TJHSST Computer Systems Lab Senior Research Project
Third Quarter Research Paper
Economic Policy Simulation and Optimization
2008-2009

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Abstract

There are several variations on gubernatorial economic policy around the world. Given different populations and demographics, economic policy changes. How can we best predict the ramifications of a given policy? Can we produce an optimal policy? Computer simulations and optimization using genetic algorithms may be able to provide policy makers with the data to answer these questions.

Keywords: genetic algorithm, social modeling, agent based modeling

1 Introduction

1.1 Purpose

The core of this project is an agent based model system to provide data of government and population economic and subjective satisfaction over time. Changing demographics and complicated economic systems may obstruct desired outcomes in certain economic policy, disrupting social order. Computer models can provide prediction data quickly and at a low cost to economists,

businessmen, and policy makers. Data from the model will be run through genetic algorithm based optimization. Output may guide those involved in decision making in regard to economic policy.

1.2 Scope of Study

The idea is to model simple income and sales taxation and overall welfare (government provided services) over a short period of time. Assessments of each citizens health, wealth, and wealth assessment will be factored into their approval rating of the government. Similarly, the government will factor those assessments along with their approval rating to produce a value representing overall well being of the society. Economic cycles will have to be researched, and relatively realistic economic data will have to be obtained. Approval, happiness, wealth assessment, and health are relative and general trends will have to be researched. Once the model became feasible enough, a genetic algorithm was implemented to determine optimal policy given a situation.

1.3 Expected results

I expect the project to model government/population economic relationships reasonably well and for the genetic algorithm to optimize data. Assessment data can already be printed out and represented in a graph over time using GNUPlot. Graphs showing the relationship between different variables and overall assessment can be made. The genetic algorithm works in theory – but the effects are not clear yet since it has not been completely modified for the project. This project data should lay some groundwork for policy makers, sociologists, and economists.

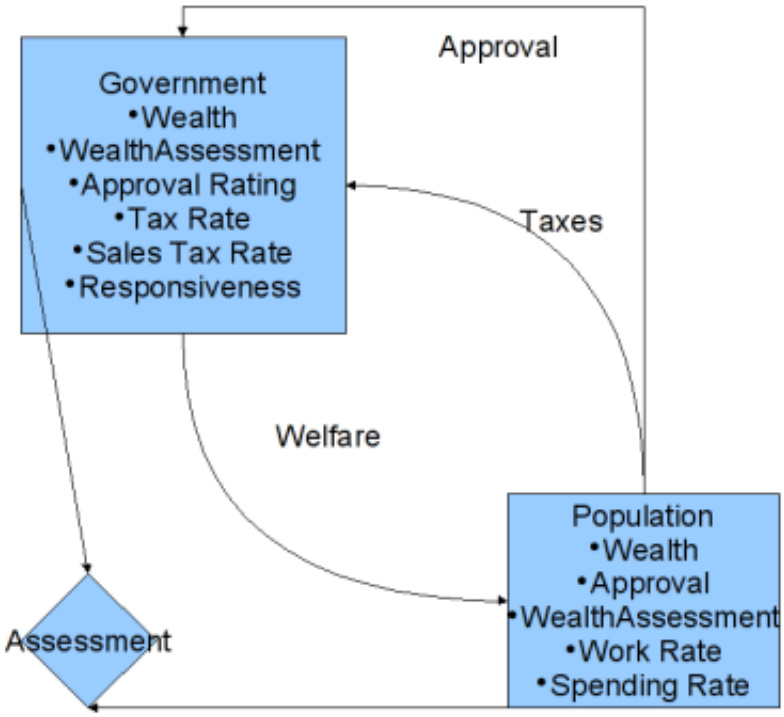
This project should be useful in a social/economic study sense as well as in learning more about computer modeling and optimization algorithms. Learning more about modeling and data optimization may prove to be useful in shaping public policy. The development of computer models and optimization are both relevant to this and many other fields.

