

Developing A Decision Support Tool, With Agent-Based Modeling, For Policy Simulations Of The Tallahassee Clean Energy Plan

Research Goal:

Develop a decision-support platform, drawing from interdisciplinary datasets, to run policy simulations of the Tallahassee Clean Energy Plan and support related operational and planning use cases

What is an Agent-Based Model?

Agent-based models (ABMs) simulate how individual agents interact with each other and their environment, revealing insights and patterns from collective behavior [1].

- Traffic can be thought of as an ABM, where the cars are the agents and overall traffic flow would be an emergent behavior.
- These models account for agent heterogeneity, bounded rationality, and non-market interactions, combining policy analysis and behavioral economics in a microsimulation approach [1].

Introduction:

Much agent-based modeling research for solar energy applications is focused on case studies out of the United States, notably Chile and China [2] [3].

- **This work is focused on Florida, specifically Tallahassee, where the local government has a robust Clean Energy Plan.**
- Previous research often employs average solar irradiation data [2].
- This work leverages Google Project Sunroof to **obtain personalized estimates for each home based on satellite imaging of each roof**, accounting for home-specific barriers to solar such as minimal sunlight or tree coverage.
- Previous research also often utilizes generalized adoption thresholds, such as the case of Wang et al. [2], which employed a high and low threshold based on factors like income.
- Personalized adoption estimates in this work leverage a household's income and race, with a noise parameter to account for uncaptured variables.

