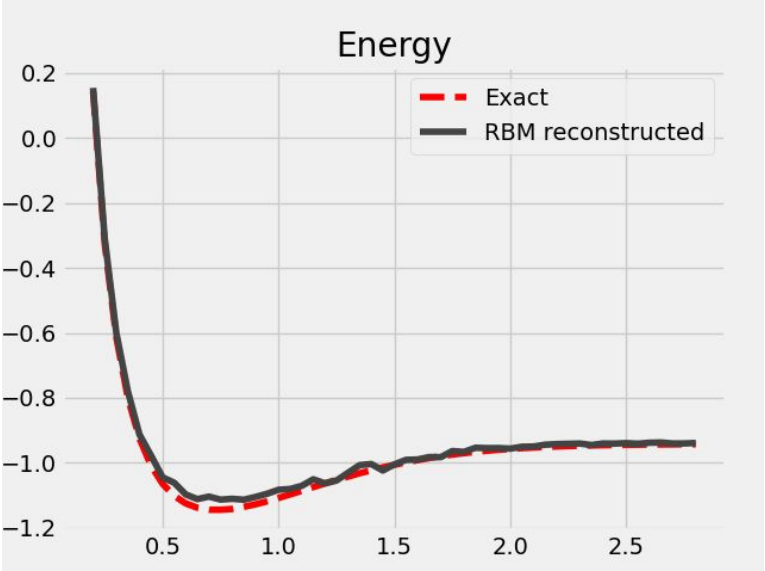
Quantum Cohort Project Business Application

Step 1: Explain the technical problem you solved in this exercise

The main goal of this exercise was to understand the power of Restricted Boltzmann Machines (RBM), which allow us to bypass the “curse of dimensionality”. Two tasks were presented in this regard.

1. In the first task we trained a RBM on H2 data. We examined the potential energy stored in the molecule as a function of the interatomic distance r, and obtained a really good approximation. We explained this behavior of the potential energy in an intuitive way.

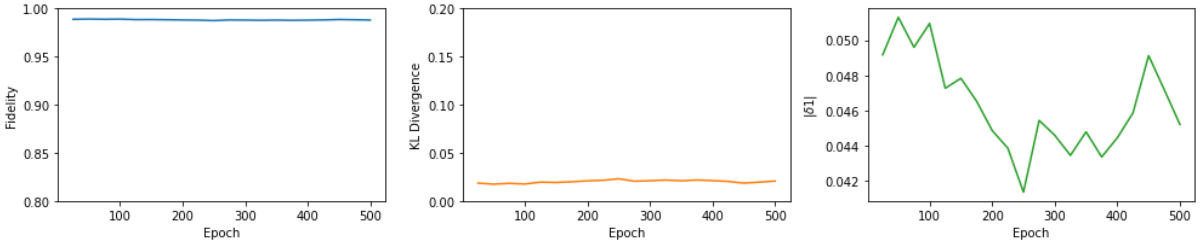


2. In the second task, we tackled a much bigger problem. The system consisted of 100 Rydberg atoms and the energy had to be found up to a certain precision. We explored how different sample sizes affected the difficulty of the training, and how changing the number of hidden layers can provide an advantage by allowing for more

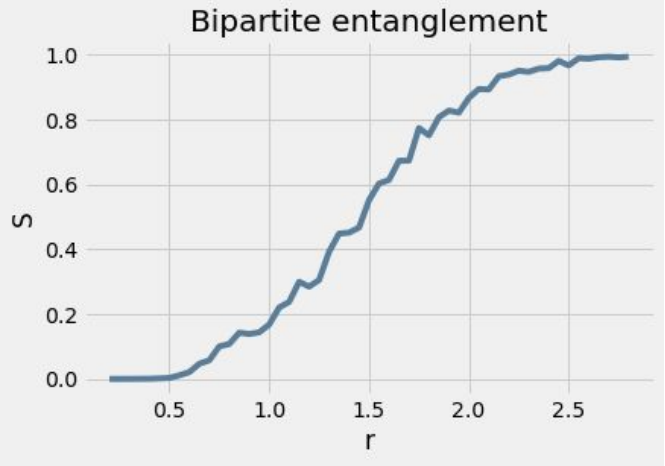
complex treatments. This task was very useful for understanding the amount of compression an RBM is capable of performing, going from an exponential sized method (proportional to 2^N) to an almost linear behavior (n_hid + n_vis + n_hid*n_vis).

We also completed two additional challenges.

1. We reconstructed the wavefunction of the LiH with RBM using the QuCumber package. This task involved taking into account measurements on different bases. The results were compared to the known coefficients with excellent results.



2. We studied the bipartite entanglement between the 2 atoms of H2, assuming a distinguishable treatment. Quantum correlation increases with the interatomic distance in this regime. This quantity is known to be a resource in quantum information protocols.



Step 2: Explain or provide examples of the types of real-world problems this solution can solve

Quantum Computing is an expensive resource. As such, service providers who can assure the quality and fidelity of their computing platform can be expected to benefit from higher demand. We aim to be a third party that independently certifies the correct functioning of quantum hardware containing a high number of qubits by using RBM to corroborate the fidelity of the experimental results and expected states.

Step 3: Identify at least one potential customer for this solution - ie: a business who has this problem and would consider paying to have this problem solved

Any company interested in building massively scalable quantum hardware would need some kind of certification in order to move from the developing to the commercial phase.

- Google
- IBM
- Microsoft
- Xanadu
- PsiQuantum
- Rigetti

Step 4: Prepare a 90 second video explaining the value proposition of your innovation to this potential customer in non-technical language

Quantum Computing is an expensive resource. As such, service providers who can assure the quality and fidelity of their computing components can be expected to benefit from higher demand and reliability. Therefore, there is a need for a third party that independently certifies the correct functioning of quantum hardware containing a high number of qubits.

Quantum Hack provides this service for gate-model based hardware architectures. This certification involves verifying that a chip is manufactured in such a way that known states are correctly generated after applying a specific predetermined circuit. Even more so, this must be true for every known circuit.

Taking this into account, QuantumHack uses a tool called RBM for state reconstruction in order to corroborate the fidelity of the experimental result and expected state for a certain circuit. In addition, it curates a broad spectrum of gate combinations so as to cover a wide range of implementable circuits, thus providing a comprehensive verification of the hardware at hand.

Any company interested in building massively scalable quantum hardware would need some kind of third-party certification in order to move from the developing to the commercial phase.

We envision a future in which quantum computation is universally adopted. Our mission is to ensure its correct functioning in a transparent and unbiased manner.