Forecasting Unit Sales (Task 1)

Install Required Libraries

```
pip install pandas matplotlib seaborn scikit-learn statsmodels xgboost
```

Show hidden output

```
import pandas as pd
```

Correct Data Paths

```
train_df = pd.read_csv('train.csv')  # Update with your actual path
test_df = pd.read_csv('test.csv')    # Update with your actual path
```

```
print("Train Data:", train_df.head(), sep="\n")
print("Test Data:", test_df.head(), sep="\n")
```

```
Train Data:
                        ID        date     Item Id  \
0  2022-04-12_B09KDTS4DC  2022-04-12  B09KDTS4DC
1  2022-04-12_B09MR2MLZH  2022-04-12  B09MR2MLZH
2  2022-04-12_B09KSYL73R  2022-04-12  B09KSYL73R
3  2022-04-12_B09KT5HMNY  2022-04-12  B09KT5HMNY
4  2022-04-12_B09KTF8ZDQ  2022-04-12  B09KTF8ZDQ

                                           Item Name  ad_spend anarix_id  \
0  NapQueen Elizabeth 8" Gel Memory Foam Mattress...       NaN  NAPQUEEN
1  NapQueen 12 Inch Bamboo Charcoal Queen Size Me...       NaN  NAPQUEEN
2     NapQueen Elsa 8" Innerspring Mattress, Twin XL       NaN  NAPQUEEN
3        NapQueen Elsa 6" Innerspring Mattress, Twin       NaN  NAPQUEEN
4     NapQueen Elsa 6" Innerspring Mattress, Twin XL       NaN  NAPQUEEN

   units  unit_price
0    0.0         0.0
1    0.0         0.0
2    0.0         0.0
3    0.0         0.0
4    0.0         0.0
Test Data:
                        ID        date     Item Id  \
0  2024-07-01_B09KDR64LT  2024-07-01  B09KDR64LT
1  2024-07-01_B09KDTS4DC  2024-07-01  B09KDTS4DC
2  2024-07-01_B09KDTHJ6V  2024-07-01  B09KDTHJ6V
3  2024-07-01_B09KDQ2BWY  2024-07-01  B09KDQ2BWY
4  2024-07-01_B09KDYY3SB  2024-07-01  B09KDYY3SB

                                           Item Name  ad_spend anarix_id  \
0  NapQueen Elizabeth 10" Gel Memory Foam Mattres...       NaN  NAPQUEEN
1  NapQueen Elizabeth 8" Gel Memory Foam Mattress...       NaN  NAPQUEEN
2  NapQueen Elizabeth 12" Gel Memory Foam Mattres...       NaN  NAPQUEEN
3  NapQueen Elizabeth 12" Gel Memory Foam Mattres...       NaN  NAPQUEEN
4  NapQueen Elizabeth 10" Gel Memory Foam Mattres...    101.72  NAPQUEEN

   unit_price
0         0.0
1         0.0
2         0.0
3         0.0
4      1094.5
```

Inspect Data

Generate a slider using jupyter widgets Close

```
print("Train Data Info:", train_df.info(), sep="\n")
print("Missing Values in Train Data:", train_df.isnull().sum(), sep="\n")
print("Test Data Info:", test_df.info(), sep="\n")
print("Missing Values in Test Data:", test_df.isnull().sum(), sep="\n")
```

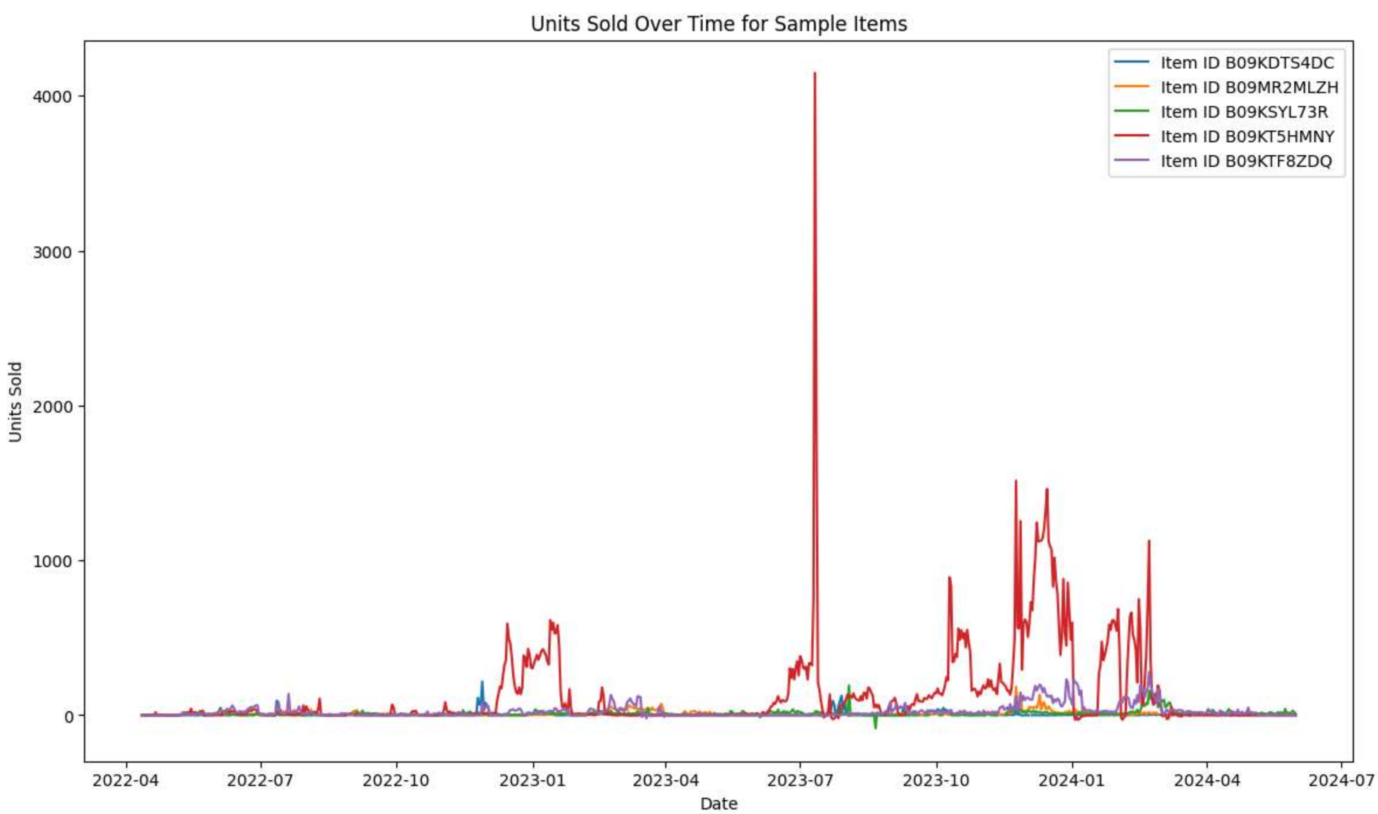
Convert Date Columns

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

```
sample_item_ids = train_df['Item Id'].unique()[:5]
```

Plotting Time Series

```
import matplotlib.pyplot as plt
plt.figure(figsize=(14, 8))
for item_id in sample_item_ids:
    item_data = train_df[train_df['Item Id'] == item_id]
    plt.plot(item_data['date'], item_data['units'], label=f'Item ID {item_id}')
plt.title('Units Sold Over Time for Sample Items')
plt.xlabel('Date')
plt.ylabel('Units Sold')
plt.legend()
plt.show()
```




```
print("Columns in Train Data:", train_df.columns, sep="\n")
```

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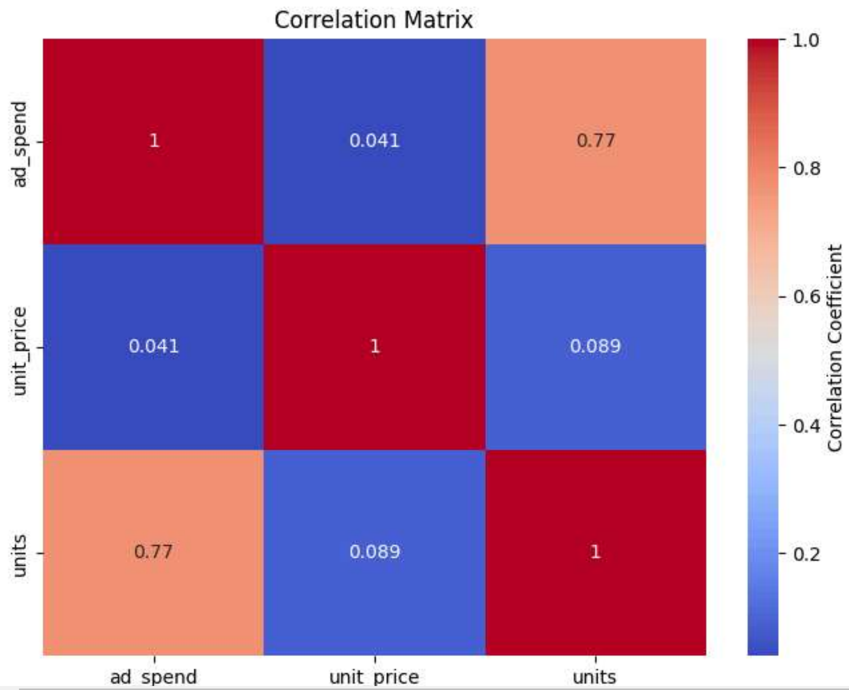
Correlation Matrix

```
import seaborn as sns
columns_for_correlation = ['ad_spend', 'unit_price', 'units']
correlation_matrix = train_df[columns_for_correlation].corr()
plt.figure(figsize=(8, 6))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', cbar_kws={'label': 'Correlation Coefficient'})
plt.title('Correlation Matrix')
plt.show()
```



