Exploring Perceptions of Structural Racism in Housing Valuation Through 3D Visualizations

Lisa Haye
lisa.haye@jjay.cuny.edu
City University of New York
New York City, USA

Courtney D. Cogburn
cc3803@columbia.edu
Columbia University
New York, USA

Oyewole Oyekoya
oo700@hunter.cuny.edu
City University of New York
New York City, USA

ABSTRACT

This research, formatted as an exploratory study, attempted to investigate perceptions concerning the consequences of redlining and structural racism in housing valuation via three-dimensional (3D) visualization models. Unity3D and Mapbox SDK for Unity were used to visualize two neighborhoods in the Bronx County of New York; single or multiple dimensions of visualization to represent both racial differences and the presence of condominiums in the respective neighborhoods were used. Thirty-three respondents participated in a user study to capture perceptions of seventeen visualizations, and responses generally favored the use of multiple dimensions of congruent visualizations. This work attempts to encourage future development of 3D visualization techniques to stimulate interactive understanding of structural racism.

CCS CONCEPTS

• **Computing methodologies** → Perception; • **Human-centered computing** → **Geographic visualization**; **Information visualization**.

KEYWORDS

data visualization, structural racism, perception, redlining, housing valuation

ACM Reference Format:
Lisa Haye, Courtney D. Cogburn, and Oyewole Oyekoya. 2023. Exploring Perceptions of Structural Racism in Housing Valuation Through 3D Visualizations. In *Companion Proceedings of the Conference on Interactive Surfaces and Spaces (ISS Companion '23), November 05–08, 2023, Pittsburgh, PA, USA.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3626485.3626533

1 INTRODUCTION

Structural racism refers to the political, social, and legal norms and systems that foster racial discrimination against racial and ethnic minorities, while reinforcing societal privileges to whites [6]. As such, despite the passage of the Civil Rights Act of 1964, which formally bans racial discrimination in the United States, structural racism remains interwoven into the fabric of social systems such as housing, healthcare, criminal justice, education, and the environment [6]; consequently, people of color disproportionately experience less access to public goods such as quality food, healthcare, education, and transportation [6][15], and are more likely to be burdened with environmental hazards [15][9].

One of the most explicit forms of structural racism, redlining, was conducted between 1933 and 1968 [14], wherein the Home Owners Loan Corporation ("HOLC") constructed maps that outlined neighborhoods based on their riskiness in mortgage refinancing [15]; riskiness, however, was assessed partly due to a neighborhood's racial composition, and neighborhoods with racial minorities were colored red and deemed hazardous [15]. Racial minorities were excluded from federally-insured mortgage loans [3], and effectively segregated urban communities by race.

While explicit redlining has been outlawed since the passage of the Fair Housing Act of 1968 [8], the consequences of redlining continue today, as neighborhoods that were redlined by the HOLC are more likely to experience poverty, racial segregation, income inequality [9], less tree canopy [14][4], higher temperatures [4], and housing and neighborhood devaluation [12][3]. The objective of our project attempts to examine perceptions of these redlining consequences on modern communities by constructing 3D maps of two communities within the Bronx County of New York. It is important to note that this research was designed to be an exploratory study to investigate what possible dimensions of visualizations do users potentially find most effective at visualizing these disparities with 3D visualizations.

1.1 Related Works

Lakonso and Aditya [5] visualized various topographic data in a 3D environment by reconstructing two buildings within the Universitas Gadjah Mada. While their work did not center upon structural racism, Lakonso and Aditya [5] exemplified the advancements of platforms such as Unity3D and Mapbox SDK for Unity towards supporting diverse 3D data formats, as well as highlighting Unity's powerful execution of immersive 3D visualizations that could simulate the real world.

Data-driven representations of structural racism, such as the Black-white wealth gap, have elicited a greater understanding for users than narrative representations [2]. Various papers have visualized data capturing structural racism [7, 8, 10, 12–14, 16], but these data representations are relegated to two-dimensional formats such as tables, graphs, and figures. Indeed, there is a dearth in literature studying structural racism visualization in a 3D format. To our knowledge, our work is the first to attempt to visualize disparities in housing valuation utilizing Unity3D and Mapbox SDK for Unity.

