1) Strategy Description:
The strategy is based on the momentum investing approach, where the goal is to select the top-performing stocks from the S&P 500 based on their past 12 months' performance. This strategy operates under the assumption that past top performers will continue to perform well in the future. The portfolio is rebalanced monthly, selecting the top 5 performing stocks each month. Additionally, adjustments for **survivorship bias** are implemented to exclude stocks that have been delisted or added to the S&P 500 after the period of analysis started.

Factor Selection:
The momentum factor is selected as the primary determinant for stock selection. Stocks are chosen based on their 12-month trailing return, with the highest-performing stocks considered for inclusion in the portfolio.

Rebalancing Logic:
The portfolio is rebalanced every month, where the top 5 stocks based on their trailing 12-month performance are selected for the following month. This ensures that the strategy stays in line with current market trends, capitalizing on momentum. The **survivorship bias removal** ensures that only the stocks that were part of the S&P 500 during the backtest period are considered, excluding those added or removed mid-period.

2) **ML Model Details:**
The strategy integrates a linear regression model to estimate **alpha** and assess the risk-adjusted returns relative to the S&P 500. The model helps determine whether the momentum strategy outperforms the broader market after adjusting for risk.

Model Selection and Training:
The model used for the analysis is a **linear regression (OLS)**, The independent variable represents the excess return of the market (rm) over the risk-free rate (rf), while the dependent variable represents the excess return of the stock (rs) over the risk-free rate (rf), that we are trying to predict.

CAPM (Capital Asset Pricing Model) Formula:
$\mathbf{E(R_i) - R_f = \alpha + \beta_i\ (E(R_m) - R_f\ )}$
Where,
$E(R_i)$ = Expected returns of the Asset
R_f = Risk-Free Return
$E(R_m)$ = Expected Return of Market
α = Edge of strategy over benchmark (Excess return)
β_i = Covariance(R_i , R_m) / Variance(R_m) i.e volatility (systematic risk level)

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                 rs - rf   R-squared:                       0.470
Model:                             OLS   Adj. R-squared:                  0.465
Method:                  Least Squares   F-statistic:                     95.87
Date:                 Mon, 10 Feb 2025   Prob (F-statistic):           1.39e-16
Time:                         22:49:27   Log-Likelihood:                 162.44
No. Observations:                  110   AIC:                            -320.9
Df Residuals:                      108   BIC:                            -315.5
Df Model:                            1
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.0054      0.005      0.990      0.324      -0.005       0.016
rm - rf        1.1725      0.120      9.791      0.000       0.935       1.410
==============================================================================
Omnibus:                       11.008   Durbin-Watson:                   2.179
Prob(Omnibus):                  0.004   Jarque-Bera (JB):               23.379
Skew:                          -0.287   Prob(JB):                     8.38e-06
Kurtosis:                       5.184   Cond. No.                         22.5
==============================================================================
```

Here, the Alpha is the coefficient of constant = 0.0054 (monthly return)
the Beta is the coefficient of (rm-rf) = 1.1725

Here, Alpha in percentage is 0.54, and yearly = (0.54*12) = 6.48% yearly return over the market return,

Performance Metrics:
Performance metrics such as Sharpe ratio, CAGR, Max Drawdown, and Profit Factor are used to assess the momentum strategy's performance. The submitted code generates and stores all the metrics in a txt file can be used for evaluation.
Cumulative Return: The strategy has outperformed the benchmark with a cumulative return of **4.07** vs. **1.97** for the S&P 500.

Robust Analysis:
The robustness analysis of the strategy suggests that it performs well under normal market conditions, but the higher **max drawdown** and slightly lower **Sharpe ratio** indicate that it may carry more risk than the benchmark.

Conclusion:

The momentum strategy demonstrates a solid **cumulative return** and performs well in comparison to the benchmark **S&P 500**, though it does carry slightly higher risk as expressed by the Beta value of 1.17