0.3970
Epoch 109/300
466/466 ──────────────── 0s 684us/step - loss: 0.2382 - mae:
0.3455 - val_loss: 0.3428 - val_mae: 0.4028
Epoch 110/300
466/466 ──────────────── 0s 697us/step - loss: 0.2367 - mae:
0.3448 - val_loss: 0.3211 - val_mae: 0.3914
Epoch 111/300
466/466 ──────────────── 0s 641us/step - loss: 0.2394 - mae:
0.3457 - val_loss: 0.3133 - val_mae: 0.3844
Epoch 112/300
```

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466/466 ──────────────── 0s 641us/step - loss: 0.2358 - mae:
0.3448 - val_loss: 0.3266 - val_mae: 0.3943
Epoch 113/300
466/466 ──────────────── 0s 806us/step - loss: 0.2316 - mae:
0.3416 - val_loss: 0.3156 - val_mae: 0.3912
Epoch 114/300
466/466 ──────────────── 0s 674us/step - loss: 0.2386 - mae:
0.3454 - val_loss: 0.3253 - val_mae: 0.3909
Epoch 115/300
466/466 ──────────────── 0s 665us/step - loss: 0.2391 - mae:
0.3464 - val_loss: 0.3247 - val_mae: 0.3884
Epoch 116/300
466/466 ──────────────── 0s 660us/step - loss: 0.2331 - mae:
0.3422 - val_loss: 0.3284 - val_mae: 0.3934
Epoch 117/300
466/466 ──────────────── 0s 786us/step - loss: 0.2398 - mae:
0.3455 - val_loss: 0.3329 - val_mae: 0.3921
Epoch 118/300
466/466 ──────────────── 0s 684us/step - loss: 0.2399 - mae:
0.3472 - val_loss: 0.3278 - val_mae: 0.3942
Epoch 119/300
466/466 ──────────────── 0s 673us/step - loss: 0.2350 - mae:
0.3438 - val_loss: 0.3426 - val_mae: 0.3995
Epoch 120/300
466/466 ──────────────── 0s 675us/step - loss: 0.2348 - mae:
0.3423 - val_loss: 0.3302 - val_mae: 0.4014
Epoch 121/300
466/466 ──────────────── 0s 658us/step - loss: 0.2349 - mae:
0.3419 - val_loss: 0.3258 - val_mae: 0.3965
Epoch 122/300
466/466 ──────────────── 0s 792us/step - loss: 0.2352 - mae:
0.3420 - val_loss: 0.3419 - val_mae: 0.4029
Epoch 123/300
466/466 ──────────────── 0s 667us/step - loss: 0.2339 - mae:
0.3433 - val_loss: 0.3488 - val_mae: 0.4082
Epoch 124/300
466/466 ──────────────── 0s 688us/step - loss: 0.2340 - mae:
0.3433 - val_loss: 0.3420 - val_mae: 0.4055
Epoch 125/300
466/466 ──────────────── 0s 676us/step - loss: 0.2329 - mae:
0.3432 - val_loss: 0.3441 - val_mae: 0.4116
Epoch 126/300
466/466 ──────────────── 0s 824us/step - loss: 0.2325 - mae:
0.3419 - val_loss: 0.3582 - val_mae: 0.4131
Epoch 127/300
466/466 ──────────────── 0s 659us/step - loss: 0.2362 - mae:
0.3447 - val_loss: 0.3475 - val_mae: 0.4131
Epoch 128/300
466/466 ──────────────── 0s 681us/step - loss: 0.2284 - mae:
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0.3392 - val_loss: 0.3434 - val_mae: 0.4042
Epoch 129/300
466/466 ──────────────── 0s 674us/step - loss: 0.2349 - mae:
0.3437 - val_loss: 0.3560 - val_mae: 0.4102
Epoch 130/300
466/466 ──────────────── 0s 788us/step - loss: 0.2308 - mae:
0.3415 - val_loss: 0.3225 - val_mae: 0.3952
Epoch 131/300
466/466 ──────────────── 0s 668us/step - loss: 0.2327 - mae:
0.3410 - val_loss: 0.3366 - val_mae: 0.4030
Epoch 132/300
466/466 ──────────────── 0s 670us/step - loss: 0.2307 - mae:
0.3409 - val_loss: 0.3138 - val_mae: 0.3898
Epoch 133/300
466/466 ──────────────── 0s 661us/step - loss: 0.2319 - mae:
0.3405 - val_loss: 0.3316 - val_mae: 0.4010
Epoch 134/300
