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

100%|████████████| 1.68M/1.68M [00:00<00:00, 105MB/s]

/usr/local/lib/python3.12/dist-packages/statsmodels/stats/outliers_influence.py:197: RuntimeWarning: divide by zero encountered in scalar divide

  vif = 1. / (1. - r_squared_i)

[VIF] Dropped 'is_weekend' (VIF=inf). Remaining cols: 46

ADF Statistic: -9.6707, p-value: 0.0000

Any object dtypes in X? -> False

Remaining NaNs in X? -> 0

X columns used: 46

Checked order (0, 1, 0), AIC=68371.38, LB p10=0.000, p20=0.000

Checked order (0, 1, 1), AIC=67231.20, LB p10=0.000, p20=0.000

Checked order (0, 1, 2), AIC=67145.11, LB p10=0.000, p20=0.000

Checked order (0, 1, 3), AIC=67116.33, LB p10=0.000, p20=0.000

Checked order (1, 1, 0), AIC=67694.53, LB p10=0.000, p20=0.000

Checked order (1, 1, 1), AIC=67128.75, LB p10=0.000, p20=0.000

Checked order (1, 1, 2), AIC=67104.51, LB p10=0.000, p20=0.000

Checked order (1, 1, 3), AIC=67079.27, LB p10=0.000, p20=0.000

Checked order (2, 1, 0), AIC=67390.63, LB p10=0.000, p20=0.000

Checked order (2, 1, 1), AIC=67099.60, LB p10=0.000, p20=0.000

Checked order (2, 1, 2), AIC=67101.11, LB p10=0.000, p20=0.000

Checked order (2, 1, 3), AIC=67044.33, LB p10=0.000, p20=0.000

Checked order (3, 1, 0), AIC=67324.06, LB p10=0.000, p20=0.000

Checked order (3, 1, 1), AIC=67047.09, LB p10=0.000, p20=0.000

Checked order (3, 1, 2), AIC=67094.21, LB p10=0.000, p20=0.000

Checked order (3, 1, 3), AIC=67078.40, LB p10=0.000, p20=0.000

Selected order by AIC (no model fully passed Ljung–Box): (2, 1, 3), AIC=67044.33

SARIMAX Results

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Dep. Variable:	daily_active_users	No. Observations:	4631
Model:	SARIMAX(2, 1, 3)	Log Likelihood	-33470.167
Date:	Wed, 15 Oct 2025	AIC	67044.334
Time:	08:00:01	BIC	67379.186
Sample:	08-01-2012	HQIC	67162.158
	- 04-05-2025		
Covariance Type:	oim		

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	coef	std err	z	P>|z|	[0.025	0.975]
session_count	1014.1542	8.389	120.895	0.000	997.713	1030.596
avg_session_duration	15.8810	16.598	0.957	0.339	-16.651	48.413
like_count	9.2072	15.308	0.601	0.548	-20.796	39.210
share_count	7.3796	13.307	0.555	0.579	-18.702	33.461
download_count	-11.2907	16.078	-0.702	0.483	-42.804	20.223
comment_count	-11.4160	15.420	-0.740	0.459	-41.638	18.806
error_count	9.9856	6.449	1.549	0.122	-2.653	22.624
release_flag	-1.5648	4.486	-0.349	0.727	-10.356	7.227
app_Business Courses app	1.5008	6.202	0.242	0.809	-10.654	13.656
app_Facebook	3.9115	11.270	0.347	0.729	-18.178	26.001
app_Health Courses app	-3.4755	5.506	-0.631	0.528	-14.267	7.316
app_Instagram	1.0682	9.967	0.107	0.915	-18.467	20.603
app_LinkedIn	6.7849	7.240	0.937	0.349	-7.405	20.975

	coef	std err	z	P>|z|	[0.025	0.975]
app_Online Course app	-5.2135	60.086	-0.087	0.931	-122.980	112.552
app_Pinterest	-1.7092	6.730	-0.254	0.800	-14.901	11.482
app_Programming Courses app	0.3888	4.695	0.083	0.934	-8.814	9.591
app_Quora	5.4834	6.530	0.840	0.401	-7.314	18.281
app_Quora Website	0.6752	4.754	0.142	0.887	-8.642	9.992
app_Reddit	2.2745	6.994	0.325	0.745	-11.434	15.983
app_Science Courses app	6.2414	4.537	1.376	0.169	-2.652	15.135
app_Snapchat	9.5793	6.162	1.555	0.120	-2.497	21.656
app_Telegram	10.7855	5.736	1.880	0.060	-0.456	22.027
app_Threads	-2.7534	5.281	-0.521	0.602	-13.105	7.598
app_TikTok	2.4155	7.132	0.339	0.735	-11.564	16.394
app_Twitter	5.2246	7.019	0.744	0.457	-8.533	18.982
app_WeChat	8.0760	5.058	1.597	0.110	-1.838	17.990
app_WhatsApp	11.8479	4.885	2.425	0.015	2.273	21.423
app_X (formerly Twitter)	15.2728	5.062	3.017	0.003	5.352	25.194
app_YouTube	1.8269	6.007	0.304	0.761	-9.947	13.601
dow_1.0	-1.3165	5.255	-0.251	0.802	-11.616	8.983
dow_2.0	-12.9578	5.766	-2.247	0.025	-24.259	-1.656
dow_3.0	-6.2351	5.818	-1.072	0.284	-17.639	5.168
dow_4.0	-4.6101	5.815	-0.793	0.428	-16.008	6.788
dow_5.0	-15.9596	5.766	-2.768	0.006	-27.261	-4.658
dow_6.0	-5.7282	5.251	-1.091	0.275	-16.020	4.564
mon_2.0	11.1777	14.721	0.759	0.448	-17.675	40.031
mon_3.0	-8.2222	15.219	-0.540	0.589	-38.051	21.607
mon_4.0	-20.8209	16.213	-1.284	0.199	-52.597	10.956
mon_5.0	-16.8654	16.423	-1.027	0.304	-49.054	15.323
mon_6.0	14.2065	15.205	0.934	0.350	-15.594	44.007
mon_7.0	42.4480	15.655	2.711	0.007	11.765	73.131
mon_8.0	15.9213	16.537	0.963	0.336	-16.490	48.333

mon_9.0	7.4648	16.362	0.456	0.648	-24.604	39.534
mon_10.0	1.8571	15.673	0.118	0.906	-28.861	32.575
mon_11.0	-8.9686	15.005	-0.598	0.550	-38.377	20.440
mon_12.0	22.5615	14.171	1.592	0.111	-5.212	50.335
ar.L1	0.4386	0.219	2.000	0.045	0.009	0.868
ar.L2	0.3662	0.181	2.024	0.043	0.012	0.721
ma.L1	-1.0436	0.215	-4.845	0.000	-1.466	-0.621
ma.L2	-0.2322	0.309	-0.752	0.452	-0.838	0.373
ma.L3	0.2592	0.092	2.802	0.005	0.078	0.440
sigma2	1.057e+05	2429.648	43.507	0.000	1.01e+05	1.1e+05

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Ljung-Box (L1) (Q):	0.00	Jarque-Bera (JB):	690570.16
Prob(Q):	0.95	Prob(JB):	0.00
Heteroskedasticity (H):	0.16	Skew:	-0.27
Prob(H) (two-sided):	0.00	Kurtosis:	62.85