ISS Companion '23, November 05–08, 2023, Pittsburgh, PA, USA

ACM ISBN 979-8-4007-0425-3/23/11…$15.00
https://doi.org/10.1145/3626485.3626533

2 METHODOLOGY

To concentrate illustrating the impact of redlining and structural racism on closely-located communities, two neighborhoods within the Bronx County of New York City, Riverdale and Soundview, served as case studies for this project. This project specifically centered upon the presence of condominiums and their property value, as well as the racial demographics of these communities as of 2020, to visualize differences in housing valuation. Data concerning condominium property value was extracted from Zillow using a Google Chrome extension, Zillow Data Exporter, of properties for sale in Riverdale and Soundview, respectively, as of June 2023. Racial demographics of each neighborhood was extracted from a 2020 report from the New York City Department of the Aging.[1]

To create 3D representations of the two neighborhoods, Mapbox SDK was imported into Unity 3D; utilizing the map prefab included with Mapbox's packages, two maps were initialized on Unity and the geographical coordinates for Riverdale and Soundview were inputted on two separate maps to visualize the neighborhoods side-by-side. Various visualization factors such as color, size, symbols, data, and map layout manipulation were created and captured in screenshots; condominium buildings were inserted onto each map manually, with each condominium representing a current property for sale in their respective neighborhoods as of June 2023. A sample of seventy-seven properties from Riverdale and Soundview were observed, with 47 condominiums belonging to Riverdale, and 17 condominiums were located in Soundview. An online survey was then disseminated from Google Forms to voluntary, unpaid participants via a link to assess perceptions of seventeen different versions of the two maps.

3 USER STUDY

Users were first introduced to a definition of structural racism, redlining, and the Home Owners' Loan Corporation from this paper before answering any questions regarding the models. The first phase of the survey included two questions that were asked with every model represented; the first question included a visualization description and users were asked to rate the accuracy of that description with the model ("On a scale of 1 to 5, how well does the model represents the description above accurately?"), and the following question asked users their perception of the models depicting racial differences between Riverdale and Soundview ("How well does the visualization convey the racial demographic differences between Riverdale and Soundview?") on a five-point likert scale. The second phase of the survey consisted of one question, where users were asked to rank their preferences towards the models that characterize structural racism in housing valuation, from best to worst, with 1 representing best and 17 representing worst.

4 RESULTS AND ANALYSIS

Thirty-three participants completed the survey and submitted responses; of this sample, two participants declined to supply demographics information, with one omitting racial/ethnic identities, and the other omitting both age range and racial/ethnic background.

Summary Results: For the first question of the first section of the survey, Model 17 has the highest average likeability, with a mean of 4.55, while Model 3 had the lowest average likeability, with a mean of 1.79. Question two of the first section's highest average of preference for visualizing racial differences in the two neighborhoods also belonged to Model 17, with a mean of 4.48, while the lowest average preference was for Model 3, with a mean of 1.97. In terms of the ranking question, Model 17 was voted first most frequently with 19 votes (57.6%), while Model 3 was ranked last most frequently with 12 votes (36.4%).

Tables 2, 3, and 4 summarize results for question one, two, and the ranking procedure, grouped by demographic information (gender identity, racial/ethnic background, and age). Of the thirty-two who supplied information regarding gender, 18 respondents (56.3%) identified as women, and 14 respondents identified as men (43.8%). Six respondents identified themselves as Asian (18.8%), six as Black or African-American (18.8%), four as white (12.5%), fifteen as Hispanic or Latino (46.9%), and only one as two or more races (3.1%). Five respondents (15.6%) stated they were 18-20 years old, twenty-one respondents (65.6%) were 21-29, four respondents (12.5%) were 30-39, and two respondents (6.3%) were 50-59.

