ESG-Integrated Portfolio Optimization: A Probabilistic Programming Approach

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CONTENT

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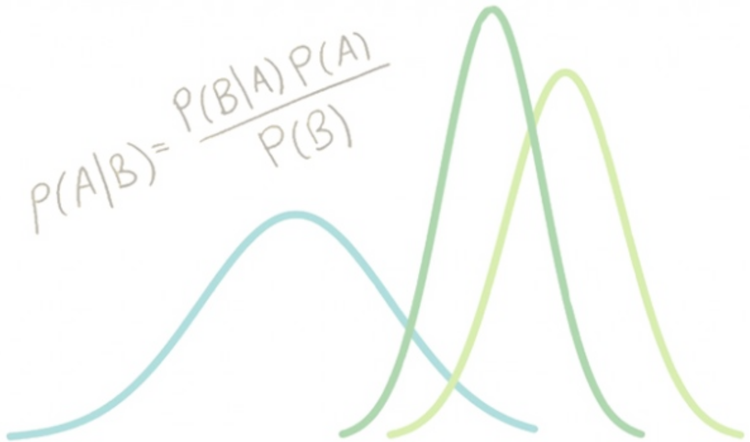
Methodologies

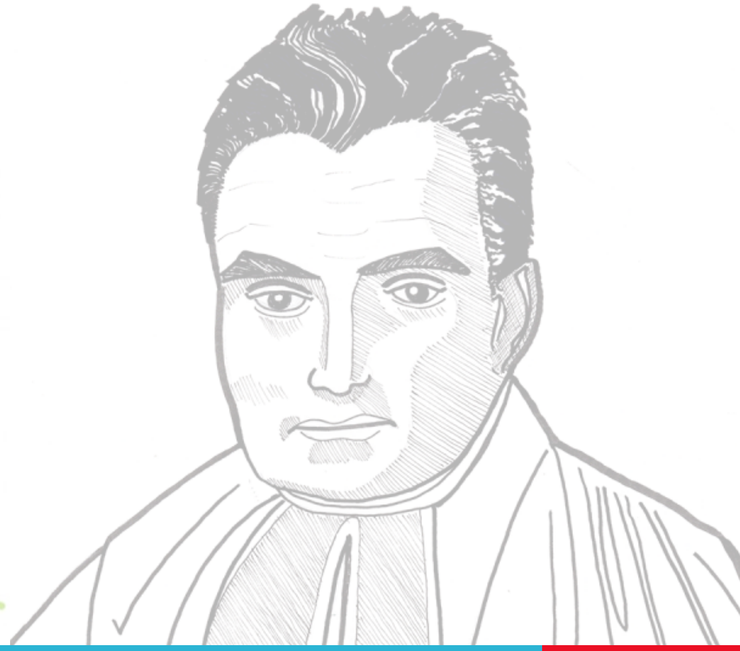
Results & Discussion

Tool propose

MOTIVATION

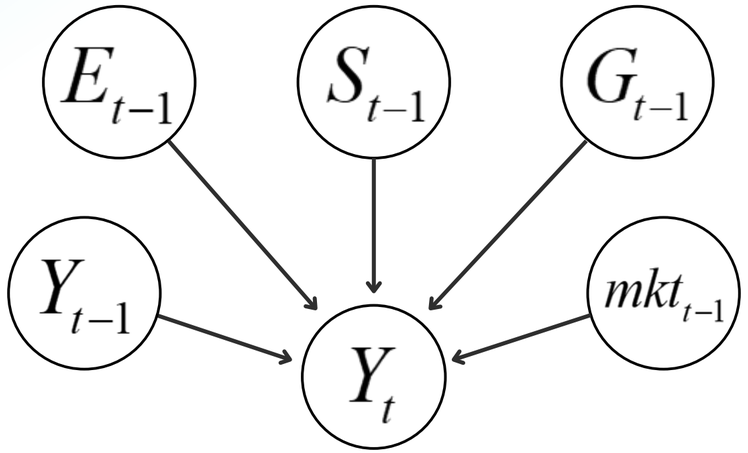
" To harness the power of **Black-Litterman model** without subjective bias, we employ a **probabilistic programming** approach to systematically infer the views, bridging data-driven insights with strategic portfolio optimization."





