DM4ML — Prepared Dataset: Summary & Visualizations

This notebook loads `prepared.csv` (expected at repository root / current working directory), prints summary statistics, and generates meaningful visualizations for churn EDA.

Assumptions

- Dates are parseable; `ingest_ts` uses format `%Y-%m-%d-%H:%M:%S` (e.g., `2025-08-17-16:56:02`).
- `churned` is 0/1.
- `subscription_plan_le` is a label-encoded integer (e.g., 0,1,2).

In [1]:
```
# --- Setup & Imports ---
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

# Inline plots
%matplotlib inline

# Display options
pd.set_option('display.max_columns', 100)
pd.set_option('display.width', 160)
pd.set_option('display.float_format', lambda x: f"{x:.4f}")
print("Libraries imported.")
```

```
Libraries imported.
```

In [2]:
```
# --- Load Data ---
PATH = "prepared.csv"  # Assumes the file is present in the working director

# Read without date parsing first to handle custom formats robustly
df = pd.read_csv(PATH)

# Parse dates where present
def parse_date(col, fmt=None):
    if col in df.columns:
        if fmt is None:
            df[col] = pd.to_datetime(df[col], errors="coerce")
        else:
            df[col] = pd.to_datetime(df[col], format=fmt, errors="coerce")

parse_date("asof_date")
parse_date("signup_date")
parse_date("last_login_date")
# Ingest ts has a dashed date-time like 2025-08-17-16:56:02
parse_date("ingest_ts", fmt="%Y-%m-%d-%H:%M:%S")
```

```
# Derived features for better EDA (created only if dates exist)
if "asof_date" in df.columns and "signup_date" in df.columns:
    df["tenure_days"] = (df["asof_date"] - df["signup_date"]).dt.days

if "asof_date" in df.columns and "last_login_date" in df.columns:
    df["days_since_last_login"] = (df["asof_date"] - df["last_login_date"]).

# Create a boolean auto_renew_enabled if one-hot columns exist
auto_false = "auto_renew_enabled_False"
auto_true = "auto_renew_enabled_True"
if auto_false in df.columns and auto_true in df.columns:
    def to_bool(s):
        return s.astype(str).str.lower().map({"true": True, "1": True, "yes"
    # prefer the "_True" column if clearly boolean, else fallback
    df["auto_renew_enabled"] = to_bool(df[auto_true]) | (~to_bool(df[auto_fa
elif "auto_renew_enabled" in df.columns:
    df["auto_renew_enabled"] = df["auto_renew_enabled"].astype(str).str.lowe
else:
    # No auto-renew columns, skip silently
    pass

print(f"Rows: {len(df):,} | Columns: {df.shape[1]}")
display(df.head(8))
df.head(0)
```

```
Rows: 15,419 | Columns: 16
```

```
/tmp/ipython-input-3963511587.py:33: FutureWarning: Downcasting object dtype
arrays on .fillna, .ffill, .bfill is deprecated and will change in a future
version. Call result.infer_objects(copy=False) instead. To opt-in to the fut
ure behavior, set `pd.set_option('future.no_silent_downcasting', True)`
  return s.astype(str).str.lower().map({"true": True, "1": True, "yes": Tru
e}).fillna(False)
/tmp/ipython-input-3963511587.py:33: FutureWarning: Downcasting object dtype
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/tmp/ipython-input-3963511587.py:33: FutureWarning: Downcasting object dtype
arrays on .fillna, .ffill, .bfill is deprecated and will change in a future
version. Call result.infer_objects(copy=False) instead. To opt-in to the fut
ure behavior, set `pd.set_option('future.no_silent_downcasting', True)`
  return s.astype(str).str.lower().map({"true": True, "1": True, "yes": Tru
e}).fillna(False)
```

	customer_id	asof_date	signup_date	last_login_date	subscripti
0	68a209a39fc554f31784b8e8	2025-08-17	2021-02-24	2020-06-24	
1	68a209a39fc554f31784b8e9	2025-08-17	2020-09-04	2025-02-09	
2	68a209a39fc554f31784b8ea	2025-08-17	2021-05-15	2022-12-06	
3	68a209a39fc554f31784b8eb	2025-08-17	2025-02-15	2024-03-25	
4	68a209a39fc554f31784b8ec	2025-08-17	2025-06-18	2024-03-25	
5	68a209a39fc554f31784b8ed	2025-08-17	2024-12-08	NaT	
6	68a209a39fc554f31784b8ee	2025-08-17	2022-01-02	2021-03-27	
7	68a209a39fc554f31784b8ef	2025-08-17	2022-02-07	2020-07-19	

Out[2]:

customer_id	asof_date	signup_date	last_login_date	subscription_plan_le	n

In [3]:
```python
# === SUMMARY CELL ===
print("dtypes:")
print(df.dtypes)

print("\nMissing values (count & %):")
miss = df.isna().sum().to_frame("missing_count")
miss["missing_pct"] = (miss["missing_count"] / len(df)).round(4)
display(miss.sort_values("missing_count", ascending=False))

# Numeric summary
num_cols = df.select_dtypes(include=[np.number]).columns.tolist()
if num_cols:
    print("\nNumeric columns summary (describe):")
    display(df[num_cols].describe().T)

# Class balance for churned
if "churned" in df.columns:
    vc = df["churned"].value_counts(dropna=False).sort_index()
    print("\nChurn class balance (counts):")
    display(vc.to_frame("count"))
    print("\nChurn class balance (ratio):")
    display((vc / len(df)).to_frame("ratio"))
```

```python
# Subscription plan distribution
if "subscription_plan_le" in df.columns:
    print("\nSubscription plan label distribution:")
    display(df["subscription_plan_le"].value_counts(dropna=False).sort_index
```

```
dtypes:
customer_id                             object
asof_date                       datetime64[ns]
signup_date                     datetime64[ns]
last_login_date                 datetime64[ns]
subscription_plan_le                   float64
monthly_spend                          float64
support_tickets_last_90d               float64
avg_session_length_minutes             float64
email_opens_last_30d                   float64
auto_renew_enabled_False                object
auto_renew_enabled_True                 object
churned                                float64
ingest_ts                       datetime64[ns]
tenure_days                            float64
days_since_last_login                  float64
auto_renew_enabled                        bool
dtype: object

Missing values (count & %):
```

