

Bayes@LHC

Tilman Plehn

Regression

Generation

# Bayesian Networks for the LHC

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MLClub 5/2021

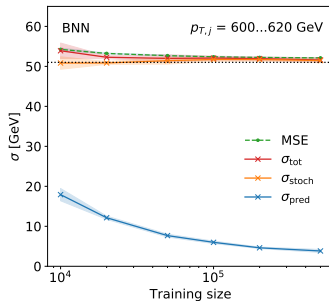
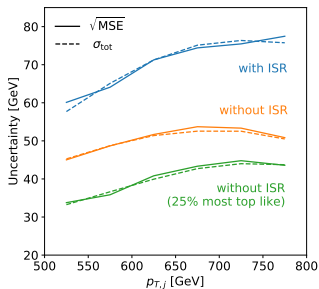


# One number is not a measurement

Regression: transverse momentum of top-jet [Kasieczka, Luchmann, Otterpohl, TP (2003.11099)]

- input: QCD jet constituents  
measurement: top energy with error bar
- Bayesian NN for noisy and size-limited training [frequentist definition]
  - $\sigma_{\text{stoch}}$  stochastic training data
  - $\sigma_{\text{pred}}$  limited training sample
- Gaussian combination  $\sigma_{\text{tot}}^2 = \sigma_{\text{stoch}}^2 + \sigma_{\text{pred}}^2$

⇒ Error estimate works



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## Things we play with [Bollweg, Haußmann, Kasieczka, Luchmann, TP, Thompson (1904.10004)]

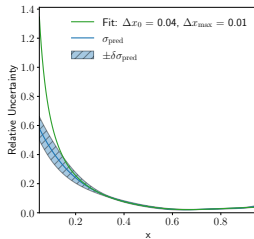
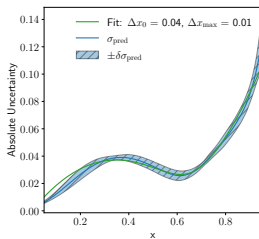
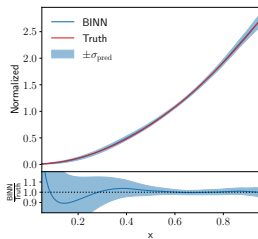
- compare to truth MSE
- validate with many deterministic networks
- separate sources of uncertainty
- confirm no prior dependence
- allow Gaussian mixture output
- test calibration
- test stability [classification]
- design adversarial-attack augmentations



# One number is not a prediction

## Bayesian generative network [Bellagente, Luchmann, Haußmann, TP (2104.04543)]

- generate events with error bars  
i.e. learn density and uncertainty maps over phase space
  - normalizing flow/INN [Köthe etal]
  - 2D toy models: wedge ramp, kicker ramp, Gaussian ring
- ⇒ Error estimate works...



...and we see how the network learns!



# One number is not a prediction

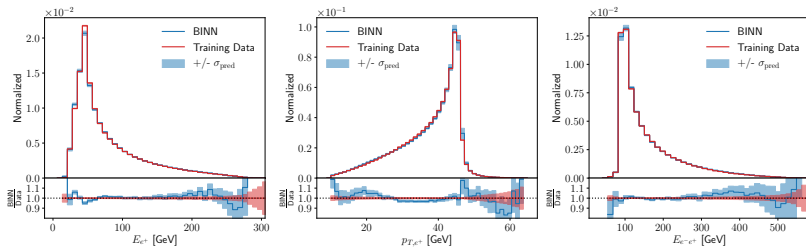
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⇒ Error estimate works...

## Simple LHC process

- 1D kinematic distributions with errors



⇒ Game changer in NN-simulations!?



Join our discussion!

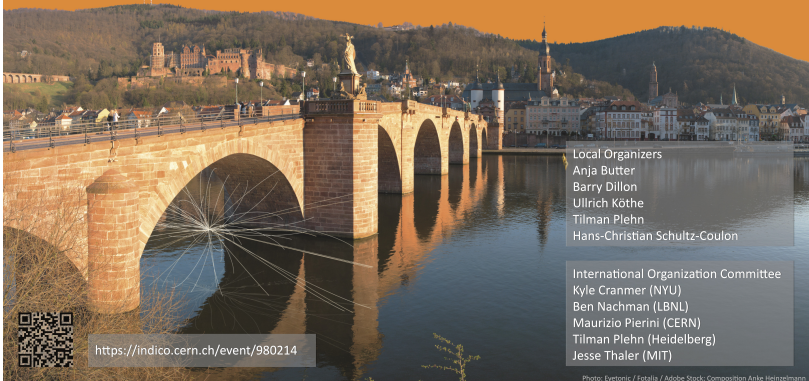
# ML4Jets hybrid

## July 6-8 2021

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### Local Organizers

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Barry Dillon  
Ullrich Köthe  
Tilman Plehn  
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### International Organization Committee

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Ben Nachman (LBNL)  
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