```python
# 📦 Install required libraries (run only once)
!pip install yfinance plotly scikit-learn statsmodels --quiet

# 📚 Imports
import yfinance as yf
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import plotly.express as px
from sklearn.linear_model import LinearRegression, LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import mean_squared_error, mean_absolute_error,
r2_score, classification_report
from sklearn.model_selection import train_test_split
from statsmodels.tsa.arima.model import ARIMA
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')

# 📈 1. Data Acquisition & Preparation
ticker = 'AAPL'
df = yf.download(ticker, start='2018-01-01', end='2024-12-31')

# 🧹 Clean and prepare data
df.columns = [col[0] if isinstance(col, tuple) else col for col in
df.columns]  # Flatten multi-index
df = df.dropna()
df['Log Return'] = np.log(df['Close'] / df['Close'].shift(1))
df['MA10'] = df['Close'].rolling(window=10).mean()
df['Volatility'] = df['Log Return'].rolling(window=10).std()
df = df.dropna()

# 🎯 Feature-target split
X = df[['MA10', 'Volatility']]
y = df['Close']

# 📊 2a. Stock Price Prediction - Linear Regression
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
lr_model = LinearRegression().fit(X_train, y_train)
y_pred = lr_model.predict(X_test)

# 📏 Evaluation Metrics
print("📉 Linear Regression Metrics:")
print("RMSE:", np.sqrt(mean_squared_error(y_test, y_pred)))
print("MAE:", mean_absolute_error(y_test, y_pred))
print("R2 Score:", r2_score(y_test, y_pred))

# 📈 2a. Stock Price Forecasting - ARIMA
model_arima = ARIMA(df['Close'], order=(5,1,0))
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arima_result = model_arima.fit()
forecast = arima_result.forecast(steps=30)

# □ 2b. Credit Risk Modeling (Synthetic)
from sklearn.datasets import make_classification
X_credit, y_credit = make_classification(n_samples=1000, n_features=5,
random_state=42)
X_train_c, X_test_c, y_train_c, y_test_c = train_test_split(X_credit,
y_credit, test_size=0.2)

log_model = LogisticRegression().fit(X_train_c, y_train_c)
y_pred_c = log_model.predict(X_test_c)
print("\n□ Credit Risk Classification Report:\n",
classification_report(y_test_c, y_pred_c))

# □ 2c. Revenue Forecasting (Synthetic)
dates = pd.date_range(start='2020-01-01', periods=48, freq='M')
revenues = np.random.normal(loc=50000, scale=5000,
size=len(dates)).cumsum()
rev_df = pd.DataFrame({'Date': dates, 'Revenue': revenues})
rev_df['Lag1'] = rev_df['Revenue'].shift(1)
rev_df = rev_df.dropna()

X_rev = rev_df[['Lag1']]
y_rev = rev_df['Revenue']
rev_model = LinearRegression().fit(X_rev, y_rev)
rev_df['Forecast'] = rev_model.predict(X_rev)

print("\n□ Revenue Forecast RMSE:", np.sqrt(mean_squared_error(y_rev,
rev_df['Forecast'])))

# □ 4. Visualization
# Linear regression: Actual vs Predicted
plt.figure(figsize=(10,5))
plt.plot(y_test.values, label='Actual')
plt.plot(y_pred, label='Predicted')
plt.title("Stock Price Prediction: Actual vs Predicted")
plt.legend()
plt.show()

# ARIMA forecast plot
plt.figure(figsize=(10,5))
plt.plot(df['Close'], label='Historical')
plt.plot(pd.date_range(start=df.index[-1], periods=31, freq='B')[1:],
forecast, label='ARIMA Forecast')
plt.title("ARIMA Stock Price Forecast")
plt.legend()
plt.show()

# Revenue Forecast plot
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plt.figure(figsize=(10,5))
plt.plot(rev_df['Date'], rev_df['Revenue'], label='Actual Revenue')
plt.plot(rev_df['Date'], rev_df['Forecast'], label='Forecasted
Revenue')
plt.title("Revenue Forecasting")
plt.legend()
plt.show()

# 5. Geometric Brownian Motion + Black-Scholes
def gbm(S0, mu, sigma, T, N):
    dt = T / N
    t = np.linspace(0, T, N)
    W = np.random.standard_normal(size=N)
    W = np.cumsum(W) * np.sqrt(dt)
    S = S0 * np.exp((mu - 0.5 * sigma ** 2) * t + sigma * W)
    return t, S

t, S_sim = gbm(100, 0.05, 0.2, 1, 252)
plt.plot(t, S_sim)
plt.title("Simulated Stock Price via GBM")
plt.xlabel("Time")
plt.ylabel("Stock Price")
plt.show()

# Black-Scholes Formula
from scipy.stats import norm

def black_scholes_call(S, K, T, r, sigma):
    d1 = (np.log(S/K) + (r + sigma**2 / 2) * T) / (sigma * np.sqrt(T))
    d2 = d1 - sigma * np.sqrt(T)
    return S * norm.cdf(d1) - K * np.exp(-r * T) * norm.cdf(d2)

call_price = black_scholes_call(100, 105, 1, 0.05, 0.2)
print("\n Call Option Price (Black-Scholes):", round(call_price, 2))

# 6. EDA - Correlation Heatmap
sns.heatmap(df[['Close', 'MA10', 'Volatility', 'Log Return']].corr(),
annot=True, cmap='coolwarm')
plt.title("Correlation Matrix")
plt.show()

# Interactive Plotly Visualizations
px.line(df, x=df.index, y='Close', title='Stock Price Over
Time').show()
px.scatter(df, x='Volatility', y='Log Return', title='Volatility vs
Log Return').show()


[notice] A new release of pip is available: 24.3.1 -> 25.0.1
[notice] To update, run: python.exe -m pip install --upgrade pip
```

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YF.download() has changed argument auto_adjust default to True

[*********************100%***********************]  1 of 1 completed

□ Linear Regression Metrics:
RMSE: 3.6587315216640346
MAE: 2.685849859044151
R2 Score: 0.9964363738915061

□ Credit Risk Classification Report:
               precision    recall  f1-score   support

           0       0.80      0.87      0.83        94
           1       0.88      0.80      0.84       106

    accuracy                           0.83       200
   macro avg       0.84      0.84      0.83       200
weighted avg       0.84      0.83      0.84       200


□ Revenue Forecast RMSE: 5492.1724738170915
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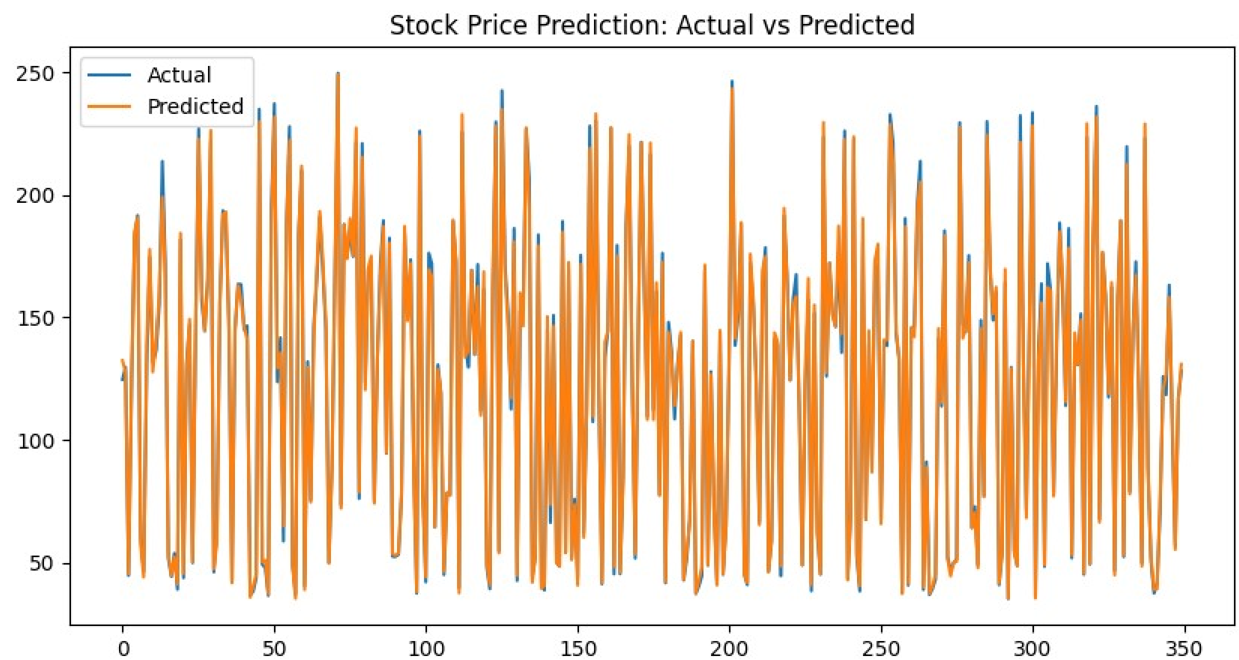

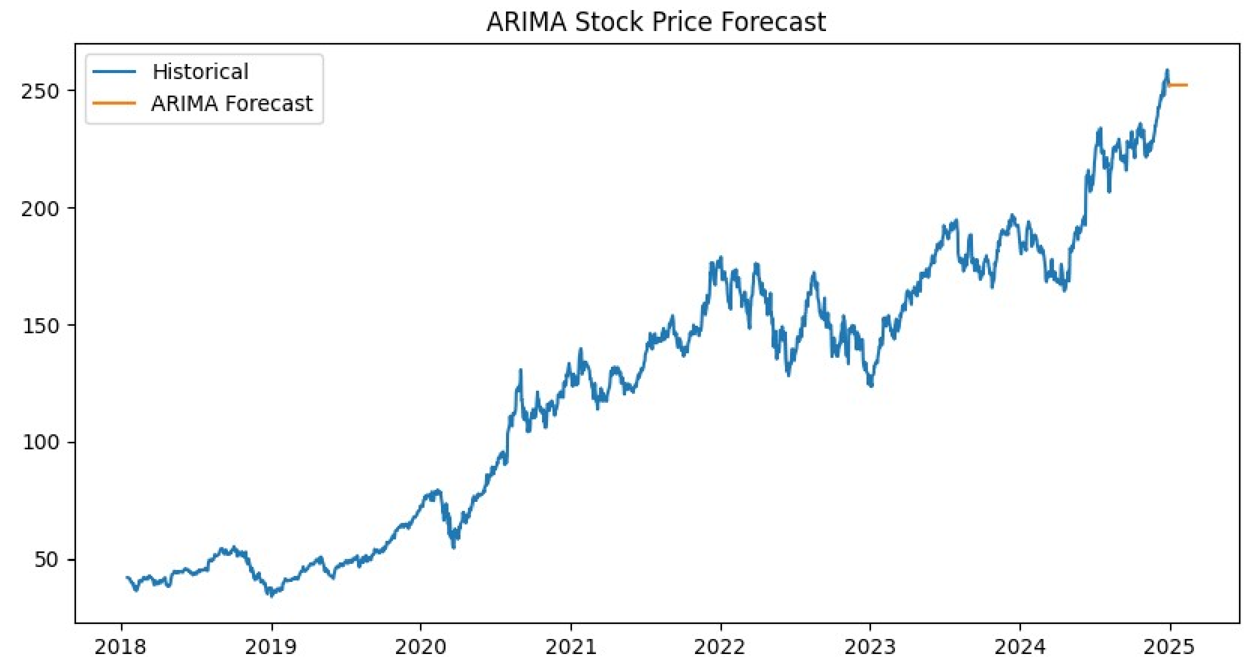
ARIMA Stock Price Forecast
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ARIMA Forecast
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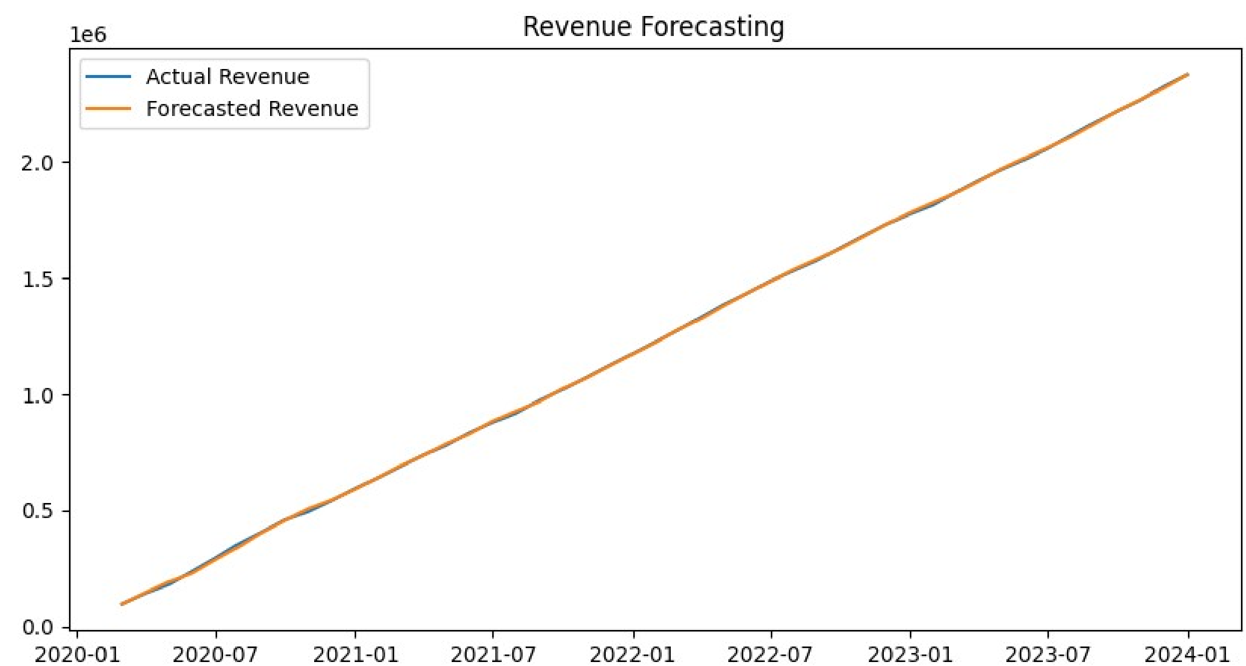
200
150
100
50
2018
2019
2020
2021
2022
2023
2024
2025


Revenue Forecasting
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Actual Revenue
Forecasted Revenue
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1.5
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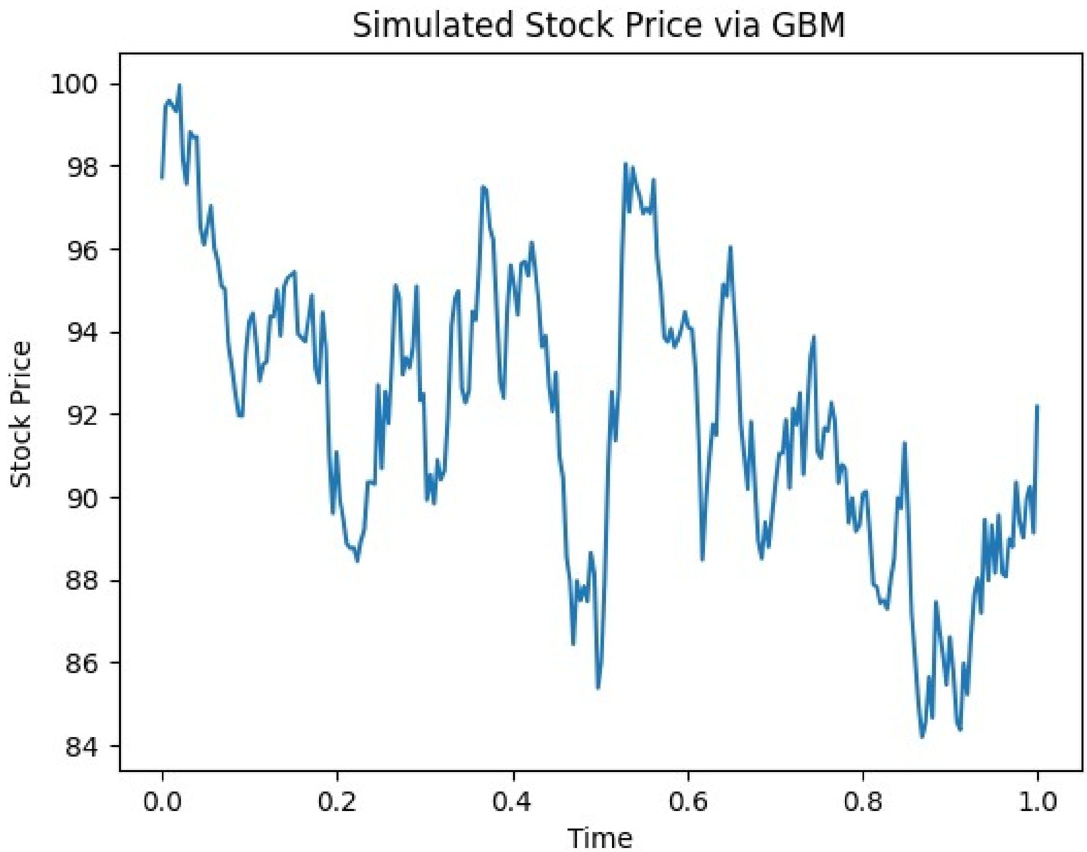


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 Call Option Price (Black-Scholes): 8.02
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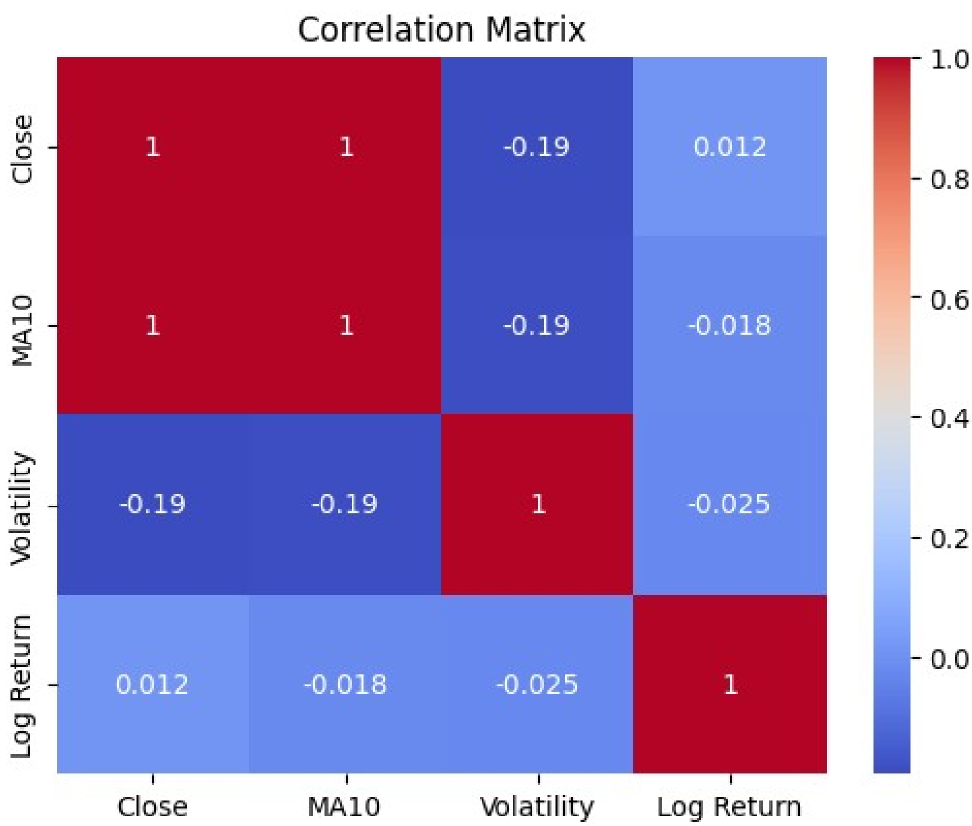


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