5 DISCUSSIONS

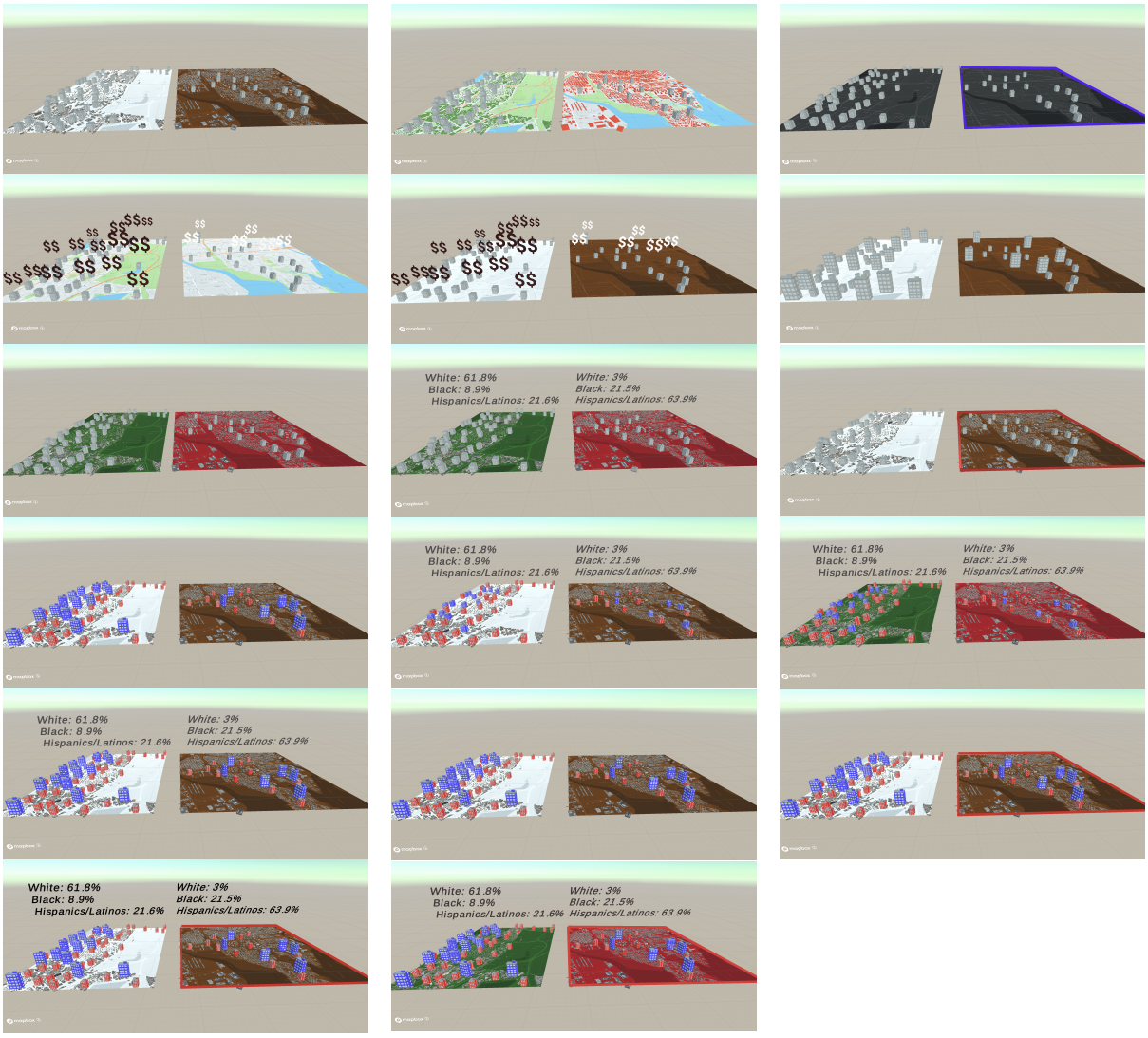
The choice for visualizing Riverdale and Soundview have profound implications for this study and the conversation regarding structural racism, the concept of race, and redlining. The area of Riverdale, as noted in the HOLC maps [10], was the only area classified as 'Best' in the entire Bronx County, and no ethnic minorities were detected in the neighborhood; today, that same area remains to be the most affluent region of the borough[2], and the racial composition of the area remains predominately white. Meanwhile, HOLC highlighted the neighborhood of Soundview was categorized as a combination of "Definitely Declining" and "Hazardous", noting the presence of a low income housing development and the presence of Italians and Russians as detrimental influences to the area [10]. Seeing as the United States experienced a social reclassification of non-Anglo-Saxon whites that came to include Italians into the majority group starting around the 1950's, [17] along with the emergence of white exodus or white "flight" from urban communities to suburbia around the same time [11], the reasoning behind Soundview's redlining only sheds a more profound dialogue for power and access to social goods such as the wider housing market being correlated with race.

