Forecasting Unit Sales (Task 1)

In [98]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from datetime import datetime
import xgboost as xgb
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import train_test_split, GridSearchCV
import warnings
warnings.filterwarnings('ignore')

color_pal = sns.color_palette()
%matplotlib inline
```

In [99]:

```
train_df = pd.read_csv('train.csv')
test_df = pd.read_csv('test.csv')
```

Step 1: Data Loading and Initial Inspection(Training Data)

In [100…

```
train_df.head()
```

Out[100…

	ID	date	Item Id	Item Name	ad_spend	anarix_id	units
0	2022-04-12_B09KDTS4DC	2022-04-12	B09KDTS4DC	NapQueen Elizabeth 8" Gel Memory Foam Mattress...	NaN	NAPQUEEN	0.0
1	2022-04-12_B09MR2MLZH	2022-04-12	B09MR2MLZH	NapQueen 12 Inch Bamboo Charcoal Queen Size Me...	NaN	NAPQUEEN	0.0
2	2022-04-12_B09KSYL73R	2022-04-12	B09KSYL73R	NapQueen Elsa 8" Innerspring Mattress, Twin XL	NaN	NAPQUEEN	0.0
3	2022-04-12_B09KT5HMNY	2022-04-12	B09KT5HMNY	NapQueen Elsa 6" Innerspring Mattress, Twin	NaN	NAPQUEEN	0.0
4	2022-04-12_B09KTF8ZDQ	2022-04-12	B09KTF8ZDQ	NapQueen Elsa 6" Innerspring Mattress, Twin XL	NaN	NAPQUEEN	0.0

In [101…

```
train_df.tail()
```

Out[101…

	ID	date	Item Id	Item Name	ad_spend	anarix_id	uni
101485	2024-05-31_B0CR4BGLK5	2024-05-31	B0CR4BGLK5	NaN	604.73	NAPQUEEN	Na
101486	2024-05-31_B0CR4BG4ZW	2024-05-31	B0CR4BG4ZW	NaN	261.21	NAPQUEEN	2
101487	2024-05-31_B0CR49NR3B	2024-05-31	B0CR49NR3B	NaN	0.00	NAPQUEEN	Na
101488	2024-05-31_B0CR49N6MQ	2024-05-31	B0CR49N6MQ	NaN	0.00	NAPQUEEN	Na
101489	2024-05-31_B0CR4BK4FW	2024-05-31	B0CR4BK4FW	NaN	0.00	NAPQUEEN	Na

In [102…

```
train_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 101490 entries, 0 to 101489
Data columns (total 8 columns):
 #   Column      Non-Null Count   Dtype  
---  ------      --------------   -----  
 0   ID          101490 non-null  object 
 1   date        101490 non-null  object 
 2   Item Id     101488 non-null  object 
 3   Item Name   99658 non-null   object 
 4   ad_spend    77303 non-null   float64
 5   anarix_id   101490 non-null  object 
 6   units       83592 non-null   float64
 7   unit_price  101490 non-null  float64
dtypes: float64(3), object(5)
memory usage: 6.2+ MB
```

In [103…

```
train_df.describe()
```

Out[103…

	ad_spend	units	unit_price
count	77303.000000	83592.000000	101490.000000
mean	110.771470	10.284381	106.750922
std	529.303777	68.945915	425.704733
min	0.000000	-173.000000	-8232.000000
25%	0.000000	0.000000	0.000000
50%	4.230000	1.000000	0.000000
75%	44.310000	5.000000	0.000000
max	47934.990000	9004.000000	21557.390000

In [104…

```
train_df.isnull().sum()
```

Out[104…

```
ID                0
date              0
Item Id           2
Item Name      1832
ad_spend      24187
anarix_id         0
units         17898
unit_price        0
dtype: int64
```

In [105…

```
print("Unique values in 'ID':", train_df['ID'].nunique())
print("Unique values in 'Item Id':", train_df['Item Id'].nunique())
print("Unique values in 'Item Name':", train_df['Item Name'].nunique())
```

```
Unique values in 'ID': 101490
Unique values in 'Item Id': 217
Unique values in 'Item Name': 199
```

Step 2: Data Loading and Initial Inspection(Testing Data)

In [106…

```
test_df.head()
```

Out[106…

	ID	date	Item Id	Item Name	ad_spend	anarix_id	unit_
0	2024-07-01_B09KDR64LT	2024-07-01	B09KDR64LT	NapQueen Elizabeth 10" Gel Memory Foam Mattres...	NaN	NAPQUEEN	
1	2024-07-01_B09KDTS4DC	2024-07-01	B09KDTS4DC	NapQueen Elizabeth 8" Gel Memory Foam Mattress...	NaN	NAPQUEEN	
2	2024-07-01_B09KDTHJ6V	2024-07-01	B09KDTHJ6V	NapQueen Elizabeth 12" Gel Memory Foam Mattres...	NaN	NAPQUEEN	
3	2024-07-01_B09KDQ2BWY	2024-07-01	B09KDQ2BWY	NapQueen Elizabeth 12" Gel Memory Foam Mattres...	NaN	NAPQUEEN	
4	2024-07-01_B09KDYY3SB	2024-07-01	B09KDYY3SB	NapQueen Elizabeth 10" Gel Memory Foam Mattres...	101.72	NAPQUEEN	1

In [107…

```
test_df.tail()
```

Out[107…

	ID	date	Item Id	Item Name	ad_spend	anarix_id	u
2828	2024-07-28_B0BRCW2B64	2024-07-28	B0BRCW2B64	NapQueen Anula Green Tea 12'', Queen	11.78	NAPQUEEN	
2829	2024-07-28_B0CFV6V981	2024-07-28	B0CFV6V981	NaN	1.17	NAPQUEEN	
2830	2024-07-28_B0BNL5BKMK	2024-07-28	B0BNL5BKMK	NapQueen 2'' Bamboo Charcoal Mattress Topper, ...	0.00	NAPQUEEN	
2831	2024-07-28_B0CR49BQRS	2024-07-28	B0CR49BQRS	NaN	1.87	NAPQUEEN	
2832	2024-07-28_B0CY5QQ49F	2024-07-28	B0CY5QQ49F	NaN	1.45	NAPQUEEN	

In [108…

```
test_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2833 entries, 0 to 2832
Data columns (total 7 columns):
 #   Column      Non-Null Count  Dtype  
---  ------      --------------  -----  
 0   ID          2833 non-null   object 
 1   date        2833 non-null   object 
 2   Item Id     2833 non-null   object 
 3   Item Name   2489 non-null   object 
 4   ad_spend    1382 non-null   float64
 5   anarix_id   2833 non-null   object 
 6   unit_price  2833 non-null   float64
dtypes: float64(2), object(5)
memory usage: 155.1+ KB
```

In [109…

