Semi-Decision-Focused Learning with Deep Ensembles:
A Practical Framework for Robust Portfolio Optimization

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A. Summary of the proposed framework

Motivation

- In portfolio optimization, **stable** performance is important when employing the strategy at real investments. However, previous deep learning-based portfolio optimization strategies exhibit instability due to **non-convex loss** and **random initialization**.

Contribution

- I propose **Semi-Decision-Focused Learning**, which reformulate portfolio optimization problem as **supervised learning**, using **cross-entropy loss** as a loss function and hypothetically optimal portfolio as a target.
- I also apply **Deep Ensemble** by averaging multiple prediction from independently-trained models to make the output portfolio stable and robust.

B. Backtesting Performances

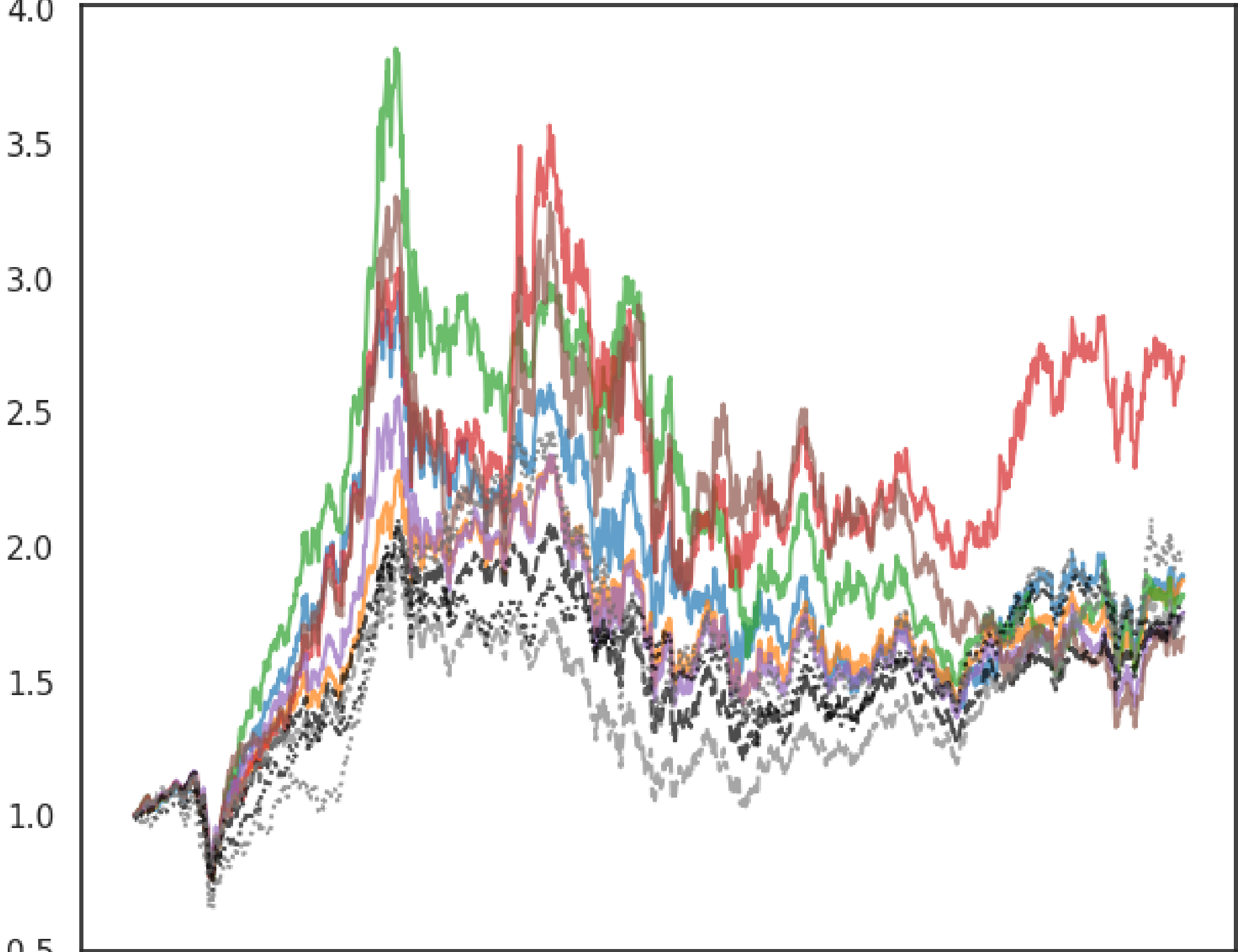|	Universe 1			Universe 2		
	CR	**SHR**	**SOR**	**CR**	**SHR**	**SOR**
Baseline						
Equal Weight	3.014	0.884	1.391	1.749	0.416	0.653
Value Weight	4.462	0.860	1.362	1.728	0.354	0.566
mSSRM PGA	2.799	0.890	1.435	1.777	0.436	0.687
DL4PO	1.408	0.219	0.341	1.976	0.388	0.642
My Method						
Mamba Max-Sortino	5.760	**1.007**	**1.577**	1.887	0.397	0.646
TRF Max-Sortino	4.013	0.981	1.546	1.870	0.447	0.713
LSTM Max-Sortino	**7.123**	0.938	1.510	1.817	0.352	0.574
Mamba One-hot	6.957	0.868	1.410	**2.685**	**0.530**	**0.894**
TRF One-hot	6.007	0.953	1.533	1.751	0.367	0.587
LSTM One-hot	6.848	0.755	1.237	1.659	0.257	0.430

CR: Cumulative Return
SHR: Sharpe Ratio
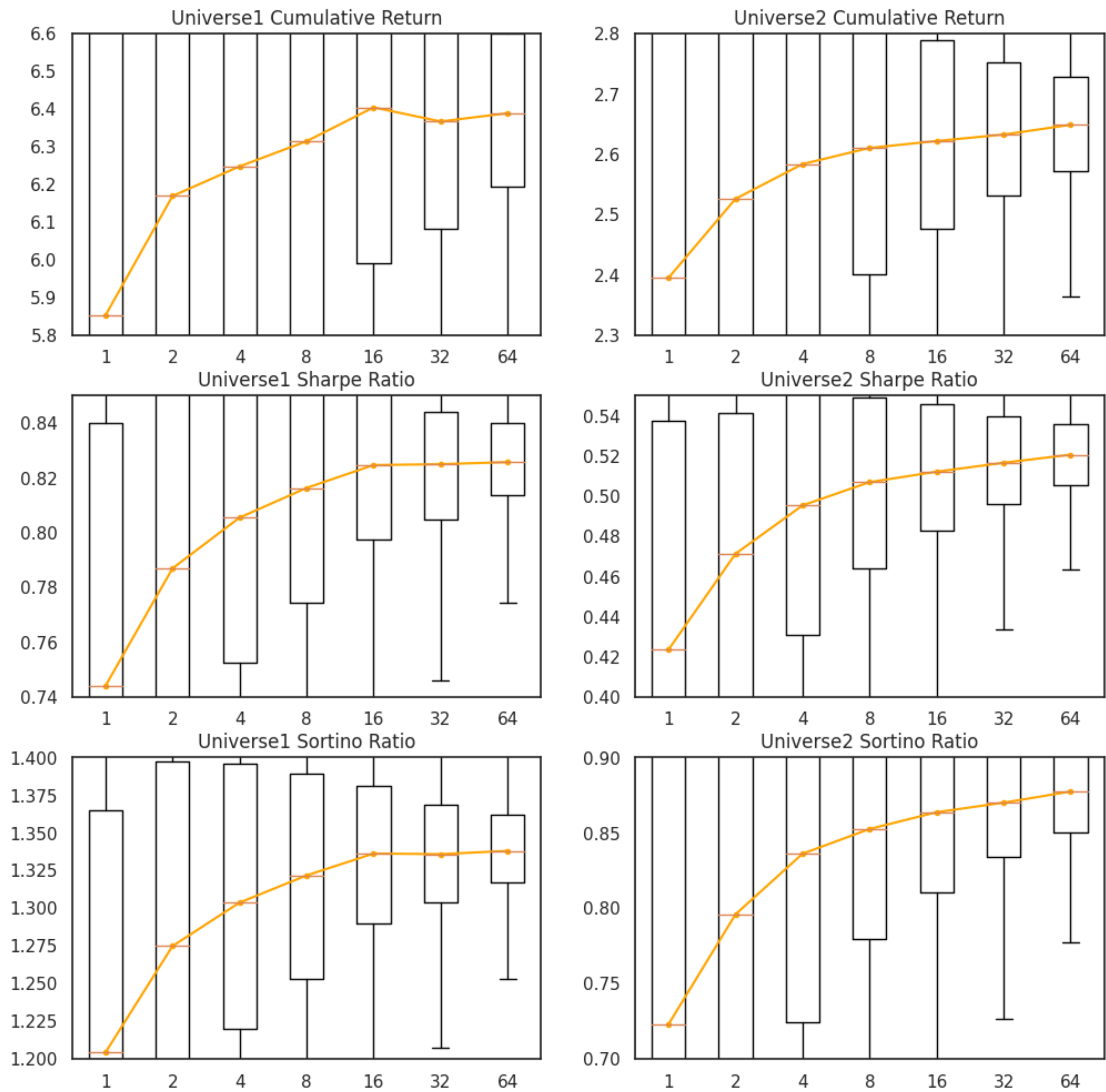**SOR**: Sortino Ratio