Ethnic groups found in Soundview such as Italians certainly experienced prejudice, but they were still considered white, and therefore had the ability to participate in the white exodus from Soundview. Since then, Soundview's population experienced an influx of those considered Black and Hispanic, while the presence of whites in the area has significantly decreased; one possible explanation for the shift in demographics to Black people and non-white Hispanics could be the emergence of housing developments such as Clason Point Gardens in 1942 [11], and a series of other New York City Housing Authority developments; it is noted that the Clason Point Gardens development was originally predominately white, but the onslaught of the white flight had white Clason Point Gardens residents moving to suburbia, the fellow Bronx community

[1] https://www.nyc.gov/assets/dfta/downloads/pdf/reports/Demographics_by_NTA.pdf

[2] https://archive.nytimes.com/www.nytimes.com/ref/realestate/nabe-riverdale.html

Table 1: Visualizations (numbered from left to right): 1 (top-left) to 17 (middle-bottom)



of Co-op City, and out of New York State altogether [11]. Today, Soundview is predominately Black and Hispanic, and although the classification of Hispanics and Latinos carries its own myriad implications for race, Soundview is considered low-income [3]; future work may consider investigating the possible correlation of low-income communities being a consequence of municipal disinvestment beyond the scope of Soundview.

Many of the models contain multiple dimensions of visualization as their frameworks, and there is a possibility that some features may be responded to more positively than others, especially in regards to the presence of the physical red line surrounding Soundview and the map layout design according to either the neighborhood's HOLC designation or racial composition; Model 17 was ranked first overwhelmingly by demographics referenced in Table 4, with the exception being from the sole respondent who identified themselves as two or more races. Model 17 is one of several of the models shown to users that contain multiple dimensions of visualization. Meanwhile, Models 1 and 3 were generally ranked last most frequently by users, which are both models that were designed to contain only one form of visualization (racial composition and an attention check design, respectively). We note that Model 17 was also specifically ranked last by men, the two or more races user, and respondents in the 30-39 range, but a greater sample size is needed to determine whether these outcomes are due to a potentially significant mode of perception amongst those groups, or if these results were due in part to the format of the ranking question. Despite this, with the positive interaction of several models that contain several modes of visualization, especially Model 17, we believe a probable conclusion for this phenomenon is due to preference for many dimensions being visualized, so long as the information is presented well and does not conflict with other

[3]https://www.nyc.gov/assets/doh/downloads/pdf/data/2018chp-bx9.pdf

Table 2: Results by Demographics - Q1

Demographics	Highest likability average - Q1	Lowest likability average - Q1
Men (n = 14)	Model 17 - 4.64	Model 3 - 1.93
Women (n = 18)	Model 17 - 4.5	Model 3 - 1.72
Asian (n = 6)	Model 5 - 4.83	Model 3 - 1.67
Hispanic or Latino (n = 15)	Models 8 and 17 - 4.53	Model 3 - 1.73
Black or African-American (n = 6)	Model 10 - 4.8	Model 3 - 2
White (n = 4)	Models 10 and 17 - 4.8	Model 3 - 1.3
Two or more races (n = 1)	-	-
18-20 (n = 5)	Models 11 and 17 - 4.8	Model 3 - 1.8
21-29 (n = 21)	Model 8 - 4.57	Model 3 - 1.81
30-39 (n = 4)	Models 16 and 17 - 4.5	Model 3 - 2.26
50-59 (n = 2)	Model 10 - 5	Model 3 - 1

