Exploring the Use of Fuzzy Constraint Satisfaction Problems to Evaluate the Happiness of Society.

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Abstract

The purpose of this project is to demonstrate the use of fuzzy constraint satisfaction techniques by creating an artificial society, then maximizing the happiness of that society. It will also explore the impacts of a sympathetic society.

Background & Introduction

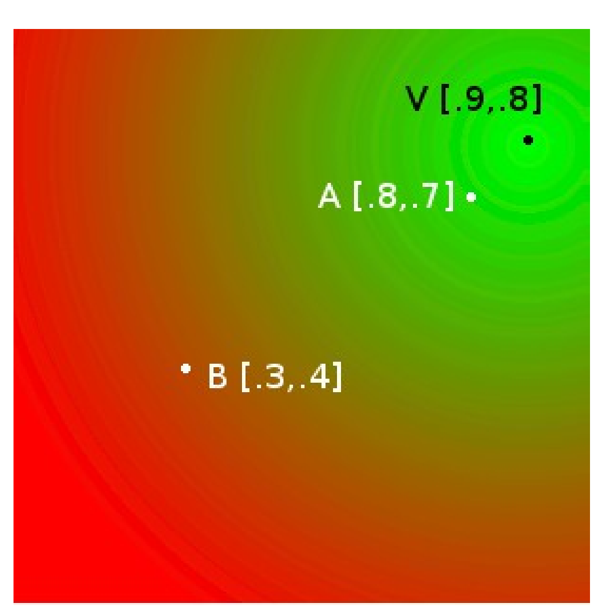
Hard constraint satisfaction problems can solve problems with perfect solutions, such as Sudoku puzzles, the 4-Color Map Problem or the N-Queens problem. However, they fail when applied to real world applications with no perfect solution. Fuzzy constraint satisfaction problems shine in these situations, because unlike hard constraint satisfaction, they are capable of finding optimal solutions. Instead of assigning each constraint a value of 0 or 1 as in regular constraint satisfaction,

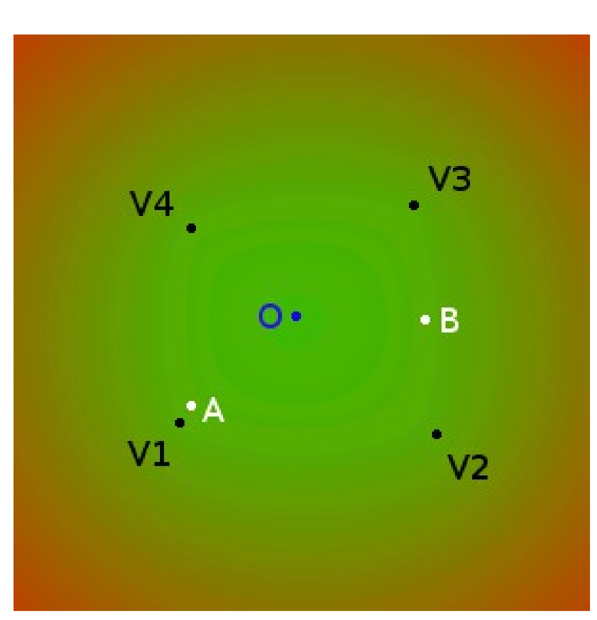
Society Model

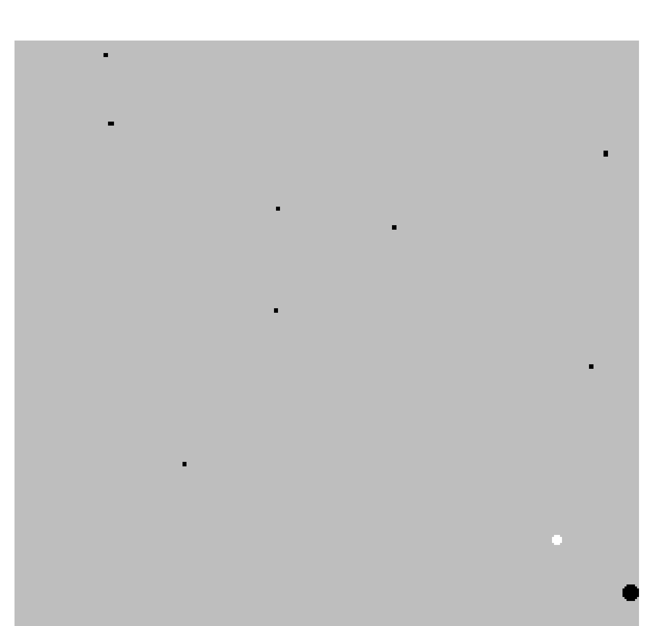
We now create a model of a simplified society. In this society, "Voters" (the constraints, formally called tuples) are placed on a 1x1 board. A proposal is then placed somewhere on the board. Each Voter's satisfaction is given a value between 0 and 1, proportional the distance between that Voter and the proposal. 0 is the farthest possible distance and the least happy, 1 is the closest possible distance and the most happy. Society's overall satisfaction is calculated as the average satisfaction of each Voter.

