Customising Urban Joy: Urban planning mechanisms for the mass - customisation of cities, through the quantifiable nature of joy using geo-tagged social media data.

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Abstract. The paper examines citizen participation in a digitally-driven society and the disparity between desired and existing cities. It emphasises the need to transform cities into adaptable environments that respond to the needs of residents. Traditional top-down urban planning often fails to match the flexible nature of digitised urban residents. To address this, an agent-based model is employed, evaluating urban environments based on individual sentiment derived from social media API. The study case of Wittenberge, Germany, showcases the methodology, including the creation of a 3D digital twin using open data sources and generating agents with unique personalities from social media keywords. These agents' "life satisfaction score" reflects their ability to fulfil daily needs and preferences within a 20-minute walking radius.

Keywords: Data-based urban design, Citizen participation, Agent-based modelling, Social media sentiment analysis, Co-creation in cities.

1. Introduction

Digital technologies were integrated into urban design under the premise of efficiency, sustainability, and improved liveability (Kitchin et, al., 2015). This amalgamation involved the implementation of data-driven decision-making models into urban infrastructure, such as transportation networks, energy systems and water supply. (Caragliu et, al., 2009) In the quest for data-based urbanism, a second realm of data sources lies within behavioural and emotional metrics. These include motives and decision-making patterns; preferences, needs and desires; and personality and temperament.

The notion of predicting personality through openly available social media data has already been outlined in 2011 by Golbeck, Robles and Turner. The researchers introduced an approach that enabled the prediction of a user's temperament based on the publicly accessible data from their Facebook profile, eliminating the necessity for self-reported personality assessments. (Golbeck et, al., 2011). Social media activity, such as Facebook "likes", can also be dissected as representations of personal attributes, including age, ethnicity, gender, personality traits, overall life satisfaction, religious and political views and even intelligence. (Kosinski, et, al., 2013)

This method has not yet been applied to the optimisation of urban planning processes. While acknowledging the risks posed to society and democracy by past precedents, as discussed later in the paper, the utilisation of social media content for systemised urban analysis is presented here as a theoretical and academic thought experiment. Its implementation and further research should be approached with utmost discernment, accountability, and media literacy.

The application of data harvesting technologies in urban environments is reconfiguring existing governance systems and opening up the opportunity for new tactics to emerge. (Karvonen et, al., 2018) Viewed as a part of a larger shift toward digital geography (Ash et, al., 2016), this development introduces questions about the role citizen participation processes play in urban decision-making practices. (Carr, 2021) Placed in the debate between collaboration and inclusivity on one end, and concentration of data and power on the other, the integration of existing “smart city” technologies is raising concerns about the loss of control over urban spaces (Sadowski, 2020).

Furthermore, existing models of citizen participation fail to reach a critical mass, excluding marginalised and underprivileged groups and tend to address preconceived markers of a “quality of life”; thus failing to generate substantial discussion and collaborative dialogue. (Innes, 2004) Digital democracy and urban governance attempts and developments have been limited, and existing models have focused on the delivery of information to the citizens rather than on the development of two-way participation channels. Additionally, unequal accessibility and digital literacy gaps have further hindered the adoption of existing solutions. Furthermore, relying on formal participation structures, such as public meetings and communication through official channels in the local language excludes citizen groups through inaccessibility (Montgomery, 2013) and barriers of time, space and linguistic proficiency.

2. Methodology

The integration of human decision-making patterns into algorithmic derivatives through personification and personalisation holds the potential to serve as a means to engage communities typically absent or excluded from conventional citizen participation systems. Additionally, this mode of data gathering and analysis enhances efficiency, (Park et, al., 2014; Markovikj et, al., 2013) equity, and fairness in the decision-making process by equally incorporating all participants into the funnel of data analysis (or at least, all active on social media).

Social media language use becomes a tool to predict individual well-being and life satisfaction through lexicon-based happiness models (Schwartz et, al., 2016, Schwartz et, al., 2015; Golbeck et, al., 2011), a method that has been cited as reliable in its accuracy. (Wu et, al., 2015). Other models have examined colour, composition and image type crossed with demographic information to deduct personality from social media profile images (Leqi Liu et, al., 2016; Guntuku et, al., 2015; Ferwerda et, al., 2016).