```
test_df.describe()
```

Out[109…

	ad_spend	unit_price
count	1382.000000	2833.000000
mean	198.838032	98.725873
std	797.354508	383.585307
min	0.000000	-1988.180000
25%	0.730000	0.000000
50%	39.200000	0.000000
75%	156.012500	0.000000
max	18724.850000	6870.000000

In [110…

```
test_df.isnull().sum()
```

Out[110…

```
ID              0
date            0
Item Id         0
Item Name     344
ad_spend     1451
anarix_id       0
unit_price      0
dtype: int64
```

In [111…

```
print("\nUnique values in 'Item Id':", test_df['Item Id'].nunique())
print("Unique values in 'Item Name':", test_df['Item Name'].nunique())
```

```
Unique values in 'Item Id': 155
Unique values in 'Item Name': 142
```

STEP 3: DATA PRE PROCESSING

In [112…

```
#CLEAN TRAIN DATA

train_df['date'] = pd.to_datetime(train_df['date'])

train_df = train_df.sort_values(['Item Id', 'date'])
```

In [113…

```
train_df = train_df.dropna(subset=['Item Id'])
```

In [114…

```
train_df['ad_spend'] = train_df['ad_spend'].fillna(0)
train_df['units'] = train_df['units'].fillna(0)
```

In [115…

```
train_df['Item Name'] = train_df['Item Name'].fillna('Unknown')
```

In [116…

```
train_df['units'] = train_df['units'].clip(lower=0)
train_df['unit_price'] = train_df['unit_price'].clip(lower=0)
```

```
train_df['missing_name'] = train_df['Item Name'].apply(lambda x: 1 if x =
```

In [117…

```
print("Rows in dataset after cleaning:", len(train_df))
print("\nMissing values after cleaning:")
print(train_df.isnull().sum())
print("\nDataset info after cleaning:")
train_df.info()
```

```
Rows in dataset after cleaning: 101488

Missing values after cleaning:
ID              0
date            0
Item Id         0
Item Name       0
ad_spend        0
anarix_id       0
units           0
unit_price      0
missing_name    0
dtype: int64

Dataset info after cleaning:
<class 'pandas.core.frame.DataFrame'>
Index: 101488 entries, 62967 to 101466
Data columns (total 9 columns):
 #   Column        Non-Null Count   Dtype
---  ------        --------------   -----
 0   ID            101488 non-null  object
 1   date          101488 non-null  datetime64[ns]
 2   Item Id       101488 non-null  object
 3   Item Name     101488 non-null  object
 4   ad_spend      101488 non-null  float64
 5   anarix_id     101488 non-null  object
 6   units         101488 non-null  float64
 7   unit_price    101488 non-null  float64
 8   missing_name  101488 non-null  int64
dtypes: datetime64[ns](1), float64(3), int64(1), object(4)
memory usage: 7.7+ MB
```

In [118…

```
print("\nBasic statistics after cleaning:")
print(train_df.describe())
```

```
Basic statistics after cleaning:
                                date       ad_spend          units  \
count                         101488  101488.000000  101488.000000   
mean   2023-07-09 19:09:44.297651200      84.374182       8.511105   
min              2022-04-12 00:00:00       0.000000       0.000000   
25%              2023-02-26 00:00:00       0.000000       0.000000   
50%              2023-07-16 00:00:00       0.720000       0.000000   
75%              2023-12-13 00:00:00      21.642500       3.000000   
max              2024-05-31 00:00:00   47934.990000    9004.000000   
std                              NaN     464.354660      62.680788   

          unit_price   missing_name  
count  101488.000000  101488.000000  
mean      107.256203       0.018032  
min         0.000000       0.000000  
25%         0.000000       0.000000  
50%         0.000000       0.000000  
75%         0.000000       0.000000  
max     21557.390000       1.000000  
std       424.513596       0.133067  
```

In [119…

```
# CLEANING TEST DATA
```

In [120…

```
test_df.head()
```

Out[120…

	ID	date	Item Id	Item Name	ad_spend	anarix_id	unit_
0	2024-07-01_B09KDR64LT	2024-07-01	B09KDR64LT	NapQueen Elizabeth 10" Gel Memory Foam Mattres...	NaN	NAPQUEEN	
1	2024-07-01_B09KDTS4DC	2024-07-01	B09KDTS4DC	NapQueen Elizabeth 8" Gel Memory Foam Mattress...	NaN	NAPQUEEN	
2	2024-07-01_B09KDTHJ6V	2024-07-01	B09KDTHJ6V	NapQueen Elizabeth 12" Gel Memory Foam Mattres...	NaN	NAPQUEEN	
3	2024-07-01_B09KDQ2BWY	2024-07-01	B09KDQ2BWY	NapQueen Elizabeth 12" Gel Memory Foam Mattres...	NaN	NAPQUEEN	
4	2024-07-01_B09KDYY3SB	2024-07-01	B09KDYY3SB	NapQueen Elizabeth 10" Gel Memory Foam Mattres...	101.72	NAPQUEEN	1

In [121…

```
test_df['date'] = pd.to_datetime(test_df['date'])
```

In [122…

```
test_df['ad_spend'] = test_df['ad_spend'].fillna(0)
```

In [123…

```
test_df['Item Name'] = test_df['Item Name'].fillna('Unknown')
```

In [124…

```
test_df['unit_price'] = test_df['unit_price'].clip(lower=0)

test_df['missing_name'] = test_df['Item Name'].apply(lambda x: 1 if x ==
```

In [125…

```
print("Rows in dataset after cleaning:", len(test_df))
print("\nMissing values after cleaning:")
print(test_df.isnull().sum())
print("\nDataset info after cleaning:")
test_df.info()
```

```
Rows in dataset after cleaning: 2833

Missing values after cleaning:
ID              0
date            0
Item Id         0
Item Name       0
ad_spend        0
anarix_id       0
unit_price      0
missing_name    0
dtype: int64

Dataset info after cleaning:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2833 entries, 0 to 2832
Data columns (total 8 columns):
 #   Column        Non-Null Count  Dtype         
---  ------        --------------  -----         
 0   ID            2833 non-null   object        
 1   date          2833 non-null   datetime64[ns]
 2   Item Id       2833 non-null   object        
 3   Item Name     2833 non-null   object        
 4   ad_spend      2833 non-null   float64       
 5   anarix_id     2833 non-null   object        
 6   unit_price    2833 non-null   float64       
 7   missing_name  2833 non-null   int64         
dtypes: datetime64[ns](1), float64(2), int64(1), object(4)
memory usage: 177.2+ KB
```

In [126…