2 Background and Literature Research

I have looked at economic data and some papers on the relationship between economics and approval/happiness. Tax burden and sudden changes in tax policy are detrimental to approval ratings according to Vermeir's model [2]. The formula for their approval rating depends on more factors but can be modified or serve as a base example for my approval rating system. To weight factors into my final assessment, I must look at social causality as well as direct causality, as public opinion is just as much perception and relative thought as much as concrete. According to Mao and Gratch, responsibility and blame assessments must be made to model accurate social cause/effect. Several different economic assessments are commonly used, including GDP, the Gini Coefficient (which measures wealth distribution), and average wealth. Currently the assessment is based on relative wealth with respect to time, but a Gini Coefficient assessment may be implemented later [7]. An agent based model is ideal because of the varying demographics in populations [1]. Most of the social models that were looked at had little to do with my project idea, although they did use agent-based models in some cases.

Building effective and modifiable tax policy is integral to a government's economic duties [5]. Computerized systems to create effective, dynamic policy is important in an age of slow bureaucracy and questionable gubernatorial expertise in light of increasingly complicated economies. Researchers at Trinity University in San Antonio, Texas sought to test the utility of genetic algorithms in distribution with multivariate crossover. The algorithm was to optimize a function with many independent variables [3]. The horizontal strategy and multivariate crossover both look suited to my simulation's genetic algorithm stage. I can't use single-variable crossover as there are many variables in my program that affect the final assessment. Researchers aimed to create a metaheuristic consisting of multiple algorithms to optimize a flow shop problem. The first part was a greedy-based heuristic to generate an initial population, the second was a genetic algorithm process to improve the population, and the last was "intensification" due to a variable neighbor search [4]. The process shown for genetic algorithms is comprehensive. I may decide to adopt a similar multi-faceted process for improving my simulated policies as well, though the variable neighbor search doesn't seem particularly applicable. researchers concluded partnering strategies all had strengths depending on the type of problem. Possible strategies are pairing based on

attraction, fitness, or randomized partnering. Each strategy has strengths in different problems – but randomized processes ensure a relatively common answer [6]. This project is using pairing based on fitness currently.

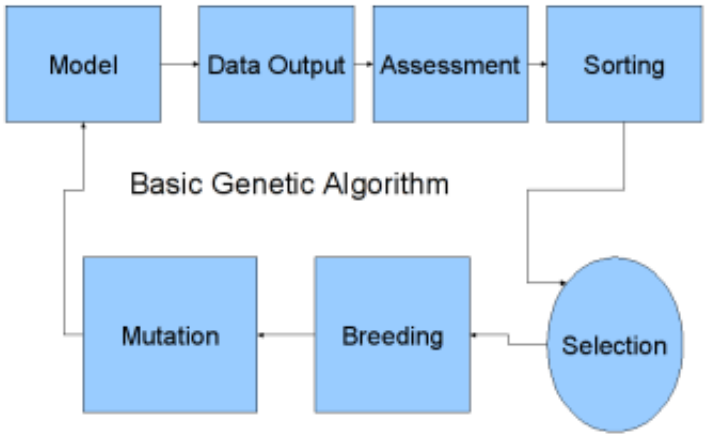


Project Flow Diagram

3 Procedures and Methodology

The simulation will continue to be written in Java using Jgrasp and other code editors. A basic project layout has been implemented. It is able to receive, process (using a preliminary economic cycle) and output data and can be modified relatively easily. The preliminary economic cycle uses somewhat arbitrary values, but more realistic data may be used. Input data should be taken from real data and perhaps modified to suit the program. Sources such as the Census Bureau may be used. Testing is already being done there are several outputs of data tracking different variables for further analysis and to pinpoint trouble spots in the program. This data can be plotted