Table 3: Results by Demographics - Q2

Demographics	Highest likability average - Q2	Lowest likability average - Q2
Men (n = 14)	Model 17 - 4.58	Model 3 - 2.43
Women (n = 18)	Models 8 and 17 - 4.5	Model 3 - 1.67
Asian (n = 6)	Model 8 - 5	Model 3 - 2.67
Hispanic or Latino (n = 15)	Model 17 - 4.47	Model 3 - 1.73
Black or African-American (n = 6)	Model 5 - 5	Model 3 - 2
White (n = 4)	Model 17 - 4.75	Model 3 - 1.25
Two or more races (n = 1)	-	-
18-20 (n = 5)	Model 11- 4.8	Model 3 - 2.8
21-29 (n = 21)	Model 8 - 4.62	Model 3 - 1.76
30-39 (n = 4)	Models 12 and 16 - 4.5	Model 3 - 2.75
50-59 (n = 2)	Model 17 - 5	Model 3 - 1

Table 4: Results by Demographics - Ranking

Demographics	Highest ranked model	Lowest ranked model
Men (n = 14)	Model 17 - six votes (42.9%)	Models 3 and 17 - four votes each (26.7% each)
Women (n = 18)	Model 17 - twelve votes (66.7%)	Models 1 and 3 - eight votes each (22.2%)
Asian (n = 6)	Model 17 - three votes (50%)	Model 3 - three votes (50%)
Hispanic or Latino (n = 15)	Model 17 - nine votes (60%)	Model 1 - seven votes (46.7%)
Black or African-American (n = 6)	Model 17 - four votes (66.7%)	Model 3 - four votes (66.7%)
White (n = 4)	Model 17 - two votes (50%)	Model 3 - four votes (100%)
Two or more races (n = 1)	Model 2 - one vote (100%)	Model 17 - one vote (100%)
18-20 (n = 5)	Models 1 and 17 - two votes each (40% each)	Model 3 - three votes (60%)
21-29 (n = 21)	Model 17 - twelve votes (57.1%)	Models 1 and 3 - seven votes each (33.3% each)
30-39 (n = 4)	Model 17 - two votes (50%)	Model 17 - two votes (50%)
50-59 (n = 2)	Model 17 - two votes (100%)	Model 3 - two votes (100%)

dimensions, which is something future researchers must consider in the design process.

5.1 Limitations and Future Work

While this study centered upon representing structural racism in a novel way, several limitations must be considered when analyzing this paper. This study is built upon a small sample size of 33 participants, given its format as an online questionnaire. The survey structure itself may have also formed limitations, due to the phrasing of the survey context and questions, the interpretation of the models' descriptions, and the arduous ranking question, which some respondents claimed it to be a complicated procedure in the feedback section. This study was solely focused on exploring perceptions of structural racism visualization in 3D with limited models; by no means are these visualizations exhaustive, nor is this specific study generalizable. The models completed for the purposes of this study only visualized housing valuation. Future work would have to capture other dimensions of what composes a community, such as the climate, access to greenspace, healthcare, education funding, etc., and visualize their potential relationship to structural racism using 3D tools as well. One element of the models created for this study include visualizing the price and presence of condominiums in the respective neighborhoods because of condominimums' correlation with income, education, and racial identities of inhabitants [1]; future work will include data and visualization of other property types in a community, such as single and multi family homes, apartments, and other residential and commercial properties that affect the valuation of neighborhoods. Future work may also consider expanding maps from limited case studies to municipal, city, or even federal representations of communities to potentially capture structural racism' influence on these groups.

6 CONCLUSION

Our study attempted to observe what possible perceptions do people glean from analyzing different 3D models of two neighborhoods in the Bronx under the lens of housing valuation and redlining. We conclude that people generally respond favorably to congruent multiple dimensions of visualizations, such as the physical depiction of a red line, racial demographic data, and scaling and coloring properties based on certain data parameters. Future work must consider utilizing more data in terms of housing valuation and other elements of communities to flesh out neighborhood models and to control for conclusions concerning race. We hope that this project brings awareness of what potential good may come of combining narrative storytelling and data in a 3D format to discuss topics revolving around structural racism.

ACKNOWLEDGMENTS

This work was supported in part by a grant from the National Science Foundation, Research Experience for Undergraduates program (Award No. 2050532, Principal Investigator - Oyewole Oyekoya). The authors would also like to thank Kwame Agyemang Baffour for his invaluable technical support throughout the course of this work.

REFERENCES

[1] Leah Platt Boustan, Robert A Margo, Matthew M Miller, James M Reeves, and Justin P Steil. 2019. *Does Condominium Development Lead to Gentrification?* Technical Report. National Bureau of Economic Research.