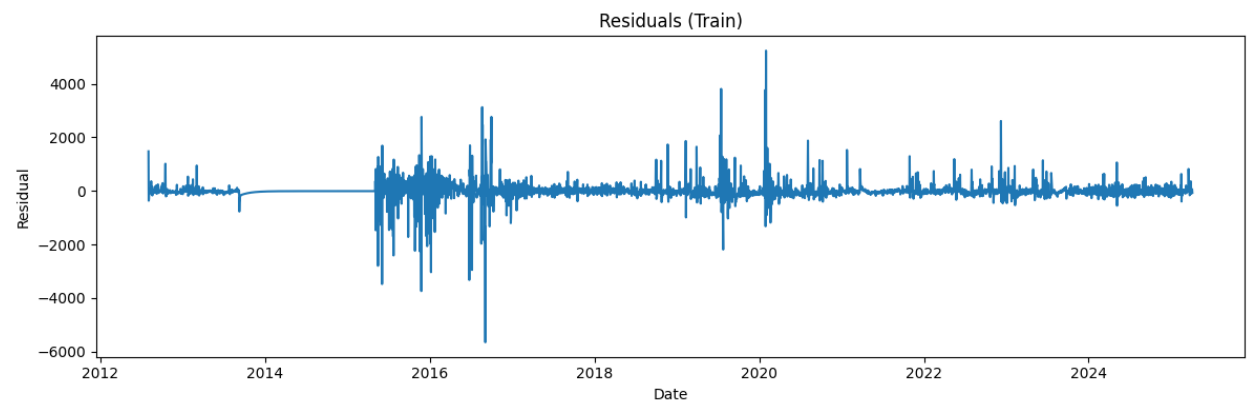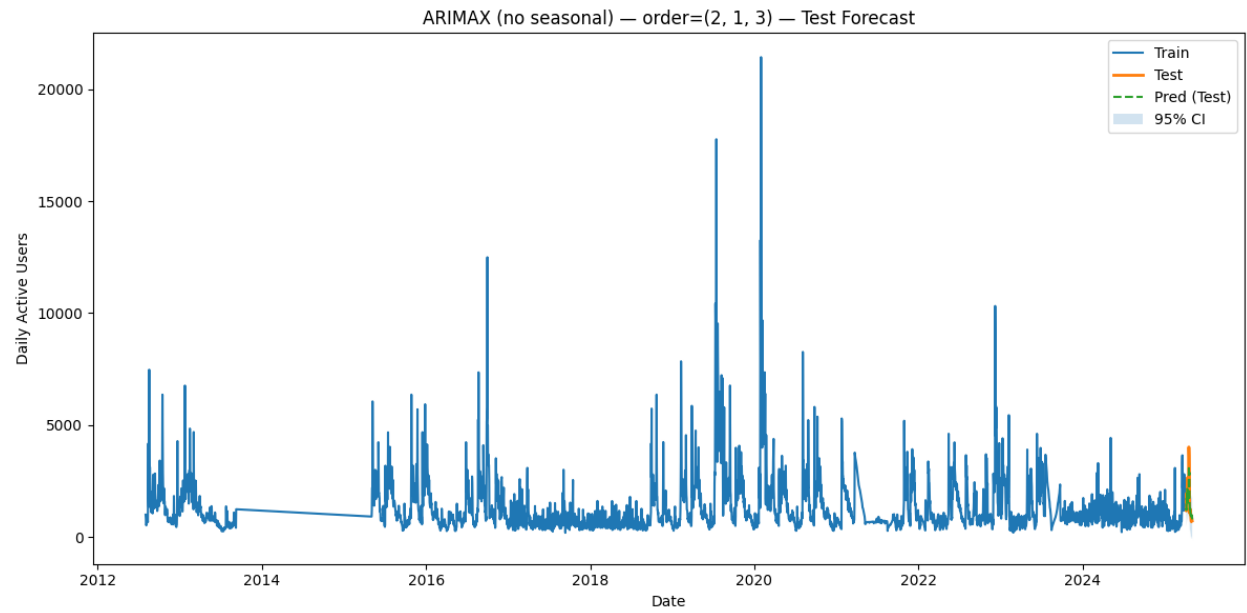===
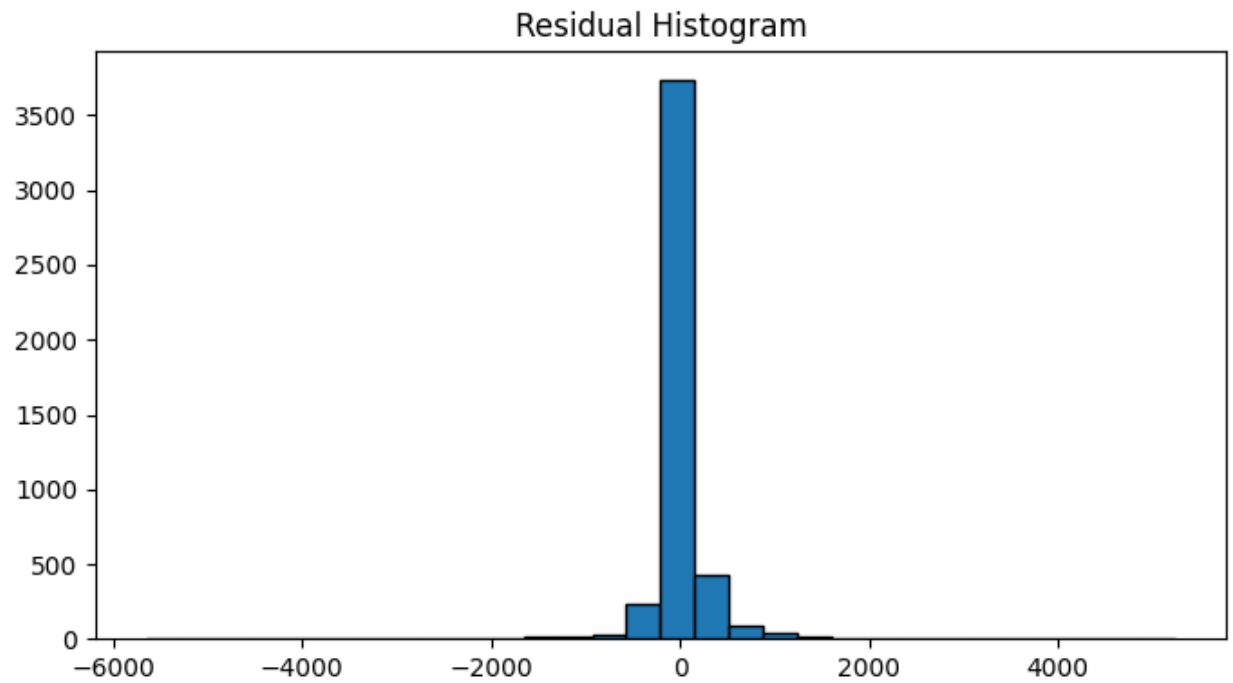========