MOTIVATION

Proposed Bayesian network



Where;

Y_t is the Return at time t

Y_{t-1} is the lag(1) of Return

E_{t-1} is the lag(1) of Environmental Factor

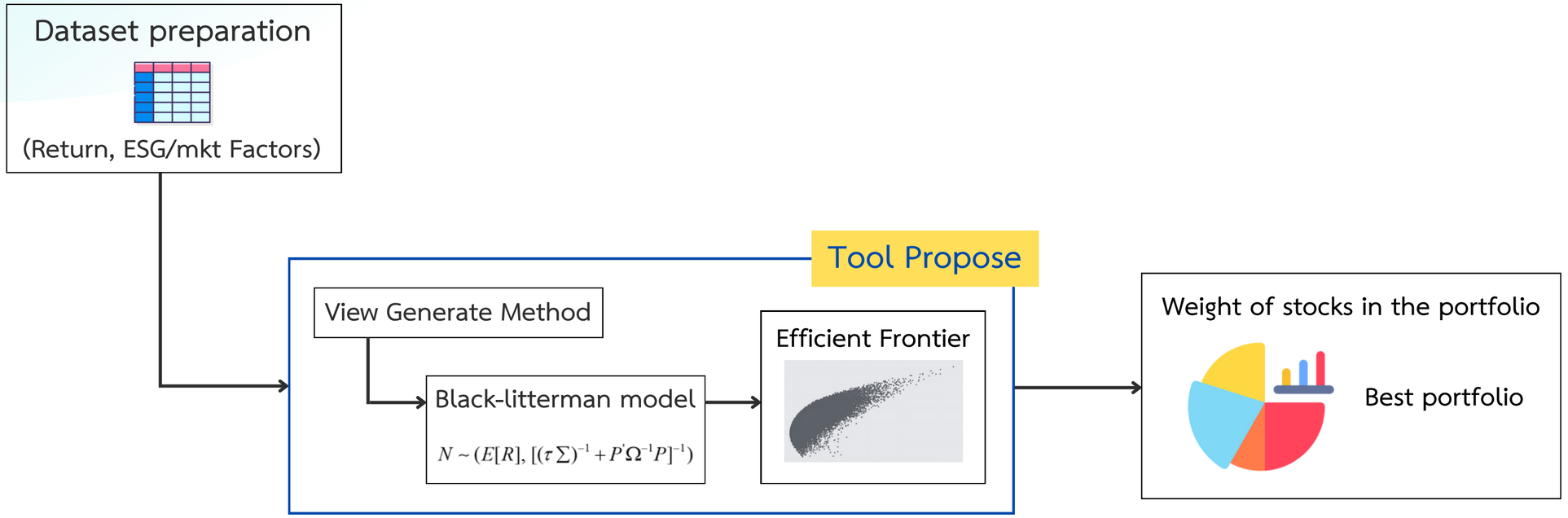
S_{t-1} is the lag(1) of Social Factor

G_{t-1} is the lag(1) of Government Factor

mkt_{t-1} is the lag(1) of Market Factor

METHODOLOGIES

Overview of all methodologies



METHODOLOGIES

Black-litterman model

Implied Equilibrium Excess return

Investor Views

$$E[R] = [(\tau\Sigma)^{-1} + P'\Omega^{-1}P]^{-1}[(\tau\Sigma)^{-1}\Pi + P'\Omega^{-1}Q] \quad (1)$$

Ensuring that sum of all weights is equal to 1

Weighted average of the implied excess return and the Investor's views.

Where;

$E[R]$ is the new (posterior) Combined Return Vector (N x 1 column vector)

τ is a scalar

Σ is the covariance matrix of excess returns (N x N matrix)

P is a matrix that identifies the assets involved in the views (K x N matrix or 1 x N row vector in the special case of 1 view)

Ω is a diagonal covariance matrix of error terms from the expressed views representing the uncertainty in each view (K x K matrix)

Π is the Implied Equilibrium Return Vector (N x 1 column vector)

Q is the View Vector (K x 1 column vector)

