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Reliability Assessment of Scenarios for CVaR Minimization for energy management system of microgrids in a chemical industry

Background

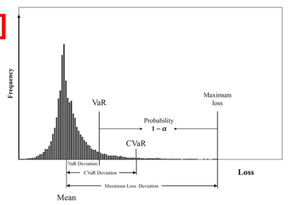
The mass transportation distance rank histogram (MTDRh) [1] was developed to assess the reliability of any given scenario generation process for a two-stage, risk-neutral stochastic program. **Reliability** is defined loosely as goodness of fit between the generated scenario sets and corresponding observed values over a collection of historical instances. This graphical tool can diagnose over- or under-dispersion and/or bias in the scenario sets and support hypothesis testing of scenario reliability. If the risk-averse objective is instead to minimize **CVaR** of cost, the only important, or effective, scenarios are those that produce cost in the upper tail of the distribution at the optimal solution.

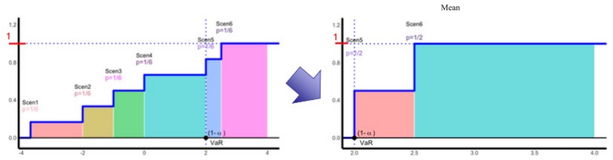
Objective

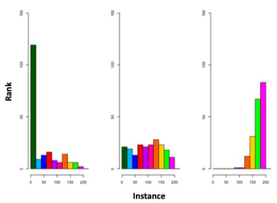
Adapt the MTDRh for use in assessing the reliability of scenarios relative to the upper tail of the cost distribution.

Approach

- Find the **effective scenarios** [2]
- Construct MTDRh







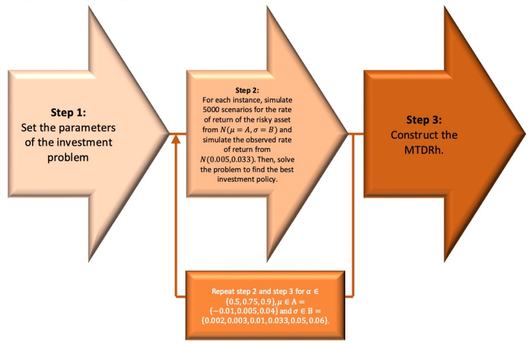
Low rank: Observation falls in the middle of scenarios

High rank: Observation is extreme among scenarios

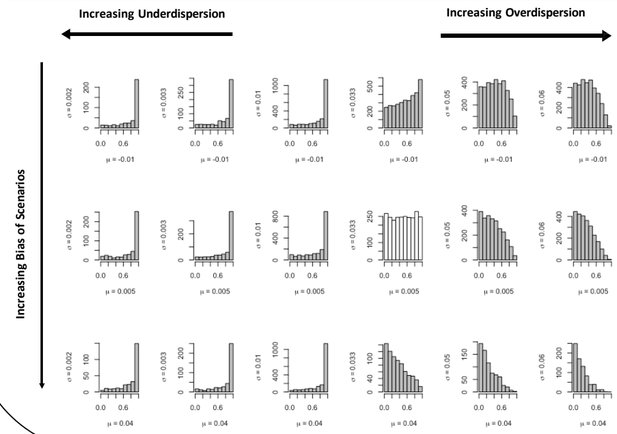
Numerical Example

Set the optimal value of allocation of wealth to risk-free and risky assets to maximize the expected excess return and minimize the investment risk **[3]**.

- The monthly rate of return of the risk-free investment is selected based on returns of the US Treasury bill (T-bill) according to the CRSP database (www.crsp.com) between January 1, 2001, and December 31, 2019.
- The rate of return of the risky asset is uncertain and generated randomly.
- We generated **m=5000** instances, which basically are our observations and **n=5000** simulated scenarios for each instance.

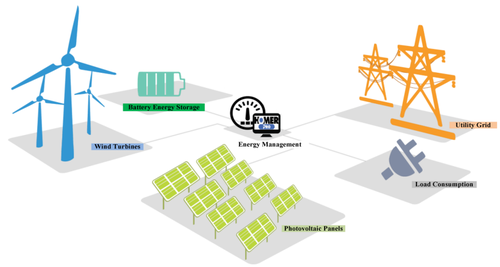


Results and Analysis



Application

- Microgrids (MG) are energy systems which relies on energy management systems **[4]**.
- We want to determine the generated energy, sold energy, bought energy, charging/discharging power of batteries, stored amount of energy, and installed capacities to design an energy management system for a battery-based microgrid in a small-scale chemical industry considering CVaR as a risk measure.
- My model aims to minimize the operational cost of the 24-hour ahead forecast data.
- precise prediction of the generated wind and solar powers is uncertain due to the nature of wind and the sun.



Conclusion

- When scenario distributions match that of the observation, the resulting histogram is flat.
- An **increasing trend** occurs when scenarios are underdispersed.
- A **decreasing trend** occurs when scenarios are overdispersed.

References

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