In [307…

```
import pandas as pd
import numpy as np
from sklearn.preprocessing import StandardScaler
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

In [359…

```
#Load stock historical data
nvda_data = pd.read_csv('nvda.csv')
spy_data = pd.read_csv('spy.csv')
# Remove Volume column from both DataFrames
nvda_data.drop(columns=['Volume'], inplace=True)
spy_data.drop(columns=['Volume'], inplace=True)
```

In [363…

```
nvda_data.head()
```

Out[363…

	Date	Close/Last	Open	High	Low
0	10/11/2024	$134.80	$134.01	$135.78	$133.66
1	10/10/2024	$134.81	$131.91	$135.00	$131.00
2	10/09/2024	$132.65	$134.11	$134.52	$131.38
3	10/08/2024	$132.89	$130.26	$133.48	$129.42
4	10/07/2024	$127.72	$124.99	$130.64	$124.95

In [365…

```
spy_data.head()
```

Out[365…

	Date	Close/Last	Open	High	Low
0	10/11/2024	579.58	576.05	580.3300	575.9100
1	10/10/2024	576.13	575.77	577.5800	574.4900
2	10/9/2024	577.14	573.16	577.7100	572.5500
3	10/8/2024	573.17	570.42	573.7800	569.5299
4	10/7/2024	567.80	571.30	571.9599	566.6300

In [373…

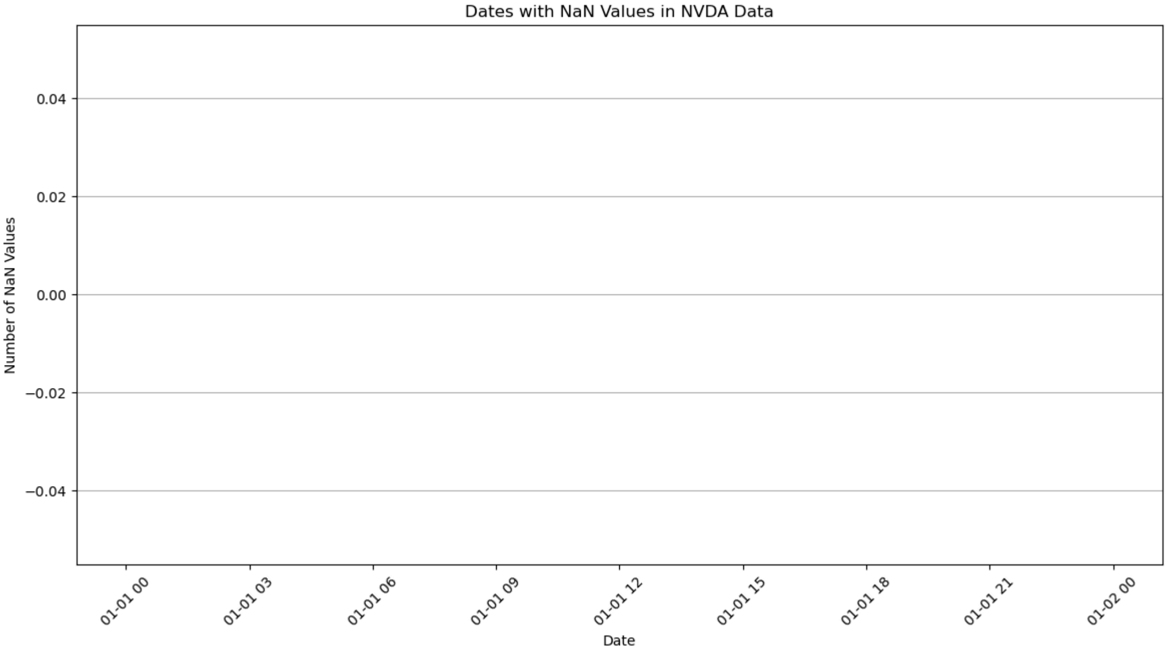
```
nvda_data['Date'] = pd.to_datetime(nvda_data['Date'])
spy_data['Date'] = pd.to_datetime(spy_data['Date'])
combined_data = pd.merge(nvda_data, spy_data, on='Date', suffixes=('_nvda', '_sp
combined_data.head()
```

Out[373…

	Date	Close/Last_nvda	Open_nvda	High_nvda	Low_nvda	Close/Last_spy	Open_spy
0	2024-10-11	$134.80	$134.01	$135.78	$133.66	579.58	576.05
1	2024-10-10	$134.81	$131.91	$135.00	$131.00	576.13	575.77
2	2024-10-09	$132.65	$134.11	$134.52	$131.38	577.14	573.16
3	2024-10-08	$132.89	$130.26	$133.48	$129.42	573.17	570.42
4	2024-10-07	$127.72	$124.99	$130.64	$124.95	567.80	571.30

In [375…

