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Data driven background estimation in HEP using generative adversarial networks

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Data-driven techniques are indispensable for addressing the limitations of Monte Carlo (MC) simulations in High Energy Physics experiments, such as insufficient statistics and process mismodeling. Accurate representation of background processes is essential for achieving optimal measurement sensitivity. Traditional approaches often involve the selection of a control region to model the background, but this can introduce biases in the distribution of certain physics observables, and hence rendering them unusable in subsequent analyses. To overcome this issue, we introduced a novel method that generates physics objects that are both compatible with the region of interest and accurately represent correlations with other event properties.
To achieve this we employ conditional generative adversarial networks (GANs), leveraging their proven efficacy in various machine learning tasks. The method is illustrated by generating a new misidentified photon for the gamma+jets background of the $\mathrm{H} \to \gamma\gamma$ analysis on the CMS Open Data simulated samples. We demonstrate that the GAN is able to generate a coherent object within the region of interest and still retains correlations with other observables within the rest of the event.

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