	missing_count	missing_pct
last_login_date	489	0.0317
days_since_last_login	489	0.0317
signup_date	1	0.0001
asof_date	1	0.0001
support_tickets_last_90d	1	0.0001
monthly_spend	1	0.0001
avg_session_length_minutes	1	0.0001
subscription_plan_le	1	0.0001
churned	1	0.0001
email_opens_last_30d	1	0.0001
auto_renew_enabled_True	1	0.0001
auto_renew_enabled_False	1	0.0001
tenure_days	1	0.0001
ingest_ts	1	0.0001
customer_id	0	0.0000
auto_renew_enabled	0	0.0000

```
Numeric columns summary (describe):
```

	count	mean	std	min	25%	
subscription_plan_le	15418.0000	1.0331	0.8532	0.0000	0.0000	
monthly_spend	15418.0000	0.4997	0.2885	0.0000	0.2486	
support_tickets_last_90d	15418.0000	0.5007	0.2995	0.0000	0.2400	
avg_session_length_minutes	15418.0000	0.4950	0.2956	0.0000	0.2333	
email_opens_last_30d	15418.0000	0.5016	0.2991	0.0000	0.2400	
churned	15418.0000	0.5030	0.5000	0.0000	0.0000	
tenure_days	15418.0000	946.3302	544.0551	1.0000	480.2500	9
days_since_last_login	14930.0000	933.9242	547.7524	1.0000	454.0000	9

```
Churn class balance (counts):
```

	count
churned	
0.0000	7662
1.0000	7756
NaN	1

```
Churn class balance (ratio):
```

	ratio
churned	
0.0000	0.4969
1.0000	0.5030
NaN	0.0001

```
Subscription plan label distribution:
```

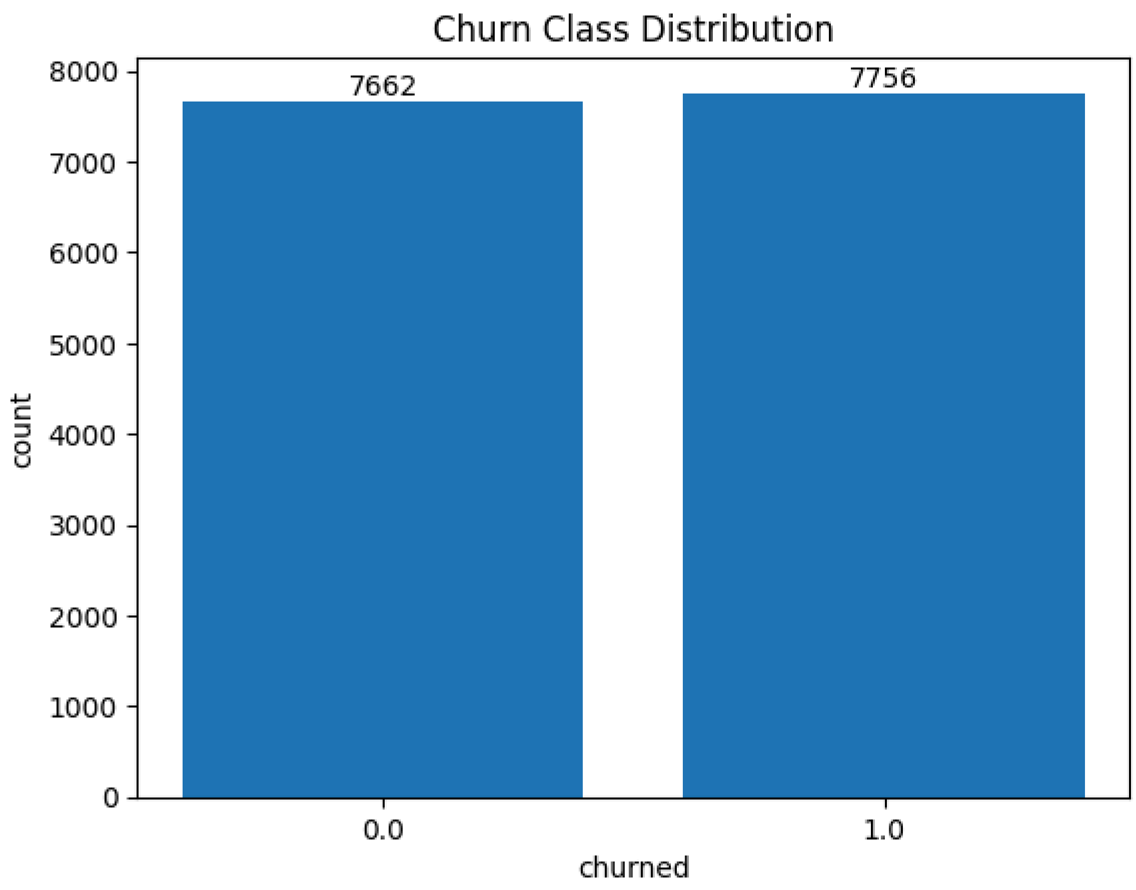
	count
subscription_plan_le	
0.0000	5073
1.0000	5052
2.0000	5002
3.0000	291
NaN	1