```python
# Check for NaN values in the specified columns
import pandas as pd
import matplotlib.pyplot as plt

# Assuming combined_data is already defined and contains the necessary data

# Create a mask for rows with NaN values in the specified columns
nan_mask = combined_data[['Open_nvda', 'Close/Last_nvda']].isna().any(axis=1)

# Extract dates with NaN values
nan_dates = combined_data[nan_mask]['Date']

# Count the occurrences of NaN values per date
nan_counts = nan_dates.value_counts().sort_index()

# Plotting the results
plt.figure(figsize=(14, 7))
plt.bar(nan_counts.index, nan_counts.values, color='red', alpha=0.7)
plt.title('Dates with NaN Values in NVDA Data')
plt.xlabel('Date')
plt.ylabel('Number of NaN Values')
plt.xticks(rotation=45)
plt.grid(axis='y')

plt.show()

print("NaN values in relevant columns:")
print(combined_data[['Open_nvda', 'Close/Last_nvda', 'Open_spy', 'Close/Last_spy
```



```
NaN values in relevant columns:
Open_nvda          0
Close/Last_nvda    0
Open_spy           0
Close/Last_spy     0
dtype: int64
```

In [377…

```
# Check for NaN values in the specified columns
print("NaN values in relevant columns:")
print(combined_data[['Open_nvda', 'Close/Last_nvda', 'Open_spy', 'Close/Last_spy
```

```
NaN values in relevant columns:
Open_nvda          0
Close/Last_nvda    0
Open_spy           0
Close/Last_spy     0
dtype: int64
```

In [379…

```
# Define columns to clean and convert
cols_to_clean = ['Open_nvda', 'Close/Last_nvda', 'Open_spy', 'Close/Last_spy']

# Convert columns to string to handle non-string types
for col in cols_to_clean:
    combined_data[col] = combined_data[col].astype(str)  # Convert to string

# Clean the columns by removing dollar signs and extra spaces, then convert to n
for col in cols_to_clean:
    combined_data[col] = combined_data[col].str.replace('$', '', regex=False)  #
    combined_data[col] = combined_data[col].str.strip()  # Remove any leading/tr
    combined_data[col] = pd.to_numeric(combined_data[col], errors='coerce')  # C
```

In [381…

```
cols_to_check = ['Open_nvda', 'Close/Last_nvda', 'Open_spy', 'Close/Last_spy']
scaler = StandardScaler()
combined_data[cols_to_check] = scaler.fit_transform(combined_data[cols_to_check]
print("Scaled data:")
print(combined_data.head())
```

```
Scaled data:
         Date  Close/Last_nvda  Open_nvda High_nvda Low_nvda  Close/Last_spy  \
0 2024-10-11         4.317199   4.287475   $135.78  $133.66        2.468255
1 2024-10-10         4.317568   4.210020   $135.00  $131.00        2.434612
2 2024-10-09         4.237884   4.291164   $134.52  $131.38        2.444461
3 2024-10-08         4.246738   4.149162   $133.48  $129.42        2.405747
4 2024-10-07         4.056012   3.954784   $130.64  $124.95        2.353382

   Open_spy  High_spy   Low_spy
0  2.434830  580.3300  575.9100
1  2.432099  577.5800  574.4900
2  2.406643  577.7100  572.5500
3  2.379919  573.7800  569.5299
4  2.388502  571.9599  566.6300
```

In [383…

```python
# Moving Averages
combined_data['MA50_nvda'] = combined_data['Close/Last_nvda'].rolling(window=50)
combined_data['MA200_nvda'] = combined_data['Close/Last_nvda'].rolling(window=20
combined_data['MA50_spy'] = combined_data['Close/Last_spy'].rolling(window=50).m
combined_data['MA200_spy'] = combined_data['Close/Last_spy'].rolling(window=200)

# Daily Returns
combined_data['Returns_nvda'] = combined_data['Close/Last_nvda'].pct_change()
combined_data['Returns_spy'] = combined_data['Close/Last_spy'].pct_change()

# Volatility (rolling 30-day standard deviation)
combined_data['Volatility_spgi'] = combined_data['Returns_nvda'].rolling(window=
combined_data['Volatility_spy'] = combined_data['Returns_spy'].rolling(window=30

