III. Physikalisches Institut A

RWTH AACHEN UNIVERSITY

VISPA Tutorial

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III. Physikalisches Institut A, RWTH Aachen

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The VISPA Project

HTTPS

VISPA

SSH

Software

Access via Web Browser

- ~ 100 active users
- Large updated software environment
  - Python, numpy, matplotlib, TensorFlow, ROOT etc.
- Physics specialized extensions

Cluster

Working environment

- ~200 CPU Cores
- 20 GPUs
- HTCondor

TensorFlow

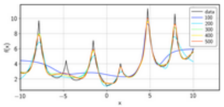
Keras

Opens the example page

- Developed in Aachen (group of Prof. Erdmann)
- GPU extension
  - 20 NVIDIA GTX 1080
- Accessible via https://vispa.physik.rwth-aachen.de/

Examples

Deep Learning



1D Function Fitting

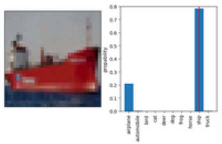
In this example, you can train a neural network to fit an arbitrary function and investigate the approximation performance during the training iterations.

Reset example | Open example

MNIST Digit Recognition

MNIST is a dataset of 28x28 greyscale images of handwritten digits and a classic task for benchmarking image classification algorithms. In this example, you can train and apply a simple convolutional neural network to identify the correct digit.

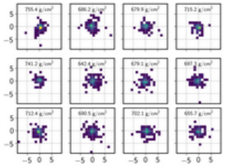
Reset example | Open example



CIFAR-10 Image Classification

CIFAR-10 is a dataset of tiny natural images showing objects of 10 different classes. It is a popular data set for experimenting with different deep learning techniques. In the provided examples you can train and apply: a fully connected net, a simple convolutional net and a deep convolutional net.

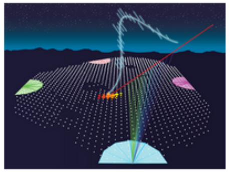
Open example



Air Shower Classification

Ultra-high energy cosmic rays produce extensive air showers, which vary among others with the cosmic ray mass. For tracking the cosmic rays back to their sources, the reconstruction of the charge is a key parameter hence it could allow for estimating the galactiv magnetic field deflection for each cosmic ray. In this example you can train a neural network on a toy data set to reconstruct the mass of the air shower (classifcation) and the showermaximum (regression).

Open example



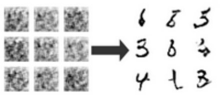
Deep learning based Air Shower Reconstruction

Ultra-high energy cosmic rays produce extensive air showers of secondary particles upon entering the atmosphere. Sampling the footprint of these particles with surface detectors is a widely used detection technique. In this example you can exploit advanced convolutional techniques to reconstruct the energy, showeraxis and depth of the shower maximum of cosmic ray induced air showers.

Open example

Open Air Shower example

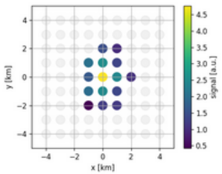
Deep Generative Models



Generative Adversarial Networks (GANs) for MNIST

In this example, you can generate handwritten digits by training a Deep Convolutional Generative Adversarial Network (DCGAN) to the MNIST data set.

Reset example | Open example



Wasserstein GANs for Physics Simulations

In this example, you can train a improved Wasserstein Generative Adversarial Network (WGAN) to generate signal patterns of cosmic ray induced air showers.

