

## Social Interaction and Cohesion Tool:

### A Dynamic Design Approach for Barcelona's *Superilles*

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## ABSTRACT

The traditional and fixed ways we understand urban space within our cities has given way to theories of dynamic urban ecology that include everyday social phenomena. Urban designers may now create custom small-scale and time-based datasets using open GIS workflows and urban sensors. This paper outlines a methodology to use new parametric workflows closely orchestrated with sociological ‘coding’ protocols, measuring indicators of social interaction and cohesion at various points along sidewalks for new walkable urban units in Barcelona.

The work presented here creates a tool for social interaction and cohesion initiated in collaboration with Salvador Rueda of the Barcelona Agency of Urban Ecology. The theoretical formulation began with criteria from the social cohesion categories of his comprehensive Methodological Guide to Urban Certification and was adapted to measure Barcelona’s newly developing *Superilla* urban unit of approximately three by three city blocks. This new socio-computational tool uses a parametric software platform, urban sensors, surveys, plugins and custom scripting to analytically visualize forty-eight criteria to measure: 1) *social use* of space, services, housing and jobs; 2) *demographic* differences of age, income, and culture; and 3) *infrastructure* access to transit and information technology. The methodology critically assesses the numerical and visual limits of flattening and combining qualitative data to understand these new urban units.

## SEARCH KEYWORDS

Social Interaction, Urban Design, Big Data, Simulation + Intuition, Interactive Architecture, Open Source in Design, Parametric and Evolutionary Design, Design Computing and Cognition

# 1 INTRODUCTION AND OBJECTIVE

Cities are becoming places understood as integrated morphologies of human and non-human systems. Urban ecological models try to simulate this integrated system of urban conditions. Salvador Rueda's Barcelona Agency of Urban Ecology urban modeling (Rueda 2012) includes the need to measure social cohesion, specifically a neighborhoods' access to social diversity via indicators of 1) land uses, 2) demographics and 3) mobility infrastructure. Meanwhile new computational advancements enable the measurement of urban phenomena to understand cities. Projects developed by Carlo Ratti's SENSEable Cities Lab understand data access (Nabien) to find new computational methods using ubiquitous access of mobile computing. The methodology presented here positions itself between theory and socio-computational workflow to measure small-scale time-based social phenomena. The key to the work is the careful 'coding' translation from qualitative understanding to quantitative information and the development of a visual analysis language to numerically and geospatially compare across neighborhoods their abilities to support social interaction and cohesion.

The methodology was developed to measure social interaction and cohesion within new units of urban space in Barcelona called *superilles*, or superblocks. A *Superilla* is prototypically a three by three block area within Ildefons Cerda's *Plan Eixample* of 100m square blocks, designed as a conceptual framework for mobility, social equity, and the public and private use of space. The new *superilles* limit vehicular traffic within the two interior streets. Local adjustments of the grid are made when superimposed with the new orthogonal Ret Bus systems informed by Salvador Rueda and the existing network of bicycle lanes. The resulting *superilles* vary in size via these parameters, sometimes larger or smaller than the three by three block prototype. Defined by the city of Barcelona "a super island is an urban unit bigger than a block of houses but smaller than a neighborhood, with pacified streets" and is influenced by Vicente Guallart's idea of geologic information architecture (2009) and block self-sufficiency (2010), and Rueda's orthogonal RETbus system (2014). The resulting "pacified" or livable public spaces are based on plazas in Barcelona's Gracia neighborhood quiet and isolated pedestrian squares.

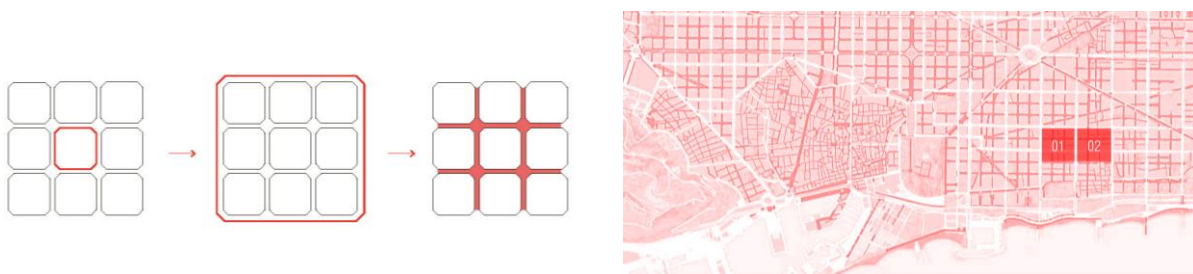


Figure 1, 1859 *Eixample* blocks to new superblock and pedestrianized interior streets; test areas 01 and 02 in the *Superilla* network of Barcelona, informed by images from the Barcelona Agency of Ecological Urbanism

The purpose of this methodology is to use a Grasshopper based platform to collect social data from scratch, ‘codify’ it, develop respective scales and modes of visualization, and iteratively design a language of visualization. Subsequently this data is used to compute forty-eight indicators of social interaction for two test areas of data in Barcelona and future datasets in Portland, Oregon. The work here pays close attention to apply sociological protocols of data and statistical analysis such as information flattening and spatial experience that represent an otherwise new scale of GIS visualization for this new multi-layer urban ecological approach.