466/466 ──────────────── 0s 799us/step - loss: 0.2319 - mae:
0.3409 - val_loss: 0.3387 - val_mae: 0.4003
Epoch 135/300
466/466 ──────────────── 0s 666us/step - loss: 0.2302 - mae:
0.3402 - val_loss: 0.3316 - val_mae: 0.3961
Epoch 136/300
466/466 ──────────────── 0s 671us/step - loss: 0.2284 - mae:
0.3394 - val_loss: 0.3463 - val_mae: 0.4084
Epoch 137/300
466/466 ──────────────── 0s 660us/step - loss: 0.2278 - mae:
0.3394 - val_loss: 0.3392 - val_mae: 0.4021
Epoch 138/300
466/466 ──────────────── 0s 657us/step - loss: 0.2288 - mae:
0.3398 - val_loss: 0.3529 - val_mae: 0.4137
Epoch 139/300
466/466 ──────────────── 0s 798us/step - loss: 0.2294 - mae:
0.3388 - val_loss: 0.3406 - val_mae: 0.4067
Epoch 140/300
466/466 ──────────────── 0s 669us/step - loss: 0.2324 - mae:
0.3407 - val_loss: 0.3557 - val_mae: 0.4160
Epoch 141/300
466/466 ──────────────── 0s 674us/step - loss: 0.2269 - mae:
0.3382 - val_loss: 0.3385 - val_mae: 0.4053
Epoch 142/300
466/466 ──────────────── 0s 653us/step - loss: 0.2295 - mae:
0.3390 - val_loss: 0.3476 - val_mae: 0.4085
Epoch 143/300
466/466 ──────────────── 0s 795us/step - loss: 0.2287 - mae:
0.3396 - val_loss: 0.3535 - val_mae: 0.4131
Epoch 144/300
466/466 ──────────────── 0s 663us/step - loss: 0.2252 - mae:
0.3376 - val_loss: 0.3675 - val_mae: 0.4167
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Epoch 145/300
466/466 ──────────────── 0s 667us/step - loss: 0.2300 - mae:
0.3396 - val_loss: 0.3580 - val_mae: 0.4096
Epoch 146/300
466/466 ──────────────── 0s 658us/step - loss: 0.2269 - mae:
0.3378 - val_loss: 0.3526 - val_mae: 0.4074
Epoch 147/300
466/466 ──────────────── 0s 790us/step - loss: 0.2288 - mae:
0.3392 - val_loss: 0.3650 - val_mae: 0.4141
Epoch 148/300
466/466 ──────────────── 0s 664us/step - loss: 0.2274 - mae:
0.3378 - val_loss: 0.3186 - val_mae: 0.3957
Epoch 149/300
466/466 ──────────────── 0s 670us/step - loss: 0.2267 - mae:
0.3377 - val_loss: 0.3353 - val_mae: 0.4033
Epoch 150/300
466/466 ──────────────── 0s 659us/step - loss: 0.2275 - mae:
0.3372 - val_loss: 0.3567 - val_mae: 0.4142
Epoch 151/300
466/466 ──────────────── 0s 781us/step - loss: 0.2254 - mae:
0.3376 - val_loss: 0.3306 - val_mae: 0.3966
Epoch 152/300
466/466 ──────────────── 0s 657us/step - loss: 0.2262 - mae:
0.3390 - val_loss: 0.3485 - val_mae: 0.4036
Epoch 153/300
466/466 ──────────────── 0s 673us/step - loss: 0.2248 - mae:
0.3373 - val_loss: 0.3626 - val_mae: 0.4101
Epoch 154/300
466/466 ──────────────── 0s 665us/step - loss: 0.2266 - mae:
0.3383 - val_loss: 0.3441 - val_mae: 0.4066
Epoch 155/300
466/466 ──────────────── 0s 805us/step - loss: 0.2269 - mae:
0.3386 - val_loss: 0.3508 - val_mae: 0.4134
Epoch 156/300
466/466 ──────────────── 0s 684us/step - loss: 0.2220 - mae:
0.3349 - val_loss: 0.3391 - val_mae: 0.4064
Epoch 157/300
466/466 ──────────────── 0s 649us/step - loss: 0.2214 - mae:
0.3342 - val_loss: 0.3396 - val_mae: 0.4081
Epoch 158/300
466/466 ──────────────── 0s 639us/step - loss: 0.2218 - mae:
0.3368 - val_loss: 0.3495 - val_mae: 0.4118
Epoch 159/300
466/466 ──────────────── 0s 649us/step - loss: 0.2222 - mae:
0.3358 - val_loss: 0.3562 - val_mae: 0.4165
Epoch 160/300
466/466 ──────────────── 0s 804us/step - loss: 0.2258 - mae:
0.3379 - val_loss: 0.3609 - val_mae: 0.4178
Epoch 161/300
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466/466 ───────────────── 0s 658us/step - loss: 0.2246 - mae:
0.3367 - val_loss: 0.3578 - val_mae: 0.4093
Epoch 162/300
466/466 ───────────────── 0s 645us/step - loss: 0.2231 - mae:
0.3369 - val_loss: 0.3548 - val_mae: 0.4116
Epoch 163/300
466/466 ───────────────── 0s 643us/step - loss: 0.2233 - mae:
0.3356 - val_loss: 0.3447 - val_mae: 0.4047
Epoch 164/300
466/466 ───────────────── 0s 679us/step - loss: 0.2207 - mae:
0.3352 - val_loss: 0.3460 - val_mae: 0.4086
Epoch 165/300
466/466 ───────────────── 0s 796us/step - loss: 0.2196 - mae:
0.3335 - val_loss: 0.3678 - val_mae: 0.4179
Epoch 166/300
466/466 ───────────────── 0s 713us/step - loss: 0.2222 - mae:
0.3347 - val_loss: 0.3408 - val_mae: 0.4091
Epoch 167/300
466/466 ───────────────── 0s 680us/step - loss: 0.2266 - mae:
0.3371 - val_loss: 0.3589 - val_mae: 0.4157
Epoch 168/300
466/466 ───────────────── 0s 791us/step - loss: 0.2215 - mae:
0.3355 - val_loss: 0.3417 - val_mae: 0.4155
Epoch 169/300
466/466 ───────────────── 0s 660us/step - loss: 0.2225 - mae:
0.3359 - val_loss: 0.3455 - val_mae: 0.4105
Epoch 170/300
466/466 ───────────────── 0s 717us/step - loss: 0.2254 - mae:
0.3375 - val_loss: 0.3450 - val_mae: 0.4113
Epoch 171/300
466/466 ───────────────── 0s 836us/step - loss: 0.2211 - mae:
0.3347 - val_loss: 0.3637 - val_mae: 0.4232
Epoch 172/300
466/466 ───────────────── 0s 665us/step - loss: 0.2198 - mae:
0.3343 - val_loss: 0.3449 - val_mae: 0.4096
Epoch 173/300
466/466 ───────────────── 0s 666us/step - loss: 0.2231 - mae:
0.3350 - val_loss: 0.3571 - val_mae: 0.4153
Epoch 174/300
466/466 ───────────────── 0s 781us/step - loss: 0.2200 - mae:
0.3335 - val_loss: 0.3414 - val_mae: 0.4087
Epoch 175/300
466/466 ───────────────── 0s 659us/step - loss: 0.2223 - mae:
0.3361 - val_loss: 0.3453 - val_mae: 0.4063
Epoch 176/300
466/466 ───────────────── 0s 657us/step - loss: 0.2201 - mae:
0.3343 - val_loss: 0.3555 - val_mae: 0.4219
Epoch 177/300
466/466 ───────────────── 0s 652us/step - loss: 0.2205 - mae:
0.3338 - val_loss: 0.3765 - val_mae: 0.4261
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Epoch 178/300
466/466 ──────────────── 0s 781us/step - loss: 0.2240 - mae:
0.3364 - val_loss: 0.3588 - val_mae: 0.4144
Epoch 179/300
466/466 ──────────────── 0s 675us/step - loss: 0.2195 - mae:
0.3336 - val_loss: 0.3555 - val_mae: 0.4087
Epoch 180/300
466/466 ──────────────── 0s 680us/step - loss: 0.2207 - mae:
0.3351 - val_loss: 0.3640 - val_mae: 0.4177
Epoch 181/300
466/466 ──────────────── 0s 782us/step - loss: 0.2188 - mae:
0.3324 - val_loss: 0.3555 - val_mae: 0.4137
Epoch 182/300
466/466 ──────────────── 0s 673us/step - loss: 0.2198 - mae:
0.3334 - val_loss: 0.3817 - val_mae: 0.4243
Epoch 183/300
466/466 ──────────────── 0s 686us/step - loss: 0.2179 - mae:
0.3324 - val_loss: 0.3708 - val_mae: 0.4218
Epoch 184/300
466/466 ──────────────── 0s 767us/step - loss: 0.2176 - mae:
0.3320 - val_loss: 0.3711 - val_mae: 0.4244
