Understanding and Analyzing the Characteristics of the Third Place in Urban Design: A Methodology for Discrete and Continuous Data in Environmental Design

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Abstract. With a rapid development of data-driven technologies, many opportunities have arisen to understand and characterize urban contexts. This paper addresses the methodology to understand a place in urban settings through the lens of third places and motility based on the walkable distance. To capture and process third-place data, fetched from Google Places, based on a given location, this paper discuses two data structures and process of discrete and continuous data. Representation of third places in a specific location of a city is characterized by representative queries. Its identified chart as a perspective of understanding a designated area could compare with other charts in different places. This method allows us to distinguish the constitution of third places based on the distance among places, enabling us to develop design strategies to differentiate or accord the sites based on mobility. The goal is to set up a method to process, interpolate, and visualize discrete and continuous urban data with representative queries of third places based on distance.

Keywords: Third place · Visualization · Continuous data · Discrete data

1 Background

Third place refers to the social environments between the two usual surroundings of the home as a first place and the workplace as second place. These places or settings such as cafes, clubs, parks, libraries, or restaurants, where we spend our daily life except for the first and second places. The diversity and density of the third place could become a barometer to characterize a place. According to the book "The third place", an engagement location, is where people consider it as a measurement of their sense of distinctiveness and wholeness. Third places are considered as sociability and nondiscursive symbolism. The benefits of third-place involvement are discussed regarding diversity and novelty, emotional expressiveness, color, and perspective. This means that the third-place shows a section of a city in many ways.

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Energy is an essential resource in modern societies. Every major city on the earth consumes diverse types of energy, such as fossil fuel or electrical energy at the expense of our environment. Climate change has become a more critical issue in modern societies. However, in everyday life, we need a certain amount of energy to guarantee our experience. Among the significant energy consumption in cities, transportation is a significant issue and could be reduced, for instance: Fig. 1.

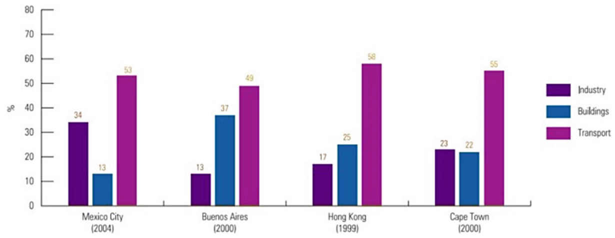

Fig. 1. Energy consumption in selected cities in middle-income countries

The urban population is more significant than rural areas, and the population increases the consumption of energy for transportation, Fig. 2. However, the energy use for transportations per person in a low density is higher than urbanized cities with high density because citizens need to use transportation to access third places in their daily life.

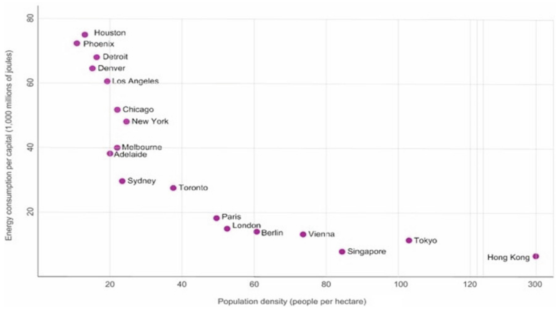

Fig. 2. Population density and energy consumption, selected World cities

The distribution of third place could be reflections from the population, sustainability, energy consumption, history, life, or style of a city. A certain place in a city could be a different setting from a place to the same city with zooming in. Even we could know the sequences of the differences between two particular points in the same cities based on the walkable distance. This lens is useful for understanding the context of an urban scale and characterizes the relationship at the architectural level.

Third place and walkable distance provides an important insight into accessible and energy for transportation in a city. Throughout the comparison among analyses in different urban settings, it becomes possible to adding removing and relocating third places in the city.

This paper discusses the mobility energy and third place which are considered as numerical data in the urban context and furthermore computes them to find a better solution of recognizing and distinguishing a position in an urban setting. With the measuring system of walkable distance, urban contexts would be reconsidered with the lens of third place.