2.1. Study case and context

The study case for this research is Wittenberge, Germany. As of December 31st, 2022, Wittenberge, a town located in the Prignitz district of Brandenburg, Germany, is home to a population of 16,837. It occupies a strategic position on the northeastern bank of the Elbe River, halfway between Hamburg and Berlin and has a rich history dating back to medieval times. The city experienced continuous development and growth, especially after becoming the site of the Singer sewing machine factory in 1903. However, following the reunification of East and West Germany in 1990 [Figure 1], the population witnessed a substantial decline, and without significant modifications to the urban landscape of Wittenberge, further population decrease is anticipated [Figure 2].

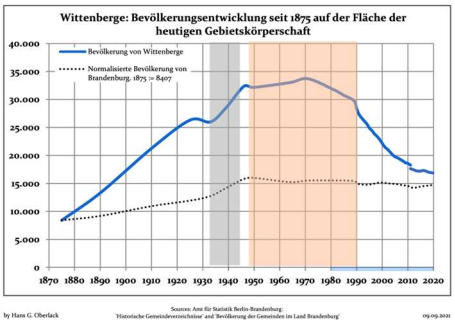

Figure 1. Population in the state of Brandenburg, Hans G. Oberlack, Amt für Statistik Berlin-Brandenburg, 09.09.2021

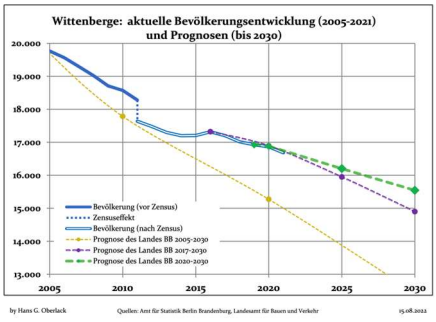

Figure 2. Current population trends (2005-2021) and forecasts (until 2030), Hans G. Oberlack, Amt für Statistik Berlin-Brandenburg, 15.08.2022

2.2. Spatial data: collection and analysis

Information from GIS layers and Open Street Maps metadata was gathered and clustered to analyse the study case. The entire municipal area, which is relatively small, underwent a thorough examination, offering a broad view of the urban fabric. The spatial data collected was subsequently sorted and grouped according to its specific metadata. In the course of the study, a dataset consisting of 3901 building curves was extracted, containing diverse types of structures, including residential, public, and commercial buildings (further termed as "amenities"). Additionally, 603 curves that represented various transportation features were incorporated, such as highways, roads, and pedestrian paths. They were further categorised based on their characteristics, distinguishing between pedestrian paths exclusively designated for walking,

roads equipped with bicycle paths or lanes, bus lanes, and inner-city roads with

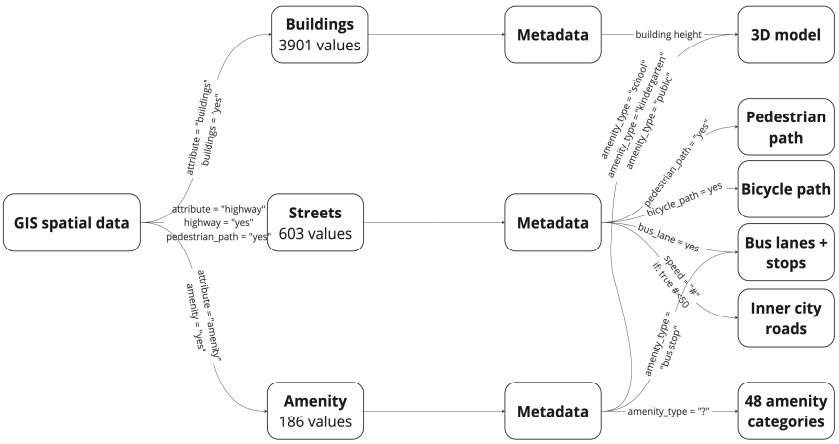

Figure 2. Spatial data import funnel. Julia Barsch kov, 2023

a prescribed maximum speed limit of 50 km per hour or lower [Figure 3].