## **2 BACKGROUND OF SOCIO-COMPUTATIONAL WORKFLOWS IN URBAN DESIGN, COMPUTATIONAL AND VISUALIZATION**

Recent geospatial design research in the area of measuring urban phenomena maybe be seen in mainstream tools such as *Walkscore’s* (Kocher 2007) overall score, ten criteria and new mapping interface, *Zillow’s* (Barton 2005) integration of various real estate criteria, Yelp’s (2004) crowd sourced use of price, spiciness and business hours and *Uber’s* spatial networking approach. Meanwhile scholarly understanding of data access, between single data type, varied type and data from scratch from Carlos Ratti’s SENSEable Cities lab (Nabien 2013) inform new data collection while Marichela Sepe’s *PlaceMaker* (2005) tool informs a procedural GIS methodology to include qualitative experience in a geospatial mapping interface. Similar objectives are being researched within the planning discipline of GIS (Carmona 2009). The author’s previously published work around the area of on-site and off-site data collection, and ideas of systematic, open and custom formulation of Grasshopper GIS workflows contributed to the methodology presented here.

Meanwhile, important approaches to visualization in urban ecology bridge numerically comparative and geospatial information found in existing ‘simulation tools’ by Barcelona’s Agency of Ecological Urbanism. The visual programming research of Manuel Lima (2011) provided critical examples to both organize information in a single understanding but, in the same visualization, allow the viewer to separately understand multiple hierarchies of information. Elsewhere within the field of design agency (Gerber 2014) and landscape ecology methods of synthetic ecologies (Holzman 2014) (Evans 2013) contribute to simulation based methods to understand and visualize natural phenomena and point out the current need for researchers to fill the gap between using computational design and understanding new theories and scales of urban ecology.

### **Formulation and Approach**

The basis of this methodology is urban theory and various previous methods of computational GIS research using a Grasshopper, Elk and Excel GIS platform to more openly formulate and collect data than traditional large-scale GIS planning software such as ESRI ArcGIS (1999) and City Engine (2008). The methods of data formulation, collection and codification informed the formulation of the tool. The research studied written description of the social cohesion (Rueda

2012) and in-person meetings with Salvador Rueda to identify three categories to measure social cohesion: 1) *land uses* of social space, social services and social housing; 2) *demographic* differences of age, income, culture and education; and 3) *infrastructure* such as transit and waste systems. Some elements such as job access via land use were added, while others were removed such as education. Indicators for both public and private access were added to match European and US contexts. Many of the first-hand datasets were geospatially measured by the author since 2010 working with Barcelona’s 22@ district planning office and matched similar block requirements for public space, social housing and social services. GIS Grasshopper approach to measure these qualities occurred in earlier teaching course work were used to codify qualitative to quantitative data and recently to develop a GH GIS tool to measure relationships between the particulate matter, PM, and small urban design characteristics to measure the effect on young children in Barcelona and Portland.

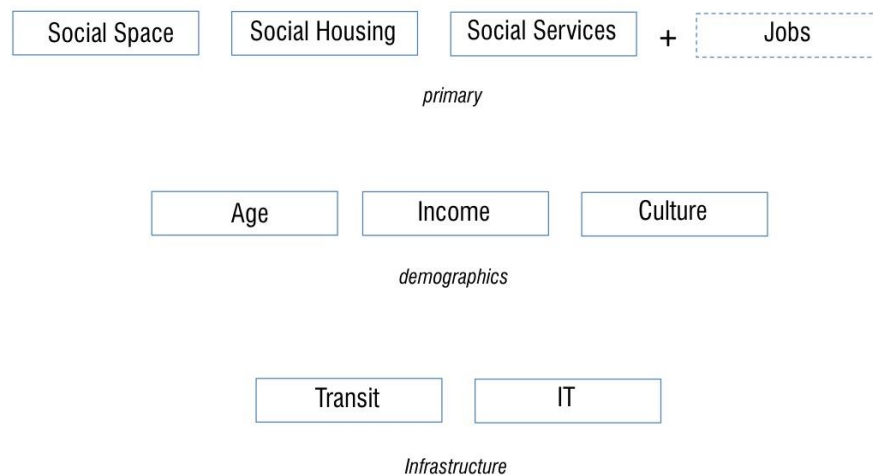


Figure 2, Formula of 3 primary level and 9 secondary level qualities.

The visualization analysis is only as valuable as the data, time of data collection and consistent adherence to codification protocols. The visualizations present here should be considered as part of a design process to develop a methodology for a computational workflow for a visualization tool rather than an ultimate understanding of urban design.

### 3 ‘CODIFYING’ SOCIAL INTERACTION METHODOLOGY

#### Building the Social Interaction Tool

When visually analyzing social interaction and cohesion there is a need to measure and thus inherently abstract the real world. The tool discussed here measures indicators of social interaction. Since social interaction is a time-based *phenomena* and thus challenging to directly measure with repeated data collection over various times of the day, week and year, the research often did not measure phenomena directly but rather the ability for the urban environment to support phenomena of social interaction.

