Small Assignment 10/7 - Code Validation

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Abstract

We give an overview of the Diffusion Monte Carlo (DMC) algorithm and its appli-
cations into finding solutions to the Schrodinger Equation when no analytical solution
is available. An implementation of the DMC algorithm is presented with a specific
focus on understanding the behaviour of Clathrate Hydrates, a complex, multi-atomic
structure often made up of water molecules and a greenhouse gas. Given the many ways
of representing such a system, we present conditions for which different representations
produce the computationally efficient results. We show how Importance Sampling can
be used to reduce some of the computational inefficiency that abounds when working
in high dimensional data sets with results that mirror those of a straightforward DMC
implementation. Finally, we provide an analysis of the above algorithm when imple-
mented in a Object Oriented versus script-based format to conclude that script-based
programming is more computationally efficient in this scope.

Related Work

This semester, we code a python based implementation of the Diffusion Monte Carlo algo-
rithm originally presented in Anderson 1975. Our implementation of the DMC algorithm

can be directly attributed to Anderson's work, as he was one of the first to propose such a method. At the time, other methods were seen as more computationally efficient for a given level of accuracy. We take Anderson's algorithm and refine it in the scope of being efficient for computing the ground level energy and bond strength of Clathrate Hydrates. While Anderson was initially only concerned with the calculation of the ground energy of H3, his simplifying approach to the 1D and 6D systems greatly influenced our approach in initial versions of our implementation. We improve on his work by designing a more efficient, vector-based implementation using the numpy library provided by python. We hope to extend this approach to the task of modelling more complicated Clathrate Hydrates which require an increased computational load. As Anderson points out, the Schrodinger Equation is only analytically solvable for certain, small systems. His DMC algorithm provides such a way to approximate solutions to complex systems. The best solution to modelling Clathrate Hydrates, given the lack of an analytical solution, is an open question. We hope to build off of Anderson's work to provide a computationally efficient method for the solution of this problem.

Acknowledgement