In order to assess the ability of the existing state of the city to provide its residents with access to their daily needs, the model was analysed for connectivity. The metric was evaluated by computing the shortest path between each building, considered as origin points, and all amenities, functioning as destination points. The frequency with which each street curve was travelled within the sum of these shortest paths provided valuable insights into the connectivity of the respective streets (Freeman, 1977) [Figure 4].

To personalise the urban model and capture the interactions of diverse focus groups with the urban environment, data from the Instagram API was collected, containing 100 posts dated November 2021, all of which were geo-tagged to Wittenberge, Germany. The analysis of the retrieved posts was conducted in three distinct layers. Firstly, the geographical locations of the 100 posts were extracted as latitude and longitude values and subsequently marked as points on the model. The second layer involved image analysis, which was performed at a later stage. Lastly, the third layer encompassed the analysis of the captions, divided into two components: the text and hashtags. Both text and hashtags underwent sentiment lexicon analysis, scanning for emotion-indicating words.

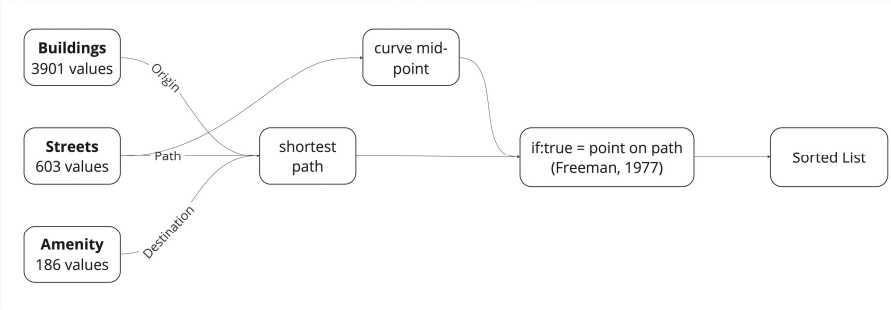

Figure 4. Connectivity analysis. Julia Barsahkov, 2023

The sentiment lexicon analysis categorised words into three emotional values: green for positive sentiments (e.g., "love," "optimistic," "beautiful"), orange for neutrality or a desire for change (e.g., "need," "should," "other"), and red for undesirable locations with a negative reputation (e.g., "hate," "ugly"). These emotional values were then associated with the respective points on the model, generating a "sentiment map" that exhibits weighted locations and roads. Points with green values were assigned a positive weight of 'plus 1', while those with red values received a negative weight of 'minus 1'. Orange values, on the other hand, retained their original state without any weight adjustment. [Figure 5]

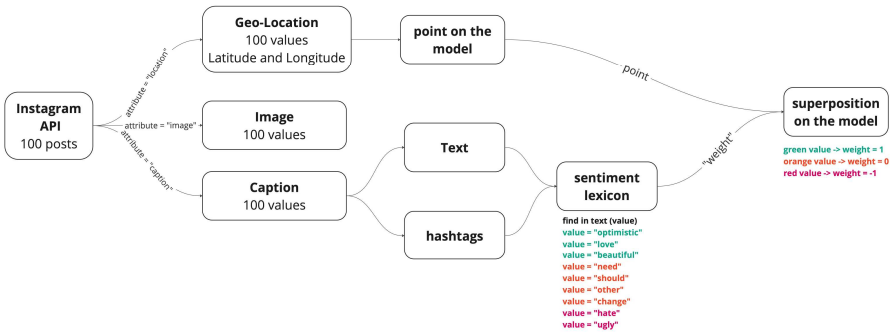

Figure 5. Instagram API sentiment analysis and the creation of a sentiment map. Julia Barsahkov, 2023

For the agent-based simulation, the formation of urban agents involved a superposition of three data sources. These urban agents were constructed by

superposing Instagram images, account data (age groups derived from the birth date assigned to accounts), and crucial insights obtained from informal interviews conducted with city officials[1]. The insights gathered from municipal officials indicated four distinct target groups that the city of Wittenberge aimed to cater to through its urban regeneration efforts.

