Conditional normalizing flows for simulation corrections

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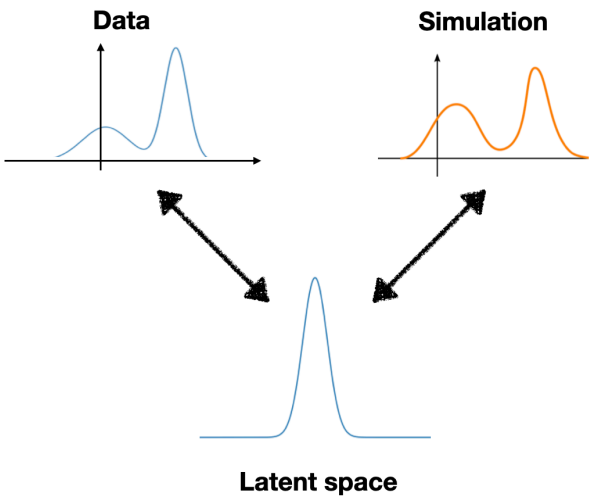
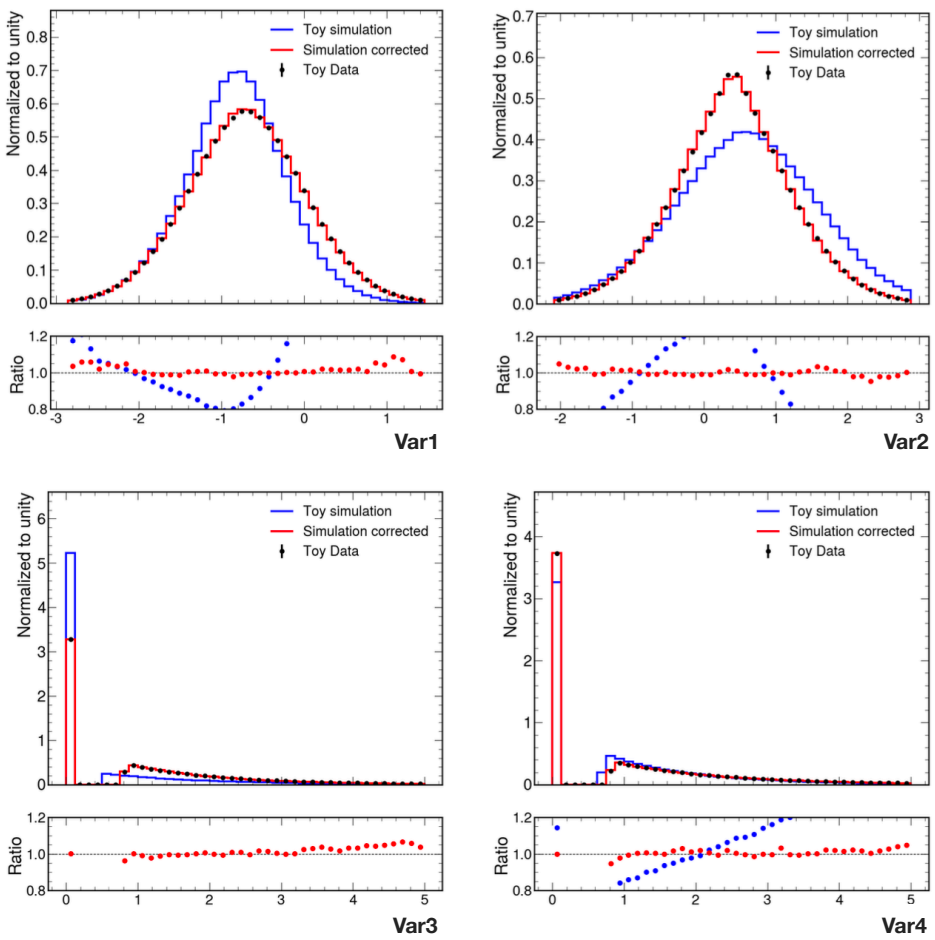
Motivation and Strategy

- Imperfections in the simulation can result in mismodelling and associated systematics
- We aim to mitigate these uncertainties using normalizing flows (NF) [1] to correct simulations
- The flows transformations conserve the quantiles of the distributions [2]
- Allowing for a quantile morphing between two distributions, using the latent space as intermediary
- Instead of several flows [3], we train a single flow with both MC and data using a IsData boolean



