Discussion Leader Proposal

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1 INTRODUCTION

I am a member of the Center for Exascale Monte-Carlo for Neutron Transport (CEMeNT), a collaborative effort between University of Notre Dame, North Carolina State University, and Oregon State University. CEMeNT is a Predictive Science Academic Alliance Program (PSAAP) which means we work closely with the tri-labs (Los Alamos, Lawrence Livermore, and Sandia National Labs) to advance Monte Carlo methods for neutron transport capabilities. Within CEMeNT I have been investigating a hybrid solution technique involving Quasi-Monte Carlo and deterministic iterative methods. Much of this work is in applied mathematics/numerical methods and it was difficult to find papers that weren't too long (less than 15 pages) or involved intense maths. Despite that, below are two papers I think would be a good fit for our review.

2 PAPERS

- Paper 1: *On the use of Shannon Entropy of the fission distribution for assessing convergence of Monte Carlo criticality calculations* [1]
- Paper 2: *A quasi-Monte Carlo solver for thermal radiation in participating media* [2]

3 PAPER 1

The primary author of this paper is Forrest Brown, a well-known and respected nuclear scientist at Los Alamos National Laboratory (LANL). He was a large contributor in developing the Monte Carlo N-Particle (MCNP) at LANL. While this paper is older, Shannon Entropy is commonly used to assess criticality calculations and until reading the paper I was unsure why.

The goal in power iteration simulations is to iteratively solve for the dominant eigenvalue of the system known as k_{eff}. The article describes why looking at the convergence of k_{eff} between iterations is not enough to know when the system has reached steady state. The fission source distribution is also important which is described in the property known as Shannon Entropy. Convergence of k_{eff} and the Shannon Entropy are displayed in three separate numerical simulations using MCNP5. Results show that more in-active batches are required for convergence than k_{eff} would suggest.

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This is the shorter of the two papers and probably the easier one to digest. Although we are focused on the structure and quality of the papers being presented, I think I would spend a bit of time giving some background that would make the significance of the paper/methods clearer.

4 PAPER 2

Paper 2 was chosen because it is a recent use of Quasi-Monte Carlo (QMC) in a particle transport application, of which there are not many. Additionally, because the primary Author, Joseph Farmer, very recently joined my lab in the AME Department. I also work with QMC but applied to neutron transport, not thermal radiation in combustion. The paper is significantly longer than Paper 1 and contains a more detailed background and discussion section.

The article begins by addressing the well-known draw back in Monte Carlo simulations - high computational cost. The paper claims that by using QMC over traditional MC, more accurate results are obtained requiring fewer number of particle simulations and ultimately less computational effort. Their claims are supported by a 1D validation experiment. Then subsequent 3D simulations in which they observe increased accuracy and computational efficiency.

REFERENCES

[1] Brown, F. B. On the use of shannon entropy of the fission distribution for assessing convergence of monte carlo criticality calculations.

[2] Farmer, J., and Roy, S. A quasi-monte carlo solver for thermal radiation in participating media. *Journal of Quantitative Spectroscopy and Radiative Transfer 242* (2 2020), 106753.