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Project Summary

Massively Parallel 2D and 4D Escape Time Fractals

Escape time fractals are constructed through functions that either converge to a single point, loop, or diverge to infinity. These functions can be real; like Cantor sets; complex, like the Mandelbrot set; or quaternary, like the Mandelbulb set. Escape time fractals are defined locally: if a point converges or loops under the given fractal function it is part of the fractal, if not it is not part of the fractal.

Escape-time fractals have several properties that make them attractive candidates for testing parallel algorithms. Their local definition makes them inherently parallelizable: points can be evaluated independently on different threads of execution, MPI ranks, or hardware nodes. However, the time requirement for evaluating a single point is impossible to predict to full accuracy. Some points may converge or diverge immediately; some may take thousands of iterations to converge or diverge. Plus, the behavior of spatially similar points is often similar, but sometimes vastly different.

Because of these properties of escape time fractals, producing a task loading algorithm that would efficiently distribute fractal point testing across supercomputer nodes would be a strong indicator that the task loading algorithm is generalizable. This project will be composed of generating such an algorithm and testing it on different types of escape time fractals, on both 2D and the computationally intensive 4D fractals. A good algorithm will scale on all fractals and in both the 2D and 4D cases. Results will be shown by renderings of pretty pictures. The 4D fractals will be rendered with the 4^{th} dimension as time in animated gifs.