15. NPLM (New Physics Learning Machine)

Author(s)

Name	Institution	Mail Address	Social Contacts
Gaia Grosso	INFN Padova, University of Padova, CERN	gaia.grosso@cern.ch	
Marco Zanetti	INFN Padova, University of Padova	marco.zanetti@cern.ch	
Andrea Wulzer	IFAE, ICREA	andrea.wulzer@cern.ch	
Maurizio Pierini	CERN	maurizio.pierini@cern.ch	
Raffaele Tito d'Agnolo	CEA	raffaele-tito.dagnolo@ipht.fr	

How to Obtain Support

Mail	gaia.grosso@cern.ch
Social	
Jira	

General Information

ML/DL Technologies	NN
Science Fields	High Energy Physics
Difficulty	medium
Language	english
Type	

Software and Tools

Programming Language	Python
ML Toolset	Keras, Tensorflow
Additional libraries	scipy.stats
Suggested Environments	bare Linux node, cern lxplus

Needed datasets

Data Creator	Gaia Grosso, Marco Zanetti, Andrea Wulzer, Maurizio Pierini, Raffaele Tito d'Agnolo
Data Type	simulations
Data Size	225.2 MB compressed
Data Source	Zenodo

Short Description of the Use Case

NPLM is a strategy to detect data departures from a given reference model, with no prior bias on the nature of the new physics model responsible for the discrepancy. The method employs neural networks, leveraging their virtues as flexible function approximants, but builds its foundations directly on the canonical likelihood-ratio approach to hypothesis testing. The algorithm compares observations with an auxiliary set of reference-distributed events, possibly obtained with a Monte Carlo event generator. It returns a p-value, which measures the compatibility of the reference model with the data. It also identifies the most discrepant phase-space region of the dataset, to be selected for further investigation. Imperfections due to mis-modelling in the reference dataset can be taken into account straightforwardly as nuisance parameters.

How to execute it

The main utilities to run the NPLM strategy have been made available in a python-based package NPLM, that can be easily installed via pip.

All useful information on how to install the package can be found at: https://github.com/GaiaGrosso/NPLM_package.

An example of the NPLM application to a simple one-dimensional use case is provided at https://github.com/GaiaGrosso/NPLM_package/tree/v0.0.6/example_1D.

Annotated Description

References

- *"Learning New Physics from a Machine"* (Phys. Rev. D)
- *"Learning Multivariate New Physics"* (Eur. Phys. J. C)
- *"Learning New Physics from an Imperfect Machine"* (Eur. Phys. J. C)

Presentation made on 20 Mar 2023 : https://agenda.infn.it/event/35036/contributions/193738/attachments/102997/143982/INFN-ML.pdf