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Decision Modeling for Housing and Community Development: ATM ethodology for Evidence-Based Urban and Regional Planning

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Decision Modeling for Housing and Community Development: A Methodology for Evidence-Based Urban and Regional Planning

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Motivation

- Analytic skills in urban planning and related programs typically provided through probability and statistics, geographic information systems and qualitative data analysis
- Problem-solving is, and should properly be seen as, driven by stakeholder needs, not available technologies
- In some contexts, and for some organizations, methods associated with 'analytics' or 'decision science' can provide unique insights.

How can data analytics and decision science provide useful guidance to planners engaged in local housing and community development beyond standard methods?

What are some different quantitatively-oriented new technologies and methods?

- Big data: collection of models, methods, tools and repositories designed to extract knowledge and insight from very large datasets (Kitchin 2014)
- Smart cities: technologies often based on real-time data to support more efficient and responsive provision of services in urban areas (Geertman et al. 2015)
- (Decision or data) Analytics: procedures and models intended to generate guidance regarding design and operation of organizations, systems and phenomena (Liberatore and Luo 2010):
  - Current characteristics (descriptive analytics)
  - Future values of important variables (predictive analytics)
  - Prescriptions , policy and guidelines (prescriptive analytics)

What types of problems in housing and community development may be well-suited for analytics?

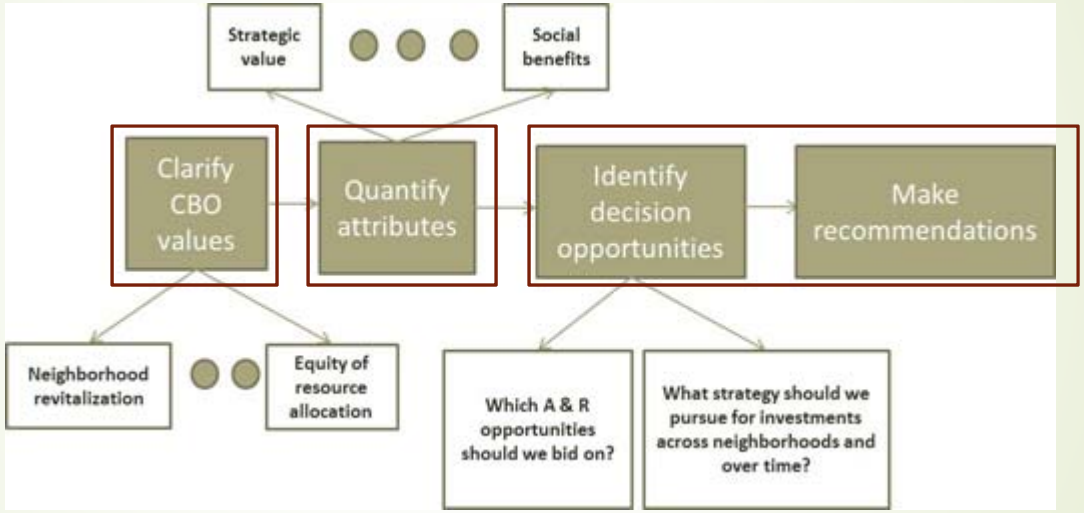
- Characteristics
  - Multi-stakeholder
  - Multi-objective
  - Support operational, tactical or strategic decisions
  - Rooted in values
  - Accommodate multiple methodological approaches
- Examples
  - Subsidized and affordable housing (Johnson 2007; 2005)
  - Foreclosure response (Johnson et al. 2016)
  - Vacant land management (Johnson, Hollander and Whiteman 2015; Johnson, Hollander and Hallulli 2014)

There are other sources of insight related to data analytics for housing and community development…

- Mallach's framework for strategic change (2008)
- Foreclosure recovery timeline (National Housing Center 2013)
- Resources for organization capacity-building and data analysis (e.g. NeighborWorks; PolicyMap)
- Evidence-based local investment strategies for community development (Federal Reserve Bank of San Francisco & Low Income Investment Fund 2012)