Epoch 185/300
466/466 ──────────────── 0s 662us/step - loss: 0.2175 - mae:
0.3327 - val_loss: 0.4085 - val_mae: 0.4373
Epoch 186/300
466/466 ──────────────── 0s 662us/step - loss: 0.2208 - mae:
0.3360 - val_loss: 0.3423 - val_mae: 0.4062
Epoch 187/300
466/466 ──────────────── 0s 667us/step - loss: 0.2210 - mae:
0.3347 - val_loss: 0.3792 - val_mae: 0.4264
Epoch 188/300
466/466 ──────────────── 0s 813us/step - loss: 0.2208 - mae:
0.3343 - val_loss: 0.3531 - val_mae: 0.4147
Epoch 189/300
466/466 ──────────────── 0s 672us/step - loss: 0.2187 - mae:
0.3326 - val_loss: 0.3803 - val_mae: 0.4253
Epoch 190/300
466/466 ──────────────── 0s 699us/step - loss: 0.2196 - mae:
0.3317 - val_loss: 0.3828 - val_mae: 0.4266
Epoch 191/300
466/466 ──────────────── 0s 821us/step - loss: 0.2228 - mae:
0.3348 - val_loss: 0.3728 - val_mae: 0.4197
Epoch 192/300
466/466 ──────────────── 0s 702us/step - loss: 0.2162 - mae:
0.3303 - val_loss: 0.3770 - val_mae: 0.4267
Epoch 193/300
466/466 ──────────────── 0s 649us/step - loss: 0.2188 - mae:
0.3332 - val_loss: 0.3707 - val_mae: 0.4177
Epoch 194/300
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466/466 ──────────────────── 0s 822us/step - loss: 0.2205 - mae:
0.3335 - val_loss: 0.3646 - val_mae: 0.4157
Epoch 195/300
466/466 ──────────────────── 0s 685us/step - loss: 0.2148 - mae:
0.3312 - val_loss: 0.3731 - val_mae: 0.4231
Epoch 196/300
466/466 ──────────────────── 0s 672us/step - loss: 0.2143 - mae:
0.3305 - val_loss: 0.3630 - val_mae: 0.4191
Epoch 197/300
466/466 ──────────────────── 0s 789us/step - loss: 0.2188 - mae:
0.3323 - val_loss: 0.3819 - val_mae: 0.4311
Epoch 198/300
466/466 ──────────────────── 0s 659us/step - loss: 0.2108 - mae:
0.3282 - val_loss: 0.3677 - val_mae: 0.4273
Epoch 199/300
466/466 ──────────────────── 0s 662us/step - loss: 0.2144 - mae:
0.3303 - val_loss: 0.3508 - val_mae: 0.4142
Epoch 200/300
466/466 ──────────────────── 0s 782us/step - loss: 0.2171 - mae:
0.3316 - val_loss: 0.3683 - val_mae: 0.4256
Epoch 201/300
466/466 ──────────────────── 0s 669us/step - loss: 0.2182 - mae:
0.3329 - val_loss: 0.3766 - val_mae: 0.4349
Epoch 202/300
466/466 ──────────────────── 0s 705us/step - loss: 0.2198 - mae:
0.3339 - val_loss: 0.3782 - val_mae: 0.4299
Epoch 203/300
466/466 ──────────────────── 0s 897us/step - loss: 0.2142 - mae:
0.3293 - val_loss: 0.3708 - val_mae: 0.4237
Epoch 204/300
466/466 ──────────────────── 0s 1ms/step - loss: 0.2175 - mae: 0.3330
- val_loss: 0.3764 - val_mae: 0.4291
Epoch 205/300
466/466 ──────────────────── 1s 2ms/step - loss: 0.2159 - mae: 0.3307
- val_loss: 0.3907 - val_mae: 0.4296
Epoch 206/300
466/466 ──────────────────── 1s 1ms/step - loss: 0.2161 - mae: 0.3321
- val_loss: 0.3670 - val_mae: 0.4165
Epoch 207/300
466/466 ──────────────────── 1s 1ms/step - loss: 0.2193 - mae: 0.3335
- val_loss: 0.3826 - val_mae: 0.4257
Epoch 208/300
466/466 ──────────────────── 0s 958us/step - loss: 0.2173 - mae:
0.3314 - val_loss: 0.3905 - val_mae: 0.4322
Epoch 209/300
466/466 ──────────────────── 1s 1ms/step - loss: 0.2158 - mae: 0.3311
- val_loss: 0.3728 - val_mae: 0.4234
Epoch 210/300