## Choosing an Indicator to Measure

A process of finding an appropriate way to measure urban characteristics of a given social interaction category, such as the demographic category of age difference, requires observation both off-site, via GIS resources and tools such as Google Earth, and repeated on-site observations of these urban characteristics. For the example of age differences one can measure proximity to senior centers, schools and day care centers. The decision making between 1) the type of urban quality (demographic), 2) the urban quality (age), 3) the urban characteristic (the ability to support seniors) and 4) the indicator (a senior center) requires various types of data collection. Other urban characteristics such as cultural background may not easily be found in existing data or in physical characteristics. In this case field observations of heard languages, written text and interviews with business owners were conducted. “Coding” verified if there was a match between local or non-local cultural background. In these cases on-site data collection was useful if not essential to measure some phenomena.

Urban Characteristic	Category	Public/Private	Variable	Indicator	Unit	On_Off_Site
Social_Space	22@	Public	Vegetation	Species		On
Social_Space	22@	Public	Vegetation	Height		On
Social_Space	22@	Public	Vegetation	Health		On
Social_Space	22@	Public	Vegetation	Color		On
Social_Space	22@	Public	Sound	Decibel		On
Social_Space	22@	Public	Sound	Frequency		On
Social_Space	22@	Public	Sound	Source		On
Social_Space	22@	Private	3rd_Space	Name		On_Off
Social_Space	22@	Private	3rd_Space	Type		On_Off
Social_Space	22@	Private	3rd_Space	Occupancy		On_Off
Social_Space	22@	Private	3rd_Space	Seating_Arrangement		On
Social_Space	22@	Private	3rd_Space	Number_Employees		On_Off
Social_Space	22@	Private	3rd_Space	Comfort_Level		On
Social_Space	22@	Private	3rd_Space	Playfulness		On
Social_Housing	22@	Public	Housing	Area		Off
Social_Housing	22@	Public	Housing	Presence		On_Off
Social_Housing	22@	Private	Housing	Rental_Cost		Off
Social_Housing	22@	Private	Housing	Area		Off
Social_Housing	22@	Private	Housing	Cost_per_M2		Off
Social_Services	22@	Public	Service_Type	Name		On_Off
Social_Services	22@	Private	Service_Type	Name		On_Off
Social_Services	22@	Private	Service_Type	Count_Within_Distance		Off
Employment_Diversity	22@+	Public	Office	Name		On_Off
Employment_Diversity	22@+	Public	Office	Type		On_Off
Employment_Diversity	22@+	Public	Office	Area		Off
Employment_Diversity	22@+	Public	Office	Rental_Cost		Off
Employment_Diversity	22@+	Private	Office	Name		On_Off
Employment_Diversity	22@+	Private	Office	Type		On_Off
Employment_Diversity	22@+	Private	Office	Area		Off
Employment_Diversity	22@+	Private	Office	Rental_Cost		Off
Demographics	Demographics	Private	Age	Age_Range		On
Demographics	Demographics	Private	Income	Price_of_Coffee		On
Demographics	Demographics	Private	Income	Price_of_Beer		On
Demographics	Demographics	Private	Income	Price_of_Vegetable_1		On
Demographics	Demographics	Private	Income	Price_of_Vegetable_2		On
Demographics	Demographics	Private	Income	Price_of_12_Eggs		On
Demographics	Demographics	Private	Income	Price_of_Liter_Milk		On
Demographics	Demographics	Private	Income	USDA_Food_Basket		Off
Access	Infrastructure	Private	IT_Access	Fiber_Optic_Presence		On
Access	Infrastructure	Private	IT_Access	Cell_Signal_Strength		On
Access	Infrastructure	Public	IT_Access	BCN_WiFi		On
Access	Infrastructure	Private	IT_Access	Private_WiFi		On
Access	Infrastructure	Private	IT_Access	3G_Network		On

Chart 1, Indicators .

## Diversity and Public vs Private Space

There is an implied theory from Reuda’s social cohesion assertion that a diversity of options or access to these options are needed, including the diverse access of land use, interaction across

age groups and infrastructure across types such as mass transit, private vehicles, bikes and pedestrians – much of which he measured in public spaces and public services only. Our own formula on the other hand would expand the need to measure not only public spaces but also include private spaces. For example, a *third-space* such as a coffee shop or a barber shop (Oldenburg 1989) would provide a social space for interaction but technically was held in a private space and not a park. Thusly it was necessary to measure access to private shops, bars, restaurants and other meeting spaces, and private counterparts to many of Rueda’s public categories, to understand a broader context of social interaction especially if the research would be tested and used in Portland and other socio-economic contexts. This meant a need to develop data collection methods to measure economic access to third-space such as the cost of coffee or beer (Yelp participation is low but still growing), which can be benefited by in-situ data collection. It would thusly be necessary to embed a codifying logic for this data prior to data collection and or an iterative process of data selection, collection, processing and visualization.

### Collecting Social Interaction Data

This process of ideation between how to measure a desired social interaction quality and urban characteristic was facilitated through previously developed Grasshopper GIS, Elk and CSV workflows and the aid of course work and academic research. A 2014 urban design summer program was used to develop a methodology to measure various phenomena first with 108 points 33m apart across a three by three block area by groups of three students and subsequently using those methods to gather data as a class for the above mentioned faculty designed formula. Nine students measured a total of 690 sidewalk address locations across a three by six final test area, effectively measuring two *superilla* areas in Barcelona’s Poblenou neighborhood.



Figure 3, On-site collecting data.