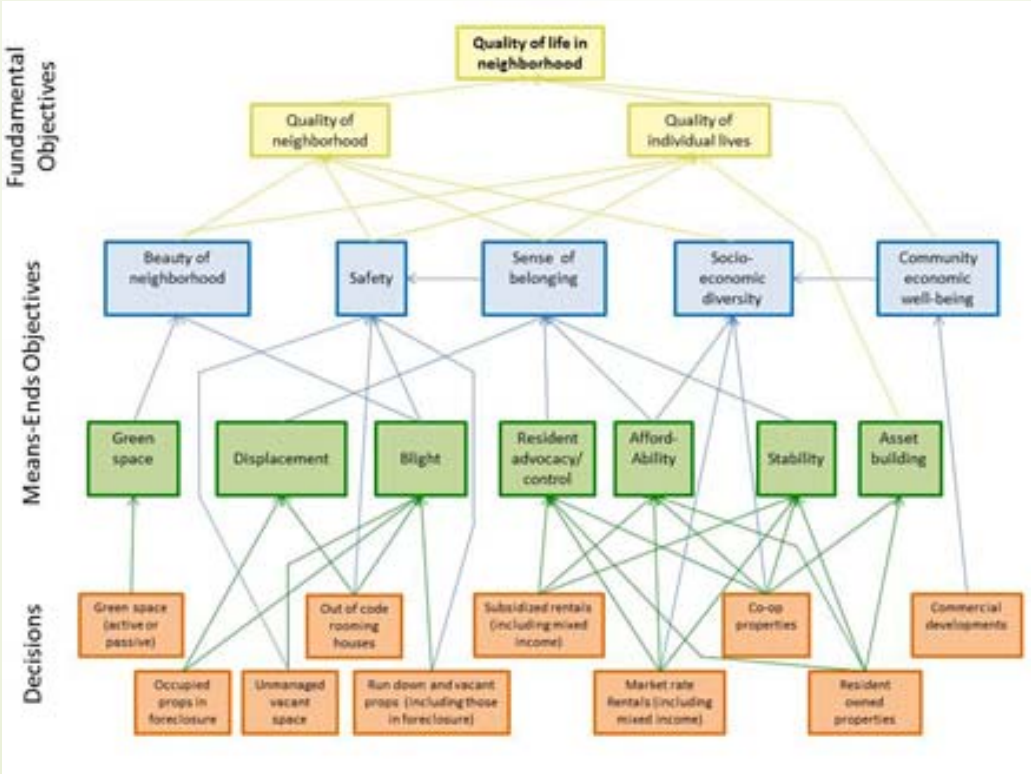
However, when we don't know what metrics to use, what tradeoffs to consider, which alternatives to choose, which policies to follow, how to incorporate uncertainty, analytics can generate new and useful solutions

How can we apply data and decision analytics to foreclosed housing response?



- Values analysis: identify strategy/intervention objectives and decision attributes
- Data analytics: quantify attributes; refine understanding of problem context
- Decision modeling: Choose most-preferred decision alternative; design optimal planning strategy

Values analysis: Generate values structures to evaluate strategy alternatives



Source: Johnson, et al. (2016)

General goal: determine relationship between ends, means, alternatives, metrics and preferences

Values structures (Keeney 1992): identify causal links between fundamental objectives and decision alternatives

