# Fast Simulation of Gamma/Proton Event Images for the TAIGA-IACT Experiment using Generative Adversarial Networks: an Executive Summary

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***What is this contribution about?***

We demonstrate the possibility of using a machine learning technique called Generative Adversarial Networks (GAN) to quickly simulate images of gamma and protons events from Imaging Atmospheric Cherenkov Telescopes for the TAIGA-IACT project.

***Why is it relevant / interesting?***

In the TAIGA-IACT project, in addition to images of extensive air shower recorded experimentally, simulated images are widely used. Current modelling involves Monte Carlo simulation of the underlying physical processes. This procedure is very resource intensive and time consuming. This can lead to a lack of simulated images for the experiment.

Generative adversarial network is a special class of machine learning frameworks designed to generate, improve or process images. The peculiarity of GANs is that they can learn from images from a given set of training data, and then generate new images that are statistically indistinguishable from the images of the training set. And although learning can take a long time, generation is very fast.

Using GAN to generate images in the TAIGA-IACT project can dramatically increase the amount of available simulated data and remove any possible computational bottleneck.

***What have we done?***

It was experimentally found that training is more stable and the generation results best correspond to the training set if we create and train two separate GANs - one network to generate proton events and another to generate gamma events. For training we used a sample of two-dimensional images obtained using TAIGA Monte Carlo simulation software.

***What is the result?***

We verified our results with a software tool that is used for classification in the TAIGA-IACT project. Verification showed that 94.5% of the generated gamma events are classified as gamma events, while 99% of generated proton events differ with confidence from gamma events. At the same time, the rate of events generation using GAN is more than 1000 times higher than the rate of generation by the traditional method: generation of 4000 event images takes about 10 seconds.

Thus, we can conclude that the use of GAN provides reasonably fast and accurate simulations for the TAIGA-IACT project, and we sincerely hope that our experience will be useful to other projects.