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

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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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