METHODOLOGIES

Views generating method

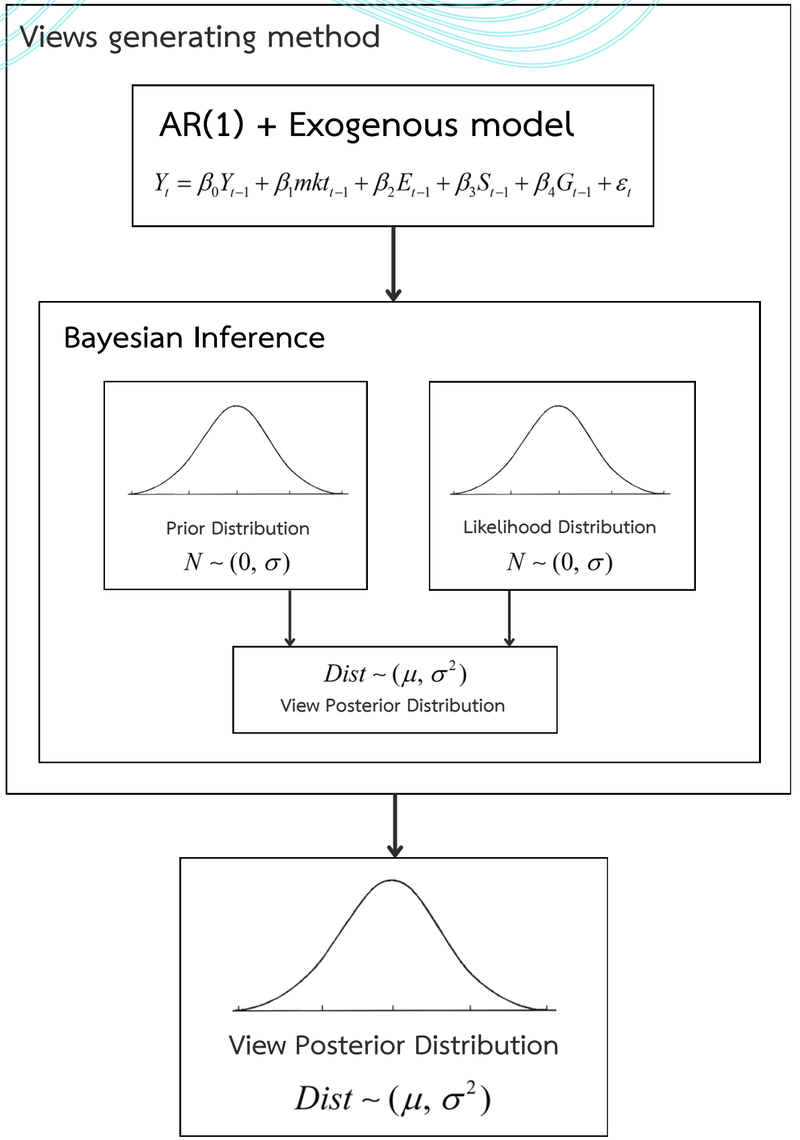
We take the expected return, which is the predicted value from the AR(1) + Exogenous model. Become a representative for Investor's views.

$$Y_t = \beta_0 Y_{t-1} + \beta_1 X_{1,t-1} + \beta_2 X_{2,t-1} + \cdots + \beta_n X_{n,t-1} + \varepsilon_t \qquad (2)$$

