

# Machine Learning Knowledge Base

This section of the ML-INFN Confluence Space contains the Knowledge Base of fully implemented use cases. This has been created in order to provide new users getting close to Machine learning with concrete examples, with step by step guides for reproducibility.

The division into categories is multidimensional

- Dimension 1: per goal (classification, regression, clustering, technological ...)
- Dimension 2: per Machine Learning algorithms (CNN, Auto encoders, LSTM, GraphNet, ...)
- Dimension 3: per scientific field (High Energy Physics, Gravitational Waves, Medical Physics, ...)
- Dimension 4: per type of used tool

and is implemented via Confluence labels.

## Table of Use cases

| Name and Link                                                                                                                                                         | Goal                                       | ML Algorithms                       | Scientific Field                      | ML Tools                                       | Comments                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------|---------------------------------------|------------------------------------------------|----------------------------------|
| <a href="#">Btagging in CMS (templated version)</a>                                                                                                                   | Classification                             | CNN, LSTM                           | High Energy Physics                   | Keras + Tensorflow                             | Realistic application            |
| <a href="#">LHCb Masterclass, with Keras</a>                                                                                                                          | Density estimation and classification      | MLP                                 | High Energy Physics                   | ROOT + Keras + TF                              | Introductory tutorial            |
| <a href="#">MNIST in a C header</a>                                                                                                                                   | Classification                             | MLP                                 |                                       | Keras                                          | Free-styling tutorial            |
| <a href="#">LUMIN: Lumin Unifies Many Improvements for Networks</a>                                                                                                   | Technological                              | CNN, RNN, GNN                       | High Energy Physics                   | PyTorch                                        | Package use examples             |
| <a href="#">INFERNO: Inference-Aware Neural Optimisation</a>                                                                                                          | Classification                             | NN                                  | High Energy Physics                   | Keras + Tensorflow                             | Technique application example    |
| <a href="#">An introduction to classification with CMS data</a>                                                                                                       | Classification                             | Fisher, BDT, MLP                    | High Energy Physics                   | Scikit-learn, TF2                              | Tutorials for Master Students    |
| <a href="#">Virgo Autoencoder tutorial</a>                                                                                                                            | Data Compression                           | Autoencoder                         | General Relativity                    | Python Keras                                   | Tutorial for student             |
| <a href="#">Distributed training of neural networks with Apache Spark</a>                                                                                             | Technological                              | DNN                                 | High Energy Physics                   | Spark + BigDL                                  | Tutorial                         |
| <a href="#">FTS log analysis with NLP</a>                                                                                                                             | Self-supervised, clustering                | NLP                                 | High Energy Physics, Computing        | Word2Vec + Rake + sklearn                      | Tutorial                         |
| <a href="#">Image Inpainting tutorial: how to digitally restore damaged images</a>                                                                                    | Inpainting                                 | CNN U-Net                           | Applied Physics                       | Keras + Sci-kit image, PIL, OpenCV, matplotlib | Tutorial                         |
| <a href="#">Signal/background discrimination for the VBF Higgs four lepton decay channel with the CMS experiment using Machine Learning classification techniques</a> | Classification                             | ANNs, RF                            | High Energy Physics                   | Keras , TensorFlow, Scikit-learn               | Tutorial                         |
| <a href="#">Explainability of a CNN classifier for breast density assessment</a>                                                                                      | Explainability AI                          | CNN                                 | Medical Physics                       | Keras, Tensorflow                              | Tutorial                         |
| <a href="#">ML for smart caching</a>                                                                                                                                  | Technological                              | ML/RL                               | High Energy Physics, Computing, Cache | Keras, Tensorflow, sklearn                     | Demo, playground                 |
| <a href="#">Signal-background Classification with Parametric Neural Networks</a>                                                                                      | Classification                             | pNN                                 | High Energy Physics                   | Keras + TensorFlow 2                           | Tutorial                         |
| <a href="#">New Physics Learning Machine</a>                                                                                                                          | Density Estimation                         | NN                                  | High Energy Physics                   | Keras, Tensorflow                              | package + tutorial               |
| <a href="#">MLaaS4HEP for the Higgs boson ML challenge</a>                                                                                                            | Technological                              | DT, MLP                             | High Energy Physics                   | XGBoost, Keras + TensorFlow 2, PyTorch         | Tutorial                         |
| <a href="#">Object counting with c-ResUnet</a>                                                                                                                        | Supervised learning, Semantic Segmentation | CNN, ResUnet                        | Computer Vision                       | PyTorch, fastai                                | Real application, Tutorial       |
| <a href="#">Fast classifier-based goodness of fit test for online data quality monitoring</a>                                                                         | Density estimation                         | Logistic Regression, Kernel Methods | High Energy Physics                   | Pytorch, Falkon library                        | Tutorial + Realistic application |

## How to insert a new use case

Follow the instructions provided in the [How To: Create a KB entry](#)

Once you finish with the creation of the page don't forget to edit the page "[Machine Learning Knowledge Base](#)" (this same page!) and add the use case in the "**Table of Use cases**".