Poster abstract: My street is better than your street: Towards data-driven urban planning with visual perception

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Abstract

Understanding people's preferences and needs is crucial for decision making in urban planning. However, studies have yet to analyze and quantify the influence of demographic factors and perception differences between countries. In this work, we explore the introduction of demographic questions, specifically age groups and the Big Five personality traits, in visual urban perception field experiments to assess the difference perception score in six dimensions – safe, lively, boring, depressing, wealthy, and beautiful – within demographic subgroups and between two countries. We found significant (p-value < 0.05) differences in perception scores in all six dimensions at the country level (conscientious and neurotic groups in Singapore and the US) and at the population level (age groups over both countries). This preliminary results set the stage to bigger and broader experiments.

CCS Concepts

• **Social and professional topics** → **User characteristics**; • **Human-centered computing** → *Collaborative and social computing*; • **Computing methodologies** → Computer vision;

Keywords

street view imagery, computer vision, human-centric, urban planning

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1 Introduction

As cities grow and become denser, studies are focusing on more human-centric evaluations through visual perception to understand people's preferences and needs [5]. This information is crucial for decision making in urban planning and in turn addresses relevant problems such as the effect of Urban Heat Island (UHI) [2] and data availability for buildings [6]. Despite the relevance of contextual preferences, these studies have yet to analyze and quantify the influence of demographic factors on perception [1]. In this poster, we propose the inclusion of demographic factors, starting with age groups and Big Five personality traits, when collecting human perception data on street view imagery. We show that visual perception scores, on six commonly used dimensions in the literature, are significantly different (p-value < 0.05) within personality subgroups and between cities. A preliminary data collection experiment is conducted in Singapore and San Francisco using the publicly available Global Streetscapes [4], the largest street view imagery dataset.

2 Data collection

Image and city selection: Singapore and San Francisco (US) were chosen as representatives of highly dense cities on opposite sides of the world. Street view images (SVI) within 2.4 km^2 of the city center were chosen and using the contextual metadata available in the dataset [4], only images with good quality, no reflection, non-panoramic, captured in clear weather, and taken during the day with front or back view direction were selected. We arbitrarily chose 80 as the number of images to sample for each city. Figure 1 shows an image of Singapore with the calculated perception scores. These images were shown to participants in a pairwise setting with a question *"which places looks more **indicator**"*, where ***indicator*** is one of the six indicators used in related work: safe, lively, boring, depressing, wealthy, and beautiful [1]. Participants were able to choose the left image, right image, or an option for "equally rated".

Human-perception survey: The survey was reviewed and approved by the Institutional Review Board (IRB) of our university

Figure 1: One of the 80 Street view images (SVI), from Singapore, obtained from the Global Streetscapes dataset [4] through Mapillary. Perception scores, calculated using the TrueSkill score algorithm, are shown for each of of the six indicators.

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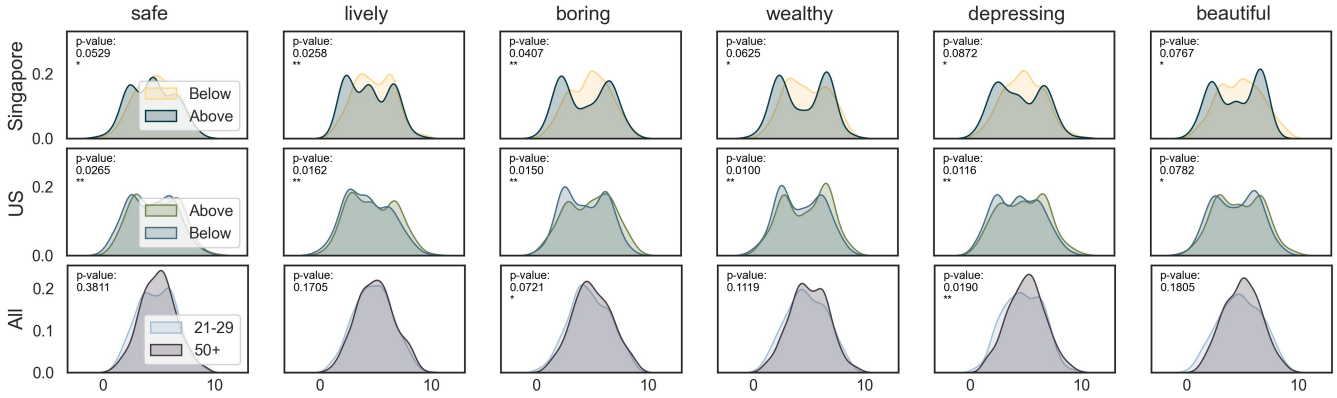

Figure 2: Comparison of two-sample independent t-test for equal means for each indicator (columns), in all and in each country (rows), by different demographic subgroups (colored distributions). Conscientiousness, neuroticism, and age groups are shown in the top, middle, and bottom rows, respectively. Significance thresholds $^{*}p < 0.1$, $^{**}p < 0.05$.

and the participants were financially compensated. It was implemented on an online platform and distributed by a local market research vendor. Participants were asked to choose their age group (i.e., 21-29, 30-39, 40-49, and Above 50) and answer a 10-item short version of the Big Five Inventory (BFI-10) [3]. A total of 104 participants from Singapore and 103 participants were recruited from San Francisco and Santa Clara. Each participant was shown 50 unique pairwise comparison questions in all six indicators.

3 Preliminary results

Across all of the six indicators, an image was rated on average 5.2 times (min. 1, max. 16). The numerical perception scores are calculated using the TrueSkill score algorithm, as similar as in [1] and scaled between $[0, 10]$. We performed independent two-sample t-tests to assess whether demographic subgroups significantly influence perception scores. Demographic subgroups are created based on age groups, 21-29 and 50+, and their five personality scores, groups with above or below the median score. Perception scores were calculated within each of these subsets and subgroups. Figure 2 shows the distribution of the scores for the six indicators (columns); for all participants, participants from Singapore, and the US (rows); for the different demographic subgroups (colored). In most comparisons, the equal means hypothesis is rejected with different degrees of significance. Country differences are seen in positive traits (conscientiousness in Singapore, top row) and negative traits (neuroticism in the US, middle row) in all dimensions. We hypothesize that cultural background and social dynamics may be behind these differences, as these traits have been found to impact thermal comfort in participants from the same location [7]. Lower and higher age groups, 21-29 and 50+, respectively, differ in negative indicators such as boring and depressing (bottom row).

4 Conclusions and discussion

These preliminary findings motivate further exploration of demographic questions and a wider scope on the countries chosen for data collection. Understanding people's preferences has the potential to improve context-based urban solutions and foster equality in urban planning decisions such as neighborhood retrofitting and enhancements of public spaces. We plan to leverage advanced tools such as Large Language Models (LLMs) to aid in scalability and reach of our data collection, as well as compare outputs of language models and computer vision models, against human preferences. Future work will consider doubling the number of participants and adding cities from the remaining continents such as Europe, Africa, and South America. These cities will overlap with those covered in existing work [1] for further comparisons. In addition, additional demographic questions such as education level, gender, and income level will be added to further analyze different population subgroups. We plan to release the dataset openly after implementing the above extensions.

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