C. Backtesting Performance Visualizations
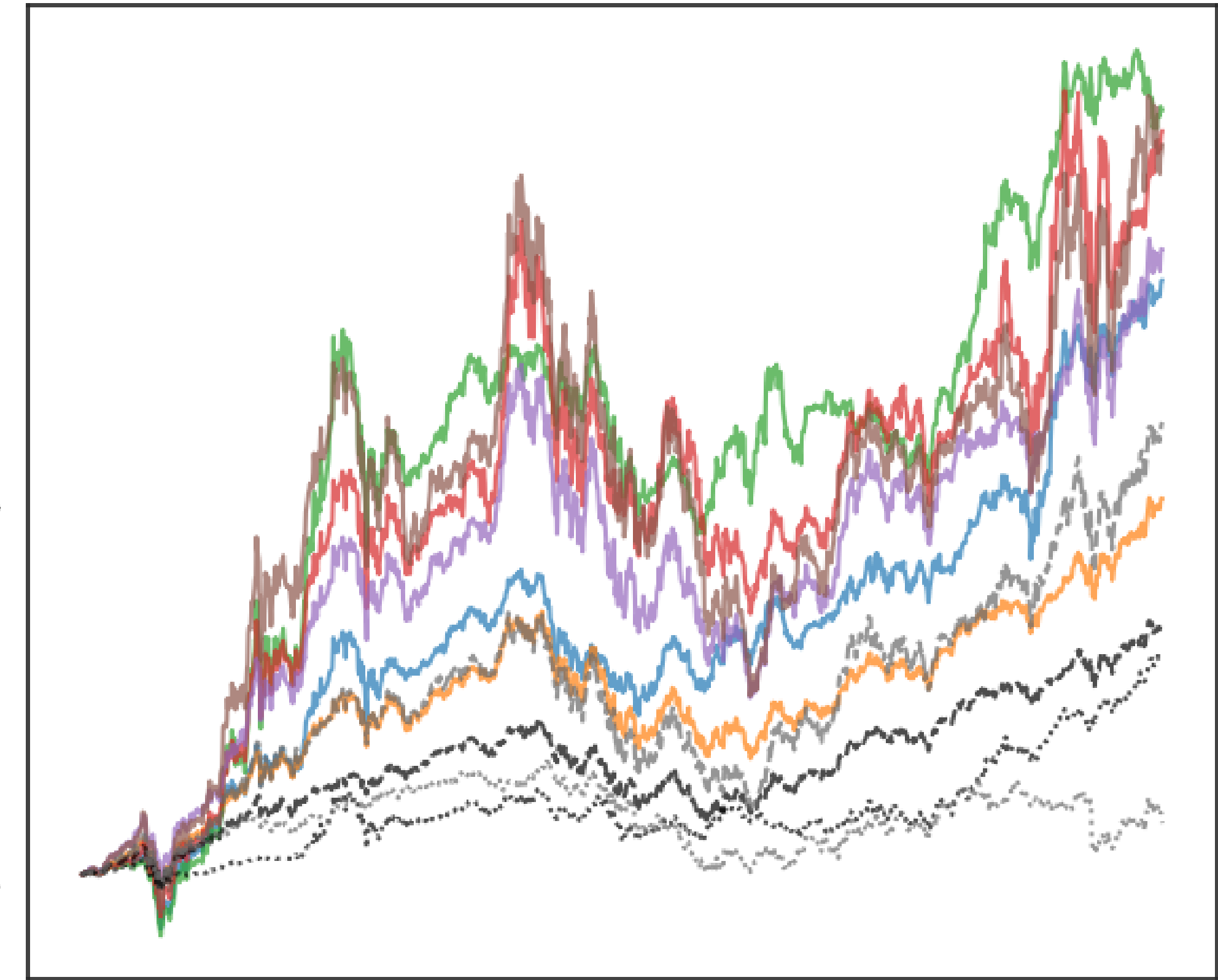
D. Ensemble Results

E. Conclusion

- I proposed a **novel portfolio optimization method** grounded in Decision-Focused Learning framework.
- In experiments on two distinct investment universes, one trending generally upward and other range-bounded, my approach **consistently outperforms** various portfolio optimization baselines, indicating its **robustness** and **superior performance** across different market conditions.
- To further enhance performance, I incorporate the Deep Ensemble method. My experiments show that increasing the ensemble size consistently yields **better portfolio optimization results** in the quality of the portfolio weight.

F. Code

https://github.com/sDFLwDE/sDFLwDE