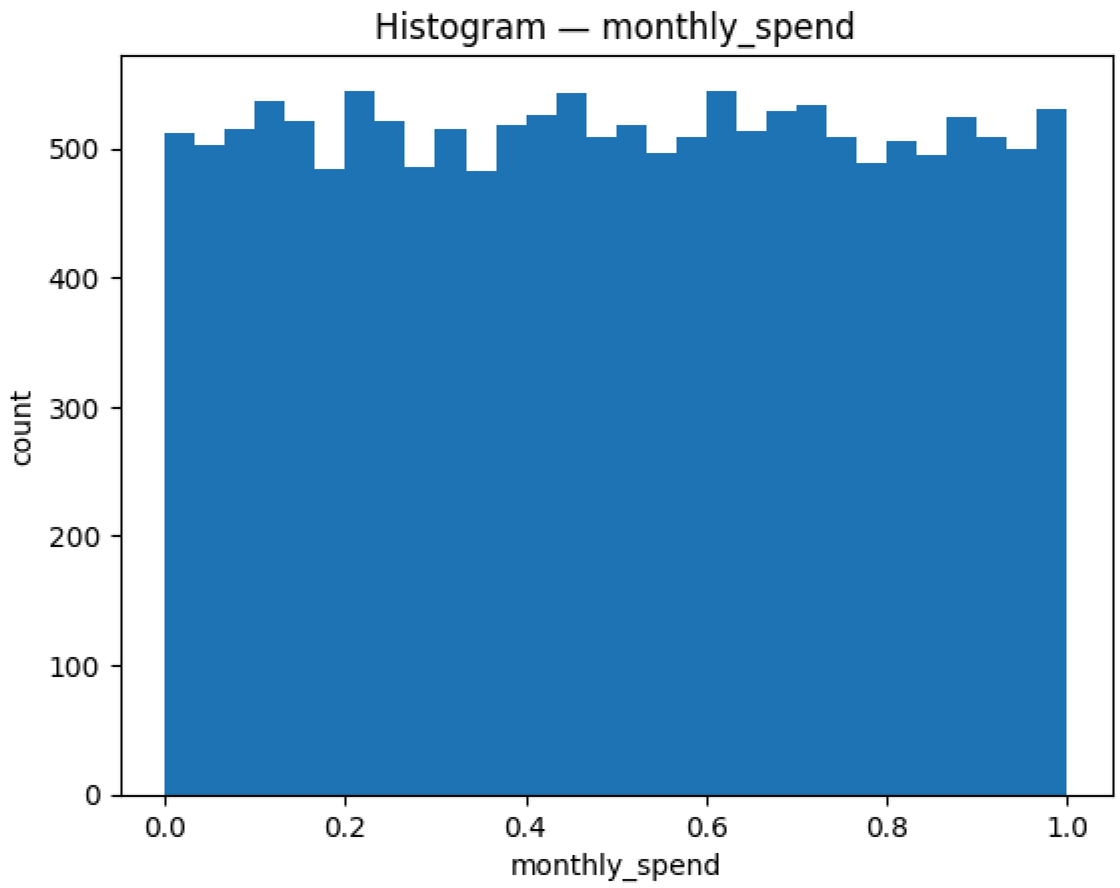
Visualizations

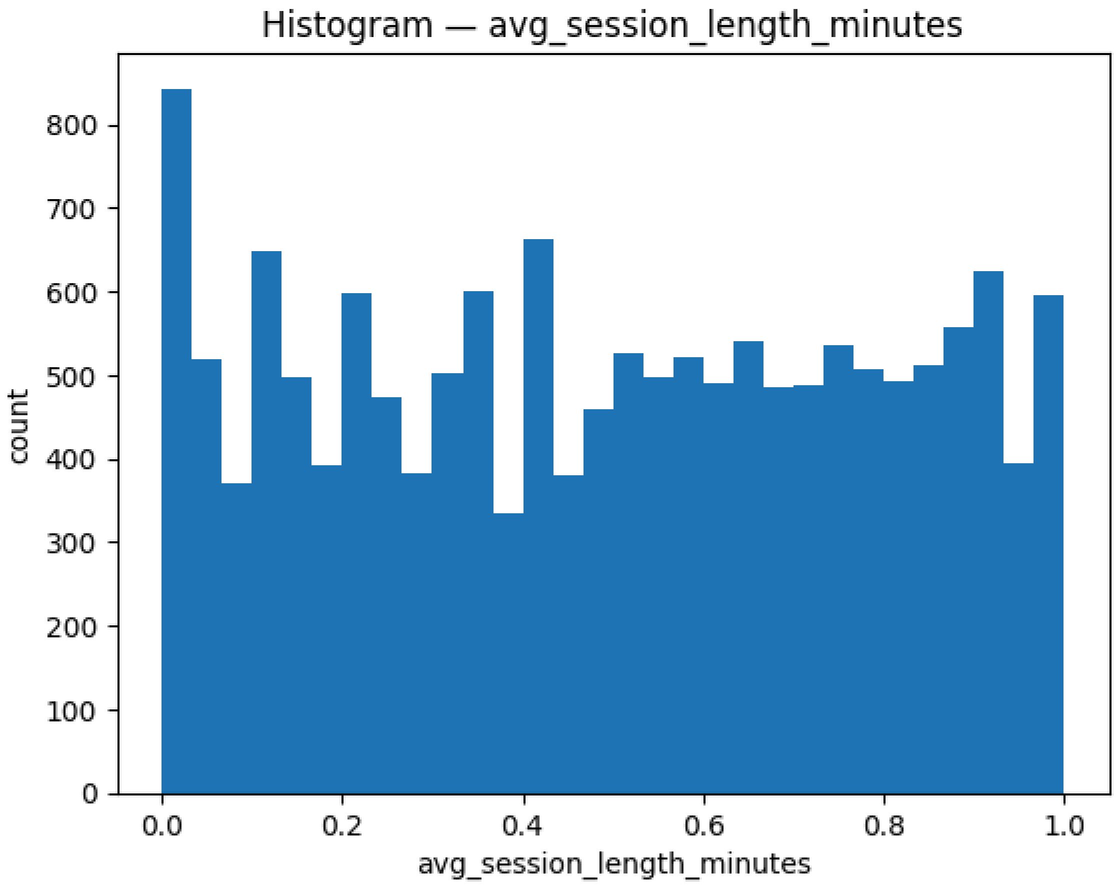
All plots below use **matplotlib** (no seaborn) and each chart is rendered on its own figure.