466/466 ──────────────────── 0s 790us/step - loss: 0.2157 - mae:
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0.3306 - val_loss: 0.3867 - val_mae: 0.4275
Epoch 211/300
466/466 ──────────────── 0s 920us/step - loss: 0.2140 - mae:
0.3301 - val_loss: 0.3745 - val_mae: 0.4233
Epoch 212/300
466/466 ──────────────── 0s 768us/step - loss: 0.2200 - mae:
0.3342 - val_loss: 0.3801 - val_mae: 0.4244
Epoch 213/300
466/466 ──────────────── 0s 660us/step - loss: 0.2148 - mae:
0.3300 - val_loss: 0.3659 - val_mae: 0.4154
Epoch 214/300
466/466 ──────────────── 0s 792us/step - loss: 0.2145 - mae:
0.3307 - val_loss: 0.3733 - val_mae: 0.4224
Epoch 215/300
466/466 ──────────────── 0s 674us/step - loss: 0.2142 - mae:
0.3297 - val_loss: 0.3576 - val_mae: 0.4182
Epoch 216/300
466/466 ──────────────── 0s 759us/step - loss: 0.2130 - mae:
0.3273 - val_loss: 0.3727 - val_mae: 0.4255
Epoch 217/300
466/466 ──────────────── 0s 714us/step - loss: 0.2108 - mae:
0.3277 - val_loss: 0.3461 - val_mae: 0.4137
Epoch 218/300
466/466 ──────────────── 0s 662us/step - loss: 0.2144 - mae:
0.3297 - val_loss: 0.3694 - val_mae: 0.4257
Epoch 219/300
466/466 ──────────────── 0s 781us/step - loss: 0.2160 - mae:
0.3312 - val_loss: 0.3646 - val_mae: 0.4218
Epoch 220/300
466/466 ──────────────── 0s 659us/step - loss: 0.2136 - mae:
0.3306 - val_loss: 0.3633 - val_mae: 0.4194
Epoch 221/300
466/466 ──────────────── 0s 661us/step - loss: 0.2170 - mae:
0.3342 - val_loss: 0.3646 - val_mae: 0.4163
Epoch 222/300
466/466 ──────────────── 0s 803us/step - loss: 0.2150 - mae:
0.3305 - val_loss: 0.3902 - val_mae: 0.4263
Epoch 223/300
466/466 ──────────────── 0s 674us/step - loss: 0.2121 - mae:
0.3286 - val_loss: 0.3665 - val_mae: 0.4189
Epoch 224/300
466/466 ──────────────── 0s 820us/step - loss: 0.2162 - mae:
0.3287 - val_loss: 0.3460 - val_mae: 0.4051
Epoch 225/300
466/466 ──────────────── 0s 686us/step - loss: 0.2138 - mae:
0.3283 - val_loss: 0.3672 - val_mae: 0.4207
Epoch 226/300
466/466 ──────────────── 0s 677us/step - loss: 0.2120 - mae:
0.3295 - val_loss: 0.3642 - val_mae: 0.4227
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Epoch 227/300
466/466 ──────────────── 0s 770us/step - loss: 0.2124 - mae:
0.3282 - val_loss: 0.3688 - val_mae: 0.4240
Epoch 228/300
466/466 ──────────────── 0s 667us/step - loss: 0.2126 - mae:
0.3294 - val_loss: 0.3488 - val_mae: 0.4183
Epoch 229/300
466/466 ──────────────── 0s 668us/step - loss: 0.2155 - mae:
0.3299 - val_loss: 0.3565 - val_mae: 0.4185
Epoch 230/300
466/466 ──────────────── 0s 781us/step - loss: 0.2122 - mae:
0.3289 - val_loss: 0.3466 - val_mae: 0.4072
Epoch 231/300
466/466 ──────────────── 0s 664us/step - loss: 0.2123 - mae:
0.3268 - val_loss: 0.3477 - val_mae: 0.4153
Epoch 232/300
466/466 ──────────────── 0s 660us/step - loss: 0.2160 - mae:
0.3306 - val_loss: 0.3716 - val_mae: 0.4253
Epoch 233/300
466/466 ──────────────── 0s 774us/step - loss: 0.2160 - mae:
0.3308 - val_loss: 0.3770 - val_mae: 0.4272
Epoch 234/300
466/466 ──────────────── 0s 662us/step - loss: 0.2156 - mae:
0.3306 - val_loss: 0.3756 - val_mae: 0.4246
Epoch 235/300