using GNUPlot or other graphing utilities. Itll also be compared to real data and judgments on the feasibility of the model will be made. Erratic or outstanding data would signal a faulty simulation. Over a simulated 12 year economic cycle, civilian agents spend, work (and gain income), pay taxes to the government, and assess their government. The governments receive taxes, make assessments whether or not to dole out welfare to those who need it (This is defined by responsiveness level along with a threshold of negative approval rating). The wealth assessment is a ratio relating current wealth and wealth from previous months. Data from the model is to be run through an optimization process. Of course, the result of running the algorithm should improve the assessment for the society. Data from the model will be analyzed, and run through a genetic algorithm. The genetic algorithm mixes attributes of government policy to create new policy, specifically the attributes of the best policies according to the assessment. Attributes are then mutated to prevent convergence to local maxima. Initial wealth and wealth assessment stays the same for offspring. New policies are tested and analyzed, and the process is repeated. Several different policies on several different populations will be tested because one policy does not fit all.



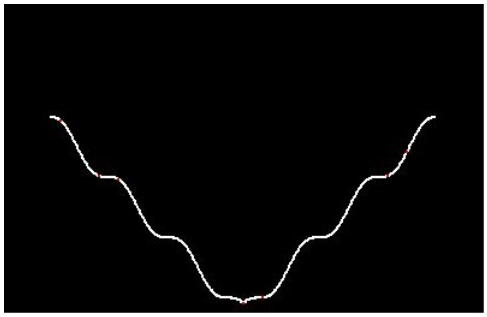
4 Current Results

The program now runs through a 12 year economic cycle of consumer spending, government taxation, government welfare, and feedback. The program is heavily modifiable for future use. Multiple governments and citizen groups have been implemented. Results seem erratic and the feasibility of the model

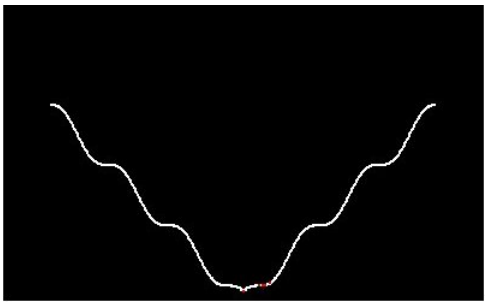
is off as approval ratings are in the extreme and erratic, meaning better input data and more realistic processes are needed.

Current data shows that the civilian population's wealth drop dramatically and level off. The governments' wealth continues to increase throughout the cycle. Because of the initial decrease in wealth, the assessment drops. However, there is a point where the assessment continues to be positive, probably because the evaluation method weighs the government's wealth assessment and the civilians' wealth assessment equally. Relative slow decrease in wealth as well as a last-month-based evaluation can also explain this data.

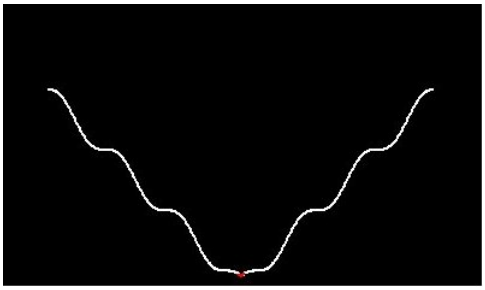
The genetic algorithm is not completely functional, but test programs indicate that it works structurally (Data converges to the local minima in these cases) – it needs to be implemented in the main model, and multiple generations must be tested. Once it is implemented, data analysis can be done. An alternate assessment, such as the Gini Coefficient, may also be implemented.



