Examining Contextual-based Error Correction Techniques in CLAMR

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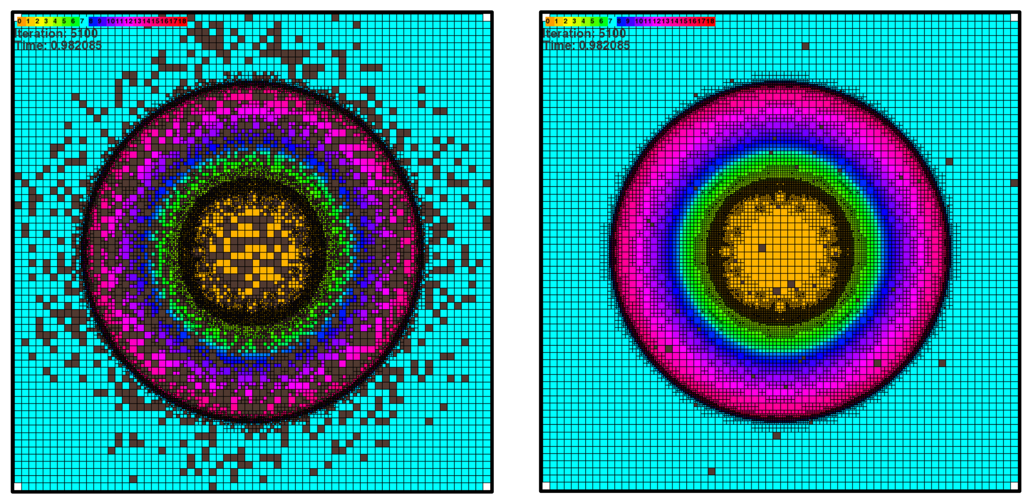
Introduction

Extending previous work in which 2-bit DUEs were applied to every cell in a CLAMR mesh before applying 2 correction methods, we let the simulation run to see how it would be affected by these corruptions and corrections.



Left: Avg. Neighbor applied to a static CLAMR mesh

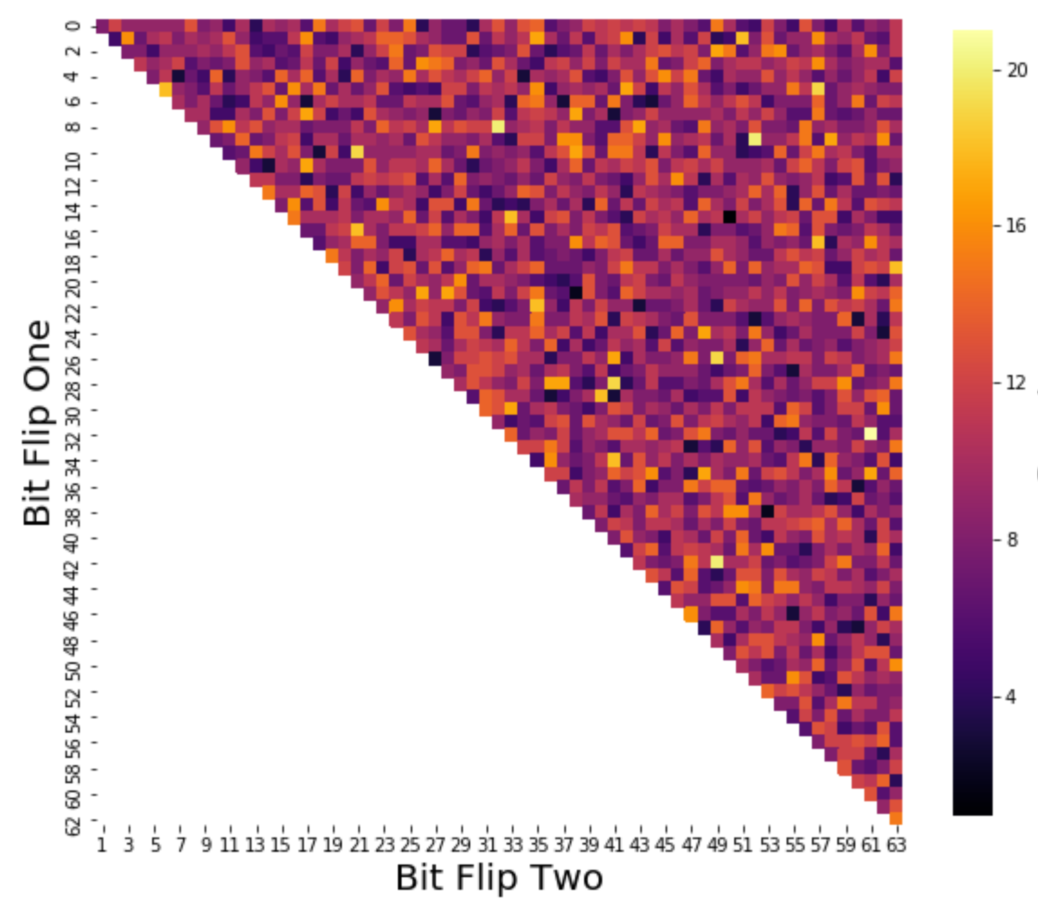
Right: Cons. of mass Applied to a static CLAMR mesh

"Improving Application Resilience by Extending Error Correction with Contextual Information", FTXS'18

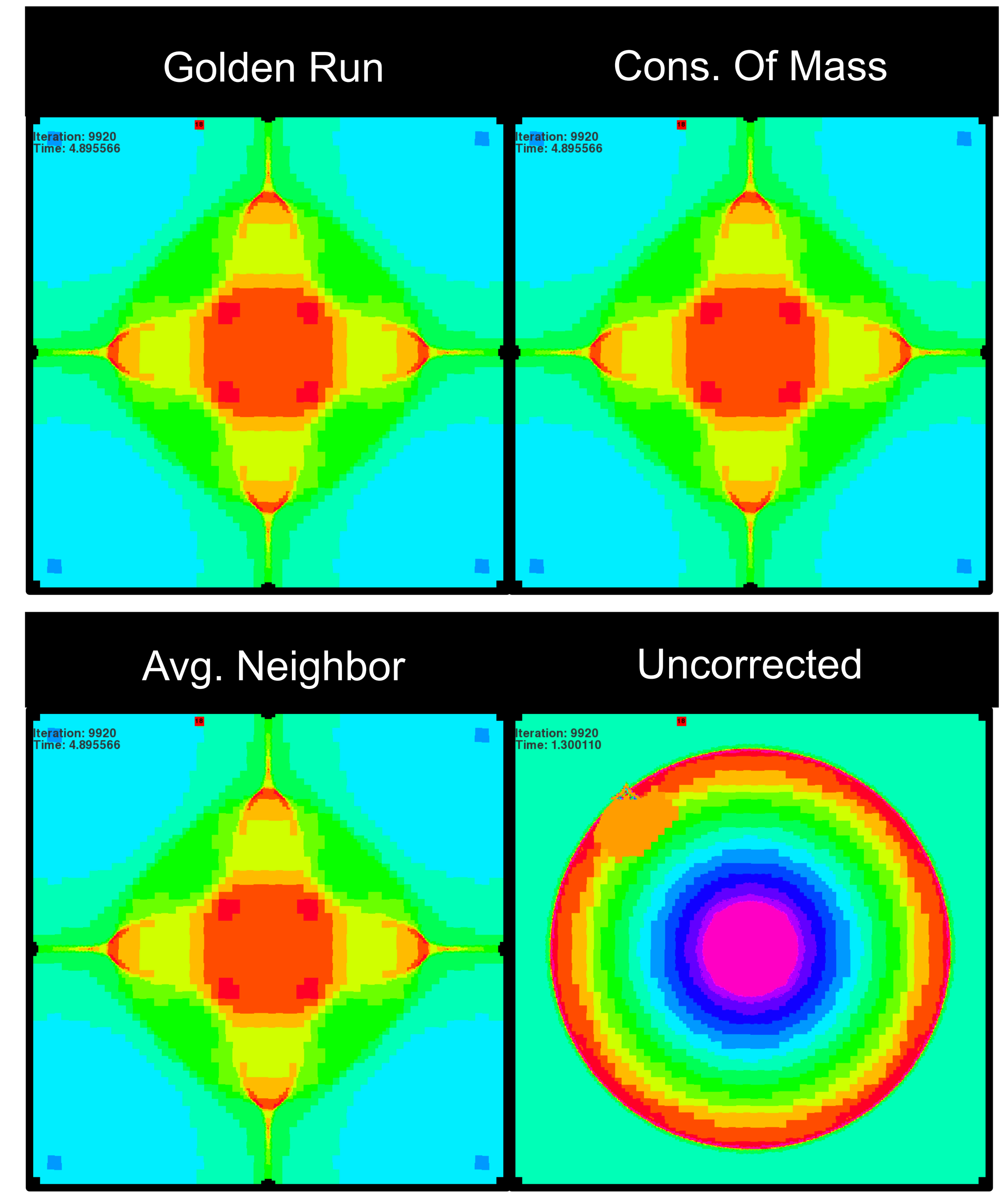
Continuing this work, we examine CLAMR's resilience to 2-bit DUEs. Using DORC, a container orchestrator, we run 3 experiment sets across 50 containers. In each trial we flip 2 random bits in a CLAMR cell, testing correction approaches average neighbor, conservation of mass, and no correction.

Execution

In each set of experiments, one cell in the mesh at a checkpoint is corrupted and is corrected using the aforementioned techniques. CLAMR is resumed from the corrupted checkpoint to see how the error propagates. This was done for ~24.5k cells with the work divided across 50 containers for each technique, totaling ~74k fault injection experiments consuming over 5TBs.



