Project Proposal

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Introduction

San Francisco and the greater Bay Area have a troublesome history when it comes to rent control, housing shortages, and zoning laws. Factors including the explosion of Silicon Valley have contributed to a shortage of housing that has led to the rethinking of housing and policy surrounding rental controls in the area. Given these radical shifts in both rent prices and attitudes, San Francisco-based and other city planners must make changes to housing and rental policies, but it is hard to anticipate the outcomes of policy changes in the long term. Agent-based modeling analysis may answer some of these questions by parameterizing some of the key factors surrounding housing policy and projecting the impact of battling policy proposals.

Literature Survey

Summary

Agent-based modeling: Methods and techniques for simulating human systems
Eric Bonabeau
http://www.pnas.org/content/99/suppl_3/7280.full.pdf?sid=9c72ddfc-e9c9-4690-800e-b94ccae13a70
"Agent-based modeling: Methods and techniques for simulating human systems" by Eric Bonabeau is a paper published in The National Academy of Sciences that details agent-based modeling's features and design specifications. The paper directly relates to the class content, as it details techniques for a methodology introduced in class. It not only explains what agent-based modeling is, but also provides examples in which the method is effective; in particular, in simulations involving flow, markets, organizations, and diffusion.

Using Adaptive Agent-Based Simulation Models to Assist Planners in Policy Development: The Case of Rent Control
Robert Bernard
http://www.santafe.edu/research/working-papers/abstract/0cbe9b4e0fc8061589e453dea9f7721e/
This Robert N. Bernard paper pushes for the use of agent-based simulation in policy decision making. Its unique methodology involves demonstrating the simple and practical nature of using agent-based simulations with real examples of rent control. The key technical content of the

paper is the setup and analysis of an agent-based simulation of rent control given factors of rent decontrol, “vacancy rates, apartment quality, tenant income, and average rent paid.” Bernard explains the probabilistic algorithms for each parameter and throughout the simulation in depth. As mentioned above, the focus on agent-based models in both the class and the application of the methodology in the paper make this a relevant piece of research for the project.

Both papers focus on the agent-based modeling methodology. Whereas Bonabeau focuses on the modeling algorithm itself and several general use cases, Bernard goes into depth on a single use case – rent control – to inform readers of the usefulness of agent-based modeling. The technical content of Bernard’s paper is significantly more comprehensive, whereas Bonabeau appeals to the general reader with little exposure to agent-based modeling. Both authors have the goal of promoting agent-based modeling, but Bonabeau promotes it as generally useful, while Bernard explores its usefulness in a specific vertical – policy planning.

Critique

Bonabeau’s paper is very comprehensive and helpful for the uneducated reader with little experience in agent-based modeling. The author grounds the reader by walking them through many real-world examples, which is useful for an inexperienced audience. This suits the general audience of agent-based modeling, which is a modeling methodology that is a low-barrier way to simulate scenarios with variable parameters. However, this paper may fall short for a reader that already has a strong understanding of agent-based modeling, and wants to instead go a step further by doing statistical or other in-depth analysis on the results created with the simulations. Similarly, the paper falls short in addressing the underlying technicalities of agent-based simulation that provide its value. It was hard to tell whether the paper was realistic, since the author used vague language when speaking about the experimental setup.

Bernard’s paper was an effective rhetorical piece towards those in the policy-crafting space. The rigor of mathematical analysis, combined with the practicality of his experimental setup, proved that agent-based modeling should be taken seriously during policy creation. The biggest weakness was the lack of clarity on the audience: it was too technical for purely policy-crafters, but too policy-focused for those interested in the mathematical portions. Another shortcoming of the paper was in the experimental design: Bernard only had one period – 250 month, the middle third of the simulation timeline – that involved changes to rent controls. There are several issues with this approach; firstly, it is unrealistic in that rent control policy lasts exactly 250 months, and reality tends to be much more sporadic. Similarly, the experimental setup is only for 750 months, which is a shortcoming for those interested in longer or shorter term analysis. A final shortcoming was the parameters that were adjustable for the simulation; there are probably more factors that could be interesting and meaningful in determining outcomes of policy on

housing and rental situations. These shortcomings could largely be addressed by investing effort into more simulations and a setup that incorporates more policy factors.

Brainstorming

Given the shortcomings in both papers – but notably in the Bernard paper – there is significant room to build on the papers above, and the nascent field of agent-based modeling. One of the most promising questions in the field of agent-based simulations is how it can be used in simulations that are tangentially related to rent control, using parameters including zoning laws, building height control, and tenant income levels. These parameters can be built into an easily navigable interface for the non-technical policy planners to test hypotheses about the future of housing in San Francisco and other cities. The specific implementation of the agent-based modeling algorithm from Bernard's paper could be modified by making total months an adjustable parameter, which would correct one of the shortcomings mentioned in the critique section above. The dataset could be expanded to other cities, but also other parameters within the same city – for example, by examining the dataset produced only by rent-stabilized apartments. Given the expansion in publicly available datasets and computational power since 1999 when Bernard's paper was published, there is a goldmine of opportunity in widening the scope of the research performed by Bernard and Bonabeau.

Project Proposal

We will apply agent-based modeling techniques to the question of rent control and other zoning regulations. We plan to leverage AgentScript, a javascript Minimalist Agent Based Modeling framework based on NetLogo, to analyze the emergent patterns based on various parameters related to these housing questions.

Our model will likely include the following parameters:

- desirability of the various housing options on the map
- number of housing units available of each level of desirability
- a distribution of tenant income levels
- a dynamic utility score for each tenant / landlord agent that varies according to their conditions
- rent control (or none)
- building height control (with density / people-per-block as a proxy for this variable)

We will include a control panel to enable seeing the changes in the system as we adjust each of these variables. There will also be a series of presets corresponding to the existing state of various city systems so we can see how well the simulation models real-life housing situations. There is a significant amount of data on these parameters for cities such as San Francisco, Chicago, and New York, so we plan to focus on those. Here are some of the sources we have found so far:

- San Francisco
    - 2013 Housing Inventory – data.sfgov.org/Housing-and-Buildings/2013-Housing-Inventory/e7d3-dxh5
    - Trulia home prices heat map – trulia.com/home_prices/California/San_Francisco-heat_map/
    - Rent stabilization by neighborhood – trulia.com/blog/trends/rent-control-sf-nyc/
    - CartoDB neighborhoods – common-data.cartodb.com/tables/sf_planning_neighborhoods/public
- New York City
    - Trulia home prices heat map – trulia.com/home_prices/New_York/New_York-heat_map/
    - Rent stabilization by neighborhood – trulia.com/blog/trends/rent-control-sf-nyc/
    - Rent-Stabilized addresses – github.com/clhenrick/dhcr-rent-stabilized-data

This project will happen over the course of several phases:

1. Familiarize ourselves with the AgentScript framework and modify it to fit our specific needs to model basic renter-tenant relationships.
2. Incorporate each of the parameters listed above and any others that we learn about over the course of further research.
3. Present the simulations in an interactive, easy-to-use way so that others can also tweak the parameters.
4. Build preset simulations for cities based on actual data (promising sources listed above).

To measure the success of the project, we will compare the simulation with actual behavior in the previously stated cities to see if our model accurately captures trends in the real world. Specifically, we will see if we can accurately predict the upwards or downwards movement of housing prices and density. Ideally we would also test our prediction of satisfaction (measured by a utility score) of the landlord / tenant agents in the program, but there's no viable way to do that.

At the end of the quarter, we will submit our agent-based model. We will also submit a paper detailing the structure of the model, the results we found from it, and analysis of the economic theory and network properties that come into play with this network. A great advantage to ABMs is that they are highly interactive. We plan to leverage that by publishing the paper as a dynamic

web page rather than a traditional PDF so we can include running examples side-by-side with our words, somewhat similar to the famous “Parable of Polygons”.