466/466 ──────────────── 0s 658us/step - loss: 0.2127 - mae:
0.3300 - val_loss: 0.3894 - val_mae: 0.4348
Epoch 236/300
466/466 ──────────────── 0s 772us/step - loss: 0.2123 - mae:
0.3273 - val_loss: 0.3677 - val_mae: 0.4245
Epoch 237/300
466/466 ──────────────── 0s 663us/step - loss: 0.2107 - mae:
0.3275 - val_loss: 0.3591 - val_mae: 0.4249
Epoch 238/300
466/466 ──────────────── 0s 758us/step - loss: 0.2143 - mae:
0.3286 - val_loss: 0.3682 - val_mae: 0.4229
Epoch 239/300
466/466 ──────────────── 0s 660us/step - loss: 0.2101 - mae:
0.3257 - val_loss: 0.3547 - val_mae: 0.4201
Epoch 240/300
466/466 ──────────────── 0s 673us/step - loss: 0.2096 - mae:
0.3265 - val_loss: 0.3723 - val_mae: 0.4231
Epoch 241/300
466/466 ──────────────── 0s 782us/step - loss: 0.2129 - mae:
0.3290 - val_loss: 0.3851 - val_mae: 0.4312
Epoch 242/300
466/466 ──────────────── 0s 667us/step - loss: 0.2078 - mae:
0.3272 - val_loss: 0.3524 - val_mae: 0.4211
Epoch 243/300
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466/466 ──────────────────── 0s 672us/step - loss: 0.2094 - mae:
0.3266 - val_loss: 0.3832 - val_mae: 0.4280
Epoch 244/300
466/466 ──────────────────── 0s 799us/step - loss: 0.2075 - mae:
0.3238 - val_loss: 0.4051 - val_mae: 0.4386
Epoch 245/300
466/466 ──────────────────── 0s 681us/step - loss: 0.2082 - mae:
0.3267 - val_loss: 0.3757 - val_mae: 0.4230
Epoch 246/300
466/466 ──────────────────── 0s 804us/step - loss: 0.2104 - mae:
0.3272 - val_loss: 0.4010 - val_mae: 0.4362
Epoch 247/300
466/466 ──────────────────── 0s 692us/step - loss: 0.2120 - mae:
0.3286 - val_loss: 0.3832 - val_mae: 0.4339
Epoch 248/300
466/466 ──────────────────── 0s 787us/step - loss: 0.2143 - mae:
0.3303 - val_loss: 0.3736 - val_mae: 0.4329
Epoch 249/300
466/466 ──────────────────── 0s 689us/step - loss: 0.2117 - mae:
0.3282 - val_loss: 0.3849 - val_mae: 0.4342
Epoch 250/300
466/466 ──────────────────── 0s 664us/step - loss: 0.2137 - mae:
0.3281 - val_loss: 0.3710 - val_mae: 0.4228
Epoch 251/300
466/466 ──────────────────── 0s 825us/step - loss: 0.2098 - mae:
0.3262 - val_loss: 0.3743 - val_mae: 0.4261
Epoch 252/300
466/466 ──────────────────── 0s 666us/step - loss: 0.2131 - mae:
0.3285 - val_loss: 0.3769 - val_mae: 0.4275
Epoch 253/300
466/466 ──────────────────── 0s 790us/step - loss: 0.2076 - mae:
0.3269 - val_loss: 0.3807 - val_mae: 0.4291
Epoch 254/300
466/466 ──────────────────── 0s 671us/step - loss: 0.2088 - mae:
0.3271 - val_loss: 0.3748 - val_mae: 0.4316
Epoch 255/300
466/466 ──────────────────── 0s 818us/step - loss: 0.2051 - mae:
0.3237 - val_loss: 0.3618 - val_mae: 0.4168
Epoch 256/300
466/466 ──────────────────── 0s 667us/step - loss: 0.2102 - mae:
0.3283 - val_loss: 0.3903 - val_mae: 0.4374
Epoch 257/300
466/466 ──────────────────── 0s 678us/step - loss: 0.2115 - mae:
0.3263 - val_loss: 0.3786 - val_mae: 0.4289
Epoch 258/300
466/466 ──────────────────── 0s 784us/step - loss: 0.2055 - mae:
0.3244 - val_loss: 0.3628 - val_mae: 0.4182
Epoch 259/300
466/466 ──────────────────── 0s 685us/step - loss: 0.2100 - mae:
```

```
0.3276 - val_loss: 0.3678 - val_mae: 0.4247
Epoch 260/300
466/466 ──────────────── 0s 797us/step - loss: 0.2091 - mae:
0.3265 - val_loss: 0.3867 - val_mae: 0.4284
Epoch 261/300
466/466 ──────────────── 0s 685us/step - loss: 0.2090 - mae:
0.3247 - val_loss: 0.3996 - val_mae: 0.4384
Epoch 262/300
466/466 ──────────────── 0s 765us/step - loss: 0.2084 - mae:
0.3249 - val_loss: 0.3903 - val_mae: 0.4324
Epoch 263/300
466/466 ──────────────── 0s 670us/step - loss: 0.2093 - mae:
0.3256 - val_loss: 0.3848 - val_mae: 0.4286
Epoch 264/300
466/466 ──────────────── 0s 669us/step - loss: 0.2084 - mae:
0.3264 - val_loss: 0.3775 - val_mae: 0.4267
Epoch 265/300
466/466 ──────────────── 0s 778us/step - loss: 0.2098 - mae:
0.3273 - val_loss: 0.3765 - val_mae: 0.4238
Epoch 266/300
466/466 ──────────────── 0s 665us/step - loss: 0.2056 - mae:
0.3238 - val_loss: 0.4160 - val_mae: 0.4388
Epoch 267/300
466/466 ──────────────── 0s 778us/step - loss: 0.2086 - mae:
0.3254 - val_loss: 0.3835 - val_mae: 0.4275
Epoch 268/300
466/466 ──────────────── 0s 673us/step - loss: 0.2103 - mae:
0.3275 - val_loss: 0.3840 - val_mae: 0.4281
Epoch 269/300
466/466 ──────────────── 0s 667us/step - loss: 0.2080 - mae:
0.3267 - val_loss: 0.3655 - val_mae: 0.4203
Epoch 270/300
466/466 ──────────────── 0s 788us/step - loss: 0.2065 - mae:
0.3257 - val_loss: 0.3767 - val_mae: 0.4261
Epoch 271/300
466/466 ──────────────── 0s 668us/step - loss: 0.2073 - mae:
0.3249 - val_loss: 0.3894 - val_mae: 0.4322
Epoch 272/300
466/466 ──────────────── 0s 786us/step - loss: 0.2076 - mae:
0.3255 - val_loss: 0.3794 - val_mae: 0.4242
Epoch 273/300
466/466 ──────────────── 0s 676us/step - loss: 0.2064 - mae:
0.3238 - val_loss: 0.3714 - val_mae: 0.4195
Epoch 274/300
466/466 ──────────────── 0s 780us/step - loss: 0.2071 - mae:
0.3238 - val_loss: 0.3868 - val_mae: 0.4273
Epoch 275/300
466/466 ──────────────── 0s 678us/step - loss: 0.2057 - mae:
0.3230 - val_loss: 0.3881 - val_mae: 0.4262
```

```
Epoch 276/300
466/466 ──────────────── 0s 765us/step - loss: 0.2035 - mae:
0.3240 - val_loss: 0.3616 - val_mae: 0.4156
Epoch 277/300
466/466 ──────────────── 0s 661us/step - loss: 0.2089 - mae:
0.3270 - val_loss: 0.3716 - val_mae: 0.4190
Epoch 278/300
466/466 ──────────────── 0s 663us/step - loss: 0.2058 - mae:
0.3251 - val_loss: 0.3608 - val_mae: 0.4095
Epoch 279/300
466/466 ──────────────── 0s 784us/step - loss: 0.2047 - mae:
0.3230 - val_loss: 0.3663 - val_mae: 0.4280
Epoch 280/300
466/466 ──────────────── 0s 665us/step - loss: 0.2087 - mae:
0.3252 - val_loss: 0.3750 - val_mae: 0.4216
Epoch 281/300
466/466 ──────────────── 0s 786us/step - loss: 0.2103 - mae:
0.3273 - val_loss: 0.3759 - val_mae: 0.4303
Epoch 282/300
466/466 ──────────────── 0s 667us/step - loss: 0.2042 - mae:
0.3243 - val_loss: 0.3924 - val_mae: 0.4330
Epoch 283/300
466/466 ──────────────── 0s 782us/step - loss: 0.2057 - mae:
0.3253 - val_loss: 0.4204 - val_mae: 0.4446
Epoch 284/300
466/466 ──────────────── 0s 673us/step - loss: 0.2034 - mae:
0.3226 - val_loss: 0.3969 - val_mae: 0.4275
Epoch 285/300
466/466 ──────────────── 0s 778us/step - loss: 0.2059 - mae:
0.3238 - val_loss: 0.4036 - val_mae: 0.4372
Epoch 286/300
466/466 ──────────────── 0s 675us/step - loss: 0.2067 - mae:
0.3238 - val_loss: 0.3892 - val_mae: 0.4313
Epoch 287/300
466/466 ──────────────── 0s 760us/step - loss: 0.2094 - mae:
0.3264 - val_loss: 0.3896 - val_mae: 0.4294
Epoch 288/300
466/466 ──────────────── 0s 664us/step - loss: 0.2047 - mae:
0.3245 - val_loss: 0.4114 - val_mae: 0.4418
Epoch 289/300
466/466 ──────────────── 0s 666us/step - loss: 0.2056 - mae:
0.3244 - val_loss: 0.4166 - val_mae: 0.4447
Epoch 290/300
466/466 ──────────────── 0s 775us/step - loss: 0.2074 - mae:
0.3248 - val_loss: 0.4003 - val_mae: 0.4391
Epoch 291/300
466/466 ──────────────── 0s 673us/step - loss: 0.2022 - mae:
0.3218 - val_loss: 0.3788 - val_mae: 0.4227
Epoch 292/300
```

```
466/466 ──────────────── 0s 807us/step - loss: 0.2038 - mae:
0.3231 - val_loss: 0.4042 - val_mae: 0.4381
Epoch 293/300
466/466 ──────────────── 0s 675us/step - loss: 0.2021 - mae:
0.3213 - val_loss: 0.4123 - val_mae: 0.4411
Epoch 294/300
466/466 ──────────────── 0s 806us/step - loss: 0.2057 - mae:
0.3221 - val_loss: 0.3965 - val_mae: 0.4376
Epoch 295/300
466/466 ──────────────── 0s 694us/step - loss: 0.2050 - mae:
0.3227 - val_loss: 0.3648 - val_mae: 0.4251
Epoch 296/300
466/466 ──────────────── 0s 802us/step - loss: 0.2048 - mae:
0.3233 - val_loss: 0.4046 - val_mae: 0.4431
Epoch 297/300
466/466 ──────────────── 0s 674us/step - loss: 0.2005 - mae:
0.3208 - val_loss: 0.3965 - val_mae: 0.4394
Epoch 298/300
466/466 ──────────────── 0s 785us/step - loss: 0.2073 - mae:
0.3248 - val_loss: 0.3947 - val_mae: 0.4343
Epoch 299/300
466/466 ──────────────── 0s 669us/step - loss: 0.2026 - mae:
0.3225 - val_loss: 0.4016 - val_mae: 0.4369
Epoch 300/300
466/466 ──────────────── 0s 791us/step - loss: 0.2021 - mae:
0.3229 - val_loss: 0.3722 - val_mae: 0.4221
```

1. Evaluate model

```python
test_results = model.evaluate(X_test_scaled, y_test, verbose=0)
print(f"\nTest MSE: {test_results[0]:.4f}  |  Test MAE:
{test_results[1]:.4f}")
y_pred = model.predict(X_test_scaled).flatten()
```

```
Test MSE: 0.3666  |  Test MAE: 0.4220
97/97 ──────────────── 0s 635us/step
```
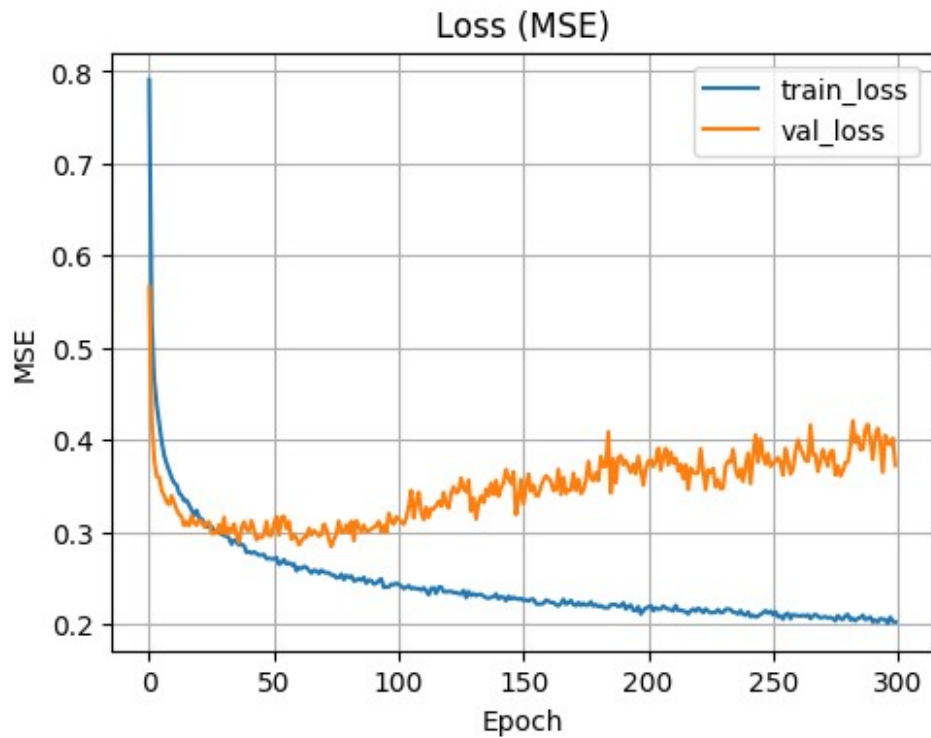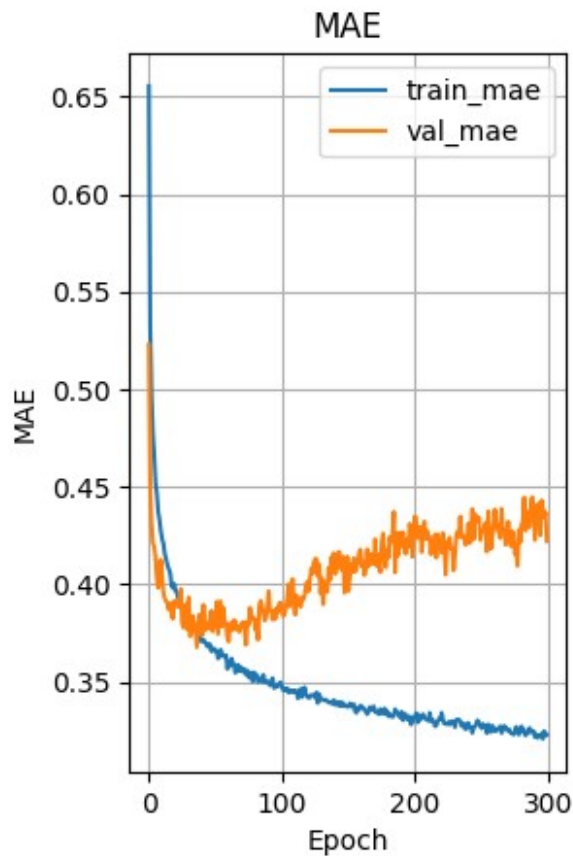
1. Visualization

9.1 Loss Curve

```python
plt.figure(figsize=(12,4))
plt.subplot(1,2,1)
plt.plot(history.history['loss'], label='train_loss')
plt.plot(history.history['val_loss'], label='val_loss')
plt.xlabel('Epoch'); plt.ylabel('MSE'); plt.title('Loss (MSE)');
plt.legend(); plt.grid(True)
```

Loss (MSE)

9.2 mae curve

```python
plt.subplot(1,2,2)
plt.plot(history.history['mae'], label='train_mae')
plt.plot(history.history['val_mae'], label='val_mae')
plt.xlabel('Epoch'); plt.ylabel('MAE'); plt.title('MAE');
plt.legend(); plt.grid(True)
plt.show()
```

MAE

9.3 Prediction vs Actual Visualization

```python
plt.figure(figsize=(6,6))
plt.scatter(y_test, y_pred, alpha=0.5, s=10)
plt.plot([y_test.min(), y_test.max()], [y_test.min(), y_test.max()],
'r--')
plt.xlabel("Actual median value (100k)")
plt.ylabel("Predicted median value (100k)")
plt.title("Actual vs Predicted — Model 4")
plt.grid(True)
plt.show()
```

Actual vs Predicted — Model 4