IOWA STATE UNIVERSITY
Industrial and Manufacturing Systems Engineering

Research Symposium
April 28, 2022

Ghazal Shah Abadi

Faculty Mentor: Professor Sarah M. Ryan

Reliability Assessment of Scenarios for CVaR Minimization

Background

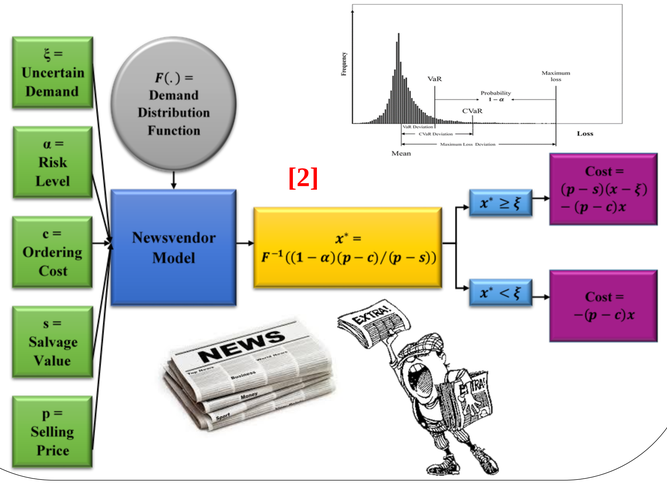
The mass transportation distance rank histogram **(MTDRh)** [1] was developed to assess the reliability of any given scenario generation process for a two-stage, risk-neutral stochastic program. **Reliability** is defined loosely as goodness of fit between the generated scenario sets and corresponding 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.

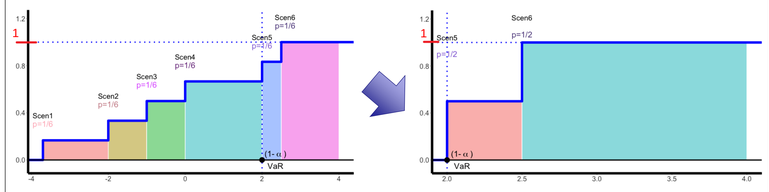
Application

- We focus on a newsvendor model.
- The goal is to minimize the expected cost in the upper $(1-\alpha)$**-probability** tail of the cost distribution by choosing order quantity x.



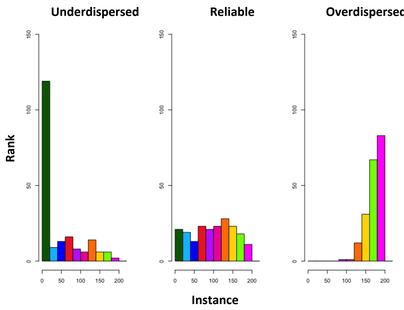
Approach

The **effective scenarios** [3] are the subset that determine the **CVaR** at optimality. $(\alpha = {}^{2}/_{3})$



Then, we revise the probabilities to construct the **MTDRh**.

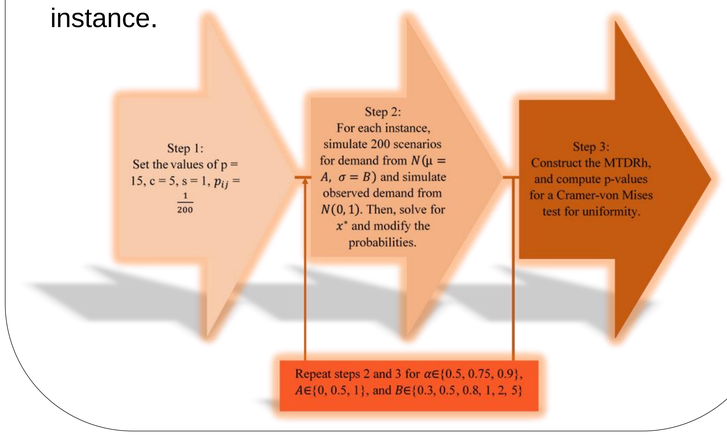
Low rank: Observation falls in the middle of scenarios



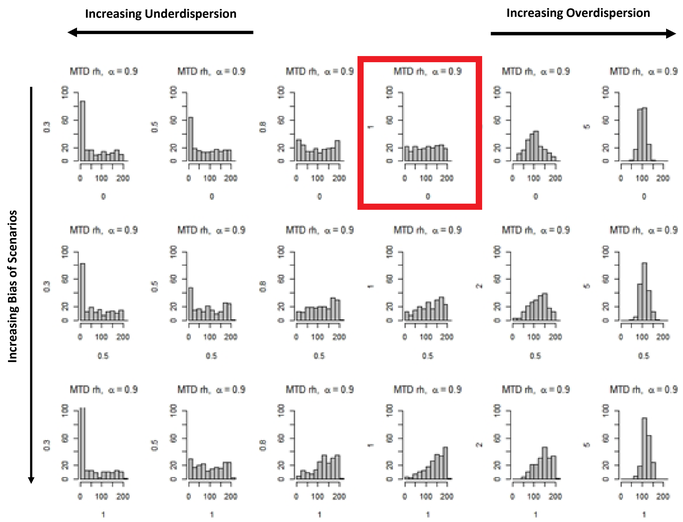
High rank: Observation is extreme among scenarios

Numerical Example

We generated **m=200** instances, which basically are our observations and **n=200** simulated scenario for each instance.



Results and Analysis



Conclusions

- When scenario distributions match that of the observation, the resulting histogram is flat.
- An **decreasing trend** occurs when scenarios are underdispersed.
- Instead of the upward-sloping, when scenarios are overdispersed, we observe **hill shaped** histograms.

Plans for Future Work

- Test more types of distributions
- Energy management for microgrids with uncertain wind power

References

[1] Sarı Ay, D. and Ryan, S.M., 2019. Observational data-based quality assessment of scenario generation for stochastic programs. *Computational Management Science*, 16(3), pp.521-540.
[2] Chen, Y., Xu, M. and Zhang, Z.G., 2009. A risk-averse newsvendor model under the CVaR criterion. *Operations Research*, 57(4), pp.1040-1044.
[3] Arpón, S., Homem-de-Mello, T. and Pagnoncelli, B., 2018. Scenario reduction for stochastic programs with Conditional Value-at-Risk. *Mathematical Programming*, *170*(1), pp.327-356.

Acknowledgements: This material is based upon work supported by the National Science Foundation under Grant No. EFMA-2132200.