The target population in the study comprised three main sectors within the existing population: teenagers facing limited self-development, employment opportunities, and cultural enrichment; young adults and young parents returning to their hometown after having children; and former employees of the closed Singer factory experiencing challenges in finding meaningful employment, relying on unemployment benefits and retirement payments. Additionally, city officials introduced a target group for incoming residents, including educated and employed young adults and young families in high-skilled positions.

The collected Instagram posts were segregated into distinctive age groups, aligning with the four age categories specified by the city officials. Subsequently, within each age group, the Instagram post images were reviewed to determine the relevance of the content or activities, corresponding to the 48 identified amenities situated within the city. For instance, the activity cluster associated with a coffee shop included Instagram images depicting various elements such as coffee cups, coffee beans, coffee tables, cakes, cookies, desserts, and takeaway cups.

The frequency of appearance of each activity within the Instagram posts for every age group served as an indicative measure of the importance accorded to these activities by the agents. This significance was quantified on a percentage scale, ranging from zero to 100%. A value of zero signified that no images of the activity cluster were captured by users belonging to the targeted age group, while a 100 rating implied that all images featuring the activity cluster were exclusively captured by members of the designated age group. This systematic approach enabled a comprehensive assessment of the agents' preferences and interests with respect to specific amenities available in the city.

3. Results

This study explores the integration of subjective elements into agent-based modelling (ABM) simulations, which are commonly utilised for calculating

[1] informal interview conducted with Christian Fenske, the former chair of the Construction and Economic Development Committee of the City of Wittenberge, conducted on the 8th November 2021.

optimal routes between locations. To achieve this, "preference maps" are incorporated into ABM simulations, assigning specific attributes of the urban environment with greater values indicating their desirability. As a result, agents within the model are programmed to prioritise routes with higher rankings, even if they are longer or less direct. This approach is recognised for its efficacy in enhancing the model's precision when predicting human behaviour and decision-making tendencies (Kaviari et al., 2016).

In the context of this study case, the agents embarked on trips lasting up to 10 minutes in each direction. To ensure accuracy, the average walking speed of a male adult, estimated at 1.15 m/s while carrying baggage, was taken into account (Mohamad et al., 2018).

The development of the pedestrian movement model aimed to comprehend and analyse the interaction with and navigation of the urban environment by the population group represented by the agents. The walkability metric, an essential aspect of the model, determined the movement patterns of the agents. This metric took into account factors such as the proximity of different locations, their accessibility for pedestrians, and the connectivity of the urban network; thus incorporating the results of the spatial analysis.

To further enhance the model's complexity, preferences were assigned to different areas within the urban environment, in relation to each agent. These preferences influenced the agents' decision-making, as certain areas were given higher priority over others, in an attempt to mimic the subconscious decisions humans make when way-finding in an urban setting. (Picard, 1997)

Enhancing the previously established model, a second set of weighted points was introduced to accommodate the distinct preferences of each individual agent. The previously ranked amenities were subsequently translated into weighted points on the sentiment map, maintaining their significance with a weight value of 2. As a consequence, these personalised preferences of the agents were given heightened importance, surpassing the average overall city-level perception.

A second pedestrian movement model was executed. In this iteration, the origin points remained consistent, comprising all buildings within the model, and the paths continued to represent all streets. However, the destination points were redefined. They now encompassed a fusion of two key components: firstly, the weighted points extracted from the comprehensive citywide sentiment map, which depicted the collective urban perception of diverse areas; and secondly, the ranked amenities reflecting the unique preferences of each agent.

Subsequently, the outcome of this analysis diverged from the pursuit of the shortest path. Instead, it pursued a different trajectory - the "joyful path," reflecting a route that not only catered to spatial proximity but also resonated with the personal enjoyment and contentment of the agents. By factoring in the weighted preferences of each agent, this approach sought to foster an urban environment that evoked positive emotions and catered to the distinctive desires of the individual residents. [Figure 6]

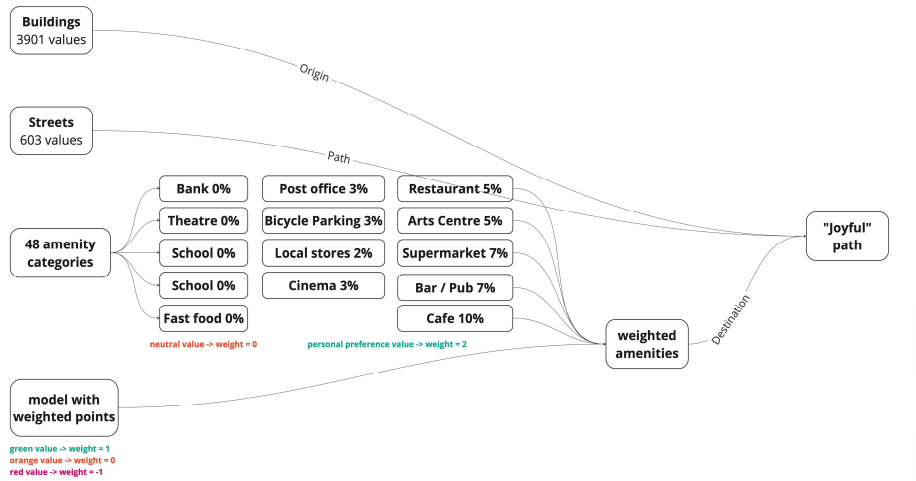

Figure 6 "Joyful path" - Julia Rorsch©, 2023

According to the simulation results, the agents representing the population the city aims to attract had several choices available to them within their designated area. They had access to 28 dining establishments, one option for nightlife, 32 local shopping choices, and 8 social, public, or cultural facilities to visit. However, when running the second pedestrian model, the agents were able to meet only 20.15% of their daily needs. This score indicates that a substantial portion of their needs remains unmet within the 20-minute walking radius for a round trip.

4. Discussion

4.1. Relevancy

Creating joyful urban experiences is crucial for developing vibrant, liveable, and sustainable cities. Previous research has identified spatial guidelines that

contribute to emotional well-being in urban environments. For example, Yang et al. (2023) found that open and visually appealing spaces surrounding subway stations in Nanjing, China, enhanced emotional well-being in an otherwise congested environment. Similarly, van der Berg et al. (2010) demonstrated that green spaces within walking distance of homes mitigated the negative effects of stressful life events on health. Incorporating strategies that promote joy and well-being can lead to more resilient and healthier urban environments.

Additionally, involving the community in planning and using evidence-based urban policies can foster positive social interactions and a sense of belonging (Carr, 1993), thus engaging local communities in the outcomes of urban regeneration processes in their area, and ensuring that the proposed plans alight with the actual needs of the population. Emphasising data-driven approaches further accentuates the importance of informed decision-making to enhance subjective well-being in urban contexts (Mouratidis, 2021). By adopting these strategies, urban planners and designers can create thriving and inclusive communities.

4.2. Biases and disclaimers

Information from GIS layers and Open Street Maps metadata was gathere

In a society that heavily emphasises self-representation (Debord, 1961), social media users forfeit privacy for the sake of extensive personal disclosures. (Johnson, 2010) Thus, rendering themselves as human data sets the behaviour of which can be analysed and anticipated, even decisions they haven't made yet. This targeting, currently employed by Facebook, can be weaponized, leading to potential concerns around privacy and political influence (Biddle,2018; Zuiderveen Borgesius et, al., 2018). Algorithmic transparency is therefore always required when dealing with prediction models.

Precedents of the misuse of behavioural and personality data can be found in the skewing of the 2016 US elections by Cambridge Analytica and the "Brexit" campaign in the UK. Cambridge Analytica's parent company, Strategic Communication Laboratories Group, has a history of behaviour analysis and influence campaigns (Confessore and Hakim, 2017) indicating the potential risks associated with implementing a similar model in an urban context. These precedents highlight the need for careful consideration and examination of the implications before adopting such data-driven approaches in real-life urban settings.

Securing a fair and unbiased application of the model depends significantly on the ownership of its outcomes. Ideally, given that social media content is generated and uploaded by individuals, they should retain rights over the analysis results derived from that content. Drawing upon Picard's philosophy in "Affective Computing" (1997), the agent-based model's results would rightfully

belong to each individual who served as an inspiration for an agent, thereby informing decision-making processes in scenarios involving urban participation.

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