Time-Based Features

```
train_df['day_of_week'] = train_df['date'].dt.dayofweek
train_df['month'] = train_df['date'].dt.month
train_df['year'] = train_df['date'].dt.year
train_df['day_of_month'] = train_df['date'].dt.day
train_df['week_of_year'] = train_df['date'].dt.isocalendar().week

test_df['day_of_week'] = test_df['date'].dt.dayofweek
test_df['month'] = test_df['date'].dt.month
test_df['year'] = test_df['date'].dt.year
test_df['day_of_month'] = test_df['date'].dt.day
test_df['week_of_year'] = test_df['date'].dt.isocalendar().week

print("Train Data with Time-Based Features:", train_df.head(), sep="\n")
print("Test Data with Time-Based Features:", test_df.head(), sep="\n")
```

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Lag and Rolling Features

Generate | create a dataframe with 2 columns and 10 rows | Close

```
for lag in range(1, 8):
    train_df[f'lag_{lag}'] = train_df.groupby('Item Id')['units'].shift(lag)

train_df['rolling_mean_7'] = train_df.groupby('Item Id')['units'].transform(lambda x: x.rolling(window=7).mean())
train_df['rolling_sum_7'] = train_df.groupby('Item Id')['units'].transform(lambda x: x.rolling(window=7).sum())

train_df_cleaned = train_df.dropna()
print("Train Data with Lag Features:", train_df.head(10), sep="\n")
print("Train Data with Rolling Statistics:", train_df.head(10), sep="\n")
```

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Model Preparation

```
features = [
    'ad_spend', 'unit_price', 'day_of_week', 'month', 'year', 'day_of_month', 'week_of_year',
    'lag_1', 'lag_2', 'lag_3', 'lag_4', 'lag_5', 'lag_6', 'lag_7',
    'rolling_mean_7', 'rolling_sum_7'
]
target = 'units'

X_train = train_df_cleaned[features]
y_train = train_df_cleaned[target]
print("Features used for training:", X_train.head(), sep="\n")
```

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Baseline and Advanced Models

```
from sklearn.model_selection import TimeSeriesSplit
tscv = TimeSeriesSplit(n_splits=5)
```

```
from sklearn.metrics import mean_squared_error
from math import sqrt
def moving_average_forecast(series, window_size):
    return series.rolling(window=window_size).mean()

window_size = 7
y_train_baseline = moving_average_forecast(y_train, window_size).shift(1).dropna()
y_train_aligned = y_train.iloc[len(y_train) - len(y_train_baseline):]
mse_baseline = mean_squared_error(y_train_aligned, y_train_baseline)
print(f"Baseline Model MSE: {mse_baseline:.2f}")
```

```
Baseline Model MSE: 7915.65
```

ARIMA Model

```
from statsmodels.tsa.arima.model import ARIMA
arima_order = (5, 1, 0)
arima_model = ARIMA(y_train, order=arima_order)
arima_fit = arima_model.fit()
y_train_arima = arima_fit.predict(start=window_size, end=len(y_train)-1)
mse_arima = mean_squared_error(y_train.iloc[window_size:], y_train_arima)
print(f"ARIMA Model MSE: {mse_arima:.2f}")
```

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Random Forest Model

```
from sklearn.ensemble import RandomForestRegressor
rf_model = RandomForestRegressor(n_estimators=100, random_state=42)
rf_model.fit(X_train, y_train)
y_train_rf = rf_model.predict(X_train)
mse_rf = mean_squared_error(y_train, y_train_rf)
print(f"Random Forest Model MSE: {mse_rf:.2f}")
```

```
Random Forest Model MSE: 152.95
```