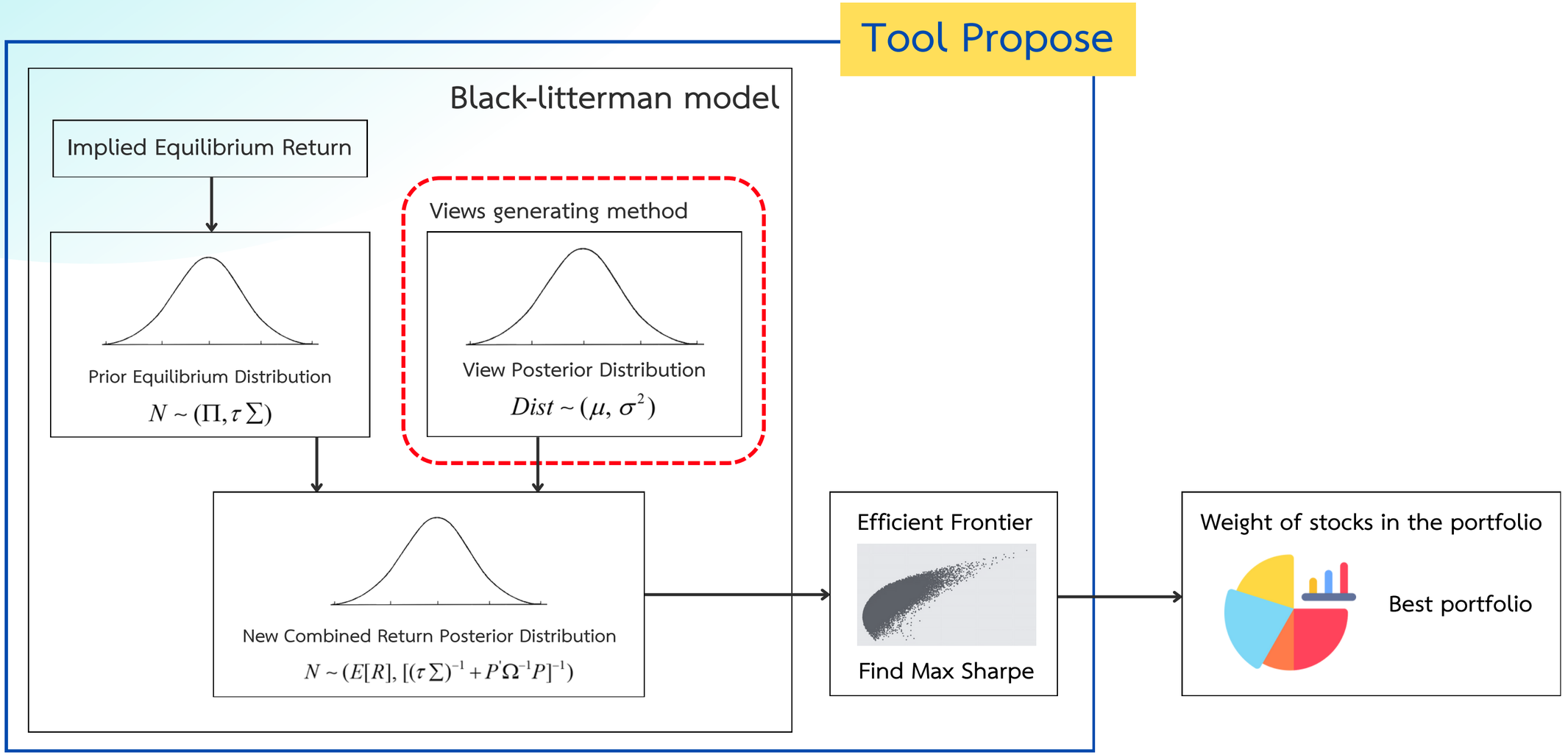
for this project, we assume the exogenous variables are ESG factors and market risk.

AR(1) + Exogenous model that is shown in (3)

$$Y_t = \beta_0 Y_{t-1} + \beta_1 mkt_{t-1} + \beta_2 E_{t-1} + \beta_3 S_{t-1} + \beta_4 G_{t-1} + \varepsilon_t \qquad (3)$$



METHODOLOGIES



RESULTS & DISCUSSION

Posterior Distribution of beta(s)

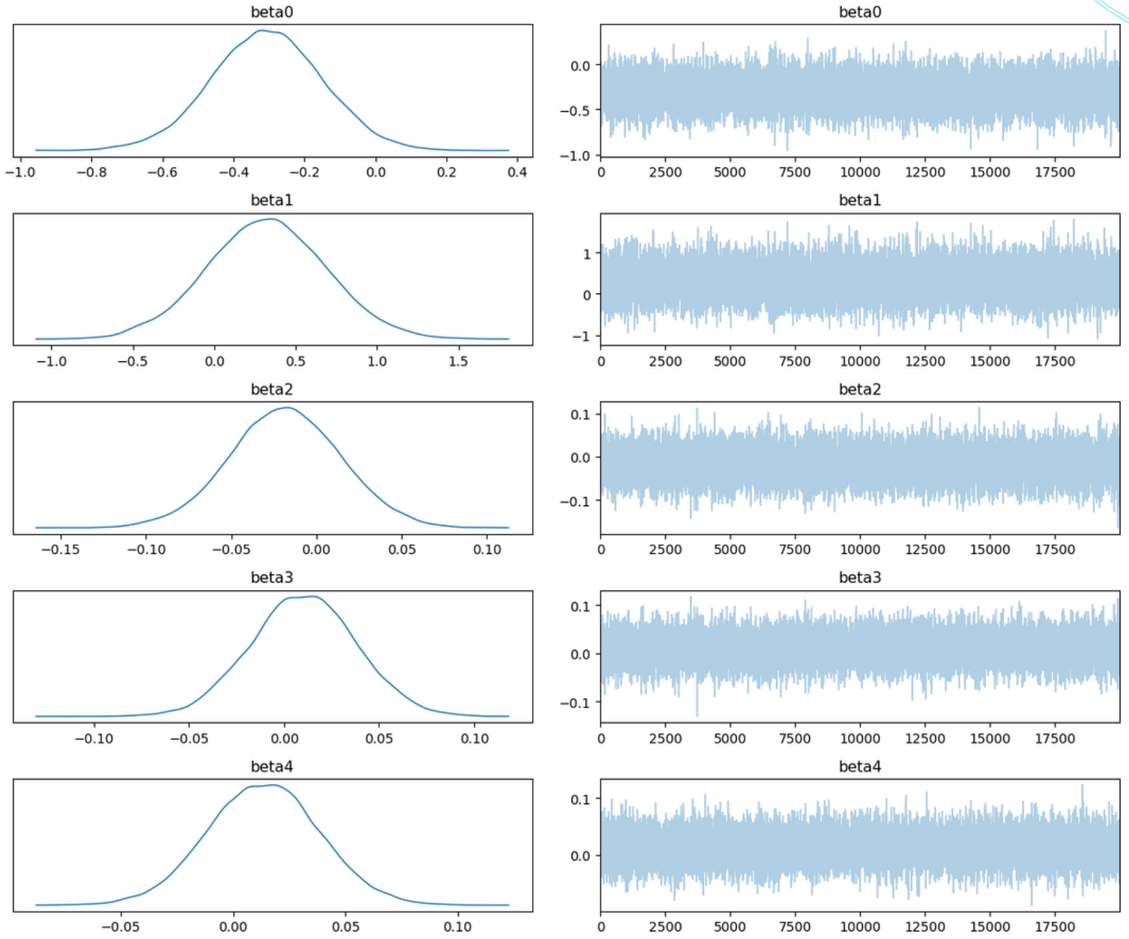
Lagged return (β_0)