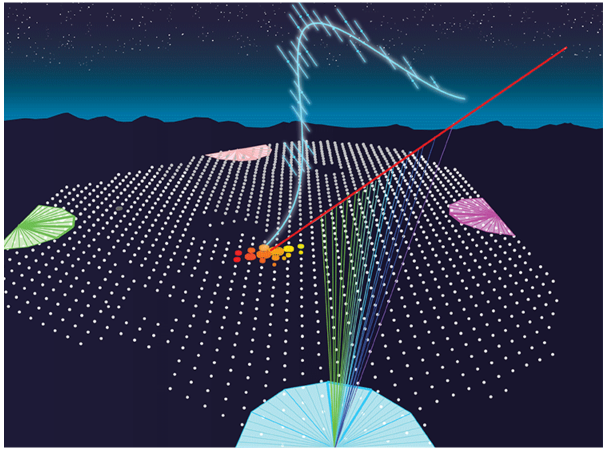
Reset example | Open example

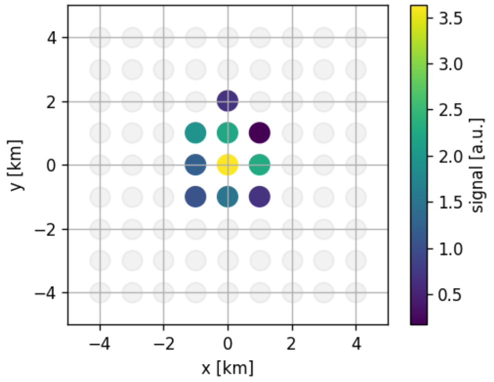
Astroparticle Examples

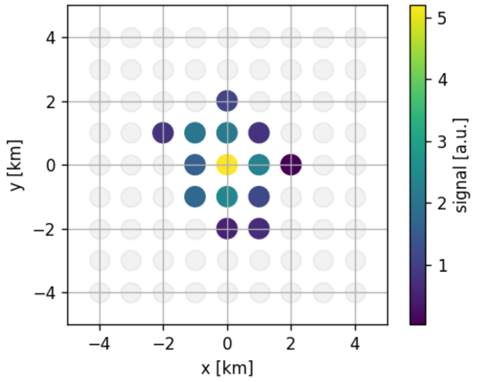
Air Shower Reconstruction

- Cosmic Ray induced Air Showers
  - Pierre Auger like Observatory
- Reconstruct energy and showeraxis

- Use footprint as 2D image
- Center image at hottest tank
  - Cutout of 9 x 9 stations
- Use arrival times and signals
- ➢ Resulting shape 9 x 9 x 2