# Drop NaN values that result from rolling calculations
combined_data.dropna(inplace=True)
```

In [385…

```python
# Label 1 if SPGI underperforms SPY, otherwise 0
combined_data['Underperform'] = (combined_data['Returns_nvda'] < combined_data['

# Optional: Shift the target label by 1 day if you're predicting the next day's
combined_data['Target'] = combined_data['Underperform'].shift(-1)

# Drop the last row because of the shift
combined_data.dropna(inplace=True)
```

In [387…

```python
from sklearn.model_selection import train_test_split

# Select features for training
features = ['Open_nvda', 'Close/Last_nvda',  'MA50_nvda', 'MA200_nvda', 'Returns
             'Open_spy', 'Close/Last_spy', 'MA50_spy', 'MA200_spy', 'Returns_spy

X = combined_data[features]  # Features
y = combined_data['Target']  # Target: Whether SPGI underperforms SPY

# Train-test split (80% training, 20% testing)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, shuffle
```

In [391…

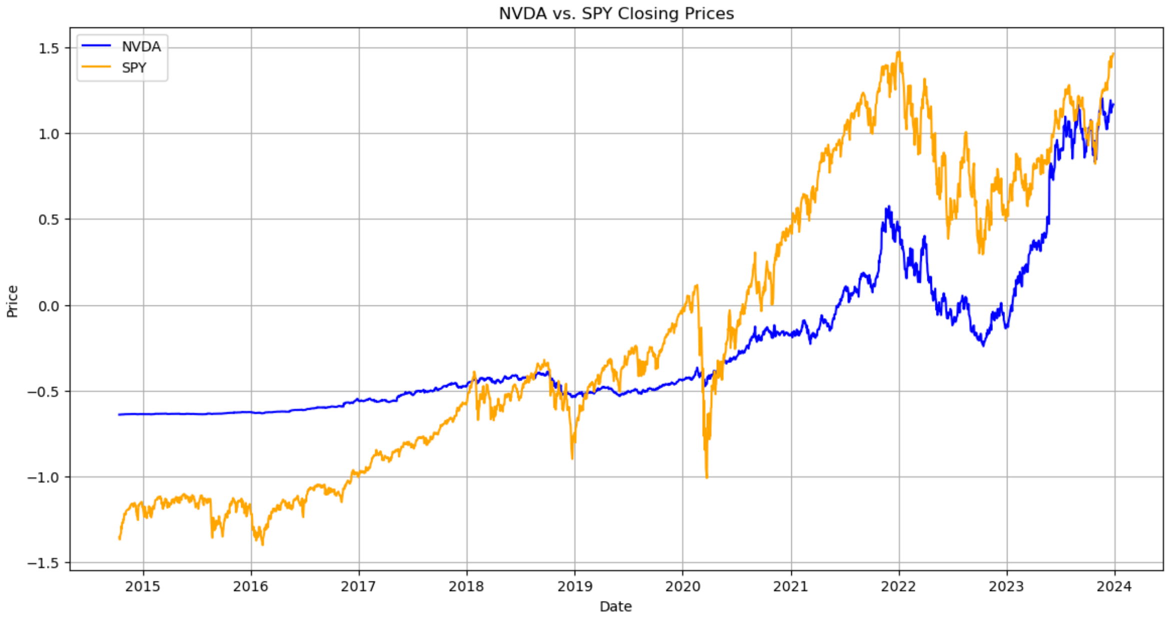
```python
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, classification_report

# Initialize and train the model
model = RandomForestClassifier(n_estimators=100, random_state=42)
model.fit(X_train, y_train)
```

```
# Predict on the test set
y_pred = model.predict(X_test)

# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print(f"Model Accuracy: {accuracy:.2f}")

# Detailed classification report
print(classification_report(y_test, y_pred))
```

```
Model Accuracy: 0.50
              precision    recall  f1-score   support

         0.0       0.49      0.99      0.66       226
         1.0       0.78      0.03      0.06       238