```
print("\nBasic statistics after cleaning:")
print(test_df.describe())
```

```
Basic statistics after cleaning:
                                date      ad_spend   unit_price  missing_n
ame
count                           2833   2833.000000  2833.000000   2833.000
000
mean   2024-07-13 16:54:33.420402176     96.997586   100.667754      0.121
426
min              2024-07-01 00:00:00      0.000000     0.000000      0.000
000
25%              2024-07-07 00:00:00      0.000000     0.000000      0.000
000
50%              2024-07-14 00:00:00      0.000000     0.000000      0.000
000
75%              2024-07-20 00:00:00     36.030000     0.000000      0.000
000
max              2024-07-28 00:00:00  18724.850000  6870.000000      1.000
000
std                              NaN    565.607189   379.505541      0.326
679
```

STEP 4: EDA (Exploratory Data Analysis)

In [127…

```
# Basic info
print("Train dataset shape:", train_df.shape)
print("Test dataset shape:", test_df.shape)

print("\nTrain dataset columns:")
print(train_df.columns)
print("\nTest dataset columns:")
print(test_df.columns)

print("\nTrain dataset info:")
train_df.info()

print("\nTest dataset info:")
test_df.info()
```

```
Train dataset shape: (101488, 9)
Test dataset shape: (2833, 8)

Train dataset columns:
Index(['ID', 'date', 'Item Id', 'Item Name', 'ad_spend', 'anarix_id', 'uni
ts',
       'unit_price', 'missing_name'],
      dtype='object')

Test dataset columns:
Index(['ID', 'date', 'Item Id', 'Item Name', 'ad_spend', 'anarix_id',
       'unit_price', 'missing_name'],
      dtype='object')

Train dataset info:
<class 'pandas.core.frame.DataFrame'>
Index: 101488 entries, 62967 to 101466
Data columns (total 9 columns):
 #   Column        Non-Null Count   Dtype
---  ------        --------------   -----
 0   ID            101488 non-null  object
 1   date          101488 non-null  datetime64[ns]
 2   Item Id       101488 non-null  object
 3   Item Name     101488 non-null  object
 4   ad_spend      101488 non-null  float64
 5   anarix_id     101488 non-null  object
 6   units         101488 non-null  float64
 7   unit_price    101488 non-null  float64
 8   missing_name  101488 non-null  int64
dtypes: datetime64[ns](1), float64(3), int64(1), object(4)
memory usage: 7.7+ MB

Test dataset info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2833 entries, 0 to 2832
Data columns (total 8 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   ID            2833 non-null   object
 1   date          2833 non-null   datetime64[ns]
 2   Item Id       2833 non-null   object
 3   Item Name     2833 non-null   object
 4   ad_spend      2833 non-null   float64
 5   anarix_id     2833 non-null   object
 6   unit_price    2833 non-null   float64
 7   missing_name  2833 non-null   int64
dtypes: datetime64[ns](1), float64(2), int64(1), object(4)
memory usage: 177.2+ KB
```

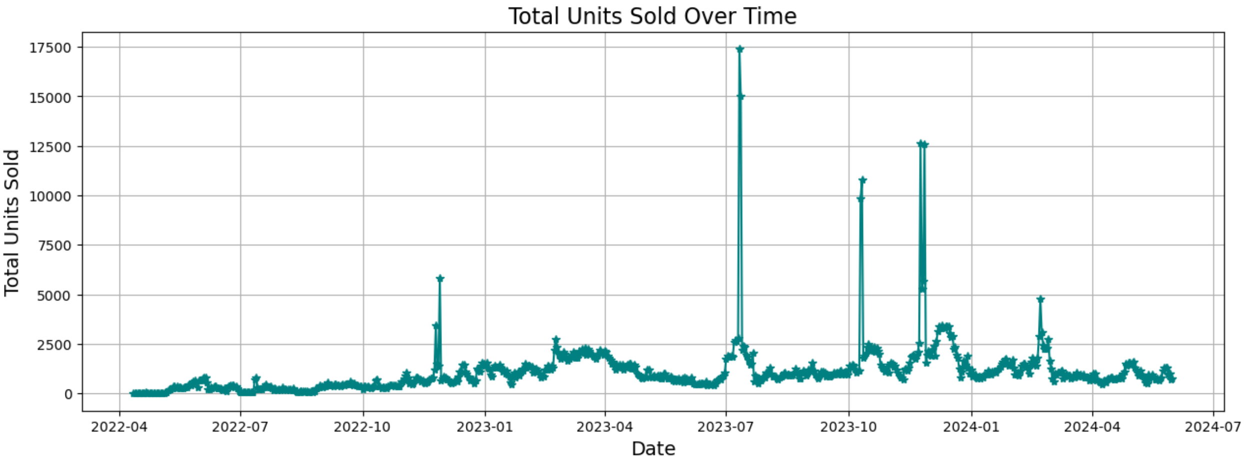
In [128…

```
print(train_df.describe())

# Check for missing values
print(train_df.isnull().sum())
print(test_df.isnull().sum())
```

```
                                date       ad_spend          units  \
count                         101488  101488.000000  101488.000000   
mean   2023-07-09 19:09:44.297651200      84.374182       8.511105   
min              2022-04-12 00:00:00       0.000000       0.000000   
25%              2023-02-26 00:00:00       0.000000       0.000000   
50%              2023-07-16 00:00:00       0.720000       0.000000   
75%              2023-12-13 00:00:00      21.642500       3.000000   
max              2024-05-31 00:00:00   47934.990000    9004.000000   
std                              NaN     464.354660      62.680788   

