Amplifying Statistics using Generative Models

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**Introduction**

- Deep generative models are used to accelerate or augment slow physics simulators.
- If you train a generator using N examples and produce M, what is the statistical power of the M examples?
- Test this using simplified dataset
- For more information see the full paper on arxiv

**Dataset**

- Camel back function
- Smooth multimodal distribution, common in physics
- Define K quantiles for comparison
  - Intervals that each contains equal probability
- Sample: 100 camel back points
- Count points per quantile
- Compare quantile fractions to true values
- True fractions given by \( \frac{1}{K_{quant}} \)
- Baseline for comparison

**Generative Model**

- Trained on 100 data points from training samples
- Use regularization methods against overfitting (dropout, training noise, batch-statistics)
- Calculate quantile fraction from GANed points
- Quantile MSE: \( \frac{1}{K_{quant}} \sum_{j=1}^{K_{quant}} \left( \gamma - \frac{1}{K_{quant}} \right)^2 \)

**Results**

- 100 training samples, 100 fits, 100 GANs
- 10,000 GANed points equal to 150 training points
- Interpretation in terms of information:
  - Sample: only data points
  - Fit: data + true function
  - GAN: data + smooth function

**Conclusion**

- It makes sense to GAN significantly more events than we have in the training sample,
- Individual events carry less information than a training sample event.
- Net benefit, if the GAN sampling is sufficiently fast

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