Values analysis: Classify action items according to means objectives

Twin Cities CDC Strategies: Organization Purpose

Fundamental Objective	Means Objective	What decisions/strategies are associated with each means/lower level/actionable objective?						
MAX Quality of Area Proximate to Units	MAX green space	Organize/ provide for clean-up crews for vacant lots (linked to youth)	Creating/sustaining green spaces from neg opportunity spaces	Turn vacant lots near multi-units into active greenspace e.g. playgrounds	Partner with city to share costs of manage public spaces (e.g. insurance, landscaping)	Other partnerships/ coordination, e.g. 'friends of the park'	Expand on existing community/ residential garden efforts	
	MAX other community spaces	Develop BF Brown school into housing to support retail/retail demand	Partner with another org to develop/manage recreational space (gym, auditorium) at BF Brown school					
	MAX quality of amenities	Develop artist space (@ BF Brown), create cultural district on Main St.	Expand farmers market on Main St.	Attract/ develop more commercial enterprises (e.g. restaurants)	Address vacant store-fronts on Main - pre-dev/bring up to code/make ready for new businesses	Expand tenant meeting space/on-site services		
	MAX accessibility of units to amenities	Increase downtown rental development	Locating green/community space close to occupied units					
(Quality AND Sustainability)	MIN Abandoned properties AND # of vacant units in non-abandoned properties	Work with realtor to identify more at-risk properties more quickly	Collect current data on rents and vacancies, share info with other landlords (e.g. North-Central landlord association)	Use access and knowledge to be intermediary for other developers?	Encourage city to pass property registration ordinance to keep track of vacancies and rent	Offering landlord training, screening assistance	Acquiring foreclosed and abandoned properties (esp. through 'first look')	Preventive foreclosure mediation and counseling	Market the neighborhood
MAX Sustainability of Quality	MAX spending/private investment/municipal investment	Encourage local employment on construction and rehab projects	Increase availability of capital in Fitchburg generally	Use local sources to access credit for developing/ rehabbing residential investors and mixed use properties	Work with redevelopment authority to increase commercial property (i.e. small business) funding			
	MAX impact of responsible investors/MIN impact of speculators	Use receivership to take control of 'cancerous' properties (bad fits, no $ for rehab, absentee landlords)	Partnership opportunities w/private property owners that lack resources (e.g. technical/administrative assistance, coordinate on adjoining properties)?	Become the go-to source for large projects, not 'developer of last resort'	Serve as advisor/ consultant/ go-to source for new neighborhood investments/ developments?			
	MAX number of responsible owner-occupants	Use receivership	Expand community building activities	Offer assistance (accessing financing, resources) to private homeowners				
	MAX number of responsible tenants (own and w/in neighborhood)	Transform existing space (e.g. liquor store) into beneficial resident space (prop mgmt, laundry)	Look into city-wide tenant association	Being responsible landlord of own properties				
MAX Quality of Individual Units	MAX quality of (own) tenants	Hire resident services coordinator in Fitchburg - for case management and community building	Tenant associations, "Neighbor Circles"	Be a responsible landlord of own props (i.e. new property management service)				
	MAX basic	Better reporting and responsiveness to maintenance needs	Increase "curb appeal"	Maintaining capacity for improving unit quality, preventative maintenance	Better quality materials and standards	Formed asset management department that reports to the board	Energy improvements	
	MAX interior quality*							
	MAX unit safety*							

* These three objectives were discussed collectively during the strategy session

LEGEND

- External-Advisor/facilitator (9)
- External-Resident services/activities (12)
- External-Place based development (18)
- External-Advocacy (3)
- Internal-Capacity building (4)

'Strategy tables' can support decision-making without need to quantify preferences or define tradeoffs

Source: Johnson, et al. (2016)

Data analytics: Provide evidence-based context for specific interventions

MARKET STRENGTH	FORECLOSURE IMPACT RISK		
	C. Actual high foreclosure density	B. High risk of high foreclosure density	A. Low risk of high foreclosure density
1. Strong	Facilitate rapid sales to sustainable owners, low/no subsidy	Lower cost effort to prevent foreclosures and vacancies, low/no subsidy	Lower priority
2. Intermediate	High payoff/priority, rehab and rapid sale to sustainable owners, target subsidies, neighborhood maintenance	High payoff/priority, prevent foreclosures and vacancies, emphasize neighborhood maintenance	Lower priority but watch carefully, head-off emerging problems early
3. Weak	More emphasis on securing/demolishing, land banking to hold until market rebound	Lower cost effort to prevent foreclosures and vacancies	Lower priority but watch carefully, head-off emerging problems early

Source: foreclosure-response.org (2013)

This foreclosure response typology can help CDCs classify interventions – but which are most relevant to which neighborhoods, according to what thresholds?