          unit_price   missing_name  
count  101488.000000  101488.000000  
mean      107.256203       0.018032  
min         0.000000       0.000000  
25%         0.000000       0.000000  
50%         0.000000       0.000000  
75%         0.000000       0.000000  
max     21557.390000       1.000000  
std       424.513596       0.133067  
ID              0
date            0
Item Id         0
Item Name       0
ad_spend        0
anarix_id       0
units           0
unit_price      0
missing_name    0
dtype: int64
ID              0
date            0
Item Id         0
Item Name       0
ad_spend        0
anarix_id       0
unit_price      0
missing_name    0
dtype: int64
```

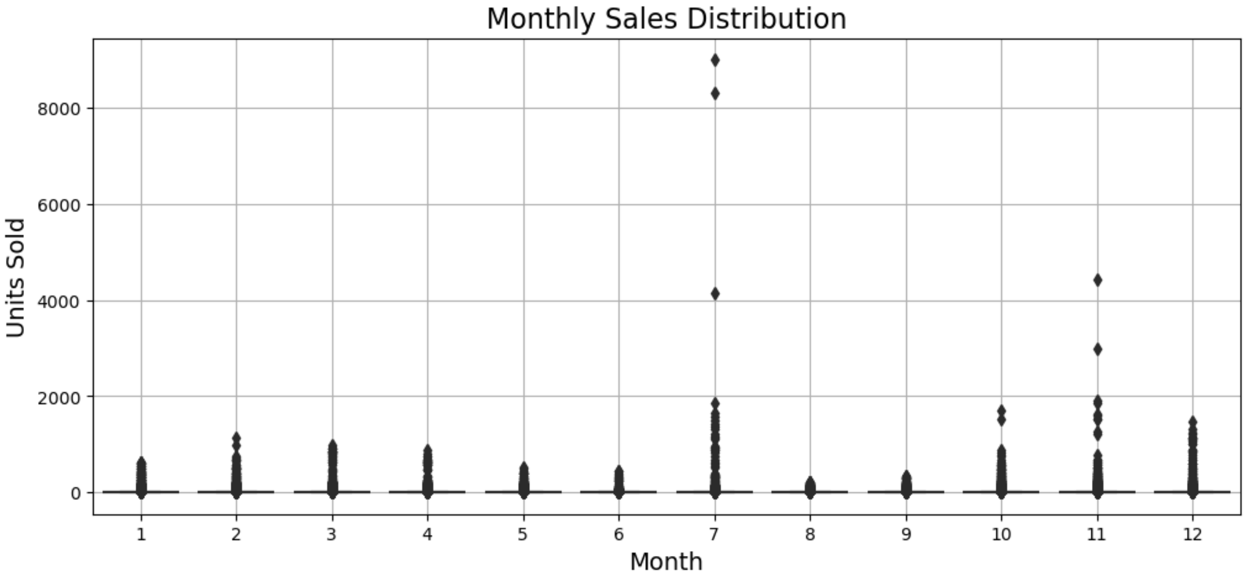
In [129…

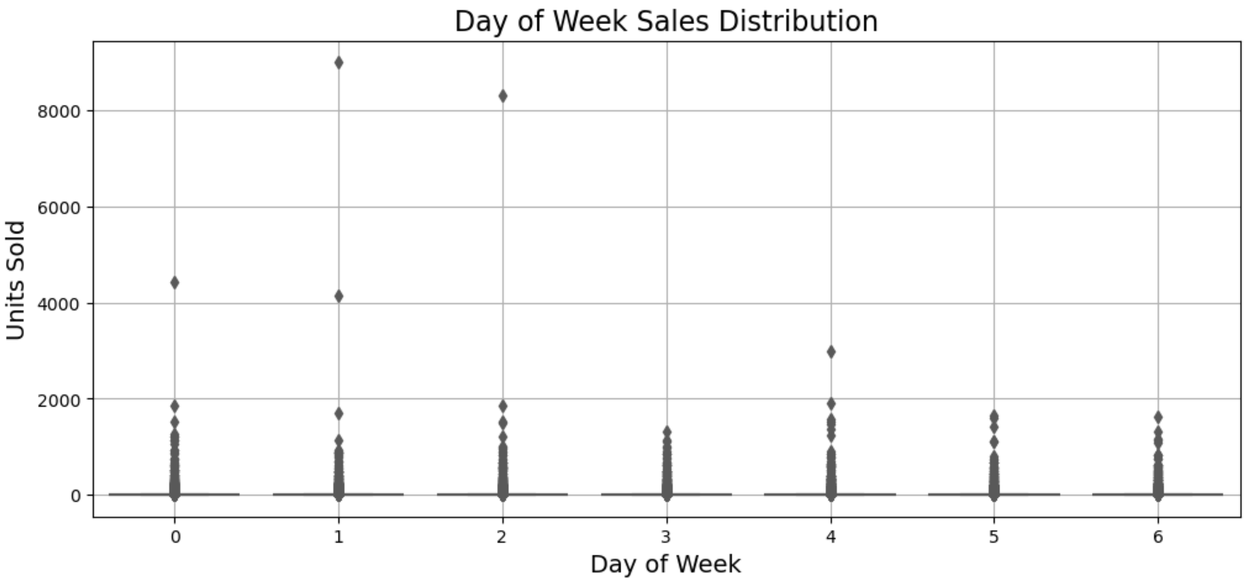
```
train_df['date'] = pd.to_datetime(train_df['date'])
test_df['date'] = pd.to_datetime(test_df['date'])

plt.figure(figsize=(15,5))
plt.plot(train_df.groupby('date')['units'].sum(), color='teal', linestyle
plt.title('Total Units Sold Over Time', fontsize=16)
plt.xlabel('Date', fontsize=14)
plt.ylabel('Total Units Sold', fontsize=14)
plt.grid(True)
plt.show()
```



In [130…

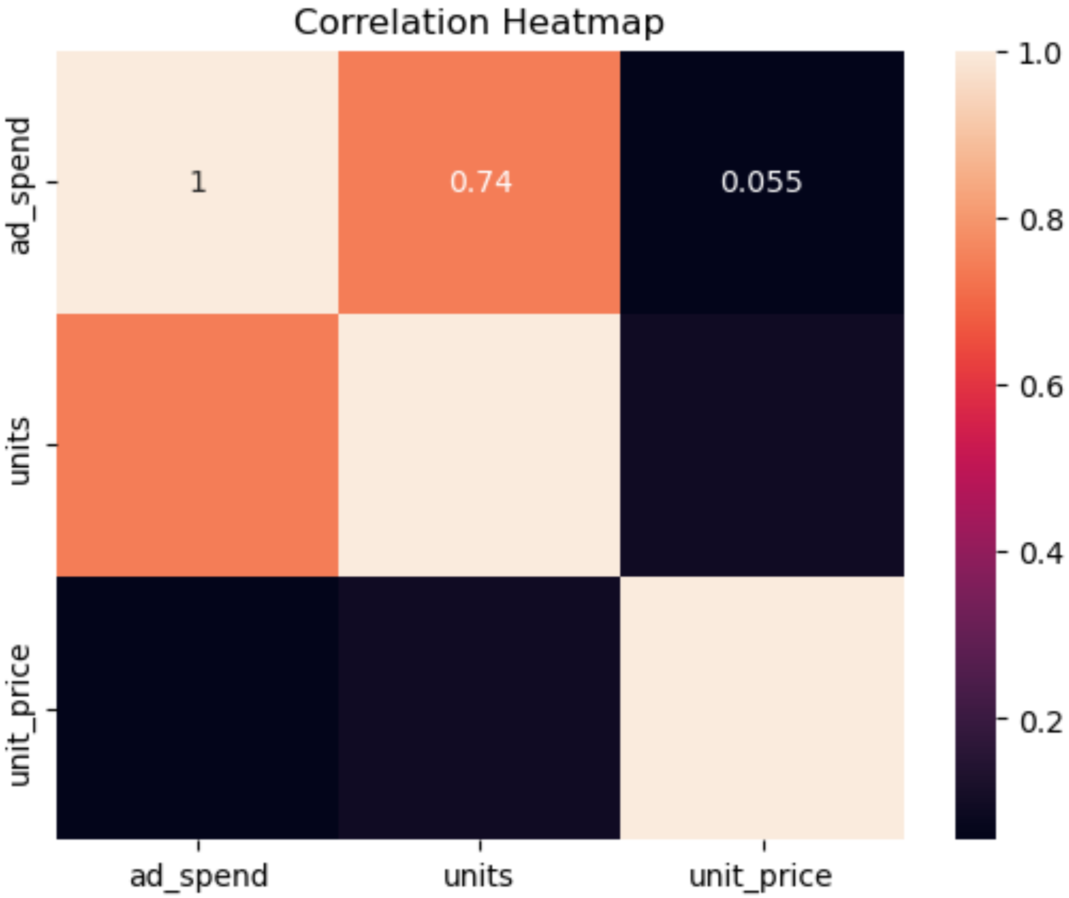
```
#seasonality
train_df['month'] = train_df['date'].dt.month
train_df['day_of_week'] = train_df['date'].dt.dayofweek