    accuracy                           0.50       464
   macro avg       0.64      0.51      0.36       464
weighted avg       0.64      0.50      0.35       464
```

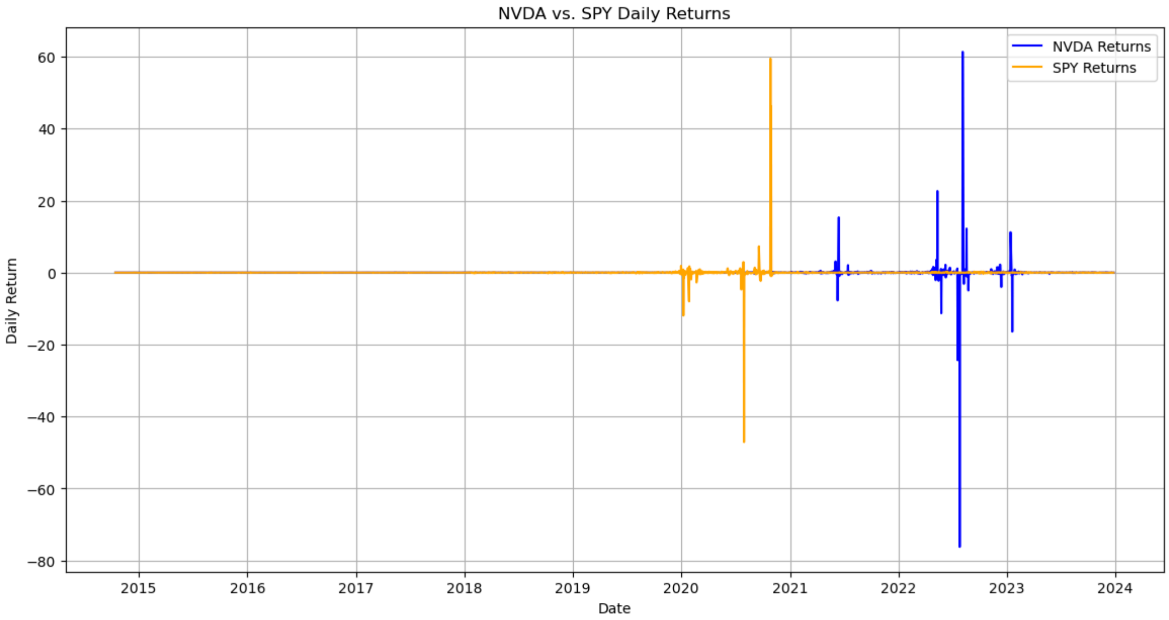
In [393…

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

# Load your combined_data DataFrame, which should contain SPGI and SPY data
# combined_data should already have Date, Close/Last_spgi, Close/Last_spy column

# Plotting
plt.figure(figsize=(14, 7))
plt.plot(combined_data['Date'], combined_data['Close/Last_nvda'], label='NVDA',
plt.plot(combined_data['Date'], combined_data['Close/Last_spy'], label='SPY', cc

plt.title('NVDA vs. SPY Closing Prices')
plt.xlabel('Date')
plt.ylabel('Price')
plt.legend()
plt.grid()
plt.show()
```



In [395…

```
# Calculate daily returns
combined_data['Return_spgi'] = combined_data['Close/Last_nvda'].pct_change()
combined_data['Return_spy'] = combined_data['Close/Last_spy'].pct_change()

# Drop NaN values for returns
combined_data.dropna(inplace=True)

# Plotting returns
plt.figure(figsize=(14, 7))
plt.plot(combined_data['Date'], combined_data['Return_spgi'], label='NVDA Return
plt.plot(combined_data['Date'], combined_data['Return_spy'], label='SPY Returns'

plt.title('NVDA vs. SPY Daily Returns')
plt.xlabel('Date')
plt.ylabel('Daily Return')
plt.legend()
plt.grid()
plt.show()
```



In [398…

```
from sklearn.preprocessing import MinMaxScaler

scaler = MinMaxScaler()
combined_data[cols_to_check] = scaler.fit_transform(combined_data[cols_to_check]
```

In [400…

```
from sklearn.preprocessing import RobustScaler

scaler = RobustScaler()
combined_data[cols_to_check] = scaler.fit_transform(combined_data[cols_to_check]
```

In [402…

```
from sklearn.preprocessing import PowerTransformer

scaler = PowerTransformer()
combined_data[cols_to_check] = scaler.fit_transform(combined_data[cols_to_check]
```

In [ ]:

```
from sklearn.model_selection import GridSearchCV

param_grid = {
    'n_estimators': [50, 100, 200],
    'max_depth': [None, 10, 20, 30],
    'min_samples_split': [2, 5, 10]
}

grid_search = GridSearchCV(RandomForestClassifier(random_state=42), param_grid,
grid_search.fit(X_train, y_train)

print("Best parameters:", grid_search.best_params_)
```

In [ ]:

```
from sklearn.ensemble import GradientBoostingClassifier

model = GradientBoostingClassifier(random_state=42)
model.fit(X_train, y_train)
```

In [ ]:

```
# Predict on the test set
y_pred = model.predict(X_test)

# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print(f"Model Accuracy: {accuracy:.2f}")

# Detailed classification report
print(classification_report(y_test, y_pred))
```

In [ ]: