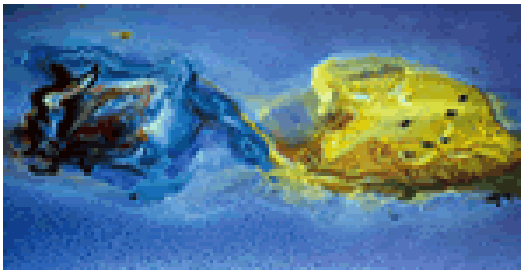

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Model independent searches for new physics via parametric anomaly detection

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The Standard Model is currently the most widely accepted physical theory that classifies all known elementary particles and represents three out of the four fundamental forces in the universe. Despite the confirmation of the model, there is a need for its generalization or for the development of a new theory, able to complete our knowledge of the Universe. For this purpose, High Energy Physics experiments are performed, to detect empirically any possible signal which behaves as a deviation from the background process, representing, in turn, the known physics. Such searches may be conducted in a model-dependent fashion, trying to confirm some particular physical conjecture alternative to the Standard Model. Alternatively, the searches follow a more general model independent approach by being unconstrained to any specific theory already formulated.

In this work, we are interested in finding physical anomalies that collectively deviate from our knowledge of the universe by not taking any specific assumption on the potential signal. Anomaly detection is performed parametrically by fitting mixture of Gaussian densities to model data generated by particle collisions. As the dimensionality of these data is high the standard approach is generalized in order to jointly perform regularization and proper selection of informative variables. We propose a method based on the penalized likelihood approach that puts specific constraints on components covariance matrices and performs dimensionality reduction by shrinkage of the parameters.

Primary authors: Mr KOTKOWSKI, Grzegorz (University of Padova); Dr FINOS, Livio (University of Padova); MENARDI, Giovanna (Department of Statistical Sciences, University of Padua); SCARPA, Bruno (Università di Padova)

Presenter: Mr KOTKOWSKI, Grzegorz (University of Padova)

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