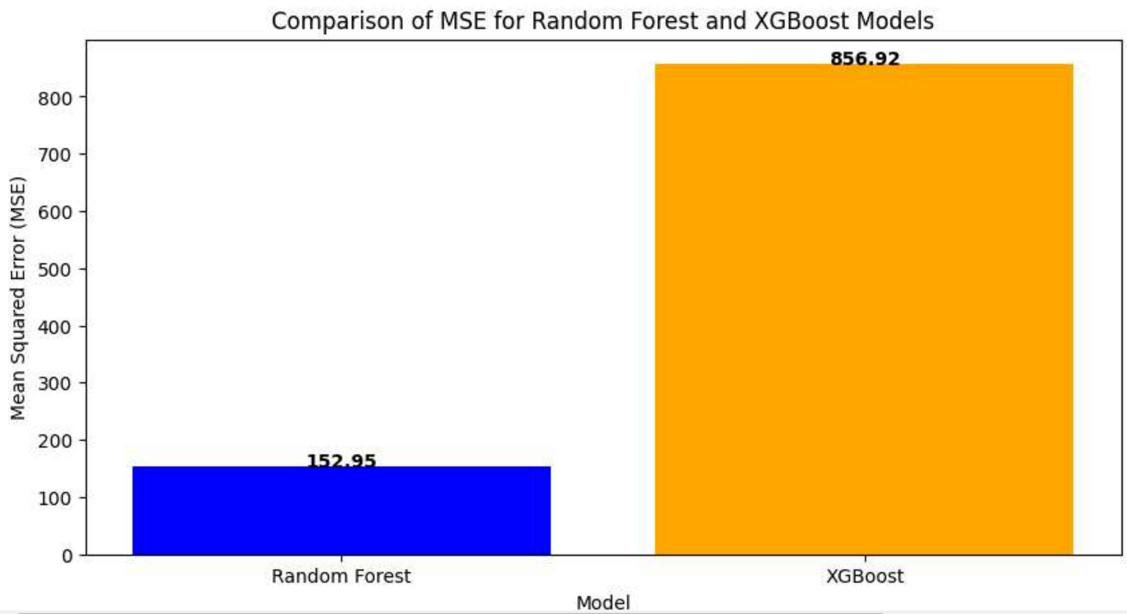
XGBoost Model

```
from xgboost import XGBRegressor
xgb_model = XGBRegressor(n_estimators=100, learning_rate=0.1, max_depth=3, random_state=42)
xgb_model.fit(X_train, y_train)
y_train_xgb = xgb_model.predict(X_train)
mse_xgb = mean_squared_error(y_train, y_train_xgb)
print(f"XGBoost Model MSE: {mse_xgb:.2f}")
```

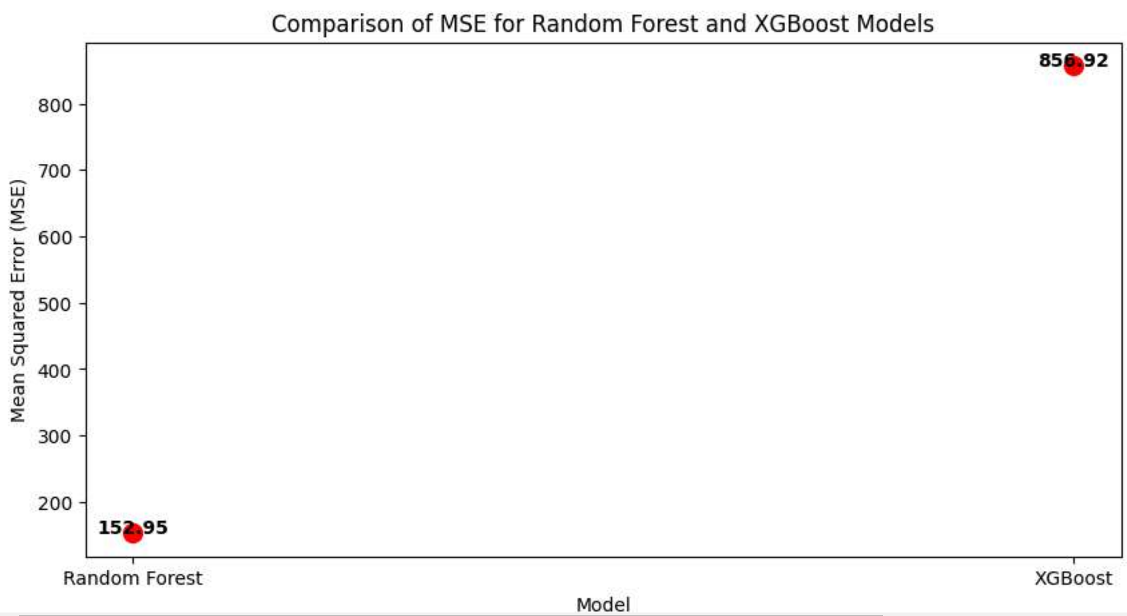
```
XGBoost Model MSE: 856.92
```

Comparision of MSE values of the models

```
import matplotlib.pyplot as plt
import numpy as np

# MSE values for the different models
mse_values = [mse_rf, mse_xgb]
models = ['Random Forest', 'XGBoost']

# Plotting the MSE values
plt.figure(figsize=(10, 5))

# Bar plot for MSE comparison
plt.bar(models, mse_values, color=['blue', 'orange'])

# Adding title and labels
plt.title('Comparison of MSE for Random Forest and XGBoost Models')
plt.xlabel('Model')
plt.ylabel('Mean Squared Error (MSE)')

# Adding value labels on top of the bars
for i, v in enumerate(mse_values):
    plt.text(i, v + 0.01, f"{v:.2f}", ha='center', fontweight='bold')

# Display the plot
plt.show()
```



```
import matplotlib.pyplot as plt

# Scatter plot for MSE comparison
plt.figure(figsize=(10, 5))
plt.scatter(models, mse_values, color='red', s=100)

# Adding title and labels
plt.title('Comparison of MSE for Random Forest and XGBoost Models')
plt.xlabel('Model')
plt.ylabel('Mean Squared Error (MSE)')

# Adding value labels on the plot
for i, v in enumerate(mse_values):
    plt.text(i, v, f"{v:.2f}", ha='center', fontweight='bold')

# Display the plot
plt.show()
```



