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# CaloClouds: Fast Geometry-Independent Highly-Granular Calorimeter Simulation

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Simulating showers of particles in highly-granular detectors is a key frontier in the application of machine learning to particle physics.
Achieving high accuracy and speed with generative machine learning models would enable them to augment traditional simulations and alleviate a major computing constraint.
This work achieves a major breakthrough in this task by for the first time directly generating a point-cloud of $O(1000)$ space points with energy depositions in the detector in 3D-space without relying on a fixed-grid structure. This is made possible by two key innovations: i) using recent improvements in generative modelling we apply a diffusion model and ii) an initial even higher-resolution point-cloud of up to 40000 so-called GEANT4 steps which are subsequently down-sampled to the desired number of up to 6000 space points.
We showcase the performance of this approach using the specific example of simulating photon showers in the planned electromagnetic calorimeter of the International Large Detector (ILD) and achieve overall good modelling of physically relevant distributions.

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