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Research Paper

Mathematize *urbes* by humanizing them. Cities as isobenefit landscapes: psycho-economical distances and personal isobenefit lines

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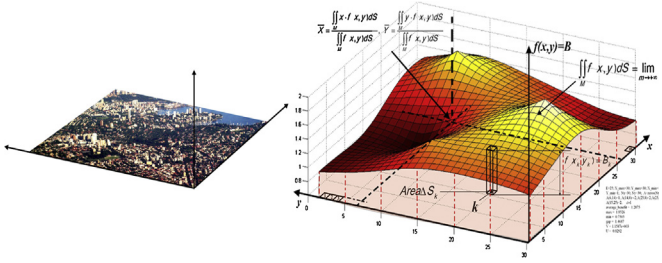
HIGHLIGHTS

- A city is viewed from different private visions: personal isobenefit lines visualize it.
- They transform aggregative habits to personal and isotropic spaces to anisotropic.
- Psycho-economical distances include pleasantness to cost, distance and time.

GRAPHICAL ABSTRACT



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ABSTRACT

The city reading proposed is a modern-postmodern urbanism approach which quantifies but by passing through subjectivism. The isobenefit lines shown translate cities into benefit landscapes, subjective and continually changeable according to personal moods/needs/preferences and urban transformations. They read attractiveness and how they flow throughout the city. Doing it for each urban point and for each urban attraction, we obtain the isobenefit orography of the city, namely a map of its urban attractions and of their flows. This is a liquid surface rather than solid, as it varies across time and people. It is in this liquidness where resides the complexity of cities, their bottom-up spirit and the dynamicity of equilibriums and networks. People do not necessarily go in the most accessible points, but where they need and want to, and, they flow through paths they need or choose to pass through. It is also introduced the likeability of places and paths: in addition to the usual parameters currently used – which weight distances in terms of physical distance, cost, time or mental easiness representations – psycho-economical distances used in the isobenefit lines proposed here, also consider how a place and a path pleases us. According to the Underground Hedonic Theory, this pleasure to pass through or to stay in agreeable areas has an underground and an inertia effect too which contributes to delight our lives. The final purpose of the science of cities and urban design is to understand cities and make them efficient and attractive to please our lives in them.

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1. Introduction

Individual personal visions of their own cities may slightly or greatly differ among people. Formulizing this variety implies to consider a certain number of contemporary factors which influence personal views. A main aim of psycho-economical distances appearing in this paper is to extend the isobenefit lines (MIT Technology Review, 2012) into a heterogeneity and bottom-up pattern, where decision-making processes of each city dweller give their influence on the emergency of the complex system for antonomasia which is the city.

Following the romantic reaction to modernism, which began in the 1960s, against "the abstract platonic structures" of the modern universalism (Ellin, 1999), isobenefit lines, personalized by psycho-economical distances and individual preference criteria, respond also to pluralism and multiculturalism which are more and more characterizing our cities. Quoting Lynch, "cities are too complicated, too far beyond our control, and affect too many people, who are subject to too many cultural variations, to permit any rational answer. [. . .] Someone might say 'I like Boston', but we all understand that this is merely a trivial preference, based on personal experience" (Lynch, 1984).

While isobenefit lines refer to the criteria of the majority of citizens of a city, where "majority" means the "ordinary" citizen (if this "ordinary" citizen exists; mainly if the variance of the preference criteria/behaviors of the "ordinary citizens" is limited), personal isobenefit lines refer to the criteria of each individual. Since the beginning of the postmodern urbanism reaction, urban sociologists began criticizing the environmental determinism of urban designers who do not consider how people perceive places. The consequent new field of environmental psychology underlined the "individual's personal identity in relation to the physical world through memories, ideas, feelings, attitudes, values, preferences, meanings, and conceptions about behavior relevant to the physical settings in his or her daily life" (Proshansky, 1990).

In this view, personal isobenefit lines humanize cities by transforming them as texts with many readings. As isobenefit lines read cities as 3 dimensional solids whose shapes diverge among cities and, for a same city, throughout timelines, personal isobenefit lines read cities as 3 dimensional solids whose shapes diverge among each person even for a same city in a same moment, and among different moods, times of life of a person.