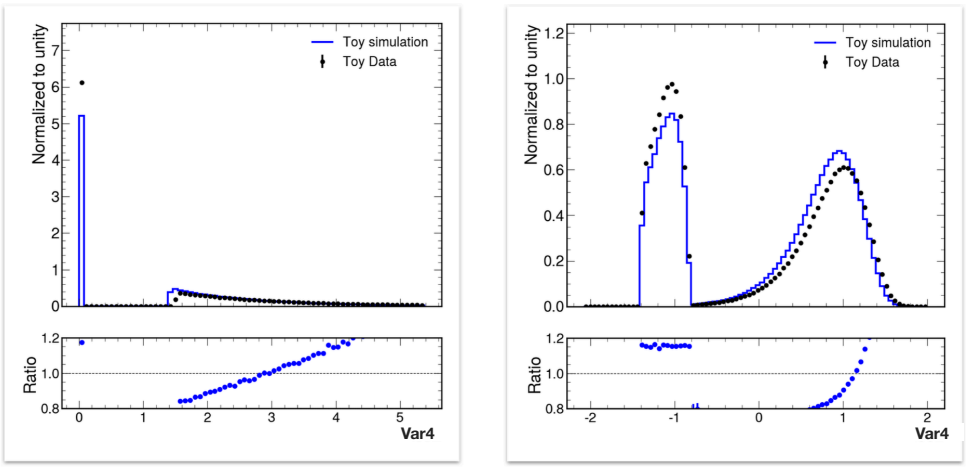
Performance of the single flow

- Toy data and simulation multivariate distributions are generated, inspired by physics distributions
- Non-trivial correlations, conditioned on p_T and η like variables

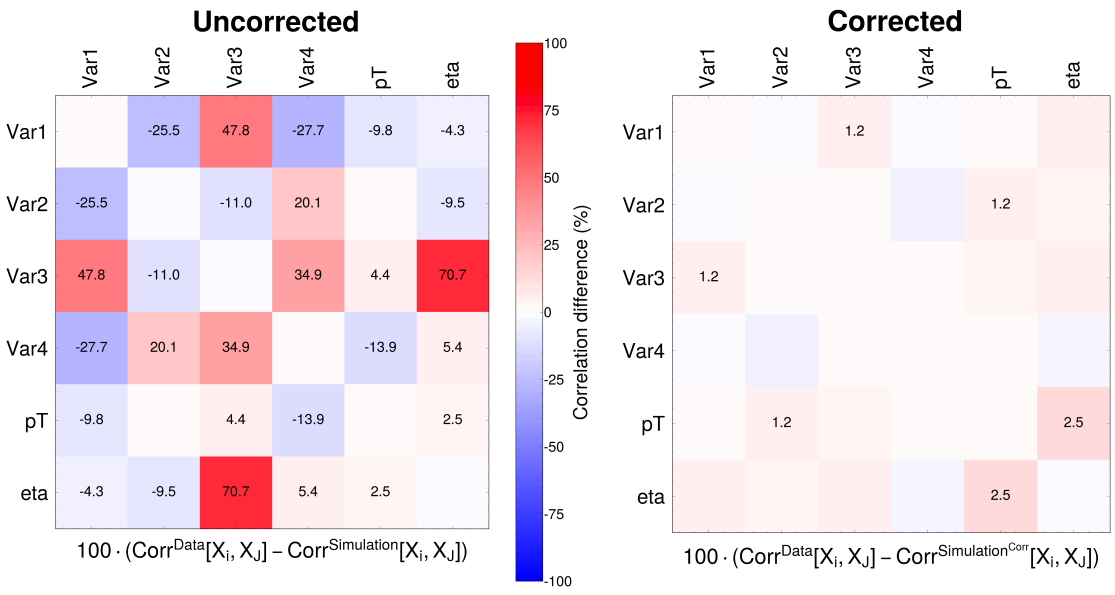


Handling discontinuous distributions

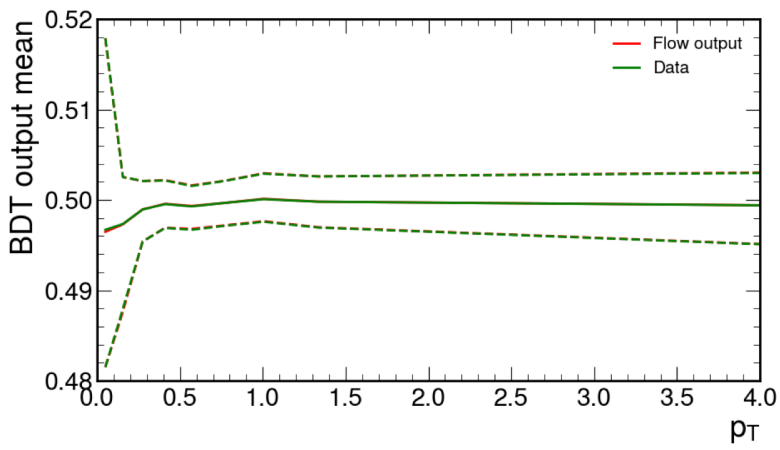
- Discontinuous distributions can be important inputs to classifiers and are difficult to correct
- As pre-processing, we apply a smoothing transformation



Good results in marginal distributions, how about correlations?



Are differential corrections good?



Conclusions

- We present a simple and effective model to perform simulation corrections
- Able to capture multidimensional distributions and its correlations
- Able to correct discontinuous distributions
- Further check: train BDTs to discriminate (un-)corrected MC from data and find an AUC of 0.91 (0.53)

[1] G. Papamakarios, E. Nalisnick, D. J. Rezende, S. Mohamed, B. Lakshminarayanan, JMLR 22 (2021) 1
[2] S. Bright-Thonney, P. Harris, P. McCormack, S. Rothman, arXiv:2309.15912
[3] T Golling, S. Klein, R. Mastandrea, B. Nachman, J A Raine, PRD 108 (2023) 096018