**PhD Physics course at Bari University ( Cycle)**

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| **Title** | Machine Learning Techniques in High Energy Physics |
| **Proponent** | Prof. Andre Sznajder |
| **# CFU****(1 CFU = 8 hours)** | 2 CFU |
| **Schedule** | 2 lectures of 2 hours each per week |
| **Brief Summary of the course** | Thiscoursecovers the moderntechniques of High Energy Physics(HEP) data analysisasapplied to LHC experiments. Starting from an overview of Monte Carlo(MC) programs,studentswilllearnhow to simulate the colisions and analyzethis data. After a discussion of some basic statistics concepts likewe dive into machine learning techniques. Starting with simple tools like the multilayerperceptron and thenmoving to moderndeeplearning. We show howthese  toolscan be applied to classification and pattern recognitionproblems in HEP data analysis. The lectureswill include tutorial sessions wherestudentswillhavehands on experience with toolslike the Madgraph Monte Carloevent generator and KERAS with Tensor Flow backend for Deep Learning tools. |
| **Programme** | The Physics of Event Generators:* Physics processes ,Feynman diagrams and cross sections
* Monte Carlo method
* Madgraph event generator

Introduction to Statistics for HEP Data Analysis:* Basic concepts of statistics
* Parameter and interval estimation
* Hypothesis testing and goodness of the fit

Machine Learning:* Introduction to machine learning: classification and pattern recognition problems
* The multilayer perceptron (MLP)
* Universal approximation , vanishing gradient and deep learning
* Convolutional network, autoencoder and adversarial network
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| **Recommended texts** |  |
| **Assessment methods** | Students will be evaluated at the end of the course based on a final project. |