Subham Das B.Sc. project

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Title: Solving the quantum Heisenberg model with neural-network quantum states

Background: Solving quantum many-body systems is a great challenge due to the large dimensionality of the Hilbert space of quantum many-body systems. Recently, variational wavefunctions based on machine learning architectures, known as neural-network quantum states, have appeared as a powerful platform to solve quantum many-body systems. In this B.Sc. thesis you will show how neural-network quantum states allow solving a quantum Heisenberg model, using the library NetKet. During the thesis you will learn how machine learning-inspired methodologies allow solving quantum many-body systems.

References:
- https://www.netket.org/
- Solving the quantum many-body problem with artificial neural networks, Science, 355(6325), 602-606 (2017)
- Quantum Neural Network States: A Brief Review of Methods and Applications, Advanced Quantum Technologies, 2(7-8), 1800077 (2019)
- NetKet 3: Machine Learning Toolbox for Many-Body Quantum Systems, SciPost Phys. Codebases 7 (2022)

Prerequisite: Basics of quantum mechanics and Python programming

Schedule
- Week 1-2: background reading about NNQS
- Week 3-4: implementing one-dimensional Ising model with Netket, compute energies and magnetization
- Week 5-6: implementing one-dimensional Heisenberg S=1/2 model with Netket, compute energies and magnetization
- Week 7-8: discussion of the results
- Week 9-10: finishing writing of the thesis
- Week 11: thesis presentation in the B.Sc. seminar

Practicalities of the B.Sc. thesis
- B.Sc. Thesis has to be completed in 3 months (12 weeks)
- Total time devoted to the B.Sc. Thesis is approximately 270 hours (10 ECTS)
- We will have three joint meetings (Jose, Subham, Prateek): today, in week 4 and in week 8
- In case they are needed (not necessary), meeting with Prateek on week 2 and week 6
- Feedback about the thesis: week 8 and week 10
- Write two pages of the thesis every week, so that the final writing consists on mainly collecting those pages (full B.Sc. thesis is around 20 pages)

Update meeting 9.7.2024
- Start with the NETKET calculations
- Next meeting on 12.8