2 Methodology

2.1 Data and Data Structure for Manipulation

The research methodology consists of two parts: 1. Data manipulation and tool making 2. Data structure for manipulation.

The workflow was developed in a custom component in Grasshopper of Rhino3d: Fig. 3. Google Places API was used to parse the third places in Cambridge, Massachusetts.

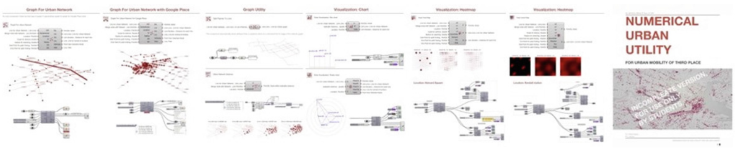

Fig. 3. Numerical Urban Analysis tool

The data structure for manipulation is unlike the well-known data array such SQL (Structured Query Language) as Tabular matrix-like CSV (Comma Separated Values), TSV (Tab Separated Values), or such NoSQL (No Structured Query Language) as JSON (JavaScript Object Notation) or graph structure. A data structure should be interactive and computable with its data sets and neighbors, children or connected data sets as efficient as possible to process more complex data.

There are two data structures for the experiment: (1) pixel and (2) graph data structure where individual data are populated and calculated. Pixel data structure is a two-dimensional matrix, interpolating a position data of an urban or district into continuous data as a finite setting for analysis, in which each pixel has the relationship with its neighbors, and each one computes its data based on neighbors' settings so that urban data can be naturally addressed and computed in the spatial context. Graph data structures enable the compute of discrete information such as distances from a particular place to third places to capture distance-based spatial urban data. Two data structures talk to each other to compute the final result as the character of the place.

2.2 Pixel Structure for Continuous Data and Blending Data with Neighbors

Pixel data structure based on a two-dimensional matrix consists of individual pixels that contain diverse data internally, for example: Fig. 4. As a parent of each pixel in the hierarchy, the pixel structure governs and controls computing and emerging the new data by processing not only its child pixel but also its neighbors. Like image processing and convolutional filters for feature extractions, the data affect their neighbors based on given algorithms so that the effect of data in the given relationships appears and emerges as a new pattern of data, for instance: Fig. 5. Thus, a point in a city becomes an area converting and visualizing the interpolated continuous data like a heat map.

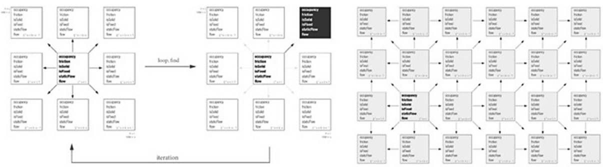

Fig. 4. The composition and relationship of a pixel map

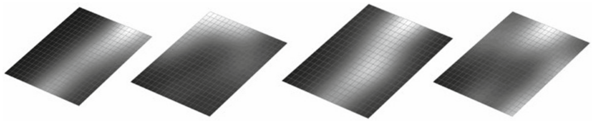

Fig. 5. The interpolation of discrete data on the pixel map

The data interpolation could be expanded to a three-dimensional degree by the voxelization of multi-layers of the pixel map along the Z-axis. Based on the parameters of the interpolations (linear and nonlinear) for damping the driven data: Fig. 6. In the case of third-place data in three-dimensional space, captured by a graph data, the voxelized treatment could be applied as a pro-process, damping, and normalizing the interpolated data, for example: Fig. 7.

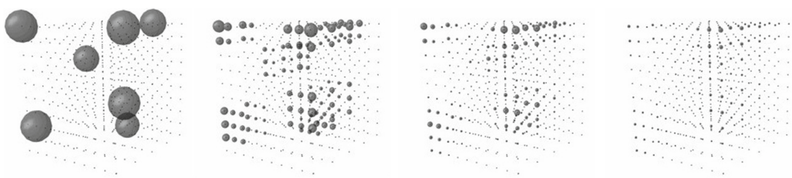

Fig. 6. Data blending in a voxel structure

For instance, a place could have a stronger attraction and others, and also a place push suppresses certain types of data. Locations of Police office could push out and minimize the density of data related to crimes. This type of assumption becomes an algorithm for interpolating and normalizing discrete data into continuous information.

2.3 Graph Structure for Discrete Data

As a different technique, A Graph data structure is utilized. The graph structure is a mathematical object that consists of nodes and edges and is widely used to represent

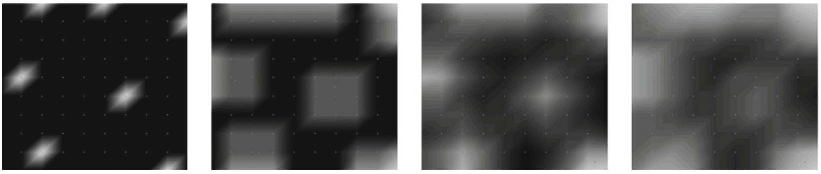

Fig. 7. Data blending in pixel by flatting the layer of voxel structure

relational data structures, for instance: Fig. 8. The street network of the urban, street, highway, or the subway map are examples of objects whose graphs closely resemble their physical form: Fig. 9. Thus, the structure is deployed to process urban data in spatial relationships to compute mobility energy consumption based on third place and the Pixel data structure.

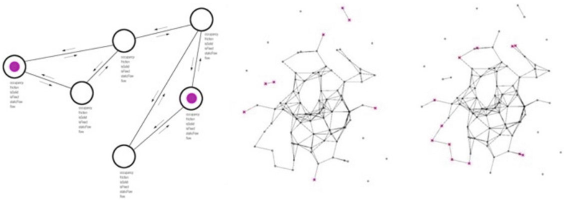

Fig. 8. The composition of nodes for parameters and edges for distances of a graph and its parameters

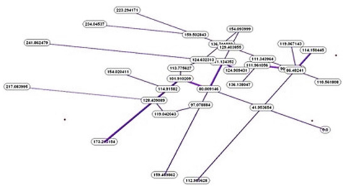

Fig. 9. Network analysis and data visualization

The graph data is constructed based on the pixel map, for instance: Fig. 5, and talk to each other in term of inspecting area information derived by position information. When considering the nature of the graph and performance issues, discrete information is needed. Thus, the pixel data map computes and sums up the weight and features of third-place data around the location, as numerical information, and feeds the information to the node of the graph. Therefore, to inspect the type and the density of third place based on walkable distance, a place could be selected in a city, and it finds the closest node of the graph to search the network of the graph based on the distance from the selected node. Walkable distance in a city

1 min (80 m, 0.0497097 mile), 5 min (400 m, 0.2485485 mile),
10 min (800 m, 0.497097 mile), 15 min (1,200 m, 0.497097 mile)
20 min (1,600 m 0.9941939 mile)

3 Case Study Implementation

3.1 Site Selection

There are four significant places which characterizes Cambridge, MA: Harvard Square Station, Kendall Station, Volpe Center, and MIT Building 7: Fig. 10. Each place has a unique place in terms of people in each site.

Fig. 10. Site selections in Cambridge

3.2 Parse Third Place Data and Visualization

Based on Google Places API, it parses third places around these sites. The API supports the types of queries below, and the data visualization of the places reveals patterns, highlighting certain streets and areas and contrasting the places: Fig. 11.

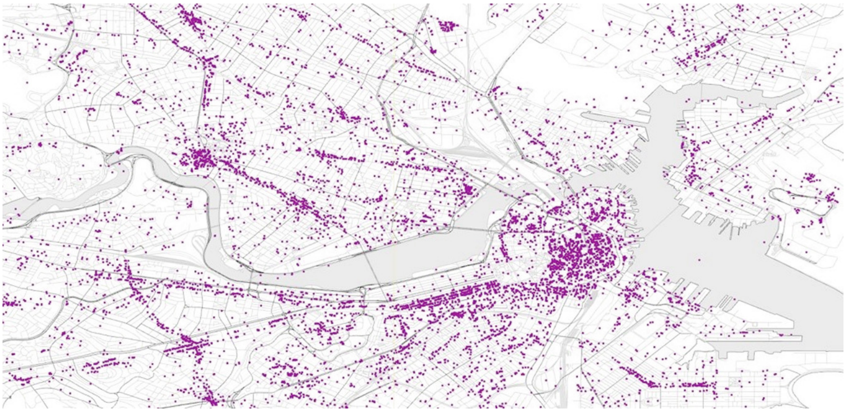

Fig. 11. Visualization: Third Place in Cambridge and Boston, Massachusetts

Type of query:

'parking', 'veterinary care', 'airport', 'plumber', 'roofing contractor', 'ATM', 'meal takeaway', 'hair care', 'insurance agency', 'school', 'synagogue', 'stadium', 'movie theatre', 'doctor', 'zoo', 'electrician', 'establishment', 'funeral home', 'spa', 'aquarium',

'storage', 'casino', 'park', 'courthouse', 'hospital', 'subway station', 'painter', 'moving company', 'movie rental', 'embassy', 'fire station', 'gym', 'bicycle store', 'local government office', 'book store', 'police', 'florist', 'museum', 'lawyer', 'car rental', 'real estate agency', 'physiotherapist', 'electronics store', 'hindu temple', 'car dealer', 'jewellery store', 'gas station', 'mosque', 'liquor store', 'campground', 'library', 'university', 'accounting', 'travel agency', 'finance', 'locksmith', 'bank', 'convenience store', 'health', 'church', 'bakery', 'lodging', 'laundry', 'shopping mall',

'dentist', 'store', 'cemetery'

Query reduction could be needed because multidimensionality tends to have much noise in terms of disclosing latent variables. In the six categories, the thirdplace data was processed, for example: Fig. 12.

Facilities : [' accounting', 'bank' , 'post_office' , 'library' , 'finance' , 'laundry'...]

Amusement : ['amusement_park' , 'zoo' , 'aquarium' , 'art_gallery' , 'spa' , 'stadium' , 'park' , 'museum','movie_theater', 'night_club...]

Health : ['doctor' , 'hair_care' , 'health' , 'hospital' , 'gym'...]

Store : ['clothing_store' , 'convenience_store' , 'department_store' , 'shoe_store' , 'store' , 'liquor_store' , 'hardware_store', ...]

Food : ['meal_delivery' , 'meal_takeaway' , 'food' , 'restaurant' , 'bakery' , 'cafe' , 'bar'...]

Transportation : ['taxi_stand' , 'subway_station' , 'train_station' , 'bus_station' , 'parking'...]

Fig. 12. The list of the queries of third places

3.3 Generate Data Structures and Inspect with Visualizations

The two data structures consume the data and process to examine a place to find and visualize the types and density of the third place: Fig. 13, Fig. 14, Fig. 15. Based on the selected node, it visualizes the places as a radial plot, which helps to compare it to others: Fig. 16, Fig. 17, Fig. 18.

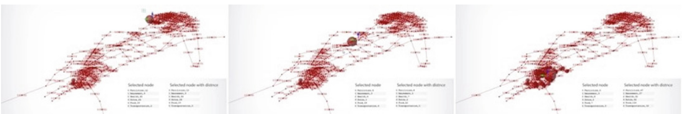

Fig. 13. Dynamic inspections and visualization the third places based on distance

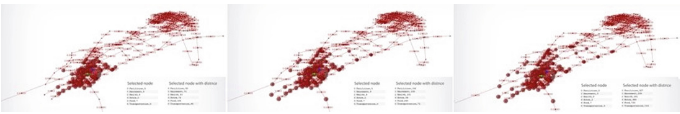

Fig. 14. Inspections for Harvard Square in 5, 15, 20 min' workable distances

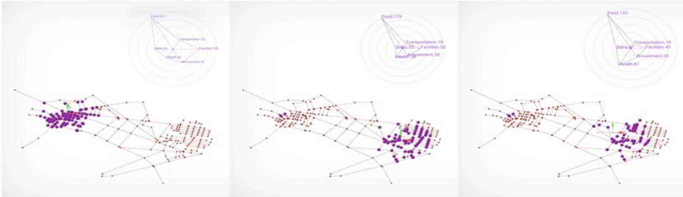

Fig. 15. Different places with the same distance and visualizing the third places.

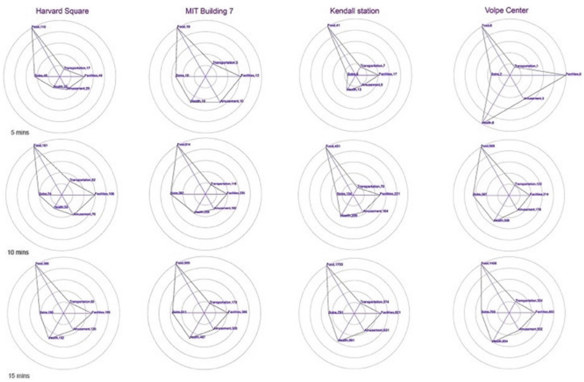

Fig. 16. Comparable charts at different distances

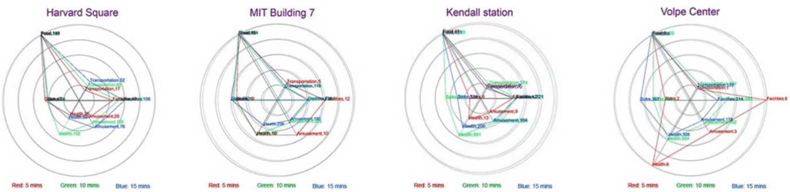

Fig. 17. Red: 5 min, Green: 10 min, Blue: 15 min

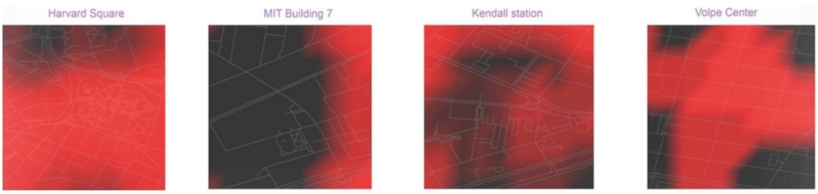

Fig. 18. Pixelated heat maps for the density of the third places in each site

3.4 Comparisons and Results

For example, Fig. 16, with many tourists and students, high density is shown compared to other places. There are 110 food places in 5-min walkable distances around Harvard

Square. For Volpe Center, where locate many companies, a small number of food places were inspected. However, it is rapidly increasing due to the Cambridge Side Galleria. In terms of mobility energy consumption, MIT Building 7 and Kendall Station are less efficient with the lack of diversity and density of third places. These places, except Volpe Center, have a high number of food areas, and Volpe Center has an imbalanced distribution of third places. This case study confirms certain assumptions about the distribution of places against people in the places based on distance. It reveals different perspectives to understand urban conditions by visualizing third places.

4 Discussion

Most of the urban data with location information are discrete data. In the real urban context, it is almost impossible to reinterpret a condition captured as data since the location always has visible or hidden relationships with their peripheries. The pixel data map allows us to interpolate discrete data as a continuous data set. Graph, a conventional and generic analysis tool, could be shaped as networks on top of the pixel map matrix to capture and compute third places data. Designers have better parameters to restore and set up urban modeling to process and characterize third place based on distances through the combination of two different data settings and processes.

This methodology makes it possible to compare and visualize a particular site with other different cities in understanding the context by third places and mobility or juxtapose a place with others in the same city. It reveals unique features and composition of third places by the comparison among designated places with the lens of the third place. As a decision-making process and visualization tool, designers could deploy it to differentiate the contrasts, or accord similarities by injecting or removing particular third place in the specific distance while developing their design in urban contexts.

5 Conclusion

Understanding the density of third place based on walkable distance could reveal the characteristic of cities which allow designers to develop their decision-making process by comparing with different locations or the past of the same location.

6 Future Work

Time-based data and other features such as the popularity of a place, race, population, or economic factors at different scales of time could reveal patterns or relationships with third places. It could provide a better understanding of the analysis at a different time, a day, and seasons.

By Deploying agents against the walkable-distance-based analysis, it makes it possible to develop diverse scenarios of modeling to simulate and understand urban contexts dynamically by parametrizing and controlling the follows and tendencies of agents with third places. Thus, we could compare the same agents in different urban contexts to reveal what we need to inject or remove third places to contrast or accord the cites.

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