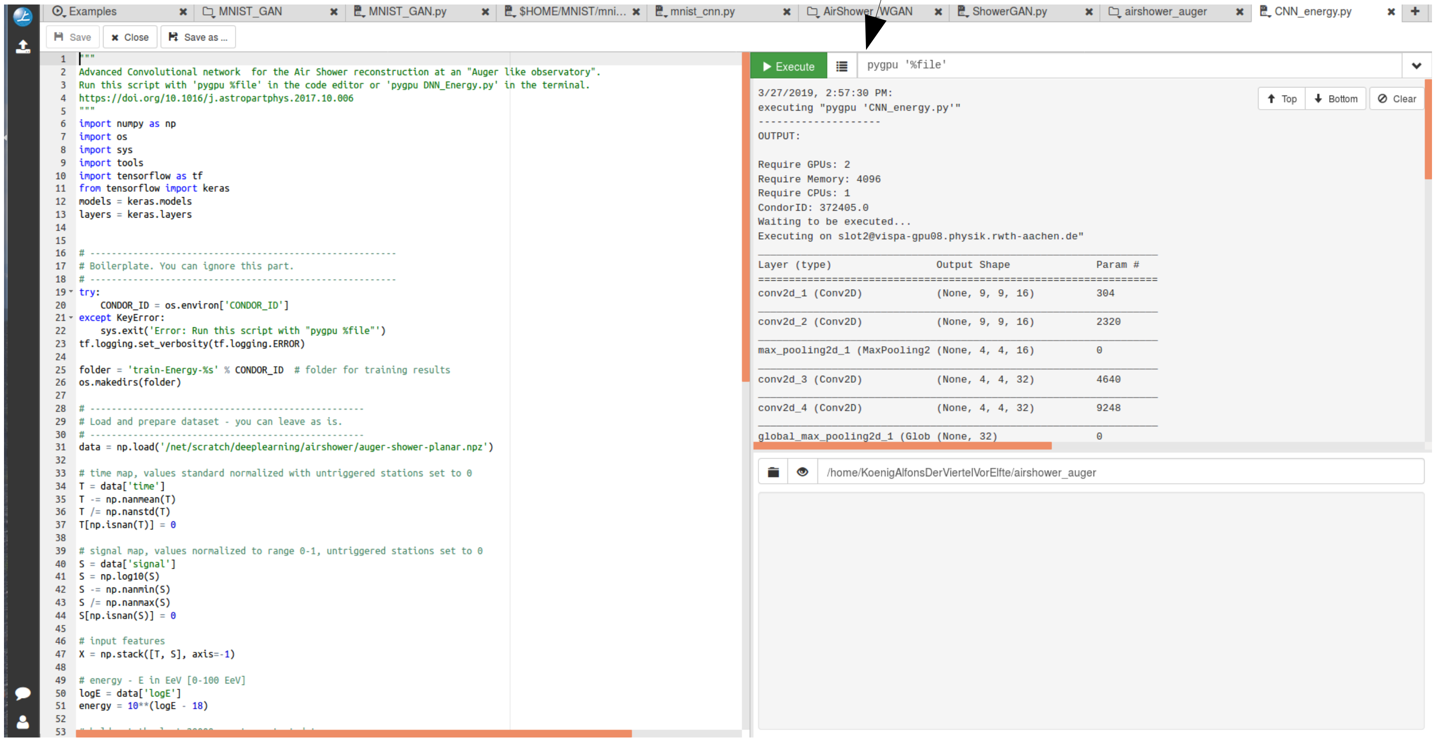




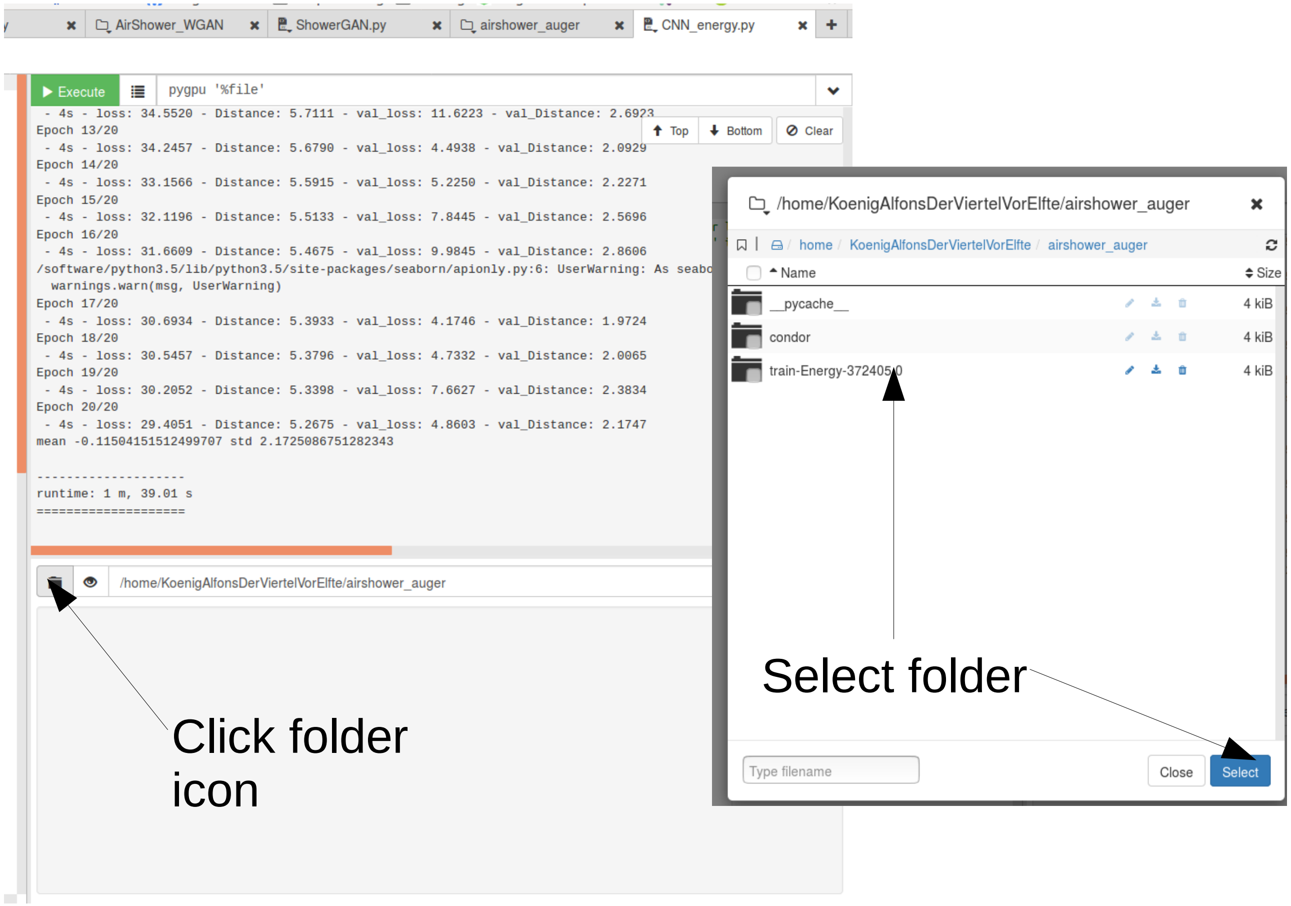
Type: pygpu '%file'