plt.figure(figsize=(12,5))
sns.boxplot(x='month', y='units', data=train_df, palette='Blues')
plt.title('Monthly Sales Distribution', fontsize=16)
plt.xlabel('Month', fontsize=14)
plt.ylabel('Units Sold', fontsize=14)
plt.grid(True)
plt.show()

plt.figure(figsize=(12,5))
sns.boxplot(x='day_of_week', y='units', data=train_df, palette='coolwarm'
plt.title('Day of Week Sales Distribution', fontsize=16)
plt.xlabel('Day of Week', fontsize=14)
plt.ylabel('Units Sold', fontsize=14)
plt.grid(True)
plt.show()
```





In [131…

```
# correlation analysis
corr = train_df[['ad_spend', 'units', 'unit_price']].corr()
sns.heatmap(corr, annot=True)
plt.title('Correlation Heatmap')
plt.show()
```



In [132…

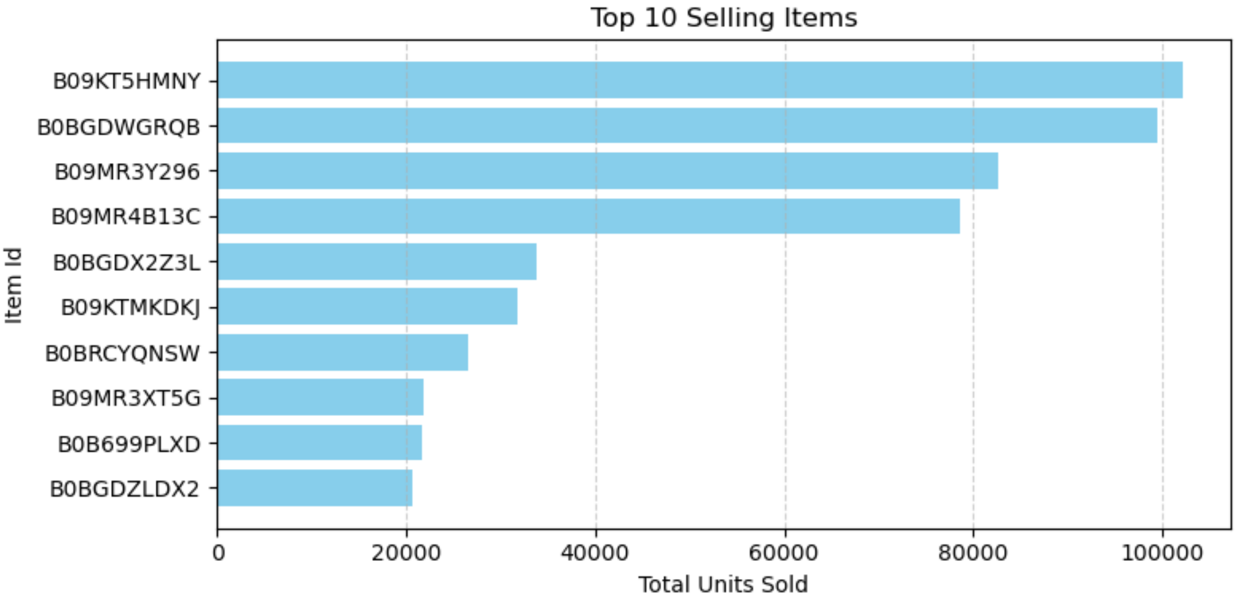
```
#item analysis
#top selling items
top_items = train_df.groupby('Item Id')['units'].sum().nlargest(10)
print("Top 10 selling items:", top_items)
```

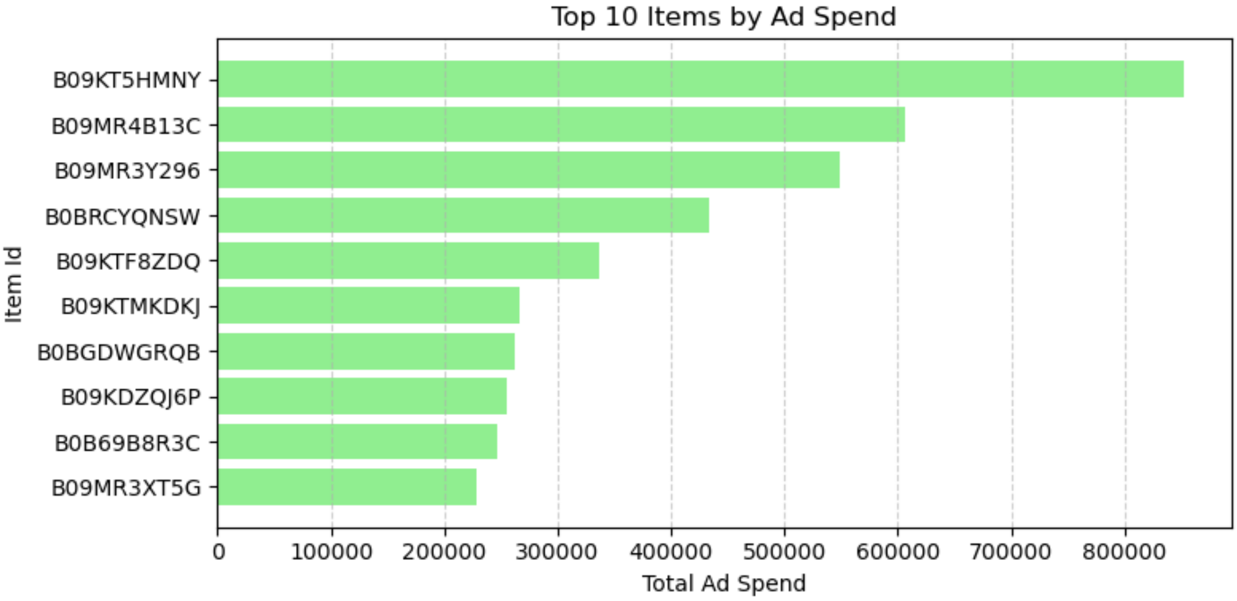
```

#items with highest ad spend
top_ad_spend = train_df.groupby('Item Id')['ad_spend'].sum().nlargest(10)
print("\nTop 10 items by ad spend:", top_ad_spend)
```