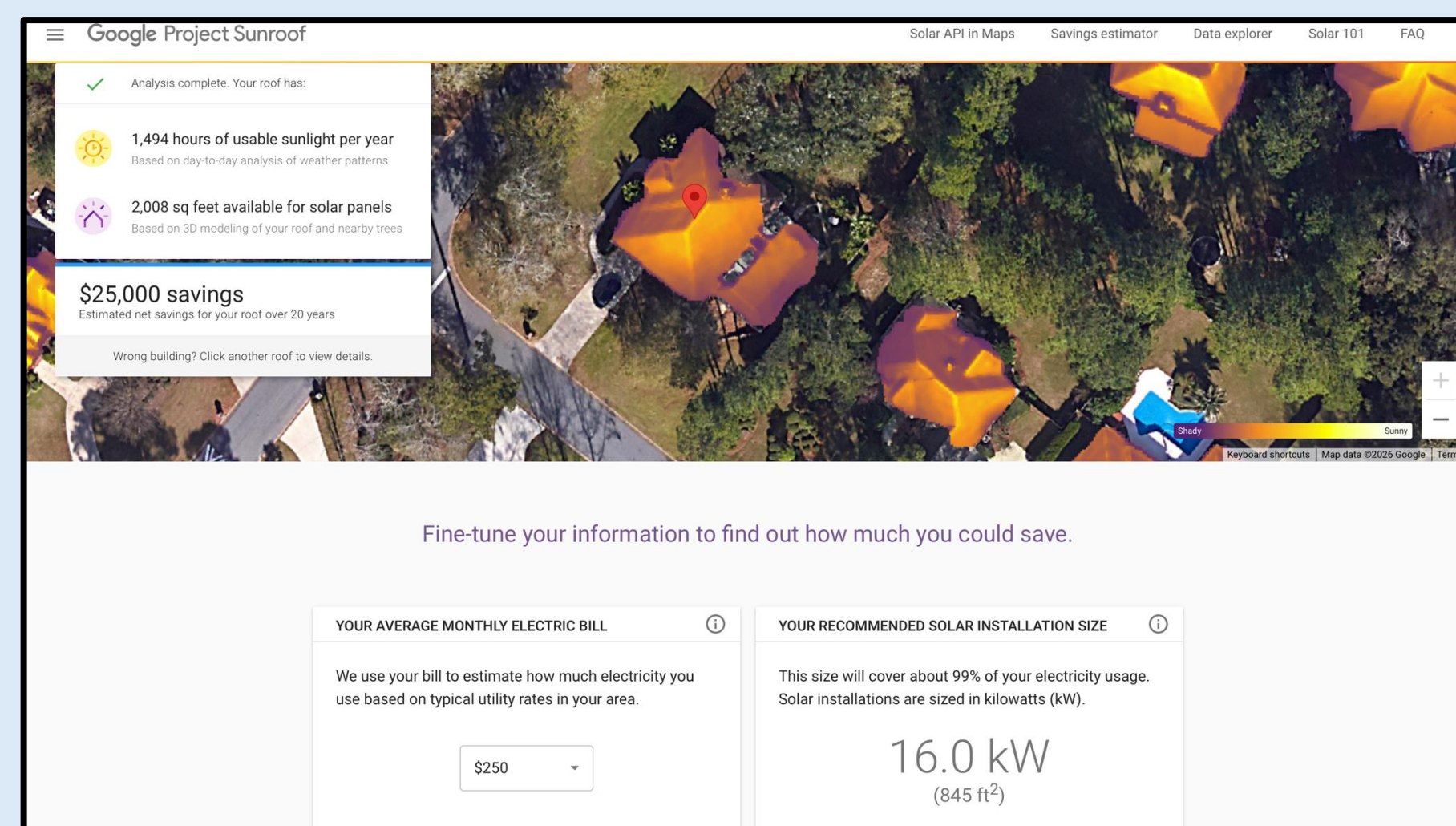


Figure 1: A screenshot from Google Project Sunroof, showing satellite imaging and savings estimate capabilities.

Applying Graph Theory to this Use Case:

It is especially useful to think of the Tallahassee community as a social networking graph, as this can help us understand how solar energy, or any product, diffuses through a community.