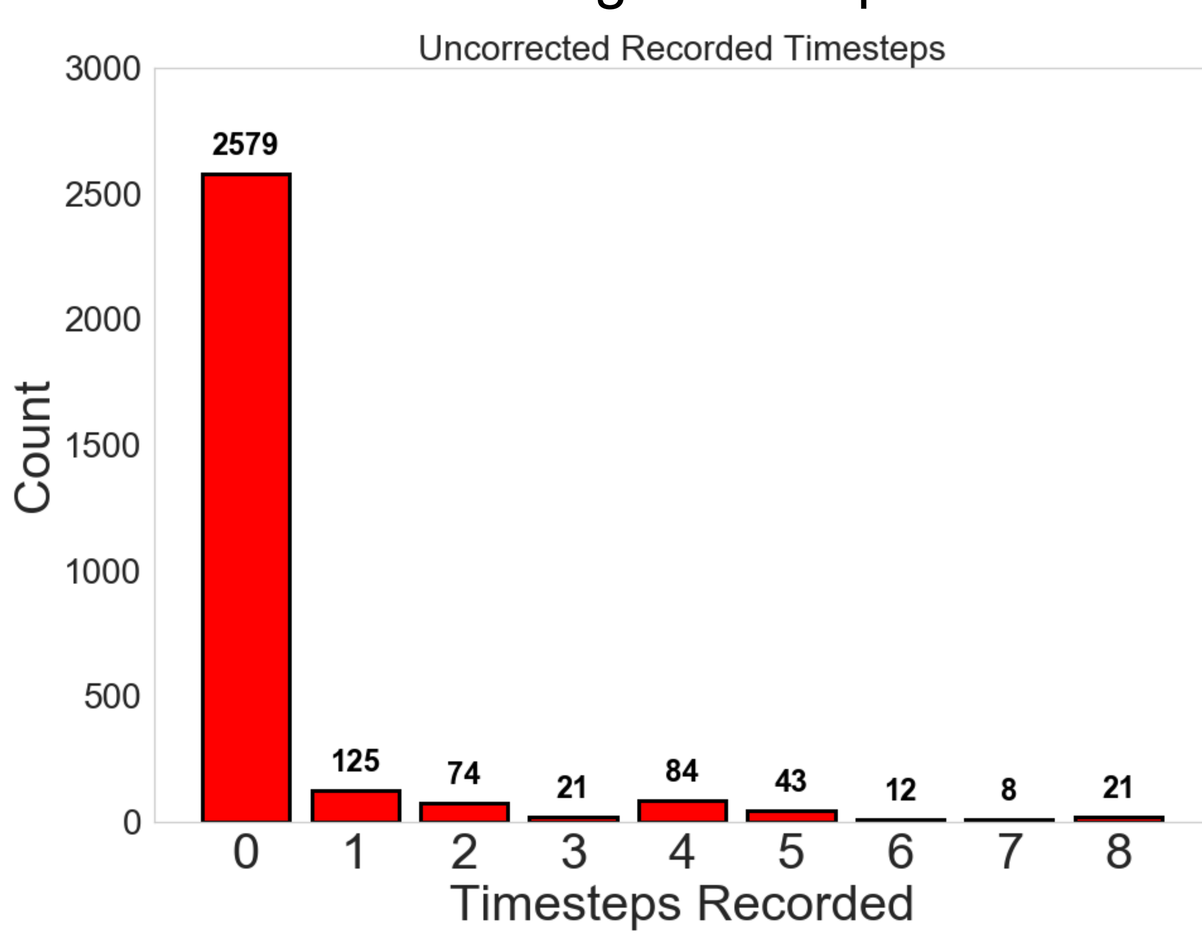
Visualization of 2 random bit flips used to corrupt the cells. Based on this heatmap, the bit positions appear to be relatively evenly distributed.



CLAMR runs at timestep 9920. Uncorrected is visibly different from the golden run. Avg. Neighbor was (imperceivably) miscorrected, Cons. of Mass was correct.

Results and Analysis

For our ~25k uncorrected experiments, we expected 9 timesteps to be recorded for each one. As shown below, ~3k of them crashed before recording 9 timesteps.



Method	Total Cell Count	Total L1 Sum
Golden	161,512	1,670,364
Avg. Neighbor	161,729	1,672,748
Cons. of Mass	161,512	1,670,363
Uncorrected	169,523	5.092e+94

- Not correcting is unacceptable
- Cons. of Mass was highly effective
- Avg neighbor is almost as good as Cons. of Mass

Future Work

- Explore Avg. Neighbor without ECC
- Explore different methods of determining correctness
- Further investigate the effectiveness of Avg. Neighbor
- Augment CLAMR to lock timesteps by iteration to observe how faults propagate more easily

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