A previous spring 2014 student project provided a foundation to some visualization techniques. The ability to not rely on a simple numerical score like Walkscore but to visualize how much of various qualities were present, was evident in the student project Intergenerational Interaction. The “spider diagram” shown in figures 4 and 5 allow one to assess which of the eight qualities studied are present in each block.

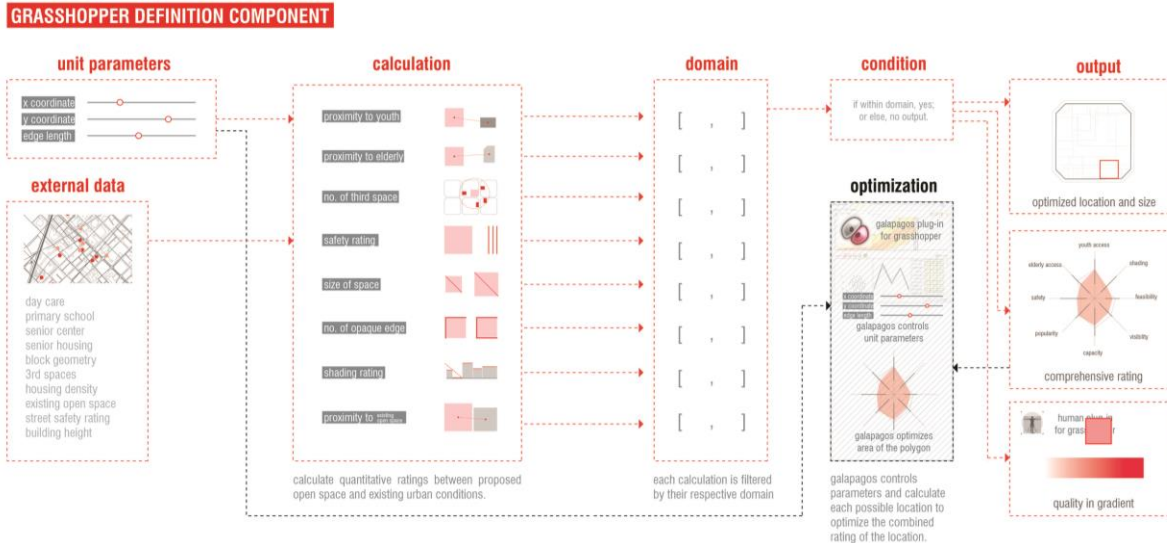


Figure 4, Intergenerational Interaction.

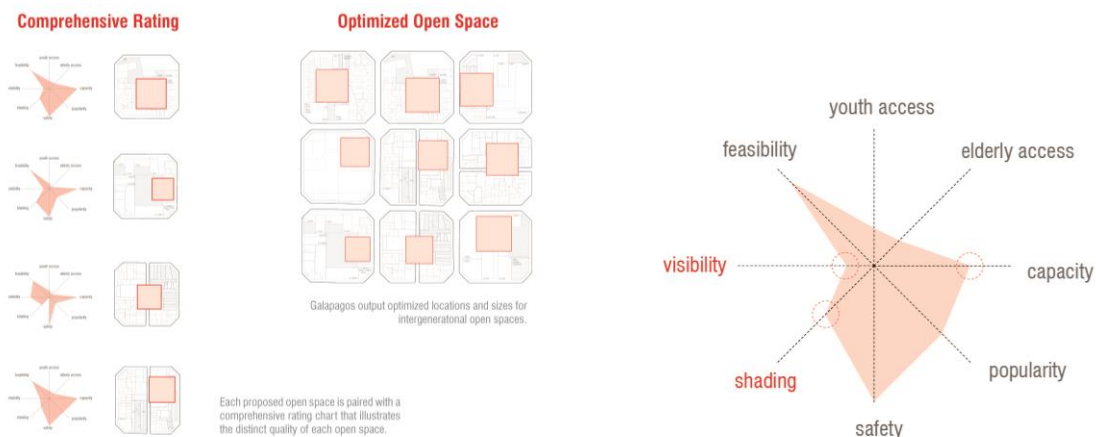


Figure 5, Intergenerational Interaction.

**“Coding”**

Prior to each summer 2014 student measuring the indicators for their category, such as transit infrastructure, a careful data dictionary was developed for each student to systematically and consistently adhere to a protocol. Coding would correspond to yes/no (0/1), ratings (0 to 5), numbers, euro amounts, means and averages, indexes and syntax matches. The partial data dictionary in figure 6 shows columns especially relevant to translation such as “coding type” and “units.” Challenges and limits to the data processing included null sets of no data and the presence of multiple businesses at one building address. Inconsistency of data entry was cleaned and syntax was replaced for a manual dataset gathered in three days for a total of approximately 33,000 data entries.