Market (β_1)

Environmental (β_2)

Social (β_3)

Governance (β_4)



RESULTS & DISCUSSION

Average Monthly Expected Returns, Volatility, and Sharpe Ratio of a portfolio

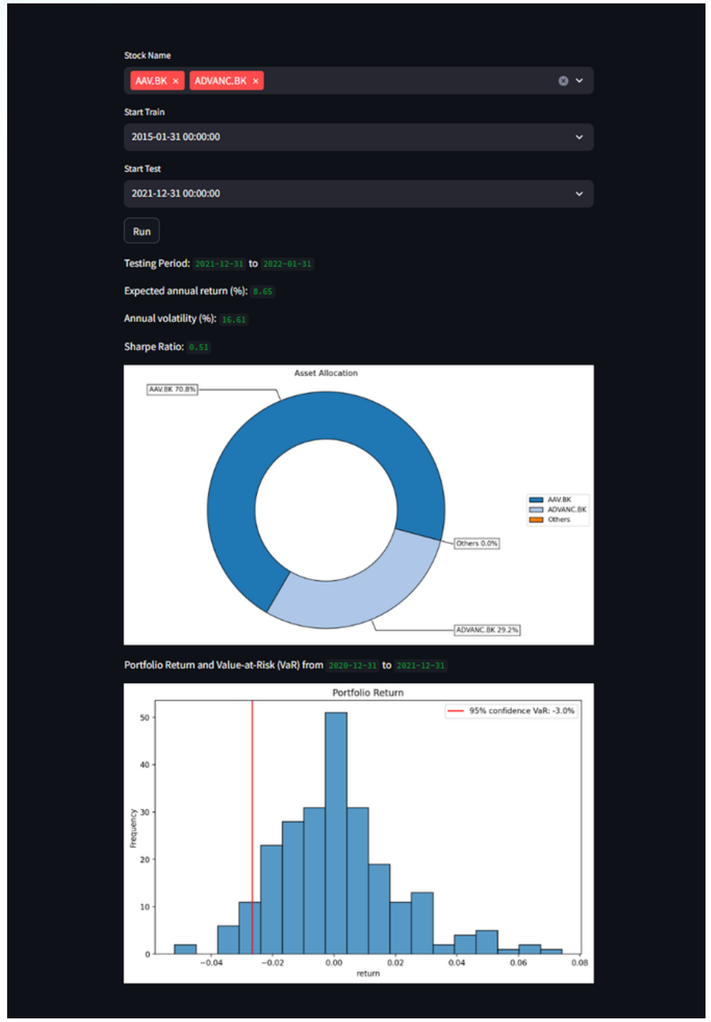
	With ESG factors	Without ESG factors
Expected Returns	0.0379	0.0163
Volatility	0.2316	0.2341
Sharpe Ratio	0.1648	0.0601

*from 2022-01-01 to 2022-12-31

**these are not a backtesting results

TOOL PROPOSE

streamlit webapp



Thank you for your Attention

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