

Mapping city-wide perceptions of neighbourhood quality using street view images: a methodological toolkit

Emily Muller¹, Emily Gemmell², Ishmam Choudhury², Seth Flaxman³, Emily Dentone⁴, Majid Ezzati¹

¹ Department of Epidemiology and Biostatistics, MRC Centre for Environment and Health, Imperial College London, London, UK; ² School of Population and Public Health, Faculty of Medicine, University of British Columbia, Vancouver, BC, CA; ³ Oxford University, UK; ⁴ Google AI Ethics, NY, USA.

Contact: emily.muller@imperial.ac.uk



Background

How individuals interact with city neighbourhoods is, in part, determined by the perceived quality of the urban environment¹. Beyond the beauty aesthetic, neighbourhood quality is a core component of urban vitality, influencing the development of social cohesion, sense of community, physical activity and mental health of residents². Large-scale assessment of perceptions of neighbourhood quality was pioneered in 2016 by the MIT's Place Pulse 2.0. project³. Researchers demonstrated the efficacy of crowd-sourcing perception ratings, training a model on user ratings of image pairs. However, variation across cities may limit the usefulness of this tool for assessing nuanced within-city perceptions.

Objective

We set forth a protocol for city-specific urban perception collection using the exemplar question 'On which street would you prefer to walk?'. We test our method in London and examine group differences.

Methods

- Pairwise images were hosted on our website www.pulselondon.co.uk (Fig 1) and shown to over 200 users to rate their preference (Table 1). We collected ratings from personal networks and supplemented data using Amazon Mechanical Turk. We examine user differences in rating.
- Images were scored using Microsoft Trueskill algorithm.
- Scores were used to finetune a CNN (Fig 2) to predict scores on unseen dataset and mapped across the city (Fig 3).

Results

1. Successfully built and deployed app with code available on Github⁴ (Fig 1).
2. Low test accuracy compared to Place Pulse perceptions (Table 2) which appears to be related to games multiplier.
3. Multi-level models with random effects for games and fixed coefficients to test group differences: London/non-London, gender, low-activity/high-activity shows no significant difference between gender and games with significant differences for London and high-activity (Fig 4).

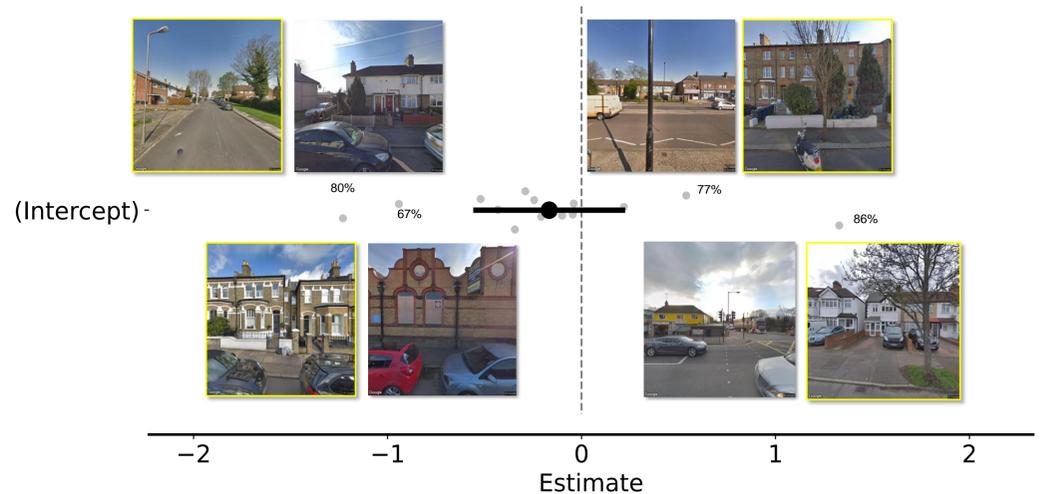


Figure 1. Web deployment architecture.

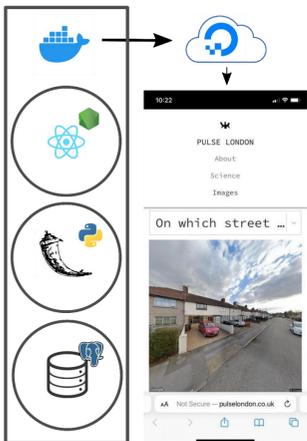


Table 1. Basic descriptives from survey data collection.

Pulse London Database	
Images in database	25,154
Pairwise ratings	37,966
Not comparable	1,079
Not shown	5,842
One-sided clicks	3,379
Duplicate choices	1,241
Usable games	25,987
Users	207 (180 demographic)
Images per user	132 mean
Repeated Games (>10)	14 games, 60 plays
Repeated games agreeability	62%

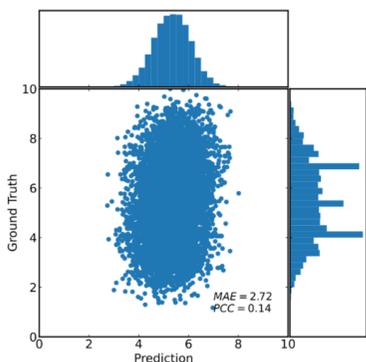


Figure 2. Scatterplot of test predictions from trained Resnet18 CNN model.

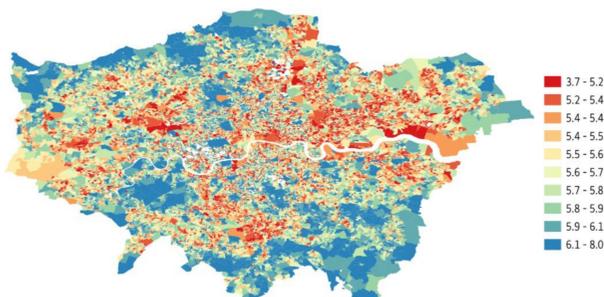


Figure 3. Deciles of average walkability prediction scores in London Output Areas.

Figure 3. Baseline random effects from multilevel model with no group coefficients. Left most game is game 3111 and right most game is 919.

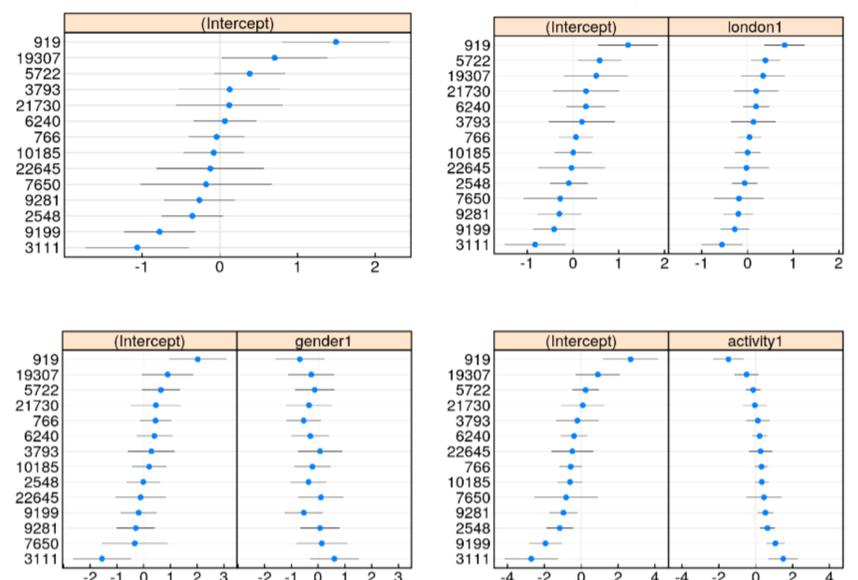


Figure 4. Multilevel model random effects and confidence intervals for games conditional on groups.

Conclusions

- i) Web-based survey design can be used to map findings at the city scale to propose regions of regeneration for urban public health.
- ii) Games multiplier threshold must be satisfied to reduce error.

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References [1] Gebel et al. 2009, [2] Jacobs 1961, [3] Dubey et al. 2016, [4] github.com/emilymuller1991/urban-perceptions.

Perception	Safety	Lively	Depressing	Boring	Beauty	Wealth	Walkability
Games Multiplier	4.65	3.34	2.01	1.59	1.36	1.31	1.03
MSE test	1.10	1.40	1.82	1.89	1.87	1.92	2.72
Mean σ TrueSkill	3.43	3.95	4.95	5.45	5.71	5.73	6.00
Pearsons Correlation	0.44	0.37	0.24	0.16	0.32	0.39	0.14

Table 2. Relationship between test error and Games Multiplier=No. Images/No. Games