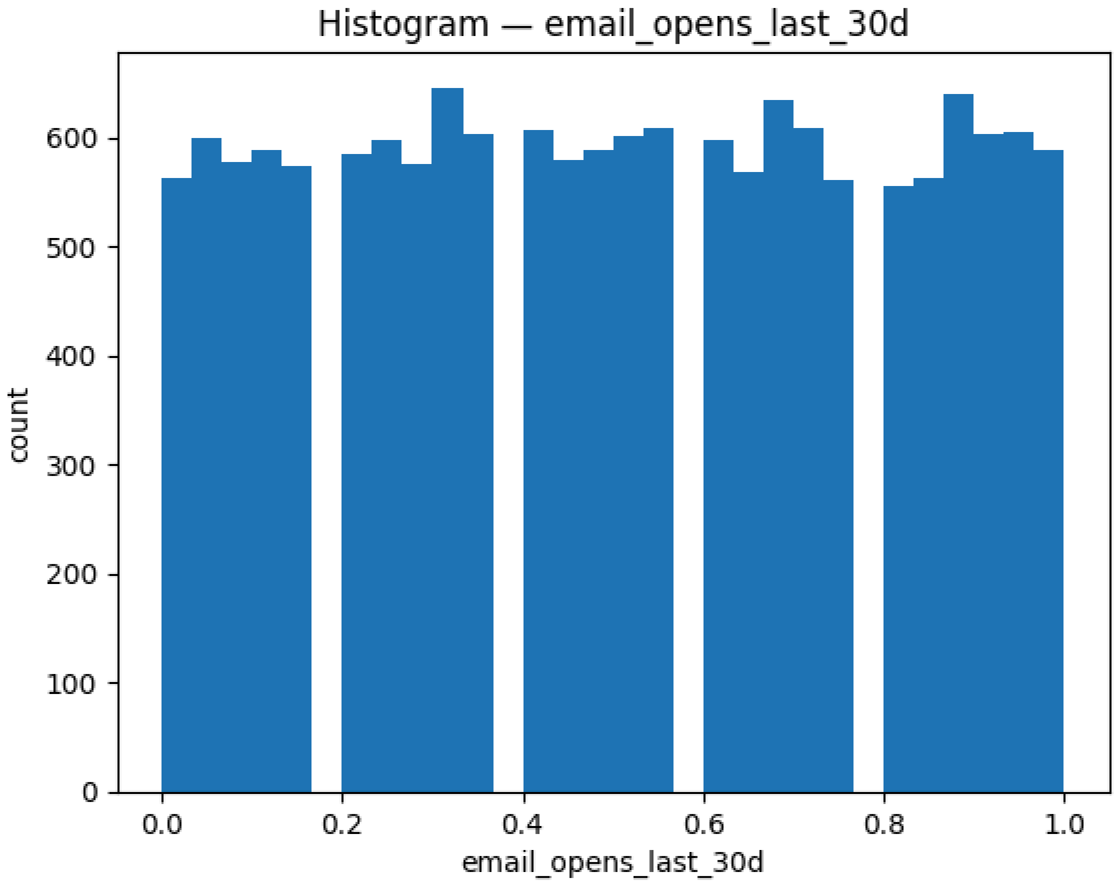
In [4]:
```
# --- Visualizations ---
import math

def safe_cols(candidates):
    return [c for c in candidates if c in df.columns]

# 1) Churn class distribution (bar)
if "churned" in df.columns:
    plt.figure()
    counts = df["churned"].value_counts().sort_index()
    plt.bar(counts.index.astype(str), counts.values)
    plt.title("Churn Class Distribution")
    plt.xlabel("churned")
    plt.ylabel("count")
    for i, v in enumerate(counts.values):
        plt.text(i, v, str(v), ha="center", va="bottom")
    plt.show()

# 2) Histograms for key numeric features (one figure per feature)
hist_candidates = safe_cols([
    "monthly_spend",
    "avg_session_length_minutes",
    "email_opens_last_30d",
    "support_tickets_last_90d",
    "tenure_days",
    "days_since_last_login"
])
for col in hist_candidates:
    plt.figure()
    plt.hist(df[col].dropna(), bins=30)
    plt.title(f"Histogram — {col}")
    plt.xlabel(col)
    plt.ylabel("count")
    plt.show()

# 3) Boxplots by churned (if churned present)
def box_by_churn(feature):
    if feature in df.columns and "churned" in df.columns:
        g0 = df.loc[df["churned"] == 0, feature].dropna()
        g1 = df.loc[df["churned"] == 1, feature].dropna()
        if len(g0) or len(g1):
            plt.figure()
            plt.boxplot([g0.values, g1.values], labels=["not churned (0)", "
            plt.title(f"Boxplot — {feature} by churned")
            plt.ylabel(feature)
            plt.show()

for feat in ["monthly_spend", "avg_session_length_minutes"]:
    box_by_churn(feat)

# 4) Churn rate by subscription plan (bar), if both present
if "subscription_plan_le" in df.columns and "churned" in df.columns:
```

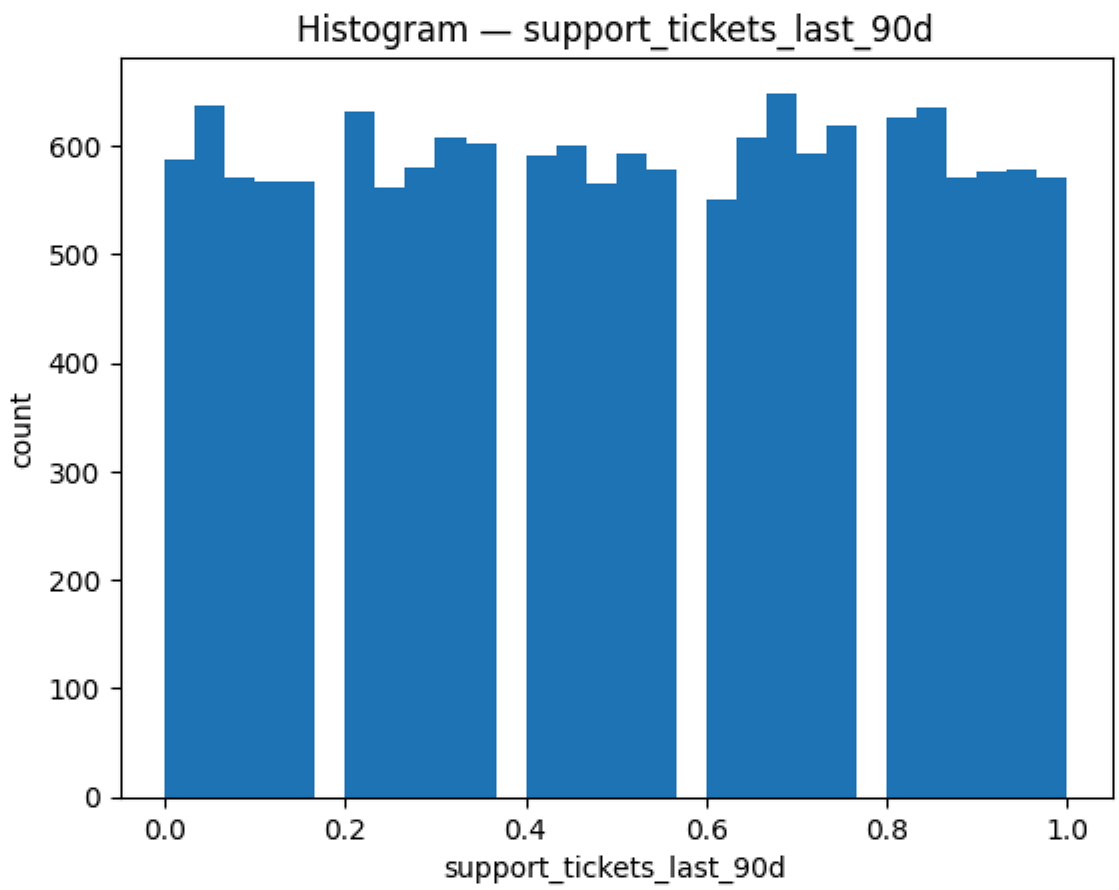
```python
    rate = df.groupby("subscription_plan_le")["churned"].mean().sort_index()
    plt.figure()
    plt.bar(rate.index.astype(str), rate.values)
    plt.title("Churn Rate by Subscription Plan (label-encoded)")
    plt.xlabel("subscription_plan_le")
    plt.ylabel("mean churn (0-1)")
    for i, v in enumerate(rate.values):
        plt.text(i, v, f"{v:.2f}", ha="center", va="bottom")
    plt.show()

# 5) Correlation heatmap for numeric features
num_cols = df.select_dtypes(include=[np.number]).columns.tolist()
if len(num_cols) >= 2:
    corr = df[num_cols].corr(numeric_only=True)
    plt.figure(figsize=(max(6, 0.6*len(num_cols)), max(5, 0.6*len(num_cols))
    im = plt.imshow(corr, interpolation='nearest')
    plt.title("Correlation Heatmap (numeric features)")
    plt.xticks(range(len(corr.columns)), corr.columns, rotation=90)
    plt.yticks(range(len(corr.columns)), corr.columns)
    plt.colorbar(im, fraction=0.046, pad=0.04)
    plt.tight_layout()
    plt.show()

# 6) Scatter: monthly_spend vs avg_session_length_minutes, colored by churne
if set(["monthly_spend", "avg_session_length_minutes", "churned"]).issubset(
    plt.figure()
    for label, subdf in df.groupby("churned"):
        plt.scatter(
            subdf["monthly_spend"],
            subdf["avg_session_length_minutes"],
            s=12, alpha=0.7, label=f"churned={int(label)}"
        )
    plt.title("Monthly Spend vs. Avg Session Length (by churned)")
    plt.xlabel("monthly_spend")
    plt.ylabel("avg_session_length_minutes")
    plt.legend()
    plt.show()
```