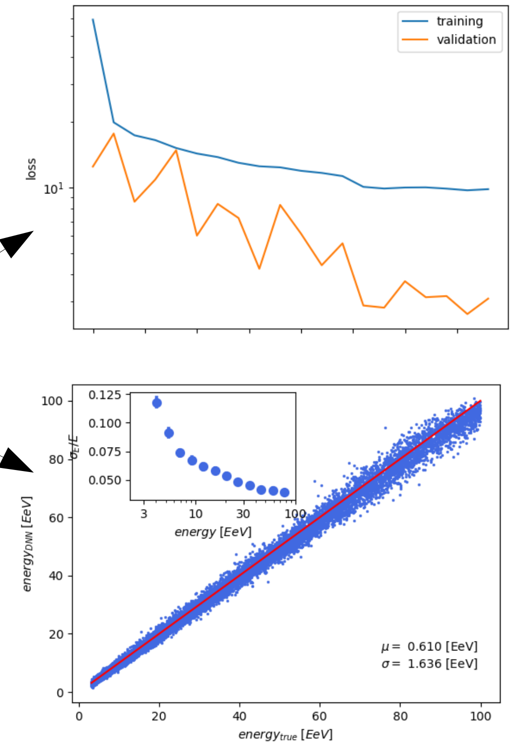
and click execute button → submit job to GPU cluster

Open CNN-energy.py



Results – Energy Reconstruction

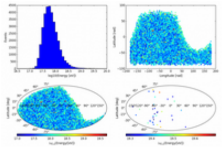




More Examples

- Feel free to try out more applications
  - Generative Models
  - Astroparticle Applications

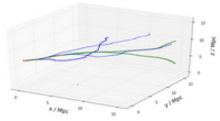
Astroparticle Examples



Pierre Auger Observatory Data Analysis Example

In this example, you can use the public data set (1 % of all events) of the Pierre Auger Observatory to study the energy distribution and to plot the arrival directions of cosmic rays.

Open example

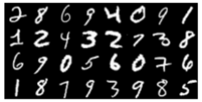


CRPropa Example

In this example, you can use CRPropa to simulate the propagation of a cosmic ray nucleus in a turbulent extragalactic magnetic field.

Open example

Generative Adversarial Networks (GANs)



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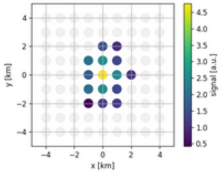
Reset example Open example

- Generate MNIST digits

Wasserstein GANs



Wasserstein GANs for Physics Simulations

In this example, you can train a improved Wasserstein Generative Adversarial Network (WGAN) to generate signal patterns of cosmic ray induced air showers.

Reset example Open example

- Generate Air Shower Footprints

The VISPA Platform

- Accessible with web browser – GPU extension
  - Many software packages available
- Connection from VISPA to my own preferred computing resources

VISPA as Marketplace?

- Exchange of code, architectures, training methods
  - Direct execution / testing on cluster
- Exchange of pre-trained models