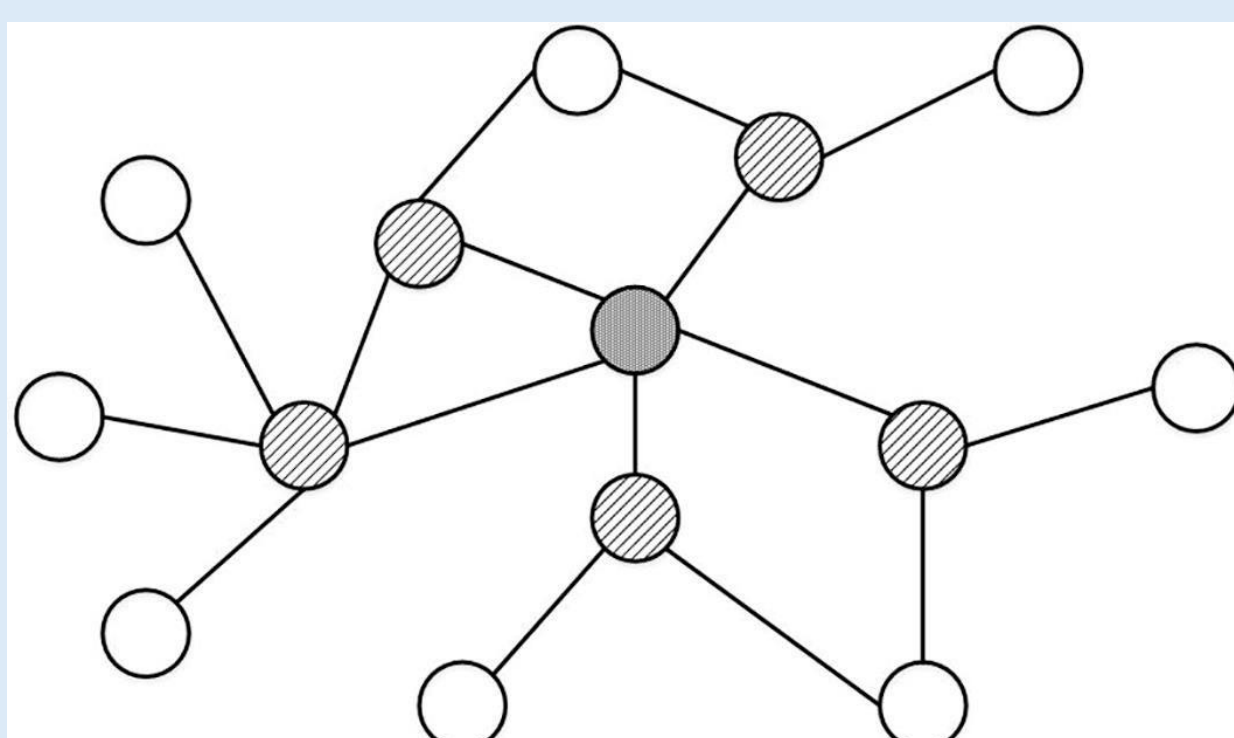
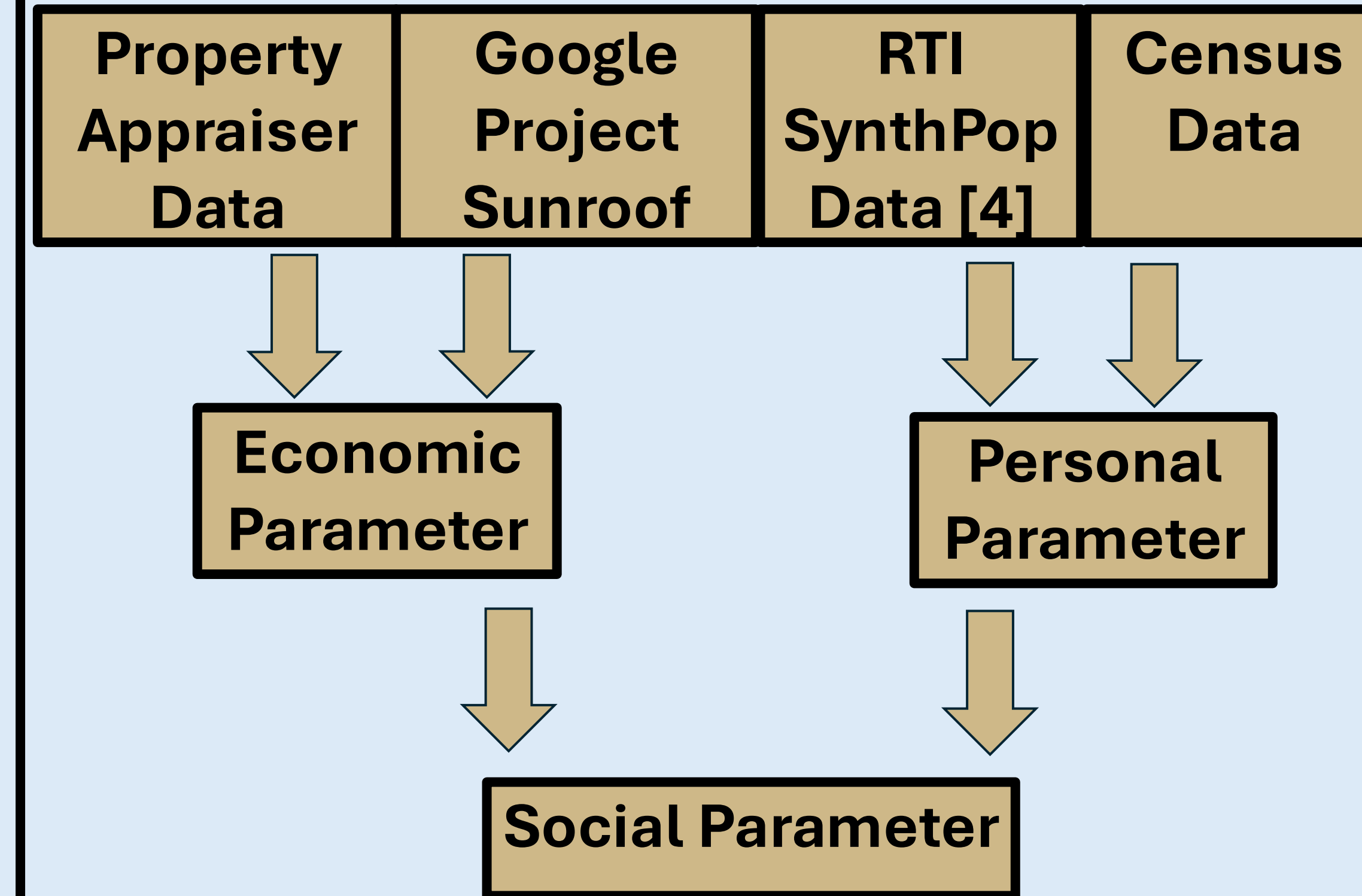


Figure 2: Social Networking Graph [2]