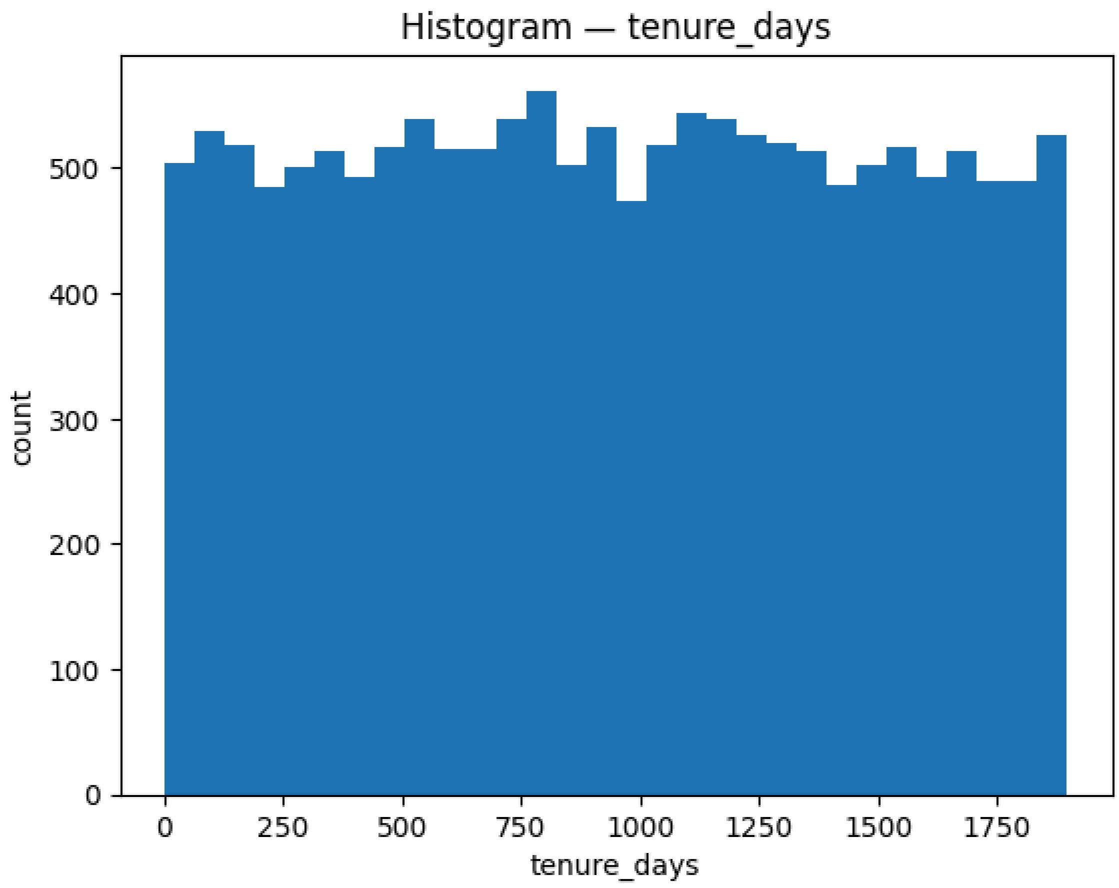

Churn Class Distribution
7662
7756
count
8000
7000
6000
5000
4000
3000
2000
1000
0
0.0
1.0
churned