Urban Character	Category	Public/Private	Variable	Indicator	Coding Type	Unit	On_Off_Site
1 Social_Space	22 @	Public	Vegetation	Species	type	1-19	On
2 Social_Space	22 @	Public	Vegetation	Height	height by floor	stories	On
3 Social_Space	22 @	Public	Vegetation	Health	type	0-2	On
4 Social_Space	22 @	Public	Vegetation	Color	type	0-3	On
4 Social_Space	22 @	Public	Vegetation	Sound (birds, etc)	yes/no	0/1	On
5 Social_Space	22 @	Public	Sound	Decibel	number	db	On
6 Social_Space	22 @	Public	Sound	Frequency	number	hz	On
7 Social_Space	22 @	Public	Sound	Source			On
8 Social_Space	22 @	Private	3rd_Space	Name	text		On_Off
9 Social_Space	22 @	Private	3rd_Space	Type	type	0-5	On_Off
10 Social_Space	22 @	Private	3rd_Space	Occupancy	number	#	On_Off
11 Social_Space	22 @	Private	3rd_Space	Seating_Arrangement	type	0-4	On
12 Social_Space	22 @	Private	3rd_Space	Number_Employees	number	#	On_Off
13 Social_Space	22 @	Private	3rd_Space	Comfort_Level	type	0-5	On
14 Social_Space	22 @	Private	3rd_Space	Playfulness	type	0-5	On

Figure 6, Data Dictionary with Coding.

## 5 VISUAL ANALYSIS OF SOCIAL INTERACTION

The visual analysis of this data tried to reveal spatial patterns 1) between *superilles* and 2) within *superilles*. The fine-grained point data makes it possible to understand data differences with existing morphological differences such as three parallel avenue types in the Poblenou study area which run toward the sea and represent three urban models, each from the 13<sup>th</sup> C., 19<sup>th</sup> C and 21<sup>st</sup> C. Additional patterns were sought within the blocks. Such fine-grained scale of GIS is not a normative scale of data for either GIS or census data taken at larger scales or traditional data types such as land use, tax values and building height rather than indicators of social interaction.

### 5.2 Informational Graphic Diagrams between *Superilles*

Point data for 690 locations across eighteen blocks provides descriptive statistical analysis of the makeup of both each block and each superblock. Circular diagrams could provide a way to understand the relative differences between three primary qualities, nine secondary qualities and 48 indicators on the scale of each block or on a superblock scale. These types of diagrams, influenced by the work of Manuel Lima, provide a comparative means with each block represented as an equal circle. Grasshopper with CSV and Human components allowed for an abstract spatial approach to translate CSV tabular data and other formulation. Like the work of Lima, the graphic circles allow an overall understand of the data and a selective comparison of data between adjacent blocks and superblocks.

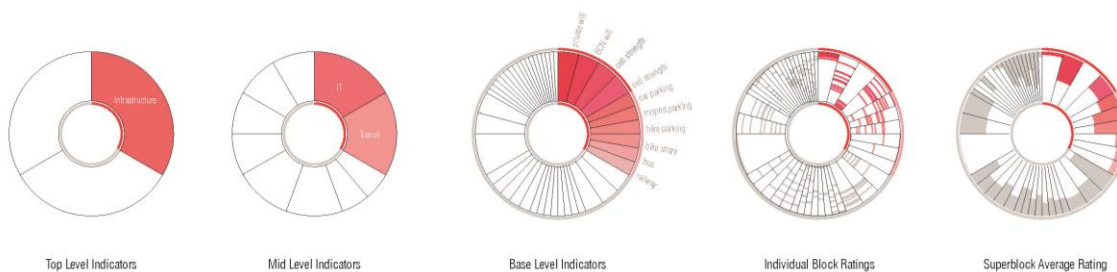


Figure 7, Sequential visualization logic.



The visualization pointed out the thresholds both numerically and spatially to combine or not combine data. A determination was made that while very small indexes could combine data, for example food affordability indexes using USDA guidelines for milk, eggs and two consistent vegetables, none of the 1) three top level (land use, demographic or infrastructure), 2) three mid-level nor 3) forty-eight base indicators would ever be merged numerically. Each group or category might share characteristics such as color range or area of the circle but at no point would the qualitatively different data of the forty-eight indicators be mixed. One can visually understand them together through visual adjacency but never be unable to separate their values. This was an important sociological protocol followed to ensure the clear understanding of data and its origin.



Figure 8, Superblock diagram.

The richness of these images achieves the goal to show both aggregate and holistic information. However the research also found it useful to isolate individual categories and even indicators to understand differences of blocks and superblocks.

