



Contribution ID: 20

Type: **Poster**

First or second? An attempt to determine the order of a phase transition with machine learning methods.

Sunday, 18 September 2022 16:54 (3 minutes)

The determination of the order of a phase transition can be quite a challenging task. In the thermodynamic limit the situation is clear: in the case of a first-order phase transition we observe discontinuity in the free energy at the critical point leading to the release of a latent heat. This phenomenon is not observable in the case of a continuous phase transition. Therefore, the results obtained with Monte Carlo computations, which simulate only the finite-size systems do not always provide an answer whether transition is of first or second-order. We attempt to overcome this issue by a careful analysis of the output obtained from the application of the learning by confusion scheme to the Potts, Blume–Capel and Falicov–Kimball models. We discover that in some cases the establishment of the order of a phase transition is plausible, but the results obtained in the case of a discontinuous phase transition strictly depend on the number of degrees of freedom and their character (quantum, classical).

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Session Classification: Poster session party