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Interpreting and Controlling Latent Space Parameters of Auto-Ecoders

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Compressed representations of input data are used to solve many problems in the natural sciences, in particular in the field of cosmic rays. Conventionally, the input data are mapped to a low-dimensional vector, which is a set of physically motivated parameters. For example, for images of extensive air showers (EAS) recorded by Cherenkov telescopes, the so-called Hillas parameters are used, which are obtained from the statistical moments of two-dimensional images. The problem with this approach is that it is difficult to determine to what extent the used set of parameters contains enough information necessary for further study of the physical phenomenon.

The effective and popular ways to construct compressed representations are autoencoders (AEs). Using elements of the AE latent space as a vector representation of the input data has a number of advantages over the conventional approach. In particular, in this approach, the dimensionality of the vector representation in the latent space can be varied to achieve the required level of accuracy. The problem with this approach is that the vector representation of the data in the AE latent space cannot be interpreted directly, and therefore its control is also difficult.

In the presented work, an approach is proposed based on the training of two additional neural networks whose function, on the one hand, is to provide an interpretation of the latent space vector in terms of a physical problem, and on the other hand, to allow control of the representation vectors through available physics parameters. In general, the set of physics parameters into which the latent space is mapped and the set of physics parameters for the inverse mapping may differ. Their choice is determined by the problem being solved. This approach was tested on data obtained from the Cherenkov telescopes of the TAIGA experiment.

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