```
Top 10 selling items: Item Id
B09KT5HMNY    102149.0
B0BGDWGRQB     99586.0
B09MR3Y296     82697.0
B09MR4B13C     78548.0
B0BGDX2Z3L     33810.0
B09KTMKDKJ     31790.0
B0BRCYQNSW     26531.0
B09MR3XT5G     21815.0
B0B699PLXD     21622.0
B0BGDZLDX2     20691.0
Name: units, dtype: float64

Top 10 items by ad spend: Item Id
B09KT5HMNY    851785.25
B09MR4B13C    607033.59
B09MR3Y296    548484.97
B0BRCYQNSW    434229.75
B09KTF8ZDQ    336946.80
B09KTMKDKJ    266972.17
B0BGDWGRQB    262212.18
B09KDZQJ6P    255192.82
B0B69B8R3C    247132.75
B09MR3XT5G    227750.13
Name: ad_spend, dtype: float64
```

In [133…

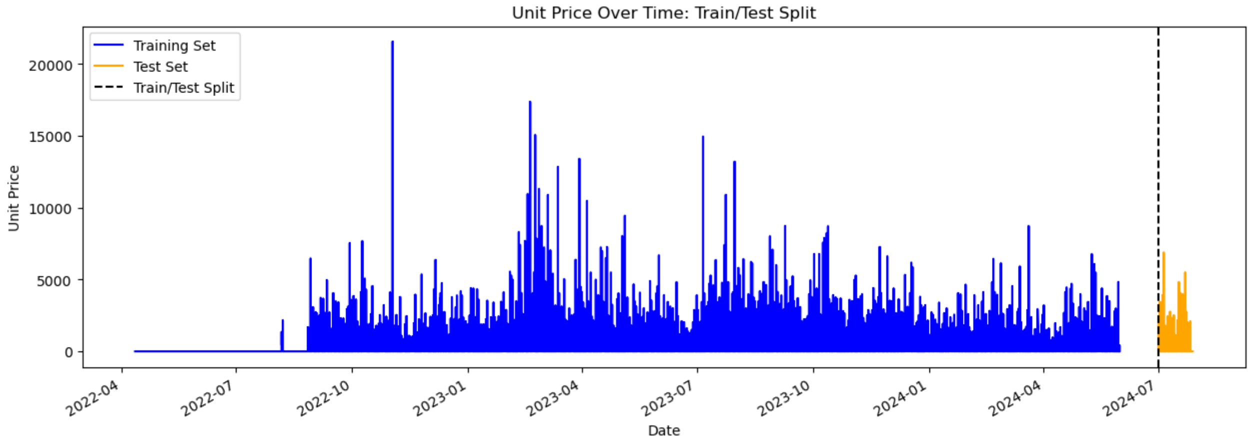
```
#horizontal bar graph for top selling items
plt.figure(figsize=(8, 4))
plt.barh(top_items.index, top_items.values, color='skyblue')
plt.xlabel('Total Units Sold')
plt.ylabel('Item Id')
plt.title('Top 10 Selling Items')
plt.gca().invert_yaxis()  # Invert y-axis to display top item at the top
plt.grid(axis='x', linestyle='--', alpha=0.6)
plt.tight_layout()
plt.show()

#horizontal bar graph for items with highest ad spend
plt.figure(figsize=(8, 4))
plt.barh(top_ad_spend.index, top_ad_spend.values, color='lightgreen')
plt.xlabel('Total Ad Spend')
plt.ylabel('Item Id')
plt.title('Top 10 Items by Ad Spend')
plt.gca().invert_yaxis()  # Invert y-axis to display top item at the top
plt.grid(axis='x', linestyle='--', alpha=0.6)
plt.tight_layout()
plt.show()
```





In [134…

```
#unitprice over time (train and test split)

train_df['date'] = pd.to_datetime(train_df['date'])
test_df['date'] = pd.to_datetime(test_df['date'])

fig, ax = plt.subplots(figsize=(15, 5))
train_df.plot(x='date', y='unit_price', ax=ax, label='Training Set', colo
test_df.plot(x='date', y='unit_price', ax=ax, label='Test Set', color='or
ax.axvline(pd.Timestamp('2024-07-01'), color='black', linestyle='--')
ax.set_title('Unit Price Over Time: Train/Test Split')
ax.set_xlabel('Date')
ax.set_ylabel('Unit Price')
ax.legend(['Training Set', 'Test Set','Train/Test Split'])

plt.show()
```



STEP 5: FEATURE CREATION

In [135…

```
print(train_df.columns)
```

```
Index(['ID', 'date', 'Item Id', 'Item Name', 'ad_spend', 'anarix_id', 'uni
ts',
       'unit_price', 'missing_name', 'month', 'day_of_week'],
      dtype='object')
```

In [136…

```
print(test_df.columns)
```

```
Index(['ID', 'date', 'Item Id', 'Item Name', 'ad_spend', 'anarix_id',
       'unit_price', 'missing_name'],
      dtype='object')
```

In [137…

```
train_df['date'] = pd.to_datetime(train_df['date'])
test_df['date'] = pd.to_datetime(test_df['date'])
```

In [138…

```
def create_features(df):
    if 'date' not in df.columns:
        raise ValueError("DataFrame must contain a 'date' column")

    df['date'] = pd.to_datetime(df['date'])

    df['day_of_week'] = df['date'].dt.dayofweek
    df['month'] = df['date'].dt.month
    df['quarter'] = df['date'].dt.quarter
    df['year'] = df['date'].dt.year
    df['is_weekend'] = df['day_of_week'].isin([5, 6]).astype(int)
    return df

train_df = create_features(train_df)
```

In [139…

```
train_df = create_features(train_df)
test_df = create_features(test_df)
```

In [140…

```
features = ['day_of_week', 'month', 'quarter', 'year', 'is_weekend']
```

In [141…

```
print(train_df.columns)
```

```
Index(['ID', 'date', 'Item Id', 'Item Name', 'ad_spend', 'anarix_id', 'uni
ts',
       'unit_price', 'missing_name', 'month', 'day_of_week', 'quarter', 'y
ear',
       'is_weekend'],
      dtype='object')
```

In [142…

```
print(test_df.columns)
```

```
Index(['ID', 'date', 'Item Id', 'Item Name', 'ad_spend', 'anarix_id',
       'unit_price', 'missing_name', 'day_of_week', 'month', 'quarter', 'y
ear',
       'is_weekend'],
      dtype='object')
```

In [143…

```
column_to_drop = ['ad_spend']
train_df = train_df.drop(columns=column_to_drop, errors='ignore')
test_df = test_df.drop(columns=column_to_drop, errors='ignore')

print(f"Train dataset shape: {train_df.shape}")
print(f"Test dataset shape: {test_df.shape}")
```

```
Train dataset shape: (101488, 13)
Test dataset shape: (2833, 12)
```

In [144…

