Evolutionary Game Theory

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Background

- Began with simple games to learn how to develop strategies from previous data and then automate this process for larger data sets.
- Initial objective: utilize evolutionary game theory to find optimal strategies for players 1 and 2 from random initial population.
- This involved creating a generic code base capable of supporting large populations of players across different games.
- Returning to the Graph Coloring Game, we attempt to find optimal coloring strategies.

Future Work

- Find correlations between winning strategies of various games.
- Identify optimal strategies in the two-player graph coloring game.
- Streamline the process of data analysis once simulations have been run.
- Containerize the code to allow for portability for future scaling
- Scale up code base to support more game types and larger population sizes.

Acknowledgments

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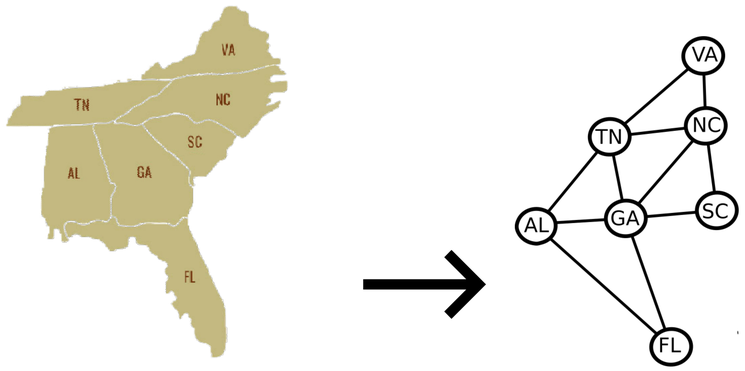
A Real World Example

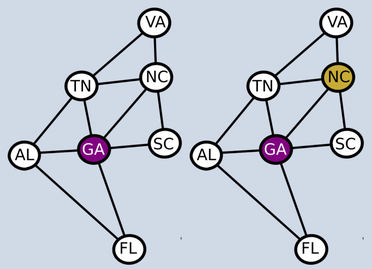


Our Work

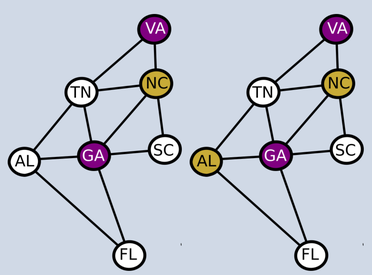
- We began by writing the code necessary to play a generic game between two players.
- With the software designed, we run simulated graph coloring games with two competing populations.
- Winning strategies are based on fitness (win percentages) and are allowed to breed
- Strategies are represented as lists with order priority(vertex:[1,3,4,2,5], colors:[Purple,Gold])
- Breeding players is as follows:
  Parent1(v[4,1,3,2], c[g,b,r,p]),
  Parent2(v[1,4,2,3], c[g,r,p,b])
  child1(no mutation): **v**[4,1,2,3], **c**[g,r,p,b]
  child2(with mutation): **v**[4,2,1,3], **c**[b,r,p,g]
- The Child takes up to a random point from Parent1 and the rest from Parent2 for both lists
- Repeat this process and look for patterns in the data.

Illustrations

A sample game where k colors is 2.



Player 1 Player 2



Player 1 Player 2

Since Player 1 has no legal move, Player 2 wins!

Graph Coloring Rules

1. Player 1 selects the maximum number of colors to be used in the game
2. Players alternate coloring a vertex each turn
3. No two adjacent vertices can be the same color
4. If a proper coloring for the entire graph is achieved, Player 1 wins. If not, Player 2 wins.

Definitions

- *Proper Coloring* - A coloring in which all vertices in a graph are colored and no two adjacent vertices receive the same color.
- $\chi(G)$ - Chromatic number; the smallest k such that a graph G can be properly colored with k colors.
- $\chi_g(G)$ - Game chromatic number; the minimum number of colors needed to ensure that Player 1 can win on a graph G.

Bibliography

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H. A. Kierstead, Tomasz Bartnicki, Jaroslaw Grytczuk, and Xuding Zhu. The map-coloring game. *The American Mathematical Monthly*, 114(9):783–803, 2007.