Ising Graphs

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Overview of Original Code

- The code initializes spins on a lattice
- Makes interaction graphs based on neighboring spins
- Identifies clusters for analysis

- Serial execution in not optimal and causes computational delays
- Limits real-time analysis

Project Outline

Approach

- Swendsen-Wang Algorithm
- Wolff Algorithm
- OpenACC

Goals

- Produce timer/counter with errors to analyze performance
- GitHub with README, Code, and Makefile
- Final Report (Analysis, Graphs, Tables, Results etc) and Presentation Slides

Swendsen-Wang Algorithm

1. Cluster Identification
    - The algorithm begins with a random spin configuration on a lattice.
    - It identifies clusters of adjacent spins with the same orientation.
    - This step is crucial for understanding the collective behavior of spins within the system.
2. Random Cluster Flipping
    - After identifying clusters, each cluster is assigned a random label.
    - The algorithm then proceeds to flip entire clusters with a certain probability.
    - The probability of flipping a cluster is determined by both the temperature of the system and the size of the cluster.
    - This random flipping of clusters induces significant changes in the system's configuration, mimicking the effects of temperature changes.
3. Advantages
    - One of the key advantages of the Swendsen-Wang Algorithm is its high degree of parallelization.

Wolff Algorithm

1. Seed Selection
    - Similar to the Swendsen-Wang Algorithm, the Wolff Algorithm starts with a random spin configuration on a lattice.
    - It selects a seed spin randomly from the lattice as the starting point for cluster growth.
2. Cluster Growth
    - The algorithm grows a cluster of spins around the selected seed spin.
    - It iteratively adds neighboring spins with aligned orientations to the cluster.
    - The probability of adding a spin to the cluster depends on the temperature of the system and the orientation of the spin.
    - This process continues until the entire cluster is formed, representing a collective behavior of spins within the system.
3. Cluster Flipping
    - Once the cluster is fully grown, the algorithm flips the orientation of the entire cluster.
    - This cluster flipping operation induces a significant change in the system's configuration, mimicking the effects of temperature changes near critical points.

Results

For most of the algorithms that were tested, the time actually increased or remained the same between 1 thread and 2+ threads

- This could be due to our implementation of parallelizing the algorithms
- E.g. Swendsen-Wang at 1 thread ran for 389ms for a grid-size 0f 1024 and when 8 threads were assigned, it ran in 1096ms
- The “speedup” metric (the ratio between the running time of different threads) was often either close to one, or around 0.5.
- The efficiency of most algorithms (which is the ratio between speedup and the # of threads was for the most part the same as the ratio between the serial and the number of threads.

Thank you