Fast Simulation of Gamma/Proton Event Images for the TAIGA-IACT Experiment using Generative Adversarial Networks

Julia Dubenskaya, Alexander Kryukov, Andrey Demichev
Skobeltsyn Institute of Nuclear Physics, Moscow State University
jdubenskaya@gmail.com

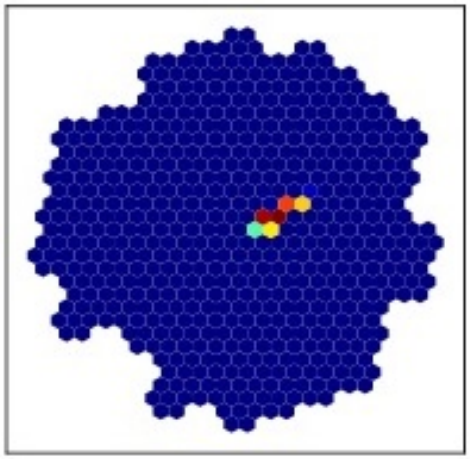
07.2021

Air showers and event images

Charged cosmic rays and high energy gamma rays interact with the atmosphere giving rise to extensive air showers emitting Cherenkov light.

TAIGA-IACT telescopes detect this light emitted and thus record "images" of the air shower.

Two types of events are observed: gamma quanta and protons.



Identifying the type of the registered event is an important task.

To accomplish this task, many simulated images of both types of events are required.

Generative adversarial networks for fast simulations

We suggest using a special class of machine learning frameworks: generative adversarial network (GAN) - to obtain simulated images.

The peculiarities of GANs:

- GAN can generate new images much faster than standard computational methods
- there is no clear algorithm for choosing the most appropriate network architecture

We created and trained two separate networks - one for gamma events and another for proton events.

After training each network generates about 400 images in a second.

Verifying simulation results

We verified generated event images with a software tool that is used for image classification in the TAIGA project. Verification showed that:.

- most of the generated events (more than 90%) are classified correctly
- the generation speed increased 1000 times comparing to the traditional Monte Carlo simulations

Thus, we can conclude that the use of GAN provides reasonably fast and accurate simulations for the TAIGA-IACT project.