Data analytics: Quantify criteria and measure impact

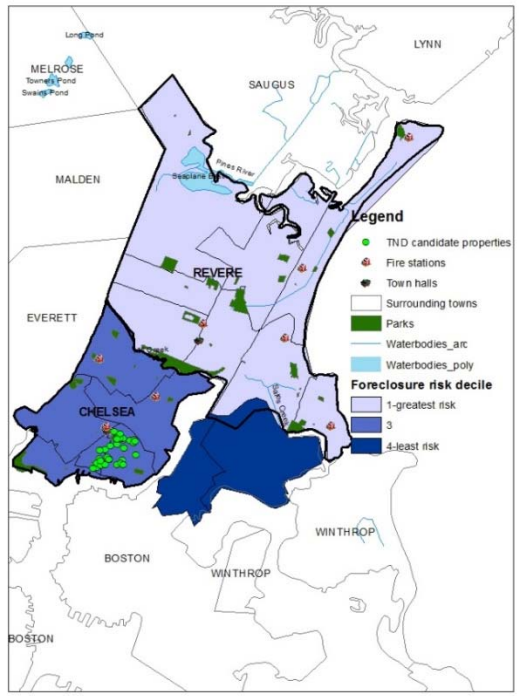
Fitchburg/Leominster, MA

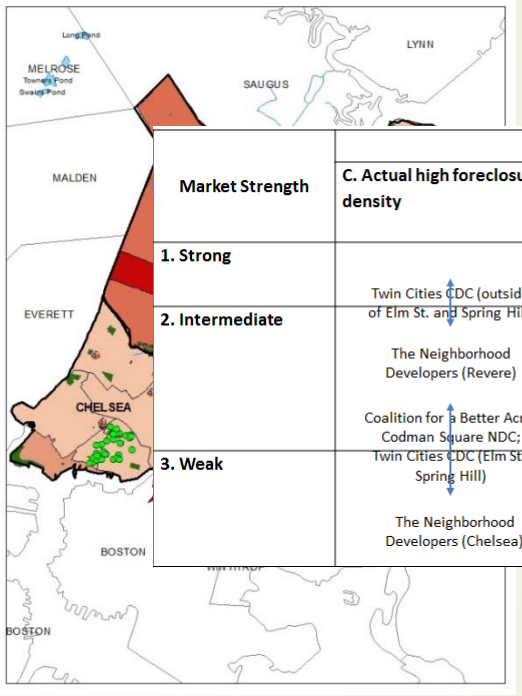
Market Strength											
Strongest ---> Weakest --->	10	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0
	7	1	0	0	0	0	0	0	0	0	0
	6	1	3	0	0	0	0	0	0	0	0
	5	1	1	0	0	0	0	0	0	0	0
	4	0	2	0	0	0	0	0	0	0	0
	3	1	2	0	0	0	0	0	0	0	0
	2	3	0	0	0	0	0	0	0	0	0
	1	3	0	0	0	0	0	0	0	0	0
		1	2	3	4	5	6	7	8	9	10
		Highest ---> ---> ---> Lowest									
		Foreclosure Risk									

Source: Johnson, et al. (2016)

For each of four partner communities, classified each Census tract according to foreclosure risk and market strength to determine what types of responses might be most relevant