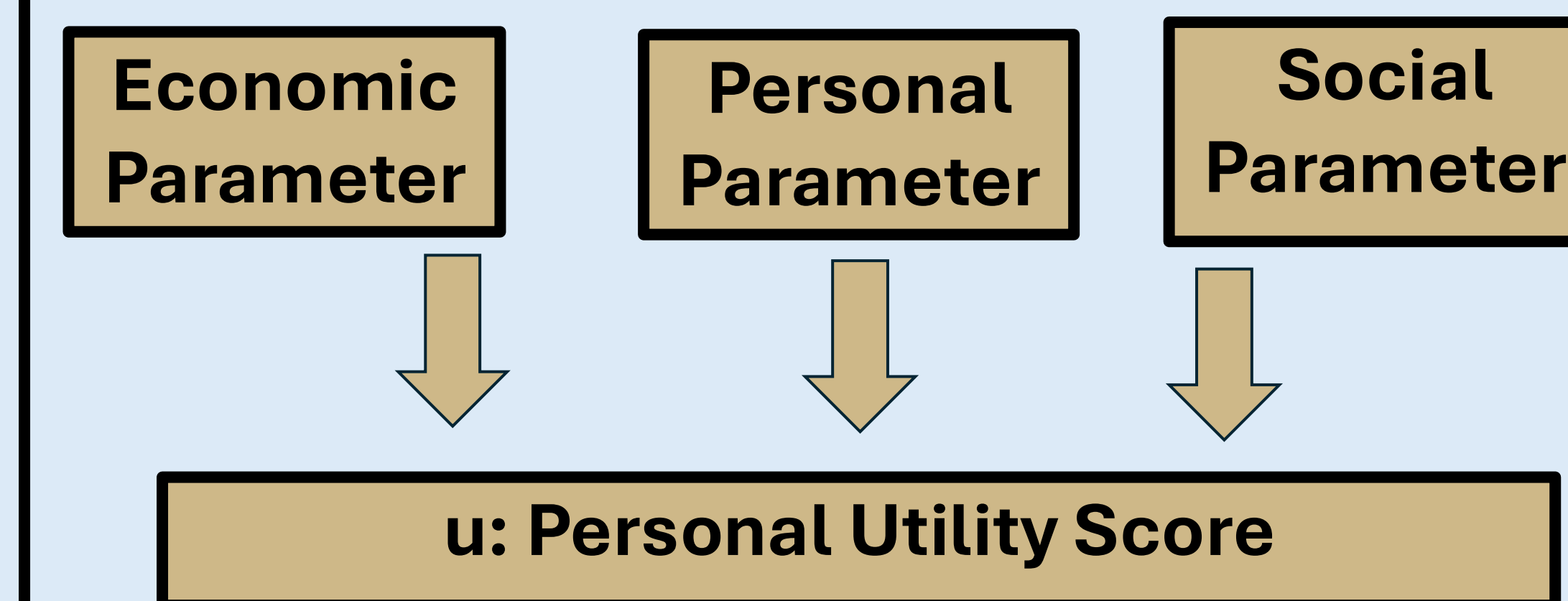
- The nodes (circles in the graph) represent households, and the edges (lines in the graph) show the connections between them.

Methodology: Modeling Framework:

