Wigner 121
Scientific Symposium

Wigner Research Centre for Physics
Institute for Particle and Nuclear Physics
Dept. of Computational Sciences
Data and Compute Intensive Sciences
Research Group

Introduction

Our Data and Compute Intensive Sciences Research Group is a small group in RMI, Dept. of Computational Sciences, currently comprising only two members. Our collective effort, in collaboration with partners, is dedicated to advancing the intersection of physics concepts and artificial intelligence (AI) tools. We apply our knowledge across various domains of life. In the field of physics, our focus lies on the applications of the renormalization group, particularly the Functional Renormalization Group theory and applications in nuclear physics. Our research extends to diverse areas, including novel AI approaches, entropy analysis, and comprehension, medical applications such as ECG analysis and human motion recognition, as well as financial applications like analyzing price movements.

Method

The Renormalization Group (RG) is a mathematical framework designed to describe and track relevant phenomena within a specific or changing environment. Originally developed in the field of physics, the underlying principles are applicable across various domains. We harness these principles to create innovative data-driven AI methodologies that are rooted in the specific laws governing each unique problem. Our approach involves utilizing networks composed of linear components alongside nonlinear units, akin to deep neural networks. However, our training methodology is different, as it centers on the identification of conserved quantities.

Publications of the group

[1] *Facilitating time series classification by linear law-based feature space transformation,* MT Kurbucz, P Pósfay, A Jakovác, Scientific Reports 12 (1), 18026 (2022)
[2] *Reconstruction of observed mechanical motions with artificial intelligence tools,* A Jakovác, MT Kurbucz, P Pósfay, New Journal of Physics 24 (7), 073021 (2022)
[3] *Entropy of Artificial Intelligence,* TS Biró, A Jakovác, Universe 8 (1), 53 (2022)

Results

In the recent years we achieved some result, in particular

- we worked out the generalization of RG that could be applied to AI
- we studied the training methods in this new approach, determined an entropy function
- we applied our method to learn laws of physical systems, characterize price movements, analyze human motions, classify ECG signals, etc.
- we also worked in the development of RG, in particular in the context of Spontaneous Symmetry Breaking and nuclear physics