American Housing Survey: Affordable Housing

DECEMBER 09, 2009

JAMES LAMPTON, SONIA NG, SWETHA REDDY, DI-WEI HUANG

PROJECT SPONSOR: DANIEL BROXTERMAN
Introduction

- **Study of affordable rental housing**
  - Where does it come from? Where does it go?
  - What policy can be made to maintain it?

- **American Housing Survey**
  - Department of Housing and Urban Development
  - Interviewed 3 samples of ~50,000 housing units

- **Visualization**: summarized longitudinal data derived from various sources
Data

- **Data sources**
  - Area Median Income Files (AMI), Housing Affordability Data System (HADS), Public Use Files of the American Housing Survey
- **Privacy issue**
  - Reduced geographical details for housing units
  - Still have a consistent way to classify housing units
### Data

- Each house can be in state 0 – 8, for any given year
  - 0  Not in the sample
  - 1  Rental, affordable rent
  - 2  Rental, moderate rent
  - 3  Rental, high rent
  - 4  Owner-occupied
  - 5  Seasonal, migratory or related vacancy
  - 7  Lost from the housing stock, reversible
  - 8  Lost from the housing stock, permanent

- 11 years of data (1985 – 2005, every other year)
  - Example path of a house instance: 00011224488
Data

- Other categorical attributes of a house instance
  - **METRO3** (Central city / suburban status)
    - From central city(1) to rural(5)
  - **NUNIT05** (Number of units)
    - From mobile home(0) to building with 50 or more units(50)
  - **BUILT05** (Reported year unit built)
  - **ASST** (Government subsidizes rent for unit)
    - From never assisted(1) to always assisted(5)
  - **NC1** (is new construction?)
  - **BEDRMS** (number of bedrooms)
Task 1: Transition Probabilities

- **Given two years**...
- **Forward analysis**
  - **Constant**: $1 \rightarrow 1$ (affordable remains affordable)
  - **Gentrify**: $1 \rightarrow 2$, $1 \rightarrow 3$ (affordable rent to higher rent)
  - **Tenure change**: $1 \rightarrow 4$ (affordable to owner-occupied)
  - **Loss**: $1 \rightarrow 7$, $1 \rightarrow 8$ (temporary or permanent loss)
- **Backward analysis**
  - **New construction**: $0 \rightarrow 1$
  - **Constant**: $1 \rightarrow 1$
  - **Filter down**: $2 \rightarrow 1$, $3 \rightarrow 1$ (higher rent to affordable rent)
  - **Tenure change**: $4 \rightarrow 1$ (owner-occupied to affordable)
  - **Restore**: $7 \rightarrow 1$ (restore from temporary loss)
Previously... (Spotfire)
AHSEExplorer

Applet Viewer: edu.umc.cs.ahsexplorer.Main.class

Filename: from.xls.csv

Title: Forward analysis

From: 1985
To: 2005

Transition Patterns
- Constant
- Gentrify
- Loss
- Tenure change

City Ranking
- By: Constant
- Ascending order
- Descending order

Within-city Ordering
- Specific order
- Gentrify
- Tenure change
- Loss
- Constant
- Ascending order
- Descending order

Stack Size
- Percentage
- Count

Applet started.
Task 2: Attribute Contributions

- How transition probabilities of affordable housing are affected by characteristics like number of units, age of the house.
- May be able to apply statistical tests to determine if any attributes have any meaningful contribution to the outcome of the states.
### AHSExplorer (Attribute Viewer)

#### House Attributes

<table>
<thead>
<tr>
<th>House Attributes</th>
<th>Size by percentage</th>
<th>Order by attribute value</th>
<th>Size by count</th>
<th>Order by count</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN05_METRO3</td>
<td>DC (Constant)</td>
<td></td>
<td>DC (Gentrify)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC (Loss)</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td>DC (Tenure change)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>DC (Constant)</td>
<td></td>
<td>DC (Gentrify)</td>
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<td>2</td>
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<td>4</td>
<td></td>
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<td>DC (Loss)</td>
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<td>5</td>
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<td>2</td>
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<td>DC (Tenure change)</td>
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<td></td>
<td>DC (Constant)</td>
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<td>DC (Gentrify)</td>
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<td>DC (Loss)</td>
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<td>DC (Tenure change)</td>
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<td>DC (Gentrify)</td>
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<td>DC (Loss)</td>
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<td>DC (Tenure change)</td>
<td>20</td>
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<td>DC (Constant)</td>
<td></td>
<td>DC (Gentrify)</td>
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<td>DC (Gentrify)</td>
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<td>DC (Loss)</td>
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<td></td>
<td>3</td>
<td></td>
<td>DC (Tenure change)</td>
<td>5</td>
</tr>
</tbody>
</table>

Applet started.
Task 3: Time Series

- Transition probability shows long term effects, but hides temporal events
- Visualize the various paths that a house takes over years.
AHSEExplorer (Time Series)
## Analysis of Affordability of New Construction

<table>
<thead>
<tr>
<th>Year</th>
<th>Total units built</th>
<th>Units built to be affordable (count)</th>
<th>Units built to be affordable (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>303</td>
<td>23</td>
<td>7.59%</td>
</tr>
<tr>
<td>1989</td>
<td>203</td>
<td>13</td>
<td>6.4%</td>
</tr>
<tr>
<td>1991</td>
<td>185</td>
<td>26</td>
<td>14%</td>
</tr>
<tr>
<td>1993</td>
<td>154</td>
<td>23</td>
<td>17.55%</td>
</tr>
<tr>
<td>1995</td>
<td>101</td>
<td>11</td>
<td>10.89%</td>
</tr>
<tr>
<td>1997</td>
<td>63</td>
<td>8</td>
<td>12.69%</td>
</tr>
<tr>
<td>1999</td>
<td>60</td>
<td>5</td>
<td>8.4%</td>
</tr>
<tr>
<td>2001</td>
<td>81</td>
<td>3</td>
<td>3.7%</td>
</tr>
<tr>
<td>2003</td>
<td>85</td>
<td>5</td>
<td>5.88%</td>
</tr>
<tr>
<td>2005</td>
<td>46</td>
<td>5</td>
<td>10.86%</td>
</tr>
</tbody>
</table>
## Older Houses are More Affordable

<table>
<thead>
<tr>
<th>Year</th>
<th>Total units build not to be affordable</th>
<th>Units filtered down to affordable (count)</th>
<th>Units filtered down to affordable (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>280</td>
<td>81</td>
<td>28.9%</td>
</tr>
<tr>
<td>1989</td>
<td>190</td>
<td>40</td>
<td>21%</td>
</tr>
<tr>
<td>1991</td>
<td>159</td>
<td>36</td>
<td>22.64%</td>
</tr>
<tr>
<td>1993</td>
<td>131</td>
<td>29</td>
<td>22.13%</td>
</tr>
<tr>
<td>1995</td>
<td>90</td>
<td>23</td>
<td>25%</td>
</tr>
<tr>
<td>1997</td>
<td>55</td>
<td>4</td>
<td>7.27%</td>
</tr>
<tr>
<td>1999</td>
<td>55</td>
<td>5</td>
<td>9%</td>
</tr>
<tr>
<td>2001</td>
<td>78</td>
<td>6</td>
<td>7.69%</td>
</tr>
<tr>
<td>2003</td>
<td>80</td>
<td>4</td>
<td>5%</td>
</tr>
<tr>
<td>2005</td>
<td>41</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>
Demo

**VIDEO:**


**APPLET:**

[HTTP://WWW.CS.UMD.EDU/~DWH/AHS/](HTTP://WWW.CS.UMD.EDU/~DWH/AHS/)
Future Work

- Rank by feature
  - Help discovering an interesting start/end pair
- Attribute summaries in stack cells
- Motif extraction
  - Help discovering unique and interesting transition patterns
- Others
  - Vertical alignment of stacks
  - Scatter plot capability
  - Regular expression via mouse actions
  - Abandon Processing
Conclusion / Discussion

- **AHSEExplorer**
  - Interactive exploring of state transitions
    - Stacked bar chart representation
    - Customizable pattern definition
    - Preserving user settings across sessions
  - Attribute viewer
    - Examining attributes of selected houses
  - Time series plot
    - Showing the path of the houses
    - Search via regular expression