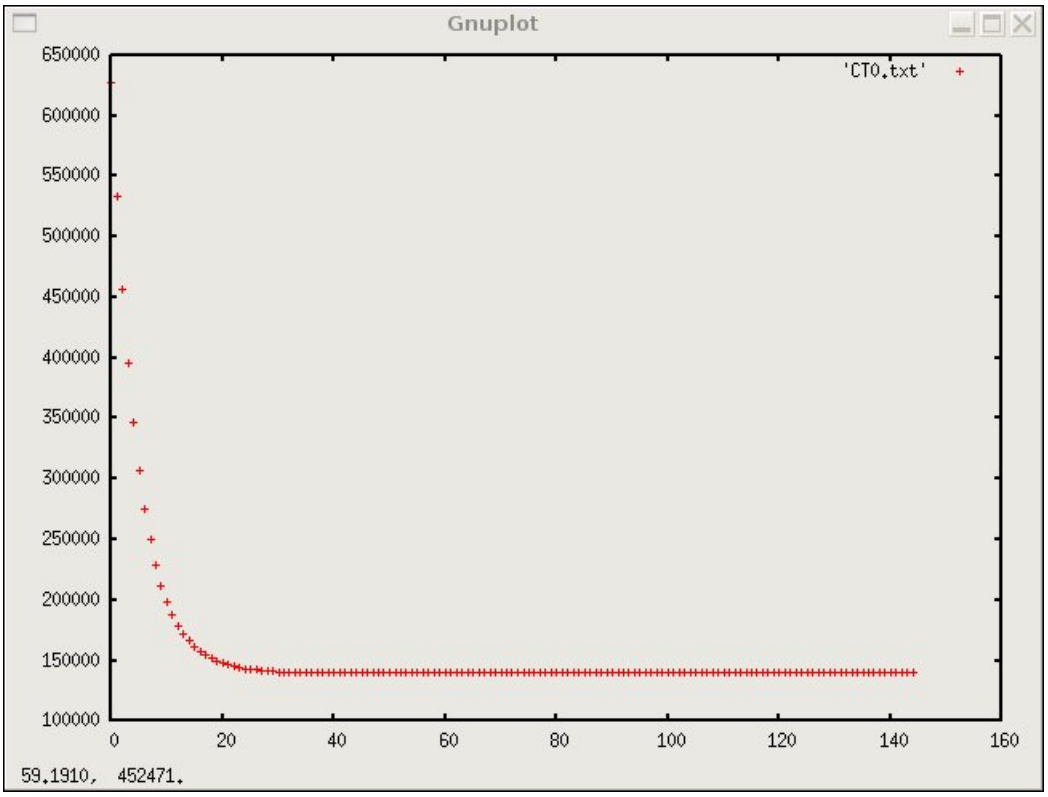
Genetic Algorithm Test - 1st Generation



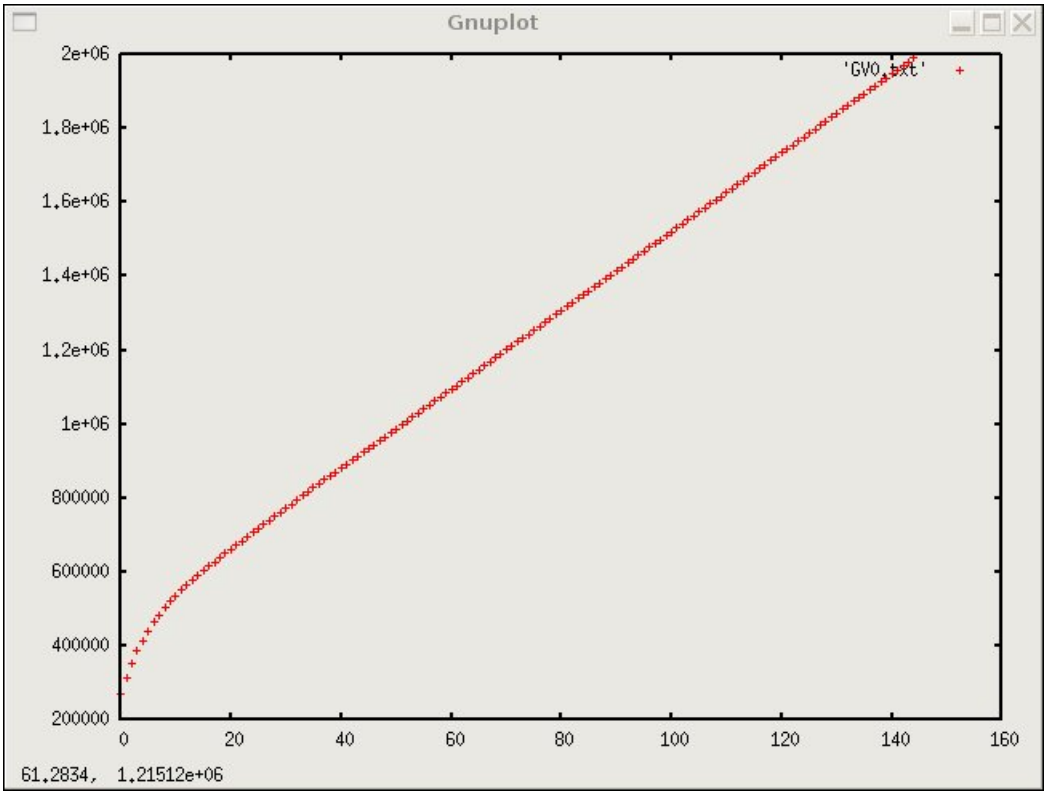
Genetic Algorithm Test - 2nd Generation