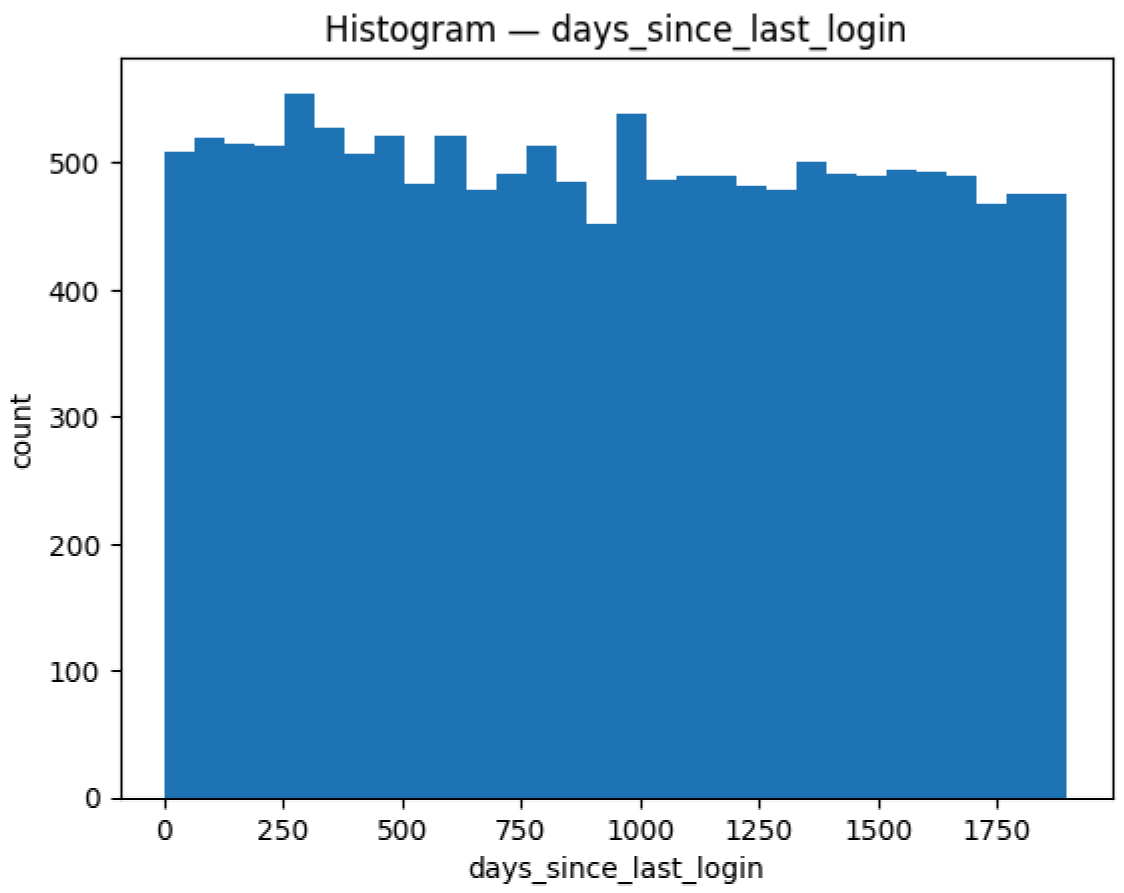

Histogram — monthly_spend
count
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
1.0
monthly_spend


Histogram — avg_session_length_minutes
count
800
700
600
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
1.0
avg_session_length_minutes

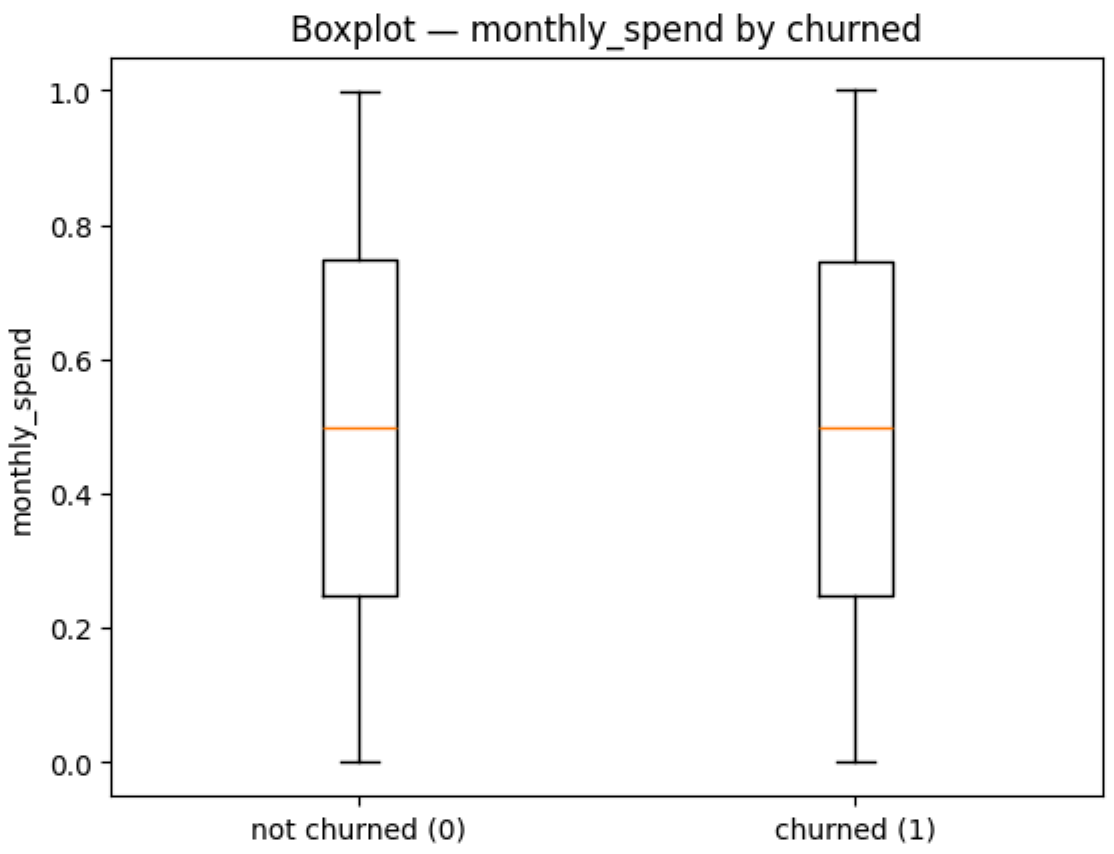

Histogram — email_opens_last_30d
count
600
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
1.0
email_opens_last_30d


Histogram — support_tickets_last_90d
count
0
100
200
300
400
500
600
0.0
0.2
0.4
0.6
0.8
1.0
support_tickets_last_90d