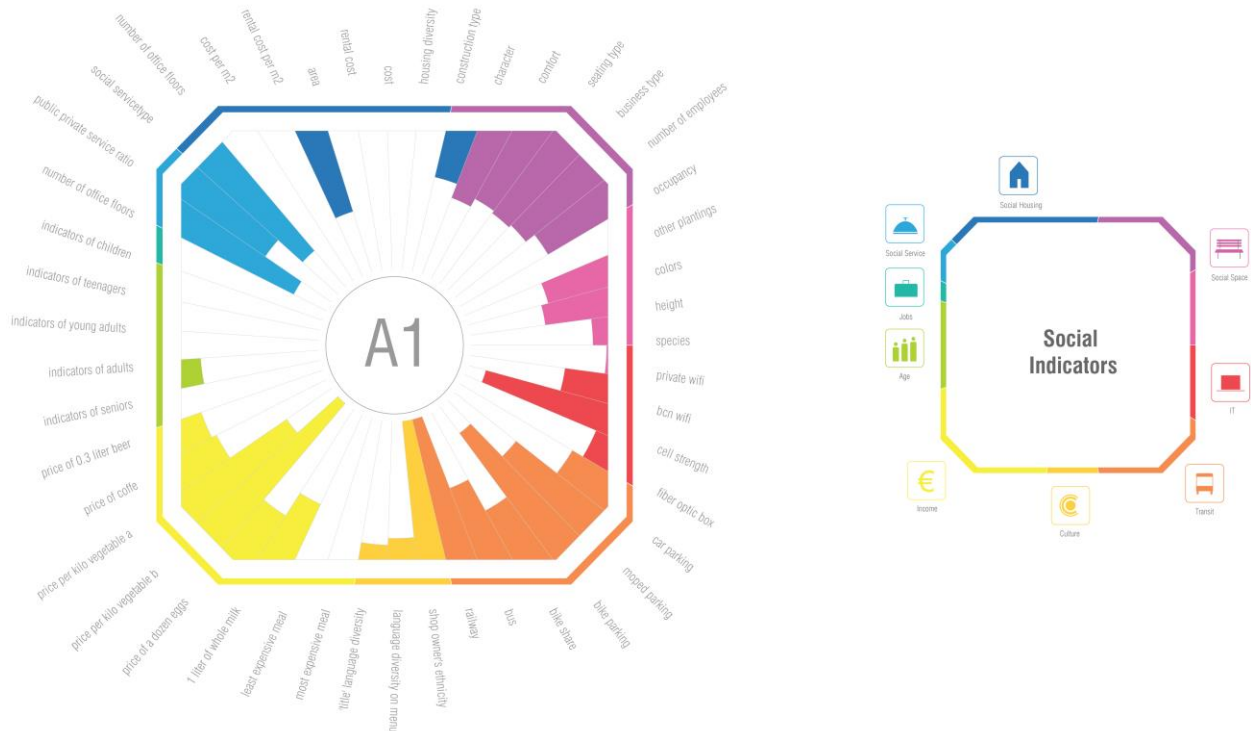


Figure 9, Individual block / indicators.



Figure 10, Individual block rating comparison.

## 5.1 Spatial Diagrams

The vast numbers of individual data points provided an ability to look at the very human scale of occupation of the *superilla* spaces. Emerging patterns could be studied across each block and superblocks. The research investigated variations in the scale, shape and color visualization of

abstract geometric organizations to translate data points to geospatial understanding. Color blending versus color pixilation was tested across various blocks and streets. Grasshopper provided an effective environment to precisely control geometry and visualization. Like the information graphic scaled visualizations discussed above, similar challenges were observed to establish protocols to blend various qualities of information.

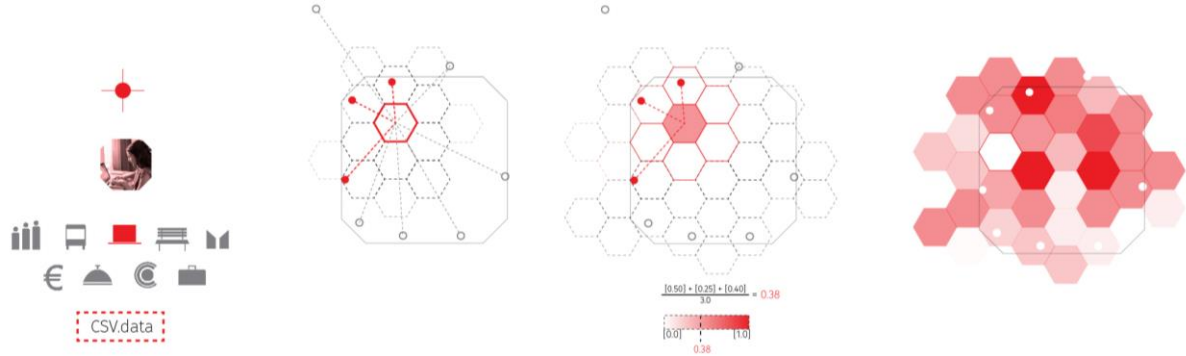


Figure 11, Sequential language logic – unit.

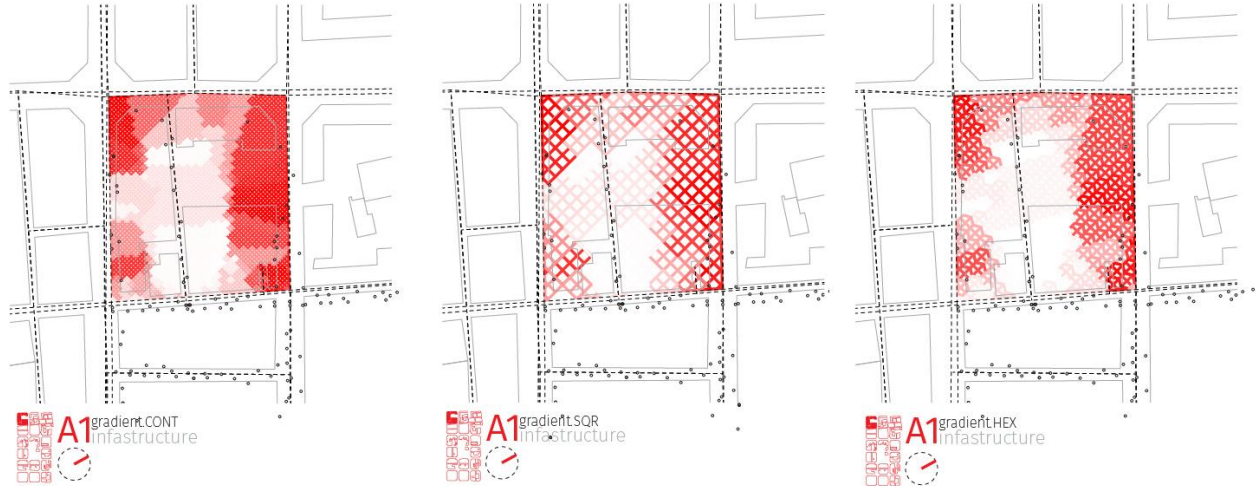


Figure 12, IT Infrastructure, block scale - 3 visualization blends.

This new scale of data visualization and phenomena visualization reveals key questions about abstraction. At the larger planning scales of city wide, district and neighborhood, visualizing data within a block seems to be an effective way to explain the urbanism. However when we consider the fine scaled data and the very human experience of this social interaction data we realize that the public space, right-of-ways, including the sidewalks of the actual data collection, may be a truer place to visualize data. Figure X demonstrates visualization of the same data in the blocks and in the right-of-ways of the streets. While the true experience of most of the indicator data was in the street, the color differences at the scale are difficult to perceive unless zoomed in to a single street and thusly limiting comparison or the larger emergence of patterns.

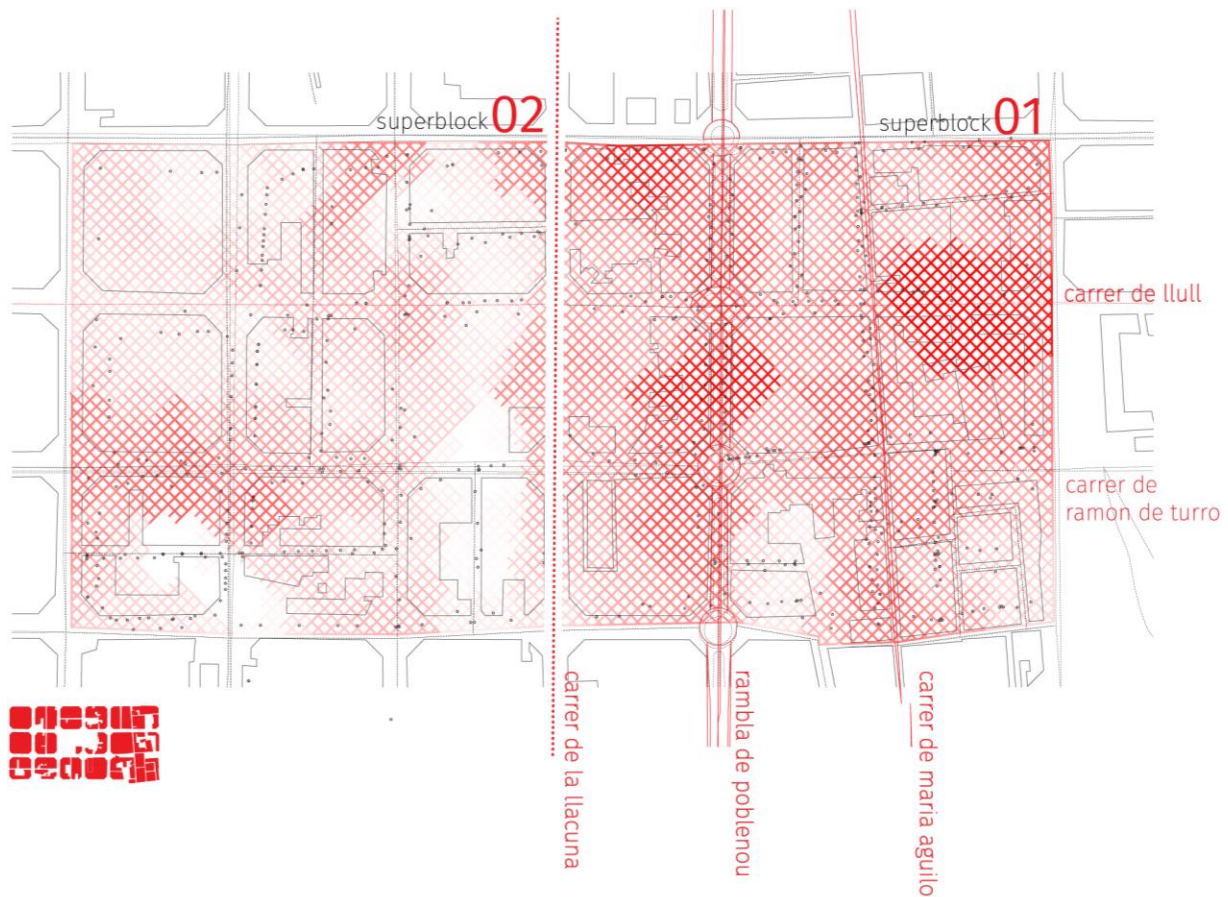


Figure 13, IT Infrastructure, scale of Superilles 01 and 02.

While the fine-grained differences afforded from this visualization seemingly is more detailed than the abstract block and superblock scaled information, many urban designers would be more comfortable with the larger scale data. The greater complexity of urban design and urban ecology today implies a danger to strip down any one aspect without consider a great range of depth and breadth of systems interaction. Thusly, although the data collection at individual street addresses may seemingly allow us to make understandings at that scale, many urban designers would still consider the scale of blocks and super blocks as a sufficiently zoomed in level of detail.