Warnings:

[1] Covariance matrix calculated using the observed information matrix (complex-step) described in Harvey (1989).

Test MAE: 234.935

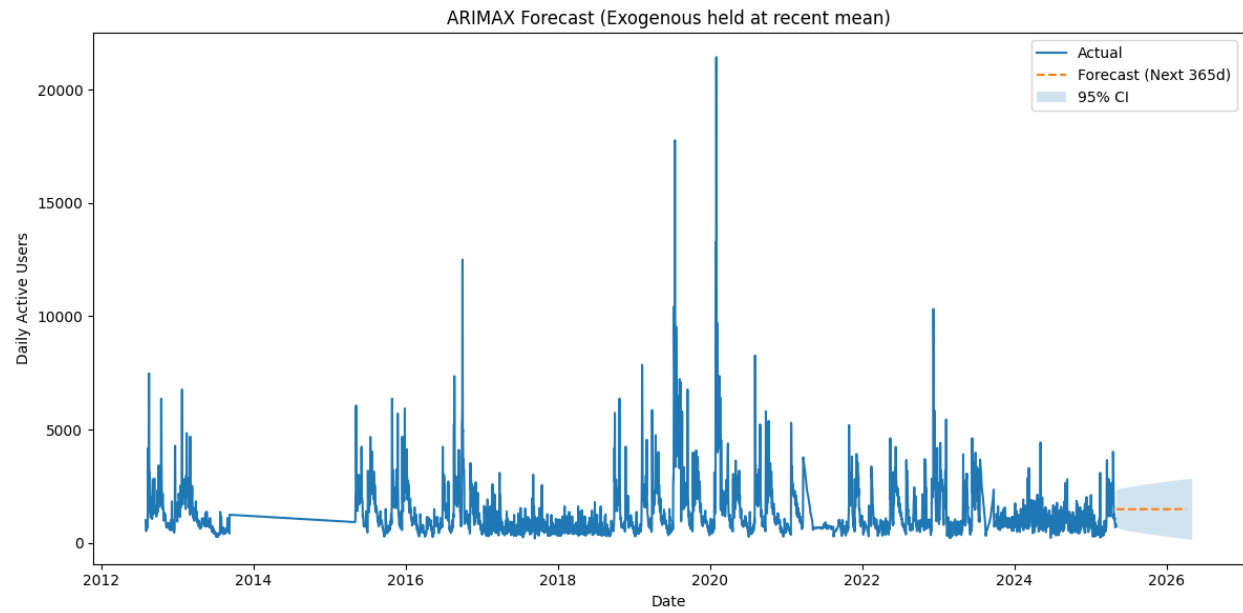Test RMSE: 331.082

Test MAPE: 12.87%

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

Residuals (Train)

Residual Histogram

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

```
      lb_stat      lb_pvalue
10  32.956525   2.770060e-04
20  99.420471   1.599141e-12
```

ARIMAX Forecast (Exogenous held at recent mean)

Classification (threshold = train median = 976.093)

Accuracy: 100.00%

F1 Score: 1.000

Precision: 1.000

Recall: 1.000