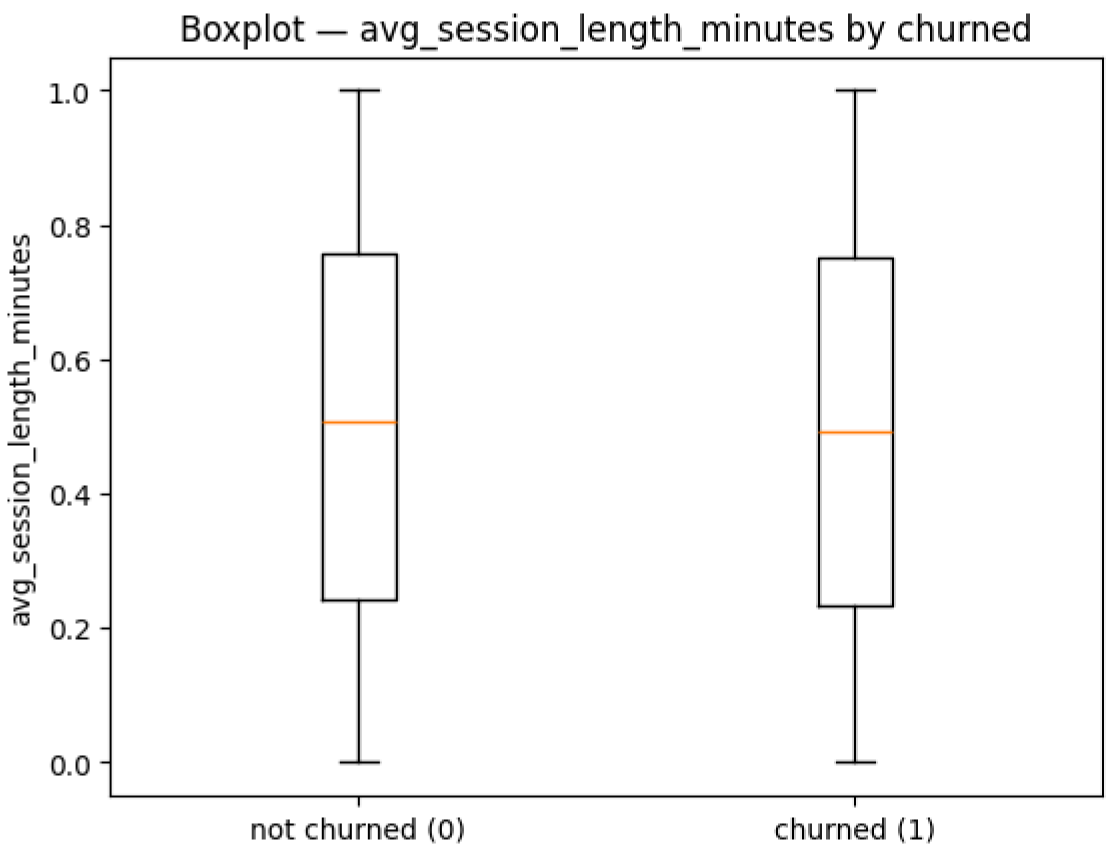

Histogram — tenure_days
count
0
100
200
300
400
500
0
250
500
750
1000
1250
1500
1750
tenure_days

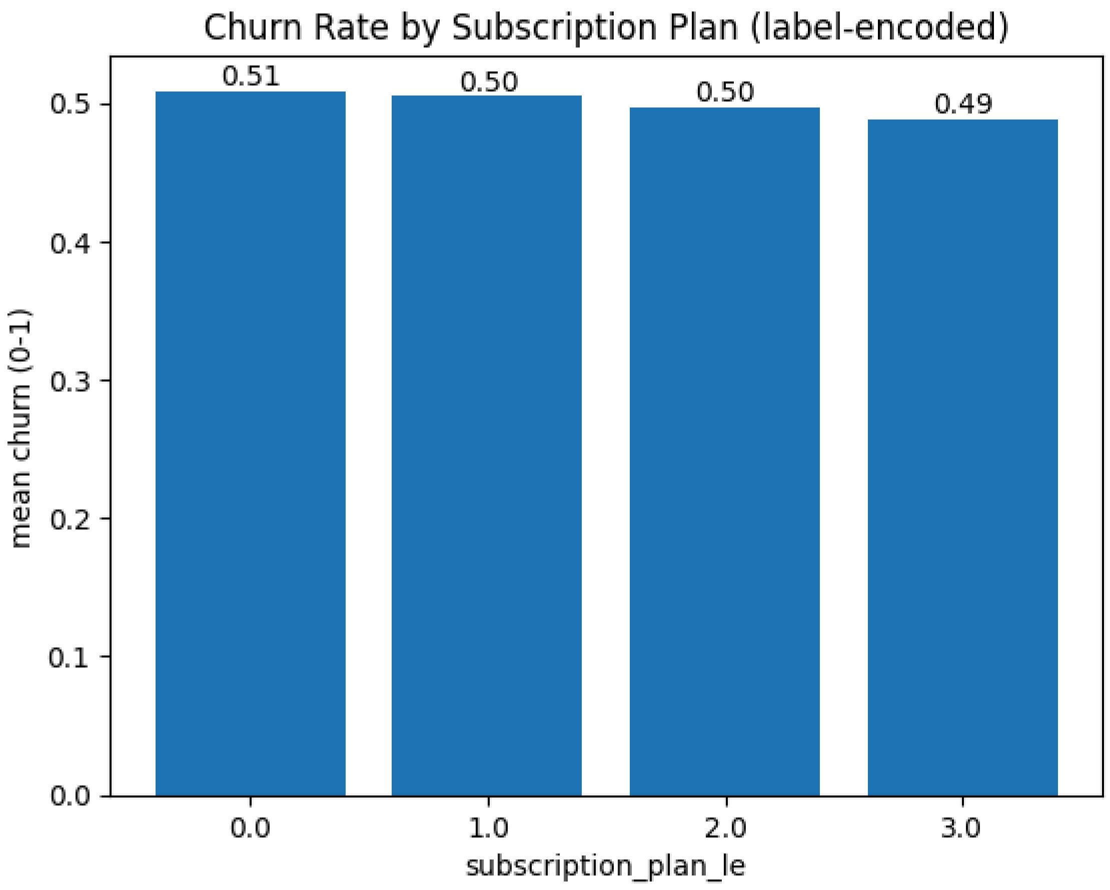


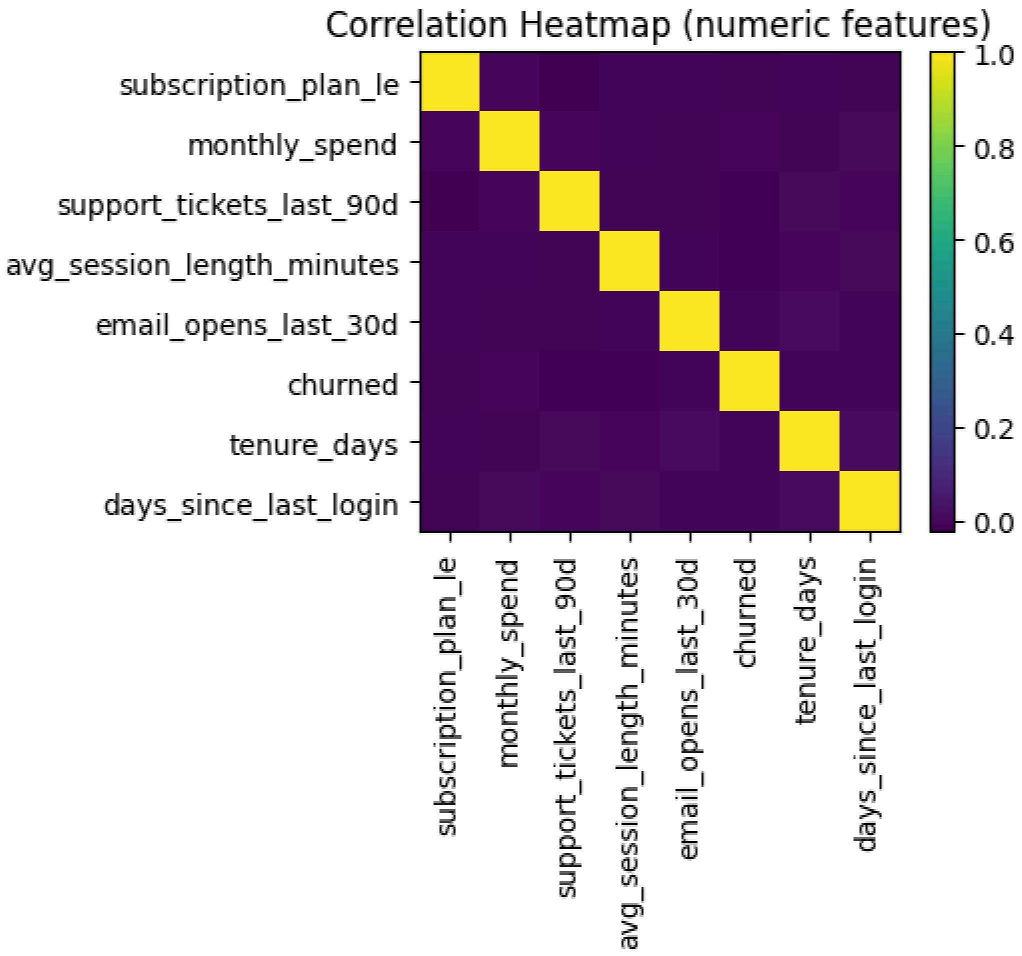
```
/tmp/ipython-input-1396662106.py:43: MatplotlibDeprecationWarning: The 'labe
ls' parameter of boxplot() has been renamed 'tick_labels' since Matplotlib
3.9; support for the old name will be dropped in 3.11.
  plt.boxplot([g0.values, g1.values], labels=["not churned (0)", "churned
(1)"])
```

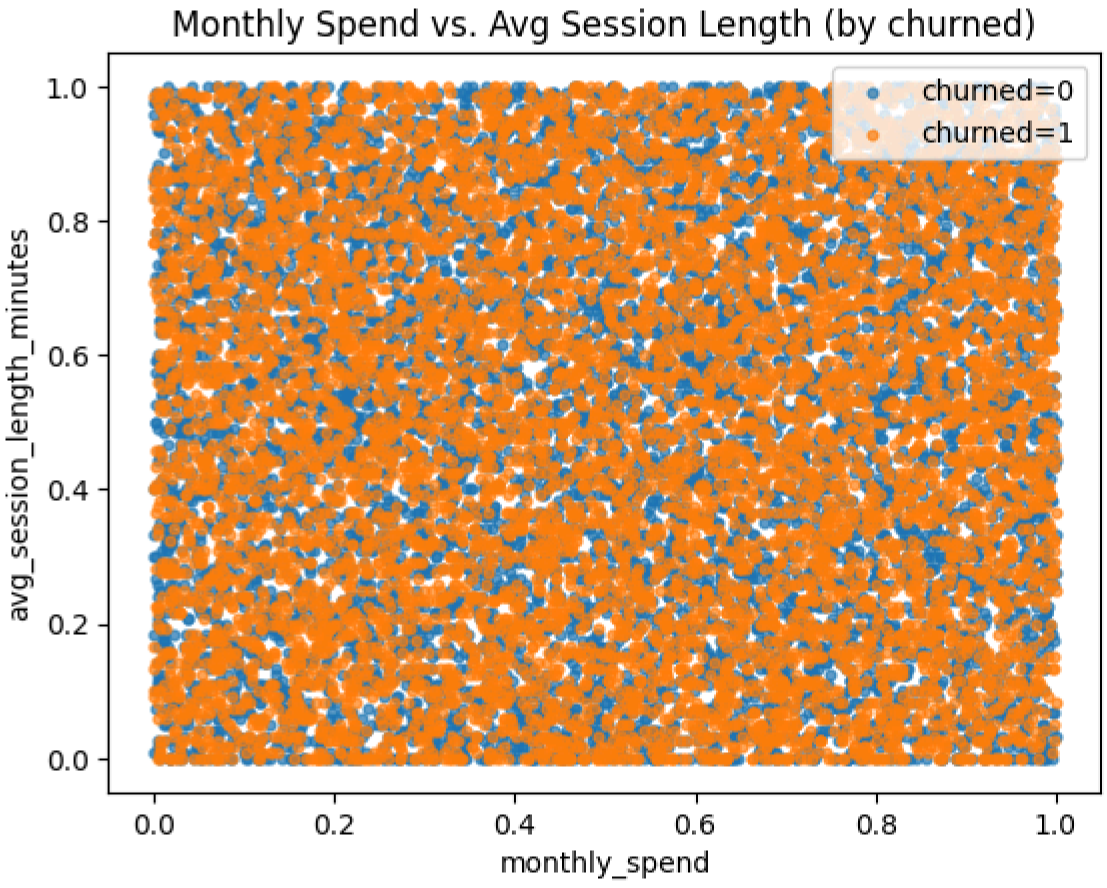


```
/tmp/ipython-input-1396662106.py:43: MatplotlibDeprecationWarning: The 'labe
ls' parameter of boxplot() has been renamed 'tick_labels' since Matplotlib
3.9; support for the old name will be dropped in 3.11.
  plt.boxplot([g0.values, g1.values], labels=["not churned (0)", "churned
(1)"])
```


Boxplot — avg_session_length_minutes by churned
avg_session_length_minutes
1.0
0.8
0.6
0.4
0.2
0.0
not churned (0)
churned (1)


Churn Rate by Subscription Plan (label-encoded)
mean churn (0-1)
0.51
0.50
0.50
0.49
0.0
1.0
2.0
3.0
subscription_plan_le


Correlation Heatmap (numeric features)
subscription_plan_le
monthly_spend
support_tickets_last_90d
avg_session_length_minutes
email_opens_last_30d
churned
tenure_days
days_since_last_login
1.0
0.8
0.6
0.4
0.2
0.0


Monthly Spend vs. Avg Session Length (by churned)
churned=0
churned=1
avg_session_length_minutes
monthly_spend
0.0
0.2
0.4
0.6
0.8
1.0