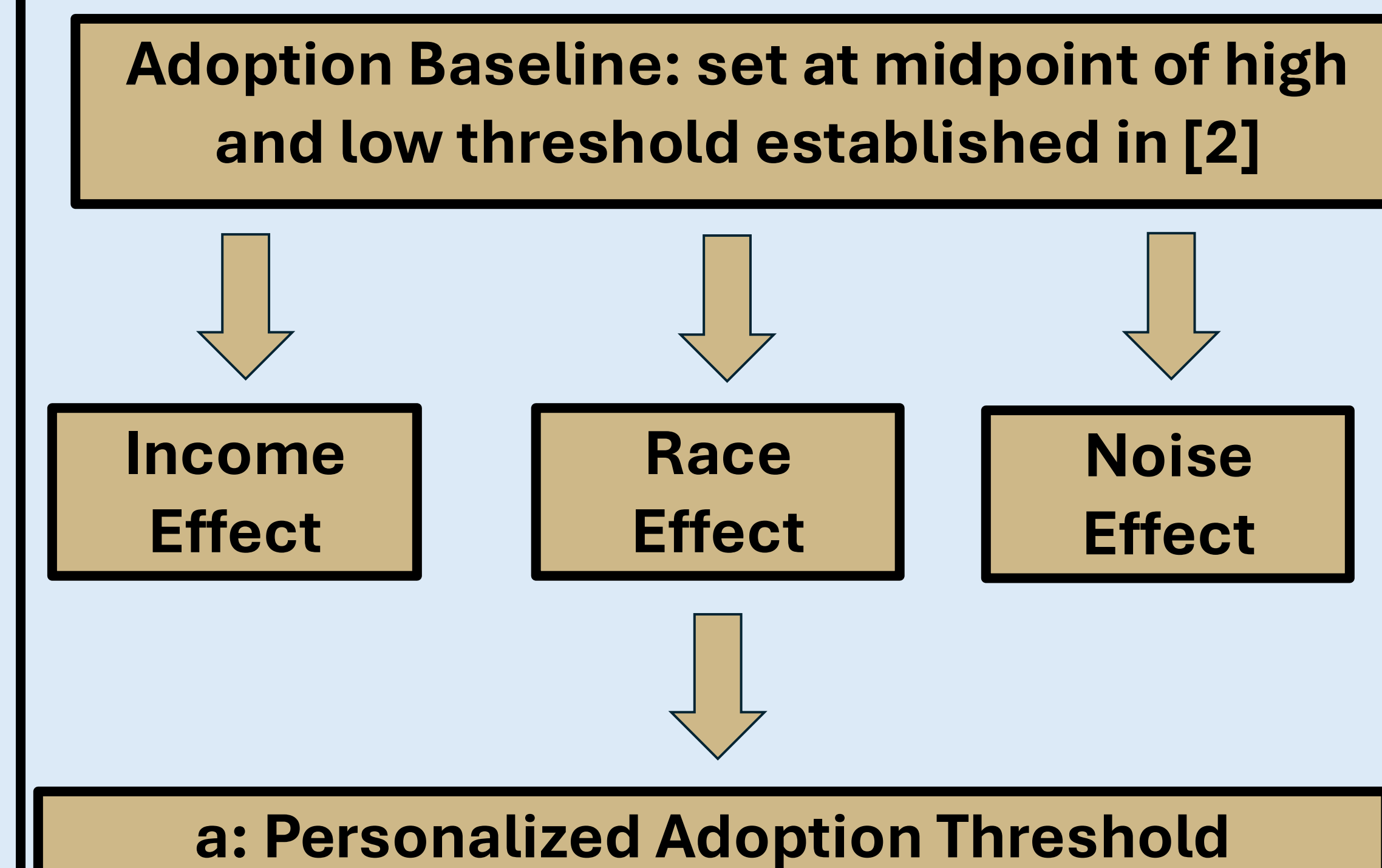
- Deriving Personal, Social, and Economic Factors:



- Deriving Personal Utility Score, u (modeled after [2]):



- Personalized Adoption Threshold:



Limitations:

- This graph is locally imbalanced. Despite having enough parcels and households, the locations of these in the graph means that out of the ~88,000 parcels, they do not all have a suitable household match.
- The auction algorithm [5] matches 64,816 parcels to synthetic households, with roughly 17,000 of the unmatched being forced mismatches due to graph topography.
- The remaining ~6,000 may be matchable with a modified assignment approach.

Data Tool Output Example:

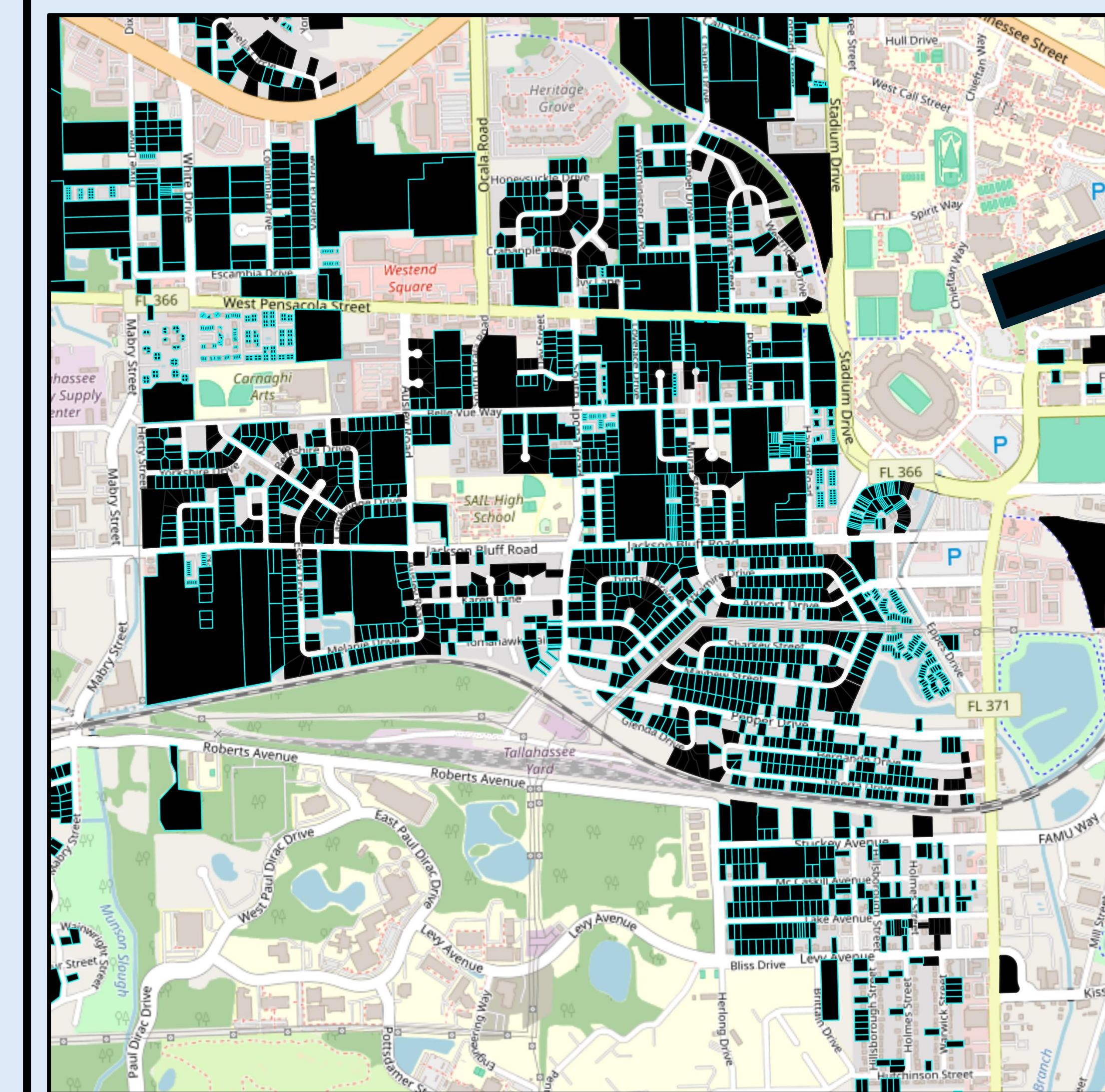


Figure 3:

- A snapshot of available data is shown here.
- Each parcel, outlined in blue, has data available for key metrics:
 - Home price
 - Home size
 - Head of Household (HH) Age
 - HH Income
 - HH Race
 - HH Educational Attainment
 - Housing Tenure

Policy Simulation Framework:

- **Policy 2.1.3: Net Metering True-Up Option:** consumers receive an annual payout for excess electricity produced [6].
 - Increase economic parameter by 10% for homeowners & re-run simulation.
- **Policy 2.1.2: Resources for Under-Banked or Under-Resourced:** expand green inclusive financing to help those with poor credit adopt solar [6].
 - Decrease a , personalized adoption threshold, by 10%.
- **Policy 2.3: Community Solar:** programs to encourage installations on public and private spaces like parking lots [6].
 - Decrease a or adoption threshold by 5% for all homeowners
 - Increase u or utility score by 5% for all homeowners.

References & Acknowledgements:

I would like to thank Dr. Romero and the rest of the PULSE Lab for their continual support and guidance.