Data analytics: Identify areas for specific interventions





Market Strength	Foreclosure Impact Risk		
	C. Actual high foreclosure density	B. High risk of high foreclosure density	A. Low risk of high foreclosure density
1. Strong	Twin Cities CDC (outside of Elm St. and Spring Hill)		
2. Intermediate	The Neighborhood Developers (Revere)		
	Coalition for a Better Acre; Codman Square NDC; Twin Cities CDC (Elm St., Spring Hill)		
3. Weak	The Neighborhood Developers (Chelsea)		

Source: Johnson, et al. (2016)

By overlaying foreclosure incidents with neighborhood characteristics, we can determine what types of interventions may be most suitable in which communities

Decision modeling: Design interventions for specific communities

Model jointly optimizes estimated strategic value and property value impact associated with foreclosure acquisitions

Optimize $\{S(\boldsymbol{x}) = \sum_{i=1}^{n} S_i \cdot x_i ; P(\boldsymbol{x}) = \sum_{i=1}^{n} P_i \cdot x_i\}$ ← Jointly optimize social objectives

s.t.

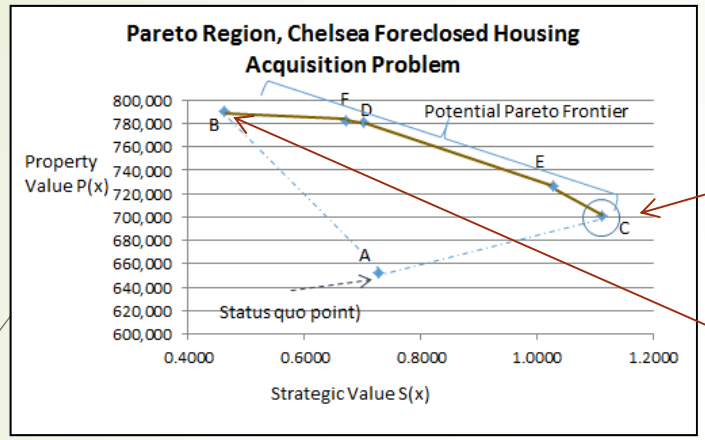
$\sum_{i=1}^{n} C_i \cdot x_i \leq B$ ← Limit expenditures to budget available

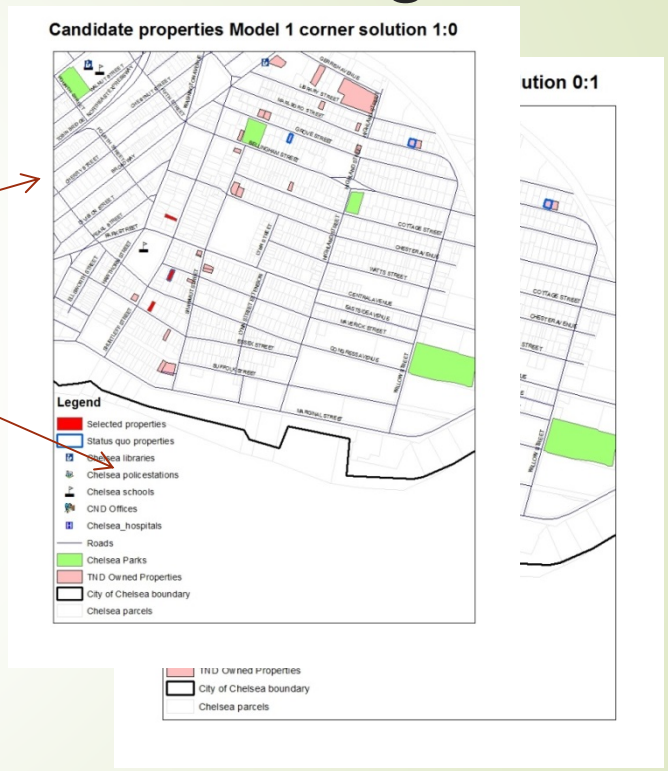
- or -

$\sum_{i=1}^{n} x_i = N$ ← Acquire only a given number of properties

$x_i \in \{0, 1\}, i = 1, \ldots, n$

Decision modeling: Generate alternative acquisition strategies



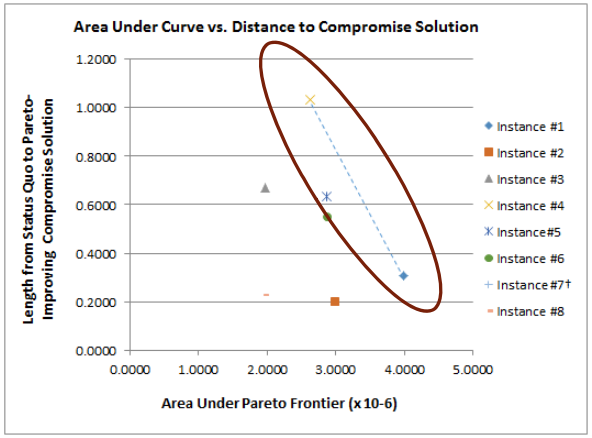


Source: Johnson et al. (2016)

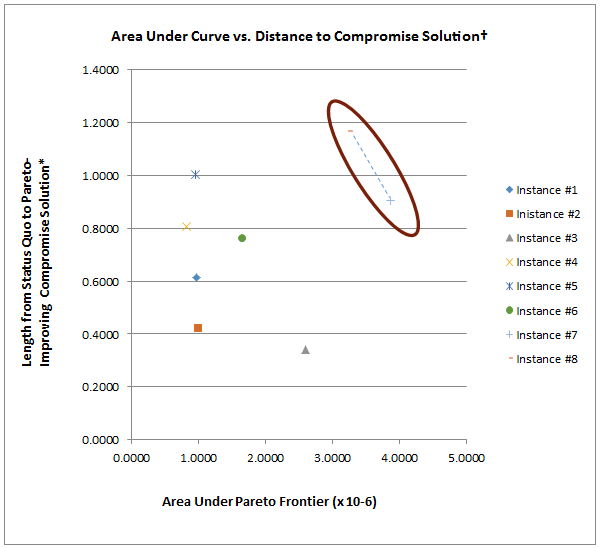
Spatial specificity of solutions is valuable – but which modeling strategy is preferred? Which strategic value metric should we use? Which acquisition strategy should the CDC pursue?

Decision modeling: Choose most-preferred modeling approach and intervention strategy

Budget constraint



Number-acquired constraint



Source: Johnson, et al. (2016)

By systematically varying model formulations and parameters, we can determine which approach is likely to maximize social value, and which specific intervention the CDC may choose

Additional applications of data and decision analytics

- Vacant land management
  - Identify alternative uses of currently unoccupied land that maximize multiple social impact metrics
    - Neighborhood-level strategies (Johnson, Hollander and Hallulli (2014)
    - Parcel-level strategies (Johnson, Hollander and Davenport Whiteman (2015)
- Gentrification and displacement
  - Identify and prioritize local responses based on a values analysis , emphasizing local knowledge and community-building rather than quantitative analysis
- Subsidized and affordable housing provision
  - Choose vacant parcels for affordable housing construction that balance accessibility to employment and perceived impacts on nearby communities

Conclusion and next steps

- Key findings:
  - Values analysis enables stakeholders to clarify objectives and goals to generate performance metrics and strategy alternatives that represent decision opportunities
  - Data analytics can quantify decision opportunities and performance metrics to complement experience and intuition
  - Decision modeling can generate specific yet flexible guidance regarding multiple aspects of foreclosure response: selection of housing units for potential acquisition; bidding strategies; neighborhood-level redevelopment under uncertainty
- Related research opportunities
  - Develop theoretical framework to help determine conditions under which decision modeling is likely to add the greatest value
  - Design and implement truly community-based and community-engaged decision modeling applications
  - Formally evaluate data and decision analytics-based solutions as compared to current or conventional practice

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