```
print("Shape of dataset after feature engineering:", train_df.shape)
print("\nNew features added:")
print(train_df[['month', 'day_of_week', 'quarter', 'year',
       'is_weekend']].head())
```

```
Shape of dataset after feature engineering: (101488, 13)

New features added:
       month  day_of_week  quarter  year  is_weekend
62967      9            0        3  2023           0
65359     10            1        4  2023           0
69206     11            3        4  2023           0
767        5            3        2  2022           0
812        5            4        2  2022           0
```

In [145…

```
train_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 101488 entries, 62967 to 101466
Data columns (total 13 columns):
 #   Column        Non-Null Count   Dtype         
---  ------        --------------   -----         
 0   ID            101488 non-null  object        
 1   date          101488 non-null  datetime64[ns]
 2   Item Id       101488 non-null  object        
 3   Item Name     101488 non-null  object        
 4   anarix_id     101488 non-null  object        
 5   units         101488 non-null  float64       
 6   unit_price    101488 non-null  float64       
 7   missing_name  101488 non-null  int64         
 8   month         101488 non-null  int32         
 9   day_of_week   101488 non-null  int32         
 10  quarter       101488 non-null  int32         
 11  year          101488 non-null  int32         
 12  is_weekend    101488 non-null  int64         
dtypes: datetime64[ns](1), float64(2), int32(4), int64(2), object(4)
memory usage: 9.3+ MB
```

In [146…

```
train_df.describe()
```

Out[146…

	date	units	unit_price	missing_name	
count	101488	101488.000000	101488.000000	101488.000000	101488.0
mean	2023-07-09 19:09:44.297651200	8.511105	107.256203	0.018032	6.0
min	2022-04-12 00:00:00	0.000000	0.000000	0.000000	1.0
25%	2023-02-26 00:00:00	0.000000	0.000000	0.000000	3.0
50%	2023-07-16 00:00:00	0.000000	0.000000	0.000000	6.0
75%	2023-12-13 00:00:00	3.000000	0.000000	0.000000	9.0
max	2024-05-31 00:00:00	9004.000000	21557.390000	1.000000	12.0
std	NaN	62.680788	424.513596	0.133067	3.4

In [147…

```
train_df.isnull().sum()
```

Out[147…

```
ID              0
date            0
Item Id         0
Item Name       0
anarix_id       0
units           0
unit_price      0
missing_name    0
month           0
day_of_week     0
quarter         0
year            0
is_weekend      0
dtype: int64
```

In [148…

```
test_df.isnull().sum()
```

Out[148…

```
ID              0
date            0
Item Id         0
Item Name       0
anarix_id       0
unit_price      0
missing_name    0
day_of_week     0
month           0
quarter         0
year            0
is_weekend      0
dtype: int64
```

In [149…

```
print("Shape of dataset after feature engineering:", train_df.shape)
print("\nNew features added:")
print(train_df[['month', 'day_of_week', 'quarter', 'year',]].head())
```

```
Shape of dataset after feature engineering: (101488, 13)

New features added:
       month  day_of_week  quarter  year
62967      9            0        3  2023
65359     10            1        4  2023
69206     11            3        4  2023
767        5            3        2  2022
812        5            4        2  2022
```

In [150…

```
print("Shape of dataset after feature engineering:", test_df.shape)
print("\nNew features added:")
print(test_df[['month', 'day_of_week', 'quarter', 'year',
       'is_weekend']].head())
```

```
Shape of dataset after feature engineering: (2833, 12)

New features added:
   month  day_of_week  quarter  year  is_weekend
0      7            0        3  2024           0
1      7            0        3  2024           0
2      7            0        3  2024           0
3      7            0        3  2024           0
4      7            0        3  2024           0
```

STEP 6: MODEL SELECTION

In [151…

```
train_df['date'] = pd.to_datetime(train_df['date'])
test_df['date'] = pd.to_datetime(test_df['date'])
```

b. XGBoost

In [152…

```
print(train_df.columns)
```

```
Index(['ID', 'date', 'Item Id', 'Item Name', 'anarix_id', 'units',
       'unit_price', 'missing_name', 'month', 'day_of_week', 'quarter', 'y
ear',
       'is_weekend'],
      dtype='object')
```

In [153…

```
print(test_df.columns)
```

```
Index(['ID', 'date', 'Item Id', 'Item Name', 'anarix_id', 'unit_price',
       'missing_name', 'day_of_week', 'month', 'quarter', 'year',
       'is_weekend'],
      dtype='object')
```

In [154…

```
# Separate features and target variable from training data
X_train = train_df[features]
y_train = train_df['units']
```

In [155…

```
X_test = test_df[features]
```

In [156…

```
model = xgb.XGBRegressor(
    subsample=0.7,
    n_estimators=1000,
    min_child_weight=3,
    max_depth=3,
    learning_rate=0.01
)
```

In [157…

```
model.fit(X_train, y_train)
```

Out[157…

```
▾                         XGBRegressor
XGBRegressor(base_score=None, booster=None, callbacks=None,
             colsample_bylevel=None, colsample_bynode=None,
             colsample_bytree=None, device=None, early_stopping_r
ounds=None,
             enable_categorical=False, eval_metric=None, feature_
types=None,
             gamma=None, grow_policy=None, importance_type=None,
             interaction_constraints=None, learning_rate=0.01, ma
x_bin=None,
```

In [158…

```
model.fit(
    X_train, y_train,
    eval_set=[(X_train, y_train)],
    verbose=100
)
```

```
[0]	validation_0-rmse:62.67904
[100]	validation_0-rmse:62.61096
[200]	validation_0-rmse:62.58460
[300]	validation_0-rmse:62.57098
[400]	validation_0-rmse:62.56220
[500]	validation_0-rmse:62.55689
[600]	validation_0-rmse:62.55265
[700]	validation_0-rmse:62.54844
[800]	validation_0-rmse:62.54572
[900]	validation_0-rmse:62.54352
[999]	validation_0-rmse:62.54133
```

Out[158…

```
▾                         XGBRegressor
XGBRegressor(base_score=None, booster=None, callbacks=None,
             colsample_bylevel=None, colsample_bynode=None,
             colsample_bytree=None, device=None, early_stopping_r
ounds=None,
             enable_categorical=False, eval_metric=None, feature_
types=None,
             gamma=None, grow_policy=None, importance_type=None,
             interaction_constraints=None, learning_rate=0.01, ma
x_bin=None,
```

In [159…

