My self presentation for the IDPASC school

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About me

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PhD topic: ‘Quantifying ML uncertainties in searches for new physics at the LHC’

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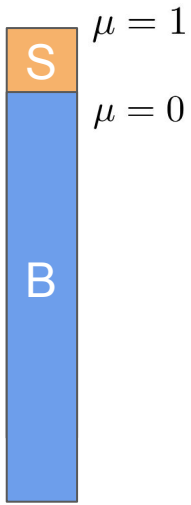
“Quantifying ML uncertainties in searches for new physics at the LHC”

- Uncertainties in Machine Learning
  - ML is often treated as a “black box”
  - Most applications of ML don’t care about uncertainties

- Particle physics
  - Uncertainties are extremely important for results
  - Already many uses of ML, only expected to grow as the amount of data does

Current projects - Likelihood estimation with ML



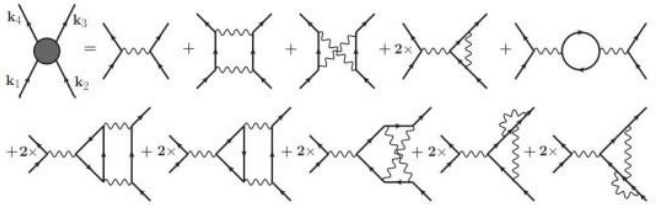
$$\mathcal{L}(\mu) = P(\{n_1, \ldots, n_k\}|\mu) \propto \prod_{b \in \text{bins}} \text{Pois}(n_b|\mu\nu_b^{\text{sig}} + \nu_b^{\text{bkg}})$$

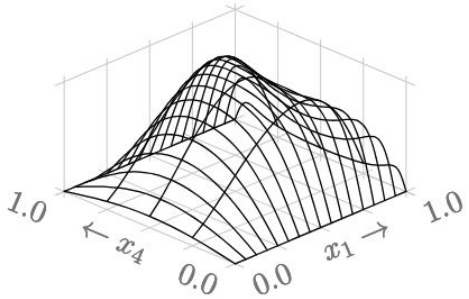
- The expected rates have associated many nuisance parameters coming from the many sources of uncertainty, for example the detector response
- From the Neyman-Pearson lemma, we know that the optimal test to discriminate is the likelihood ratio test

$$q_\mu = -2 \ln \frac{\mathcal{L}(\mu)}{\mathcal{L}(0)} \longrightarrow p_\mu = \int_{q_{\mu,\text{obs}}}^{\infty} f(q_\mu|\mu) dq_\mu$$

Current projects - Scalings in Amplitude Regression

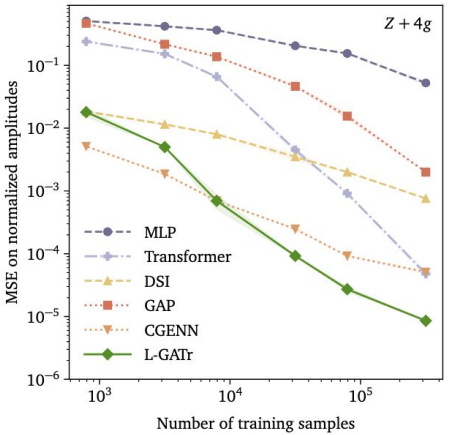
Calculating scattering amplitudes is expensive





Use ML to learn the scattering amplitudes from the 4-momentum of the interacting particles

Many applications of ML show exponentially decaying improvements as one increases **training steps**, **training dataset size**, **number of parameters**



Thanks