[2] Bennett Callaghan, Leilah Harouni, Cydney H Dupree, Michael W Kraus, and Jennifer A Richeson. 2021. Testing the efficacy of three informational interventions for reducing misperceptions of the Black–White wealth gap. *Proceedings of the National Academy of Sciences* 118, 38 (2021), e2108875118.

[3] A Mechele Dickerson. 2020. Systemic racism and housing. *Emory LJ* 70 (2020), 1535.

[4] Jeremy S Hoffman, Vivek Shandas, and Nicholas Pendleton. 2020. The effects of historical housing policies on resident exposure to intra-urban heat: a study of 108 US urban areas. *Climate* 8, 1 (2020), 12.

[5] Dany Laksono and Trias Aditya. 2019. Utilizing a game engine for interactive 3D topographic data visualization. *ISPRS International Journal of Geo-Information* 8, 8 (2019), 361.

[6] Emily E Lynch, Lorraine Halinka Malcoe, Sarah E Laurent, Jason Richardson, Bruce C Mitchell, and Helen CS Meier. 2021. The legacy of structural racism: associations between historic redlining, current mortgage lending, and health. *SSM-population health* 14 (2021), 100793.

[7] Darren Migita, Andrew Cooper, Dwight Barry, Brendan Bettinger, Alicia Tieder, and Paul J Sharek. 2023. Equity Dashboards: Data Visualizations for Assessing Inequities in a Hospital Setting. *Pediatrics* 151, 3 (2023), e2022058848.

[8] Bruce Mitchell and Juan Franco. 2018. HOLC "redlining" maps: The persistent structure of segregation and economic inequality » NCRC — ncrc.org. https://ncrc.org/holc/. [Accessed 14-Jun-2023].

[9] Anthony Nardone, Kara E Rudolph, Rachel Morello-Frosch, and Joan A Casey. 2021. Redlines and greenspace: the relationship between historical redlining and

2010 greenspace across the United States. *Environmental health perspectives* 129, 1 (2021), 017006.

[10] Robert K Nelson, LaDale Winling, Richard Marciano, Nathan Connolly, and Edward L Ayers. 2020. Mapping inequality: Redlining in new deal America. *American Panorama: An Atlas of United States History. University of Richmond: Digital Scholarship Lab* 17 (2020), 19.

[11] Maria Newman. 1992. CLASON POINT GARDENS JOURNAL; For 50 Years a Home, a Real Home. *The New York Times* (1992).

[12] Andrew M. Perry, Jonathan Rothwell, and David Harshbarger. 2018. The devaluation of assets in Black neighborhoods — brookings.edu. https://www.brookings.edu/research/devaluation-of-assets-in-black-neighborhoods/. [Accessed 14-Jun-2023].

[13] Brad Plumer, Nadja Popovich, and Brian Palmer. 2020. How decades of racist housing policy left neighborhoods sweltering. *The New York Times* 24, 08 (2020).

[14] Christopher J Schell, Karen Dyson, Tracy L Fuentes, Simone Des Roches, Nyeema C Harris, Danica Sterud Miller, Cleo A Woelfle-Erskine, and Max R Lambert. 2020. The ecological and evolutionary consequences of systemic racism in urban environments. *Science* 369, 6510 (2020), eaay4497.

[15] Danyelle Solomon, Connor Maxwell, and Abril Castro. 2019. Systemic inequality: Displacement, exclusion, and segregation. *Center for American Progress* 7 (2019).

[16] Margery Austin Turner, Diane K. Levy, Douglas A. Wissoker, Claudia L. Aranda, Rob Pitingolo, and Robert Santos. 2013. Housing Discrimination against Racial and Ethnic Minorities 2012: Executive Summary | Policy Commons — policycommons.net. https://policycommons.net/artifacts/633118/housing-discrimination-against-racial-and-ethnic-minorities-2012/1614410/. [Accessed 15-Jun-2023].

[17] Philip Q Yang and Kavitha Koshy. 2016. The "becoming white thesis" revisited. *The Journal of Public and Professional Sociology* 8, 1 (2016), 1.