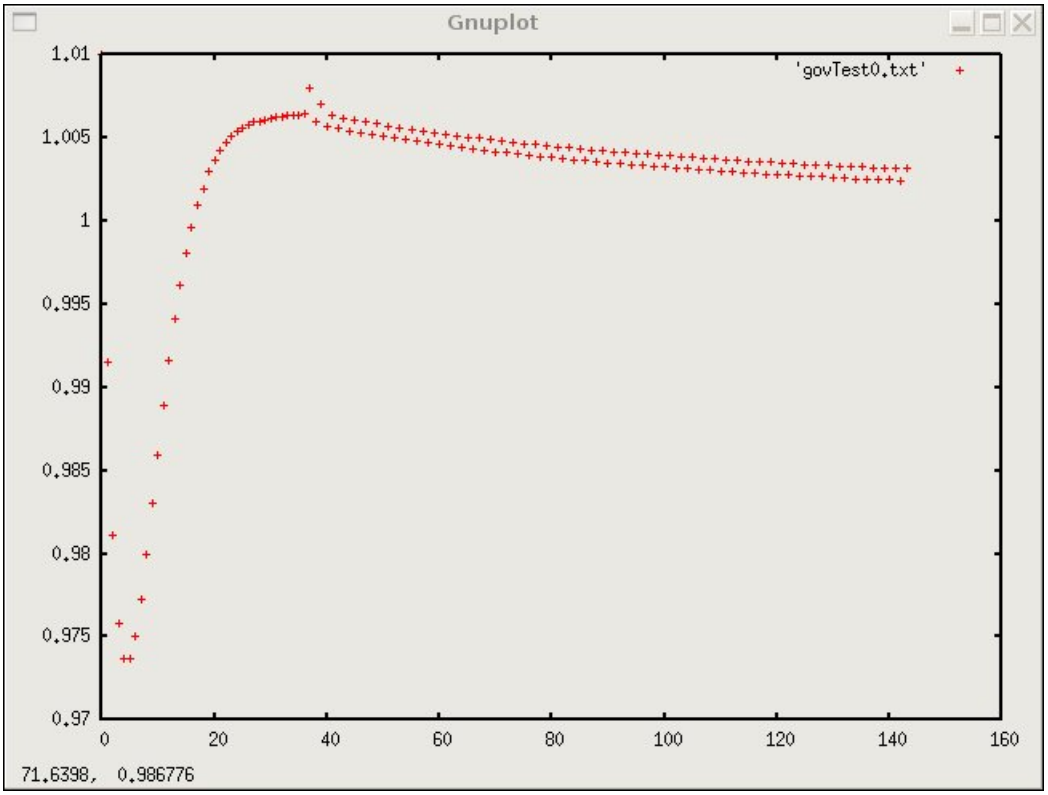
Genetic Algorithm Test - 6th Generation



Civilian Wealth



Government Wealth



Society Assessment

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