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Social Science, Economics, & Humanities

ENABLING REDISTRICTING REFORM: A COMPUTATIONAL STUDY OF ZONING OPTIMIZATION

Research Challenge

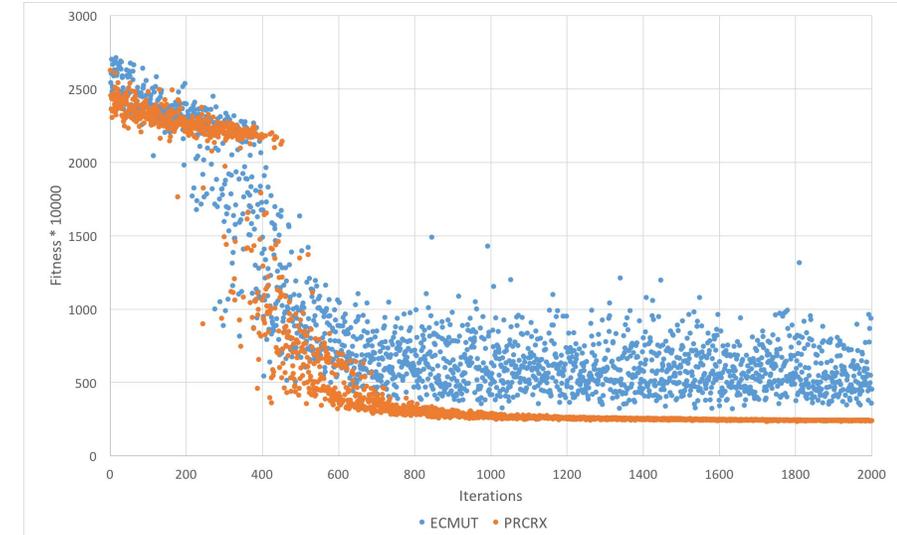
Political redistricting is intended to provide fair representation in Congress to all communities and interest groups. Gerrymandering occurs when districts are drawn in a manner that discriminates against a partisan or racial group. Due to a lack of sufficient tools to analyze and synthesize redistricting data, the Supreme Court has found it difficult to identify a workable standard by which we might regulate gerrymandering. This team has developed a computational redistricting tool utilizing massively parallel high-performance computing for redistricting optimization and analysis.

Methods & Codes

The algorithm, PEAR, or Parallel Evolutionary Algorithm for Redistricting, uses MPI nonblocking functions for asynchronous migration, and the C SPRNG 2.0 library to provide a unique random number sequence for each MPI process. They designed spatial evolutionary operators that incorporate spatial characteristics to effectively search the solution space. The parallelization of the algorithm maximizes the overlapping of computing and communication at runtime.

Why Blue Waters

The PEAR library is designed for extreme-scale redistricting applications. The computational approach implemented in the solution requires generating a very large number of electoral maps for quantitative study of redistricting phenomena. Identifying quality electoral maps requires significant computing in the combinatorial optimization process. Generating a large number of statistically independent maps is only feasible on a supercomputer at the scale of Blue Waters.



Performance comparison: Spatial Path Relinking crossover operator and the basic overlay + expansion crossover. Both take the same input. Fitness difference between the input and output solution is plotted. Negative difference value means fitness improvement.

Results & Impact

The approach is designed to identify redistricting maps that satisfy a set of user-defined criteria by leveraging and enhancing a scalable Parallel Genetic Algorithm (PGA) library to develop PEAR for the computationally intensive redistricting problem. PEAR provides a powerful tool that has never before existed to handle spatial characteristics and the associated computational challenges, and by harnessing massive computing power. The project has been the subject of numerous amicus briefs and been discussed in oral arguments before the Supreme Court.