### 5.3 Discussion and Post Analysis

The coding and visualization of social phenomena provides a systematic way to see and understand these qualities in a new scale of urban space. In most of these cases the derived understandings were relative between superblocks or between blocks. This data was overlaid with morphological or use data provided grounds for only relative speculations. For example the differences of the three avenues of the narrow 13<sup>th</sup> C. Maria Aguilar, wider Rambla de Poble Nou 19<sup>th</sup> C. and more typical example Llacuna 21<sup>st</sup> C (see figure 14). provide a basis for a relative understanding of differences of storefront activity, sidewalk widths, traffic limitations,

street trees and other urban characteristics. To establish absolute findings the research would have to establish benchmarks such as comparison to spaces of similar pedestrian livable qualities, as seen in the use of the disconnected Gracie squares in the Superilla presentation

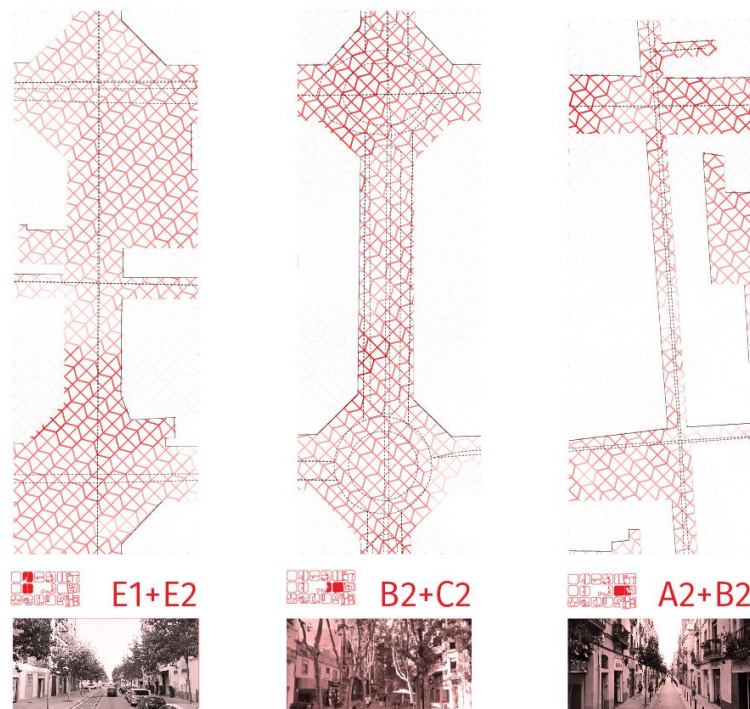


Figure 14, Street comparison diagram: Maria Aguilar, Rambla de Poble Nou and Llacuna.

## 6 THE DELICACIES OF SOCIO-COMPUTATIONAL WORKFLOW

The way we measure dynamic human and non-human urban phenomenon is time dependent. It requires new methods of urban design to breakdown “mental, physical, technological or ecological barriers (water, woods, hills, fences, traffic, infrastructural design)” of urban space (Latour 1987).

The social interaction and cohesion tool described in this paper tried to piece together new urban theory and new computational tools to measure urban phenomena and new scales of urban design understanding. The complexity of urban ecology requires new scales of data and new visualization techniques. Broad, complex models such as *superilles* in Barcelona as well as those such as *Walkscore* or previously mentioned student project which measures intergenerational interaction, require abstractions of data and decisions of what to illustrate and what not to. The authors attempted to represent indicator data as directly as possible but decisions were made to simplify and combine, in some case, even flatten data to make it accessible. “Coding” of qualities also presented challenges such as null and zero data that needed to inform protocols of

data collection. Geospatial computational complexity was removed from the Grasshopper environment when possible and done in spreadsheet software, also suggesting a future research line to use a custom Python script.

While traditional planning scaled urban design drawings typically show data over open streets and buildings, new fine-grained data help facilitate understandings of qualities within the experience of a street – making possible visualizations which more accurately show data differentiation at the scale of street right-of-ways. Future questions and Python workflows would assist scaling up data definition as well as catchment area, ie, numbers of *superilles*, and help automate data collection and coding.

Contribution of this work to the area of computational design is a methodology of analyzing and visualizing urban data. This work demonstrates the ability to capture, code, analyze and visualize data and presents challenges and examples of ways to communicate complex urban ecological information – at what scale, at what level of categories and in what visual language in both abstract and geospatial understanding.

The work to date allows for successful relative data comparison between *superilles*. To provide a more absolute understanding of social interaction and cohesion it would be essential to have benchmark and baseline examples. Future work will measure known urban spaces such as superille model spaces in Barcelona's Gracia neighborhood as well as similarly accepted rich spaces of social interaction in the Barcelona. Morphologies in the *Eixample* grid, gothic fabric and other urban fabric may provide additional visualization lessons at different scales but more importantly provide a way to frame understandings gathered in this research.

A last future computational endeavor which has begun is a simulator to run this analysis tool in reverse to understand possible patterns of indicators given a known distribution, color wheel or spatial map, for a given neighborhood. Such simulator tools could provide: 1) recommendations to city agencies and 2) provide information to everyday users to empower behavioral change (choice to live/work here), both at the small scale of indicator information.



Figure 15, Social Interaction and Cohesion Tool, Comprehensive Visualization

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