This also in part fits into the shift from *complicated* to *complex* systems of the last second half of the past century.

In the 20s the system theory approach was dominant and suggested, during all the 50s, that systems were regarded as being centrally ordered, as a hierarchical sum of subsystems dominated by negative feedback, which implied a predominant controlled equilibrium status. Examples of these systems were also cities and regions. However, cities are never in equilibrium, they are constantly changing and dominated by positive feedback, not by negative's (Batty, 2012). A standard theory of cities was developed until the middle of the 20th century as an economic and transportation model based mostly on the monocentric city. Ideas and models were built on statistical aggregations of units, as for example models based on macro economics (econometric models, population models, Keynesian models).

In the 1970s (actually even earlier: "It was not Galileo or even Newton but Darwin that split this top-down world", Batty & Marshall, 2012), the idea changed: city was observed as controlled by positive feedback and not anymore from the top-down but from the bottom-up.

> "[. . .] models were derived from work in a sub-area of artificial intelligence called distributed artificial intelligence (DAI). DAI aimed to solve problems by dividing them amongst a number of programs or agents, each with its own particular type of knowledge or expertise. In combination, the collection of agents would be better at finding solutions than any one agent working on its own. While DAI is primarily concerned with engineering effective solutions to real world problems, it was soon noticed that the technology of interacting intelligent agents could be applied to modelling social phenomena, with each agent representing one individual or organisational actor." (Gilbert & Terna, 2000).

A single agent may be able to reconfigure a complex system (system that have the potential to reconfigure themselves in ways that may be surprising, Batty & Torrneds, 2005), but the potential still exists for the system to change without us knowing the actions of any particular agent (Batty, 2012). Models were specified in more detail as, for example, by disaggregating into several types of populations, types of personal habits, etcetera. Fundamental elements themselves are to be represented: the so known agents.

The "new generation of thinking, based not on aggregative, equilibrium-seeking assumptions, consistent with models of how activities produce emergent social structures from the bottom up" (Epstein & Axtell, 1996), lies with a "new forms of representation at a fine spatial scale, in which units of space are conceived as cells and populations as individual agents, are currently changing the way we are able to simulate the evolution of cities" (Batty, 2005).

Models based on multi-agent decisions are becoming the dominant paradigm in any social simulation, due primarily to an agent-based worldview suggesting that complex systems emerge from the *bottom-up*, are highly decentralized, and are composed of a multitude of heterogeneous objects called agents (Crooks, Castle, & Batty, 2008).

> "Urban and regional modelling is a part of the broader and now fashionable field of complexity science [. . .] there is a history of 50 years or more of serious development and therefore a substantial body of literature and ideas" (Wilson, 2012).

Including interactions among isobenefit lines, they show similarities with potential models, spatial interaction models, and more generally, with retail and gravitational models. They also work inside spatial equilibrium and location models: for a State-of-the-Art in Residential Location Models see, i.e., Pagliara, Preston, & Simmonds (2010), while for a Spatial Equilibrium reading, D'Acci, 2013a, 2013b; Glaeser, 2008.

More technically speaking, the methodology proposed in this paper can profitably be inserted in the wide framework in between GIS, Space Syntax, Urban Network Analysis and Multi agent based models (Batty, 2013).

If we consider this paper from the point of view of the change of urban attractiveness and of the relative frame origins-destinations of urban movements, during different times in the day, different days of the week, and different chosen paths, we could also refer, in some senses, to the Lund group's work on space-time prisms and volumes of the 1960s/70s, and more recent works proposed by Dykes, MacEachren, & Kraak (2005), Kraak (2003), Kraak and Ormeling (2011), Kwan and Neutens (2014), Mennis (2003), Miller (2005), and many others.

> "Human activities interact and intertwine to create a complex social system that fulfills our physiological, economic, and social needs [. . .] Hägerstrand's time geography offers a useful framework for studying individual activity and travel patterns under various constraints in a space–time context (Hägerstrand, 1970, 1978, 1989)." (Shaw & Liu, 2009, p. 141).

The time geography framework helps the understanding of human spatial behavior, and the improvement of computational representations of the last decade has stimulated time geographic