Quantum kernels to learn the phases of quantum matter

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Classical machine learning has succeeded in the prediction of both classical and quantum phases ofmatter. Notably, kernel methods stand out for their ability to provide interpretable results, relatingthe learning process with the physical order parameter explicitly. Here, we exploit quantum kernels instead. They are naturally related to thefidelityand thus it is possible to interpret the learning process with the help of quantum information tools. In particular, we use a support vector machine (SVM) (with a quantum kernel) to predict and characterize quantum phase transitions. The general theoryis tested in the Ising chain in transverse field. We show that for small-sized systems, the algorithm gives accurate results, even when trained away from criticality. Besides, for larger sizes we confirmthe success of the technique by extracting the correct critical exponentv. The characterization is completed by computing the kernel alignment between the quantum and ideal kernels. Finally, we argue that our algorithm can be implemented on a circuit based on a varational quantum eigensolver.

References

[1] T Sancho-Lorente, J Román-Roche, D.Zueco , arXiv:2109.02686

Figures

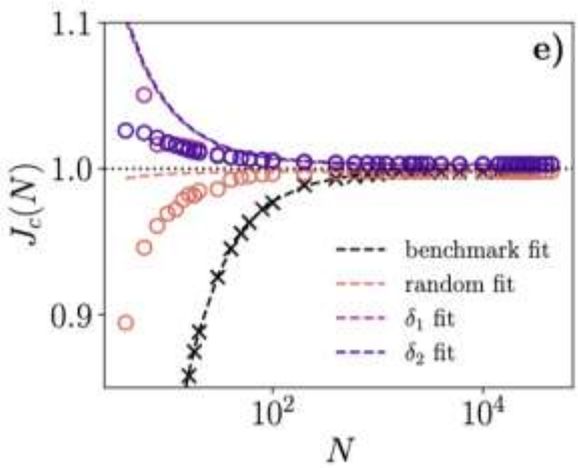

Figure 1: Prediction of a quantum phase transition using quantum machine learning. We show that a SVM can learn the phase transition and its critical exponents.