Hyperparameter Tuning

```
from sklearn.model_selection import GridSearchCV

# Random Forest Grid Search
param_grid_rf = {
    'n_estimators': [50, 100, 150],
    'max_depth': [None, 10, 20],
    'min_samples_split': [2, 5, 10],
    'min_samples_leaf': [1, 2, 4]
}
grid_search_rf = GridSearchCV(estimator=RandomForestRegressor(random_state=42), param_grid=param_grid_rf, cv=3, scoring='neg_mean_squared_e
grid_search_rf.fit(X_train, y_train)
best_rf_model = grid_search_rf.best_estimator_

# XGBoost Grid Search
param_grid_xgb = {
    'n_estimators': [50, 100, 150],
    'learning_rate': [0.01, 0.1, 0.2],
    'max_depth': [3, 5, 7],
    'subsample': [0.8, 1.0]
}
grid_search_xgb = GridSearchCV(estimator=XGBRegressor(random_state=42), param_grid=param_grid_xgb, cv=3, scoring='neg_mean_squared_error',
grid_search_xgb.fit(X_train, y_train)
best_xgb_model = grid_search_xgb.best_estimator_
```

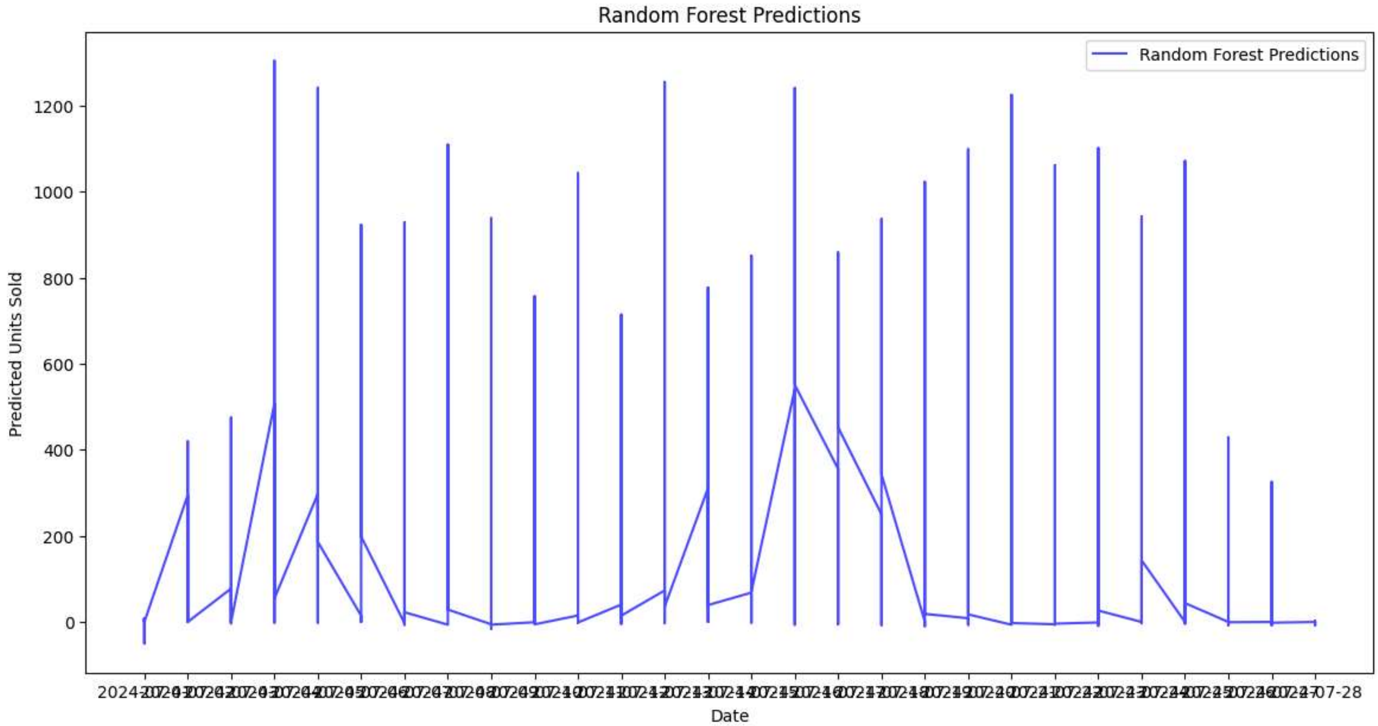
Forecasting and Submission

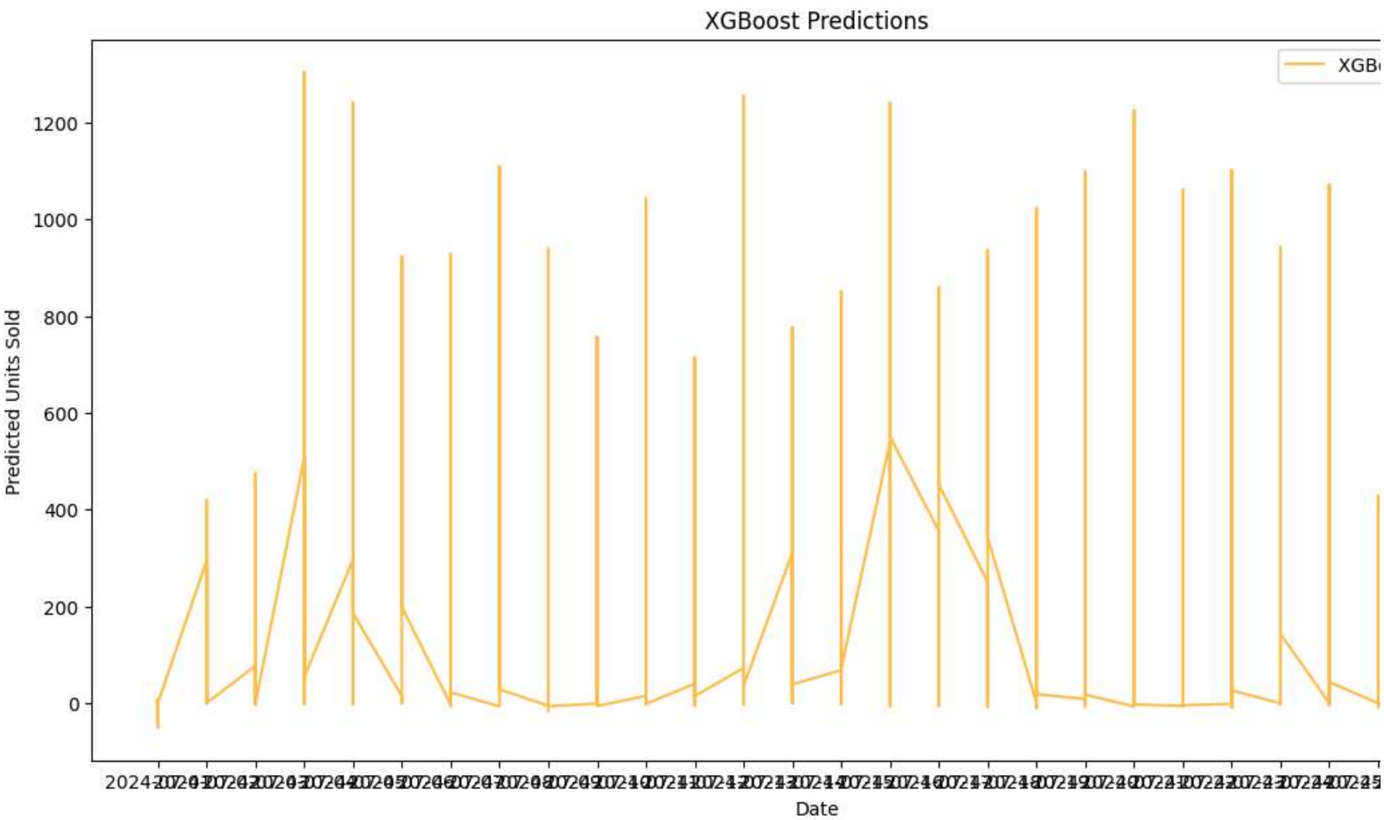
```
X_test_dropna = X_test.dropna()  # Drops rows with any missing values

# Now use X_test_dropna for prediction (but be mindful of the reduced sample size)
y_test_rf = best_rf_model.predict(X_test_dropna)
import pandas as pd
from sklearn.impute import SimpleImputer

# Create an imputer to fill missing values with the mean
imputer = SimpleImputer(strategy='mean')

# Fit the imputer on your training data (important to avoid data leakage)
imputer.fit(X_train)  # Assuming X_train is your training data

# Transform both training and test data
X_train_imputed = imputer.transform(X_train)
X_test_imputed = imputer.transform(X_test)

# Now use X_test_imputed for prediction
y_test_rf = best_rf_model.predict(X_test_imputed)

submission_rf = test_df[['Item Id', 'date']].copy()
submission_rf['predicted_units'] = y_test_rf
submission_rf.to_csv('random_forest_predictions.csv', index=False)

submission_xgb = test_df[['Item Id', 'date']].copy()
submission_xgb['predicted_units'] = y_test_xgb
submission_xgb.to_csv('xgboost_predictions.csv', index=False)

print("Predictions saved to 'random_forest_predictions.csv' and 'xgboost_predictions.csv'.")
```

```
Predictions saved to 'random_forest_predictions.csv' and 'xgboost_predictions.csv'.
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:465: UserWarning: X does not have valid feature names, but RandomForestRegresso
  warnings.warn(
```