```
test_df['units_pred'] = model.predict(X_test)
```

In [160…

```
submission = test_df[['ID']]
submission['Target'] = test_df['units_pred']
```

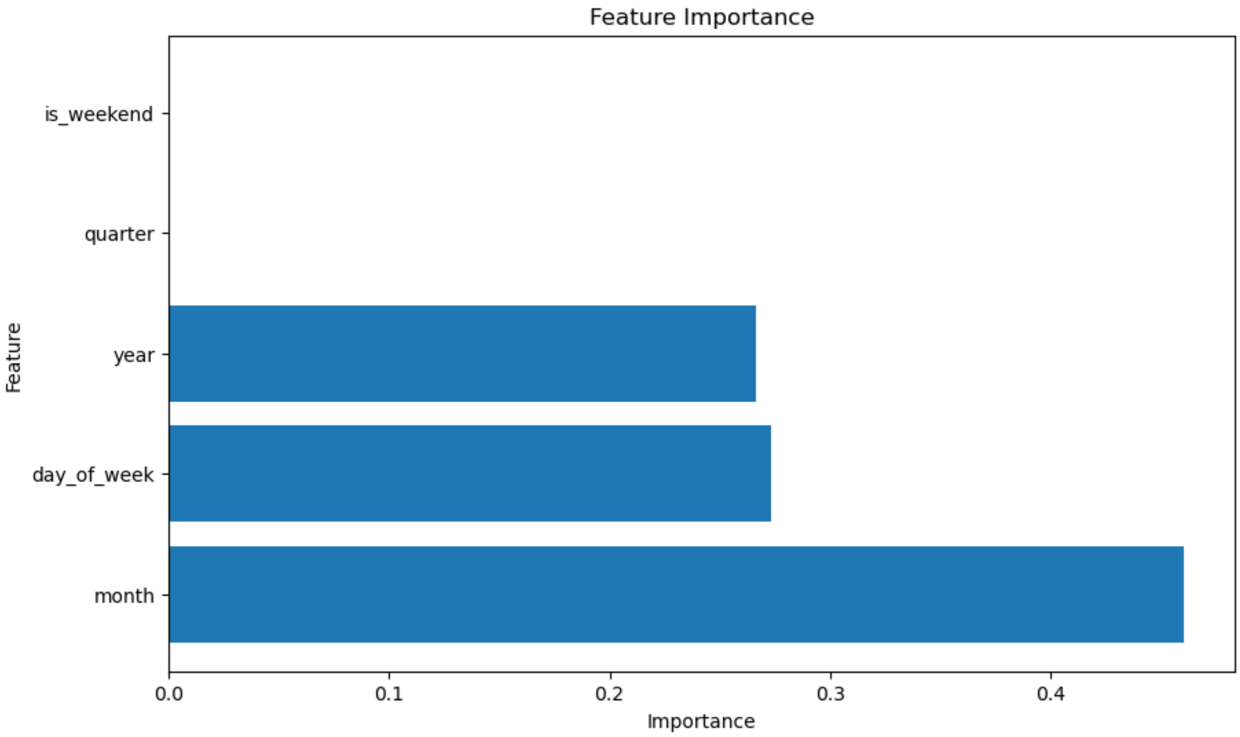
In [161…

```
submission.to_csv('submission.csv', index=False)
print("Submission file created successfully!")
```

```
Submission file created successfully!
```

In [162…

```
feature_importance = model.feature_importances_
importance_df = pd.DataFrame({
    'Feature': features,
    'Importance': feature_importance
})
importance_df = importance_df.sort_values(by='Importance', ascending=Fals

plt.figure(figsize=(10, 6))
plt.barh(importance_df['Feature'], importance_df['Importance'])
plt.xlabel('Importance')
plt.ylabel('Feature')
plt.title('Feature Importance')
plt.show()
```



In [163…

```
from sklearn.metrics import mean_squared_error
train_predictions = model.predict(X_train)

mse = mean_squared_error(y_train, train_predictions)

print(f"Mean Squared Error: {mse}")
```

```
Mean Squared Error: 3911.418409604966
```

PERFORMING HYPER PARAMETER TUNING

In [164…

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.metrics import mean_squared_error
from xgboost import XGBRegressor
```

In [165…

```
features = ['day_of_week', 'month', 'quarter', 'year', 'is_weekend']
target = 'units'
```

In [166…

```
X_train = train_df[features]
y_train = train_df[target]
```

In [167…

```
X_train_split, X_val, y_train_split, y_val = train_test_split(X_train, y_
```

In [168…

```
xgb = XGBRegressor()
```

In [169…

```
# Hyperparameter tuning
param_grid = {
    'n_estimators': [100, 200],
    'learning_rate': [0.01, 0.1],
    'max_depth': [3, 5],
    'min_child_weight': [1, 3],
    'subsample': [0.7, 1.0],
    'colsample_bytree': [0.7, 1.0]
}
```

In [170…

```
grid_search = GridSearchCV(estimator=xgb, param_grid=param_grid, scoring=
grid_search.fit(X_train_split, y_train_split)
```

```
Fitting 3 folds for each of 64 candidates, totalling 192 fits
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
```

```
weight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.3s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.3s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
```

```
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.3s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
```

```
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
```

```
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=0.7, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
```

```
weight=3, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=3, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.3s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.01, max_depth=5, min_child_
weight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
```

```
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=3, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
```

```
eight=1, n_estimators=100, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.3s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=1, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=0.7; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=100, subsample=1.0; total time=   0.1s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=0.7; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
[CV] END colsample_bytree=1.0, learning_rate=0.1, max_depth=5, min_child_w
eight=3, n_estimators=200, subsample=1.0; total time=   0.2s
```

Out[170…

```
▸       GridSearchCV
▸ estimator: XGBRegressor
     ▸ XGBRegressor
```

In [171…

```
# Best parameters and model
best_params = grid_search.best_params_
best_model = grid_search.best_estimator_
```

In [172…

```
# Evaluate on validation set
val_predictions = best_model.predict(X_val)
mse = mean_squared_error(y_val, val_predictions)
```

```
print(f"Best parameters: {best_params}")
print(f"Validation MSE: {mse}")
```

```
Best parameters: {'colsample_bytree': 0.7, 'learning_rate': 0.01, 'max_dep
th': 5, 'min_child_weight': 1, 'n_estimators': 200, 'subsample': 1.0}
Validation MSE: 1443.7185930621974
```

In [173…

```
best_model.fit(X_train, y_train)
```

Out[173…

▾ XGBRegressor

```
XGBRegressor(base_score=None, booster=None, callbacks=None,
             colsample_bylevel=None, colsample_bynode=None,
             colsample_bytree=0.7, device=None, early_stopping_ro
unds=None,
             enable_categorical=False, eval_metric=None, feature_
types=None,
             gamma=None, grow_policy=None, importance_type=None,
             interaction_constraints=None, learning_rate=0.01, ma
x_bin=None,
```

In [174…

```
#test data predictions
X_test = test_df[features]
test_predictions = best_model.predict(X_test)
```

In [176…

```
submission = pd.DataFrame({'ID': test_df['ID'], 'Target': test_prediction
submission.to_csv('submission2.csv', index=False)
```

In [ ]: