Modeling Trends in Portland, ME Homelessness: A Stochastic Analysis and Markov Chain Application

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Urban housing insecurity has proven to be a threat to communities throughout the world. Contextualized as a byproduct of rent demands, I created a model that works to map the trajectory and development of those experiencing homelessness and precarious housing conditions. Throughout our exploration of this predictive model, we worked to reorganize its rate parameters and transition matrices to better represent the specific demographics of our unique city. Specifically, these explorations worked to model the changes in marginal distributions when separations were made in the population to uniquely consider those using drugs and asylum seekers.

The most basic version of our model uses Markov Chains to track individuals who are somehow engaged in the renting populations of Portland. This is a sequence based stochastic modeling technique that uses a previous state to determine one's future state while incorporating mathematical ideas of "forgetfulness" as it only considers the most immediate past state. Using a variety of past literature involving classifications and degrees of homelessness, for this specific model and its application into Portland, ME's crisis, we depict individuals in one of four states of housing as seen in the image below. The first state, stable housing, was determined by analyzing gamma distributions of income and monthly rent. Precarious housing consists of individuals in a variety of different situations: renters paying a concerningly high percentage of their income for their housing, individuals receiving either state or private assistance to facilitate their housing, those reliant on family members or friends to help house them, and others experiencing an insecure housing experience. From here, individuals can either move into one of two different levels of even more insecure housing – shelter or encampment, stay in their precarious housing position, or move back into stable housing. The rate parameters of the Markov Chains that eventually grew into our transition matrix were calculated using past literature and statistics presented by a variety of Portland's public and private housing experts.

After building this simple model, we redeveloped it to consider binary inputs that can begin to sort individuals into smaller demographic categories. Oftentimes, these smaller demographic groups provided opportunities to specify differences in rate parameters. Through these intricate changes, we've begun to find interesting patterns in how rate parameters can influence marginal distributions of our housing populations over time. Specifically, by manipulating our model to consider the rates at which individuals may be susceptible to starting drug use given their housing state and to changes in rehousing rates dependent on an individual's drug usage, we can suggest changes to the social supports that are active in these rehousing processes. Another intricacy of the model that we've explored has been the impact of rehousing rates of asylum seekers. The trajectory of this population in our model is vastly different from the rest of the population as they must wait at least six months to begin working in the United States. Through manipulations of different rate parameters modeling movement out of shelters after this six month period, we better understand the capacities needed to adequately support this population. Looking forward, we can use this adaptable model to suggest concrete changes to shelter protocols and resource allocation because of how different rates interact with each other and can ultimately change demographic makeup in states. We also plan to add Monte Carlo randomization techniques to better account for the inconsistencies in our rate parameter estimations.

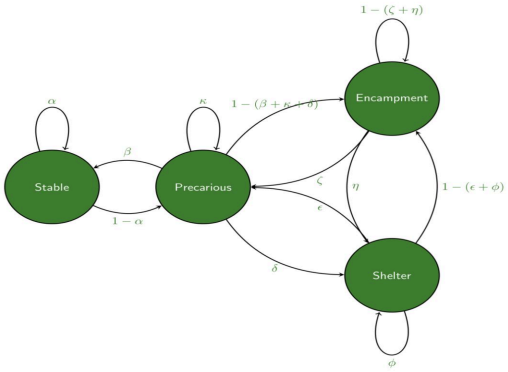

Figure: visualization of model with variables representing rate parameters

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