Comparision of the predicted_units values

```
import pandas as pd
import matplotlib.pyplot as plt

# Load the predictions
rf_predictions = pd.read_csv('random_forest_predictions.csv')
xgb_predictions = pd.read_csv('xgboost_predictions.csv')

# Ensure the data is sorted by date for proper comparison
rf_predictions = rf_predictions.sort_values(by=['date', 'Item Id'])
xgb_predictions = xgb_predictions.sort_values(by=['date', 'Item Id'])

# Plot Random Forest predictions
plt.figure(figsize=(14, 7))
plt.plot(rf_predictions['date'], rf_predictions['predicted_units'], label='Random Forest Predictions', alpha=0.7, color='blue')
plt.title('Random Forest Predictions')
plt.xlabel('Date')
plt.ylabel('Predicted Units Sold')
plt.legend()
plt.show()

# Plot XGBoost predictions
plt.figure(figsize=(14, 7))
plt.plot(xgb_predictions['date'], xgb_predictions['predicted_units'], label='XGBoost Predictions', alpha=0.7, color='orange')
plt.title('XGBoost Predictions')
plt.xlabel('Date')
plt.ylabel('Predicted Units Sold')
plt.legend()
plt.show()
```






```
import pandas as pd

# Load the datasets
train_df = pd.read_csv('train.csv')
rf_predictions = pd.read_csv('random_forest_predictions.csv')
xgb_predictions = pd.read_csv('xgboost_predictions.csv')

# Display the first few rows of each dataset
print("Train Data:")
print(train_df.head())
```

```
print("\nRandom Forest Predictions:")
print(rf_predictions.head())

print("\nXGBoost Predictions:")
print(xgb_predictions.head())
```

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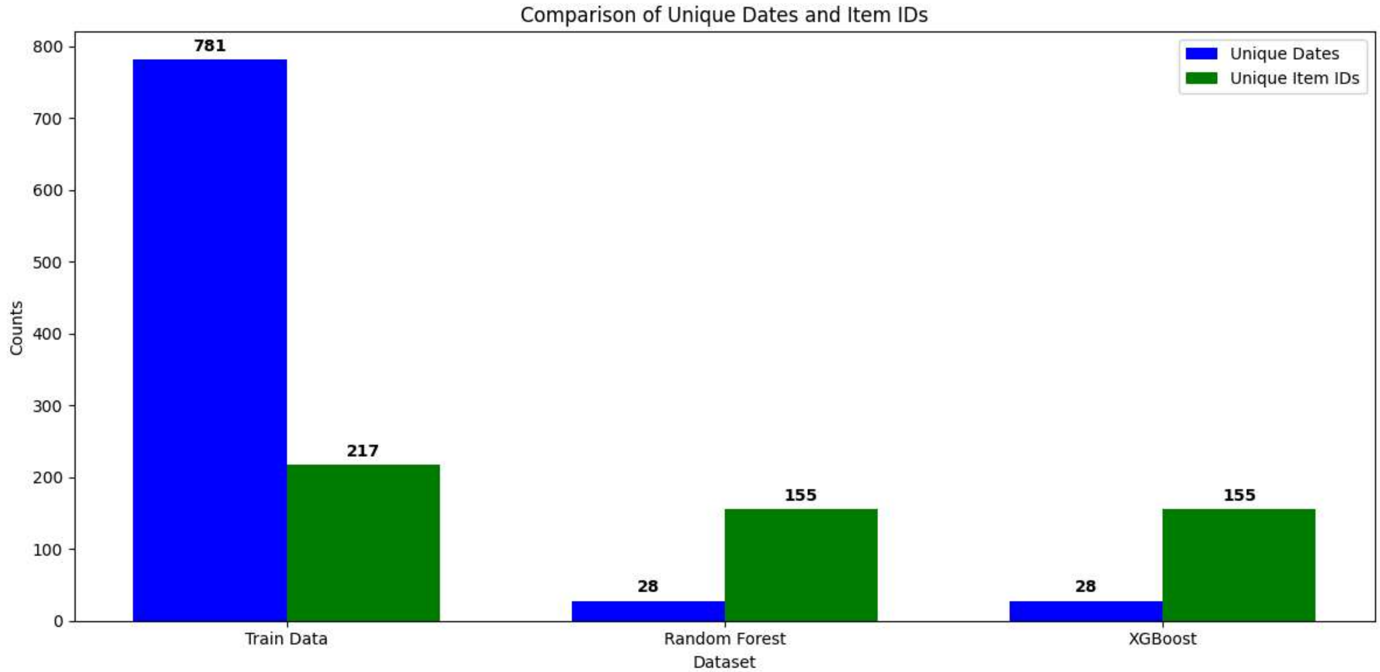
Check the unique values

```
# Check unique values in 'date' and 'Item Id' columns
print("\nUnique dates in Train Data:", train_df['date'].nunique())
print("Unique Item Ids in Train Data:", train_df['Item Id'].nunique())

print("\nUnique dates in Random Forest Predictions:", rf_predictions['date'].nunique())
print("Unique Item Ids in Random Forest Predictions:", rf_predictions['Item Id'].nunique())

print("\nUnique dates in XGBoost Predictions:", xgb_predictions['date'].nunique())
print("Unique Item Ids in XGBoost Predictions:", xgb_predictions['Item Id'].nunique())
```

```
Unique dates in Train Data: 781
Unique Item Ids in Train Data: 217

Unique dates in Random Forest Predictions: 28
Unique Item Ids in Random Forest Predictions: 155

Unique dates in XGBoost Predictions: 28
Unique Item Ids in XGBoost Predictions: 155
```

```
import numpy as np

# Unique values
unique_values = {
    'Unique Dates': [781, 28, 28],
    'Unique Item IDs': [217, 155, 155]
}
categories = ['Train Data', 'Random Forest', 'XGBoost']

x = np.arange(len(categories))  # the label locations
width = 0.35  # the width of the bars

fig, ax = plt.subplots(figsize=(12, 6))
rects1 = ax.bar(x - width/2, unique_values['Unique Dates'], width, label='Unique Dates', color='blue')
rects2 = ax.bar(x + width/2, unique_values['Unique Item IDs'], width, label='Unique Item IDs', color='green')

# Add some text for labels, title and custom x-axis tick labels, etc.
ax.set_xlabel('Dataset')
ax.set_ylabel('Counts')
ax.set_title('Comparison of Unique Dates and Item IDs')
ax.set_xticks(x)
ax.set_xticklabels(categories)
ax.legend()

# Adding value labels on top of the bars
def add_labels(rects):
    for rect in rects:
        height = rect.get_height()
        ax.annotate(f'{height}',
                    xy=(rect.get_x() + rect.get_width() / 2, height),
                    xytext=(0, 3),  # 3 points vertical offset
                    textcoords="offset points",
                    ha='center', va='bottom', fontweight='bold')

add_labels(rects1)
add_labels(rects2)

fig.tight_layout()

# Display the plot
plt.show()
```



Merge the relevent columns

```
import pandas as pd

# Load the CSV files
random_forest_predictions_df = pd.read_csv('random_forest_predictions.csv')
train_df = pd.read_csv('train.csv')

# Ensure date columns are in the same format (if not, parse them to a consistent format)
random_forest_predictions_df['date'] = pd.to_datetime(random_forest_predictions_df['date'])
train_df['date'] = pd.to_datetime(train_df['date'])

# Find the unique 'Item Id' values in each dataset
predictions_item_ids = set(random_forest_predictions_df['Item Id'].unique())
train_item_ids = set(train_df['Item Id'].unique())

# Find the intersection of the two sets to identify common 'Item Id'
common_item_ids = predictions_item_ids.intersection(train_item_ids)

# Filter the datasets for only the common 'Item Id'
common_predictions_df = random_forest_predictions_df[random_forest_predictions_df['Item Id'].isin(common_item_ids)]
common_train_df = train_df[train_df['Item Id'].isin(common_item_ids)]

# Merge the datasets on 'Item Id' only to check for date discrepancies
merged_df = pd.merge(common_predictions_df, common_train_df[['Item Id', 'date', 'units']],
                     on='Item Id', how='inner')

# Display the first few rows of the merged DataFrame
print(merged_df.head())
# Save the merged DataFrame to a new CSV file
merged_df.to_csv('merged_comparison_item_only.csv', index=False)
```

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Calculate the MSE

```
import pandas as pd
from sklearn.metrics import mean_squared_error

# Load the CSV file
merged_comparison_df = pd.read_csv('merged_comparison_item_only.csv')
```

```
# Handle NaN values (replace with 0 for demonstration)
merged_comparison_df['units'].fillna(0, inplace=True)
merged_comparison_df['predicted_units'].fillna(0, inplace=True)

# Calculate the Mean Squared Error (MSE) between actual and predicted units
mse = mean_squared_error(merged_comparison_df['units'], merged_comparison_df['predicted_units'])

# Print the MSE
print(f"Mean Squared Error (MSE) between units and predicted_units: {mse}")
```

```
Mean Squared Error (MSE) between units and predicted_units: 40300.14705973295
```