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To: /content/Python Application Usage Log Data Set.xlsx

100%|████████████| 1.68M/1.68M [00:00<00:00, 142MB/s]

ADF Statistic (train): -9.6464, p-value: 0.0000

Any object dtypes in X_train_s? -> False

Remaining NaNs in X_train_s? -> 0

X columns used: 47

Checked order (0, 1, 0), AIC=68373.38, LB p10=0.000, p20=0.000

Checked order (0, 1, 1), AIC=67233.42, LB p10=0.000, p20=0.000

Checked order (0, 1, 2), AIC=67145.17, LB p10=0.000, p20=0.000

Checked order (0, 1, 3), AIC=67116.24, LB p10=0.000, p20=0.000

Checked order (1, 1, 0), AIC=67697.32, LB p10=0.000, p20=0.000

Checked order (1, 1, 1), AIC=67132.85, LB p10=0.000, p20=0.000

Checked order (1, 1, 2), AIC=67106.51, LB p10=0.000, p20=0.000

Checked order (1, 1, 3), AIC=67081.27, LB p10=0.000, p20=0.000

Checked order (2, 1, 0), AIC=67393.48, LB p10=0.000, p20=0.000

Checked order (2, 1, 1), AIC=67098.23, LB p10=0.000, p20=0.000

Checked order (2, 1, 2), AIC=67103.11, LB p10=0.000, p20=0.000

Checked order (2, 1, 3), AIC=67030.76, LB p10=0.000, p20=0.000

Checked order (3, 1, 0), AIC=67326.39, LB p10=0.000, p20=0.000

Checked order (3, 1, 1), AIC=67049.08, LB p10=0.000, p20=0.000

Checked order (3, 1, 2), AIC=67096.21, LB p10=0.000, p20=0.000

Checked order (3, 1, 3), AIC=67080.40, LB p10=0.000, p20=0.000


Selected order by AIC (no model fully passed Ljung–Box): (2, 1, 3), AIC=67030.76


SARIMAX Results

```
================================================================================
===
Dep. Variable:    daily_active_users   No. Observations:           4631
Model:            SARIMAX(2, 1, 3)   Log Likelihood          -33462.382
Date:             Wed, 15 Oct 2025   AIC                      67030.764
Time:                    08:39:23   BIC                      67372.055
Sample:               08-01-2012   HQIC                     67150.854
                       - 04-05-2025
Covariance Type:              oim
================================================================================
====================
                        coef    std err        z      P>|z|     [0.025     0.975]
------------------------------------------------------------------------------------
session_count          1040.3740     8.515   122.185    0.000   1023.685   1057.063
avg_session_duration     17.5459    16.858     1.041    0.298    -15.496     50.587
like_count               12.1782    15.613     0.780    0.435    -18.423     42.779
share_count               5.5325    13.516     0.409    0.682    -20.959     32.024
download_count          -11.4572    16.416    -0.698    0.485    -43.632     20.717
comment_count           -12.4416    15.736    -0.791    0.429    -43.283     18.400
error_count              11.5481     6.568     1.758    0.079     -1.325     24.421
is_weekend               -7.4670     3.475    -2.149    0.032    -14.277     -0.657
release_flag             -1.4720     4.570    -0.322    0.747    -10.430      7.486
app_Business Courses app   1.0184     6.331     0.161    0.872    -11.390     13.427
app_Facebook              3.3381    11.463     0.291    0.771    -19.129     25.805
app_Health Courses app   -3.4592     5.621    -0.615    0.538    -14.476      7.558
app_Instagram             2.2690    10.114     0.224    0.822    -17.554     22.092
app_LinkedIn              6.7377     7.368     0.914    0.360     -7.703     21.178
app_Online Course app    -2.5693    60.002    -0.043    0.966   -120.170    115.032
app_Pinterest            -1.8102     6.865    -0.264    0.792    -15.265     11.645
```

| | coef | std err | z | P>\|z\| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| app_Programming Courses app | 0.5970 | 4.796 | 0.124 | 0.901 | -8.803 | 9.997 |
| app_Quora | 5.9865 | 6.638 | 0.902 | 0.367 | -7.023 | 18.996 |
| app_Quora Website | 0.5927 | 4.849 | 0.122 | 0.903 | -8.911 | 10.096 |
| app_Reddit | 3.0237 | 7.082 | 0.427 | 0.669 | -10.857 | 16.904 |
| app_Science Courses app | 6.0711 | 4.637 | 1.309 | 0.190 | -3.017 | 15.159 |
| app_Snapchat | 9.7269 | 6.287 | 1.547 | 0.122 | -2.596 | 22.050 |
| app_Telegram | 11.2293 | 5.704 | 1.969 | 0.049 | 0.050 | 22.408 |
| app_Threads | -2.3822 | 5.341 | -0.446 | 0.656 | -12.851 | 8.086 |
| app_TikTok | 0.8102 | 7.279 | 0.111 | 0.911 | -13.456 | 15.076 |
| app_Twitter | 3.7385 | 7.168 | 0.522 | 0.602 | -10.310 | 17.787 |
| app_WeChat | 7.5378 | 5.166 | 1.459 | 0.145 | -2.588 | 17.663 |
| app_WhatsApp | 11.5146 | 4.988 | 2.308 | 0.021 | 1.738 | 21.291 |
| app_X (formerly Twitter) | 15.0612 | 4.960 | 3.037 | 0.002 | 5.340 | 24.782 |
| app_YouTube | 2.6455 | 6.131 | 0.431 | 0.666 | -9.371 | 14.662 |
| dow_1.0 | -2.1623 | 5.356 | -0.404 | 0.686 | -12.661 | 8.336 |
| dow_2.0 | -13.3698 | 5.860 | -2.282 | 0.023 | -24.855 | -1.885 |
| dow_3.0 | -7.1731 | 5.907 | -1.214 | 0.225 | -18.751 | 4.405 |
| dow_4.0 | -5.5764 | 5.904 | -0.944 | 0.345 | -17.149 | 5.996 |
| dow_5.0 | -9.0830 | 3.697 | -2.457 | 0.014 | -16.330 | -1.836 |
| dow_6.0 | -0.7006 | 3.344 | -0.210 | 0.834 | -7.254 | 5.853 |
| mon_2.0 | 12.6263 | 14.865 | 0.849 | 0.396 | -16.509 | 41.762 |
| mon_3.0 | -5.6671 | 15.387 | -0.368 | 0.713 | -35.825 | 24.490 |
| mon_4.0 | -17.7823 | 15.859 | -1.121 | 0.262 | -48.865 | 13.300 |
| mon_5.0 | -15.0141 | 16.526 | -0.909 | 0.364 | -47.404 | 17.375 |
| mon_6.0 | 13.3876 | 15.374 | 0.871 | 0.384 | -16.745 | 43.520 |
| mon_7.0 | 37.0574 | 15.819 | 2.343 | 0.019 | 6.053 | 68.062 |
| mon_8.0 | 22.3057 | 16.697 | 1.336 | 0.182 | -10.420 | 55.031 |
| mon_9.0 | 3.2948 | 16.520 | 0.199 | 0.842 | -29.083 | 35.673 |
| mon_10.0 | 7.8226 | 15.841 | 0.494 | 0.621 | -23.224 | 38.870 |

| | | | | | | |
|---|---|---|---|---|---|---|
| mon_11.0 | -10.3600 | 15.169 | -0.683 | 0.495 | -40.091 | 19.371 |
| mon_12.0 | 18.3783 | 14.341 | 1.282 | 0.200 | -9.729 | 46.486 |
| ar.L1 | 0.4615 | 0.233 | 1.981 | 0.048 | 0.005 | 0.918 |
| ar.L2 | 0.3528 | 0.194 | 1.818 | 0.069 | -0.028 | 0.733 |
| ma.L1 | -1.0331 | 0.231 | -4.480 | 0.000 | -1.485 | -0.581 |
| ma.L2 | -0.1977 | 0.323 | -0.612 | 0.541 | -0.831 | 0.436 |
| ma.L3 | 0.2452 | 0.098 | 2.498 | 0.012 | 0.053 | 0.438 |
| sigma2 | 1.139e+05 | 2368.911 | 48.093 | 0.000 | 1.09e+05 | 1.19e+05 |

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| | | | |
|---|---|---|---|
| Ljung-Box (L1) (Q): | 0.00 | Jarque-Bera (JB): | 709472.01 |
| Prob(Q): | 0.98 | Prob(JB): | 0.00 |
| Heteroskedasticity (H): | 0.14 | Skew: | -0.86 |
| Prob(H) (two-sided): | 0.00 | Kurtosis: | 63.65 |

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Warnings:

[1] Covariance matrix calculated using the observed information matrix (complex-step) described in Harvey (1989).
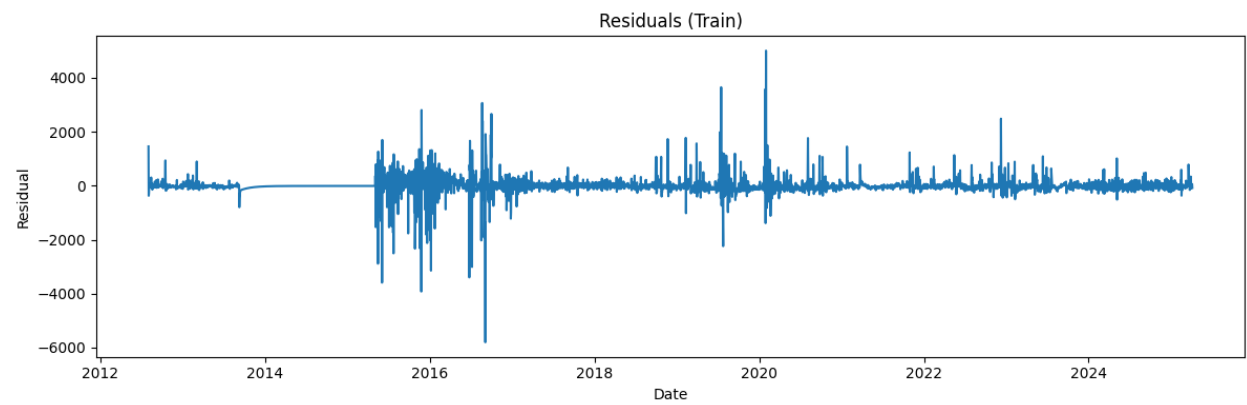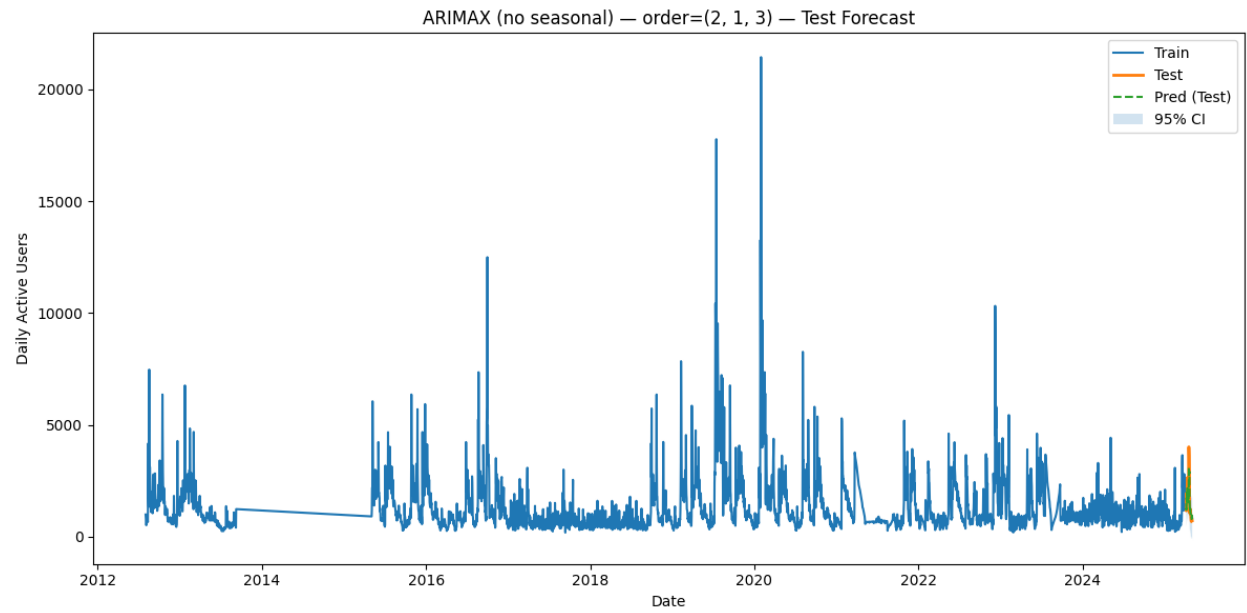
[2] Covariance matrix is singular or near-singular, with condition number 7.44e+20. Standard errors may be unstable.
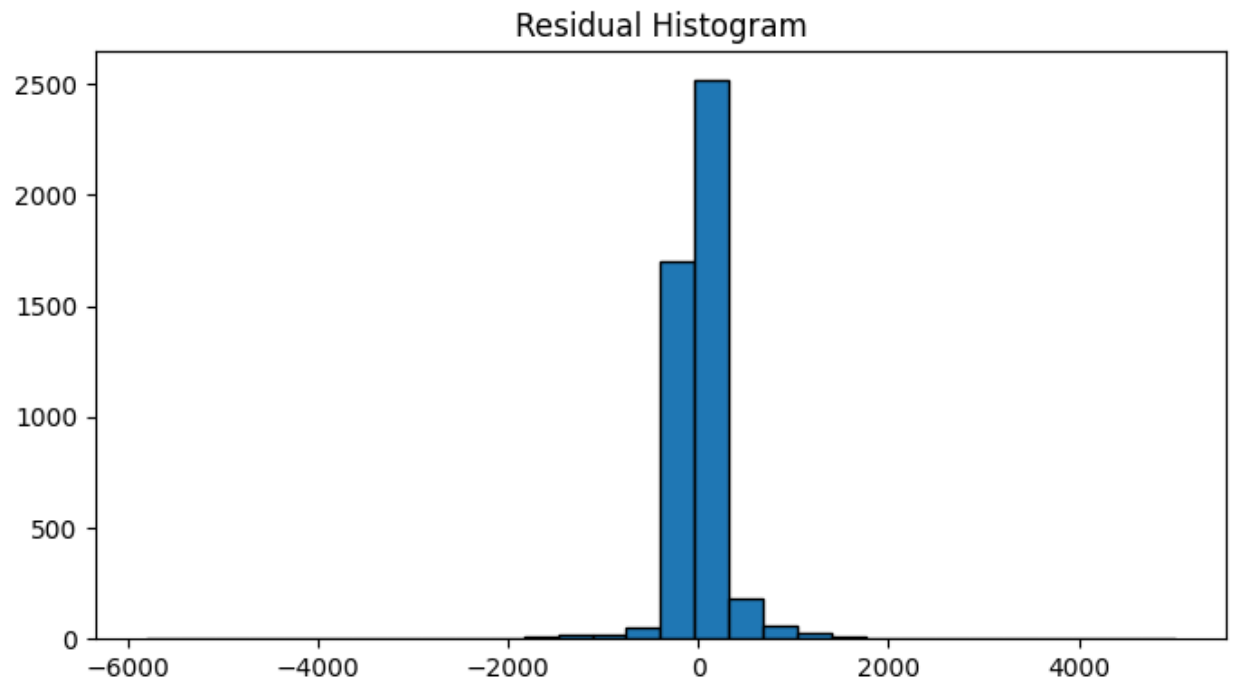
Test MAE:  226.315

Test RMSE: 318.043

Test MAPE: 12.34%
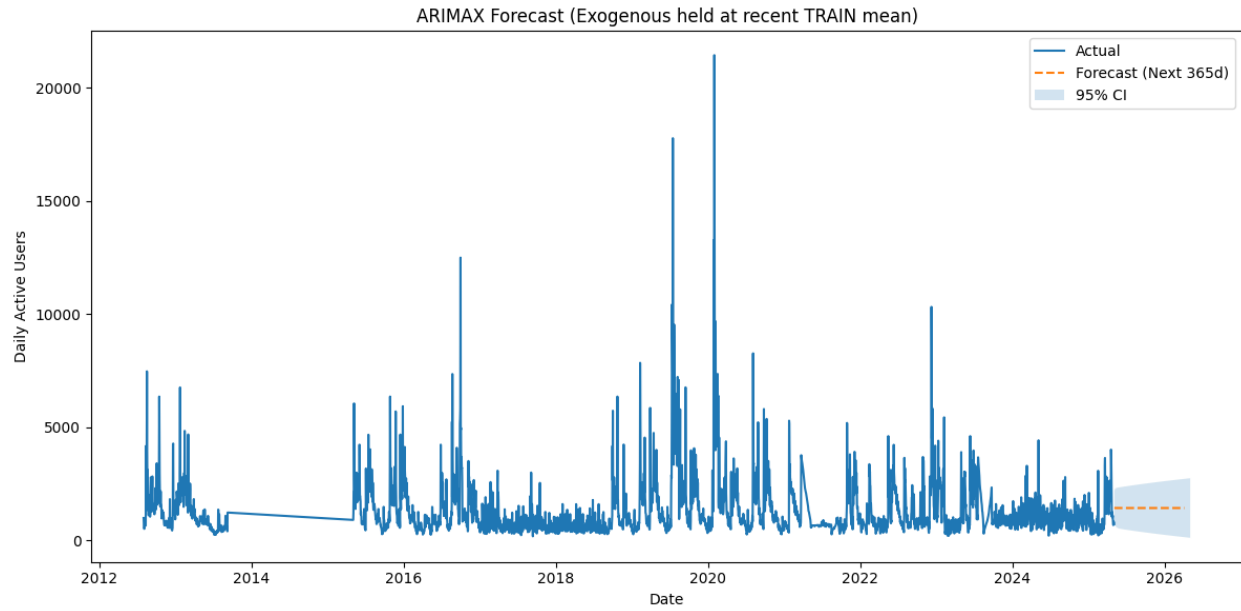
Test Accuracy (100 - MAPE): 87.66%

ARIMAX (no seasonal) — order=(2, 1, 3) — Test Forecast



Residuals (Train)

Residual Histogram

Ljung-Box stats & p-values (train):

|    | lb_stat    | lb_pvalue    |
|----|------------|--------------|
| 10 | 33.875368  | 1.938934e-04 |
| 20 | 103.911982 | 2.496693e-13 |

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ARIMAX Forecast (Exogenous held at recent TRAIN mean)

Accuracy (100 - MAPE): 87.66%

MAPE: 12.34%   sMAPE: 12.69%

MAE:  226.315    RMSE:  318.043   R²: 0.863

MASE (vs naive-1): 0.696

Directional Accuracy: 78.57%