In the top example, a single voter is placed on the board (V). The locations colored in green (A) are the spots where the Voter is more satisfied, while spots in red (B) are where the Voter is most unhappy.

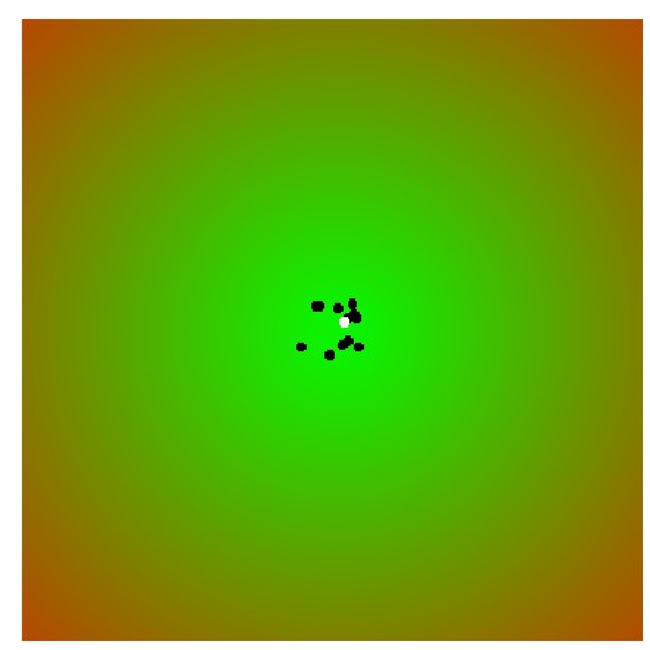
In the example below it, four voters are placed on the board. The optimal solution, O, is somewhere in the middle of the four. Note that even at this location, the satisfaction of the final solution is only 72%. No perfect solution exists, but thanks to fuzzy constraint satisfaction, we now have the best solution.



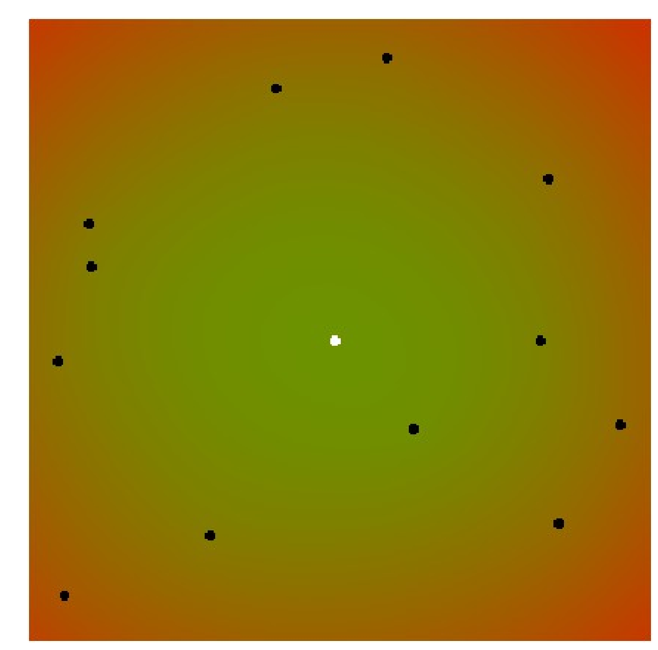




Sympathetic Society



Sympathetic Society



Antagonistic Society

One interesting discussion is the idea of sympathetic and antagonistic constraints. Sympathetic constraints are two constraints located such that increasing the satisfaction of one by necessity increases the satisfaction of the other. Antagonistic constraints are just the opposite, increasing the satisfaction of one decreases the satisfaction of another. In the society model, Voters that are close to one another are sympathetic and Voters that are farther apart are antagonistic.

Look at the above diagrams. The left society is very sympathetic, the voters are congregated, and the average satisfaction of the Voters is 96%. The right society is antagonistic, the Voters are dispersed, and the average satisfaction of its voters is 57%. This simple model leads us to conclude that sympathetic constraints are much more likely to be satisfied than antagonistic constraints.

Prioritized Constraints

Another interesting discussion is the idea of prioritized constraints. Prioritized constraints are considered more or less important than other constraints. In the society model, Voters can be given more than one vote.

In the example to the left, the Voter in the lower right corner (the largest dot) is given 50 votes, while everyone else is given one. The result is that the optimal solution (white dot) is drawn much closer to that Voter than would otherwise be the case.