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# Congressional Redistricting Using a TSP-based Genetic Algorithm

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## 1 OVERVIEW

A redistricting plan partitions a state's tracts (often counties or census tracts) into a set of congressional districts. Special interests attempt to mold districts to their political advantage, often inviting judicial review in the process. The quality of a plan has been judged by the courts using a fairly standard set of criteria: (1) the districts must be contiguous, (2) the districts must be of essentially equal population, (3) the districts should be of a pleasing (compact) shape, and (4) some consideration should be given to regions of common political interest. We will introduce a GA that attempts to satisfy the first three criteria.

## 2 ENCODING AND OPERATORS

This GA's chromosome is a string representing a path visiting all of a state's tracts exactly once. This encoding is taken from common GA solutions to the Traveling Salesman Problem. To generate a districting plan from a chromosome, an optimal district population is computed using the state's population and its allotted number of representatives. As we travel along our path, each tract's population is added to a cumulative population count. Once the necessary population threshold is reached, the set of traversed tracts forms a new district. The process repeats with the remaining districts and the remaining length of chromosome. This technique forces district populations to be relatively close to the desired size.

The objective function minimized considers a combination of the compactness (as measured by the district's perimeter squared over its area) and the number of discontinuous parts formed, both of which are to be minimized.

Several common TSP-based genetic operators are used to combine chromosomes for subsequent generations. Maximal preservative crossover and exchange mutation have produced the best results in *ad hoc* tests of possible operators.

A heuristic, called discontinuity patch, is applied following the generation of a new population. This heuristic searches for small discontinuous sets of tracts within our encoding and then transfers them within the string to a geographically nearby tract.

## 3 AN EXAMPLE: IOWA

As a proof of concept, preliminary results have been produced using Iowa as a test case. Census Bureau data was used to generate tract size, boundary and population information. Iowa is a medium size state with five congressional districts. Work is continuing on parameter selection, operator choice, and comparison with other existing techniques.

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### References

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