Identifying communities of practice through mobile phone data

*Identificando as "comunidades de prática" por meio
dos dados de telefonia móvel (celular)*

Identificare comunità di pratiche, attraverso dati di telefonia mobile

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Abstract

This paper focuses on the potentialities offered by mobile phone data to a reading of the site practices and rhythms of usage of the contemporary city by identifying the principal mobile practices of different urban populations. Beginning with the results of a research carried out in the Italian region of Lombardy, utilising mobile phone data provided by Telecom Italia, the paper will demonstrate how new maps, based on mobile phone data and better tailored to the dynamic processes taking place, can represent spatialized urban practices, provide new insights into the analysis of space-time patterns of mobility practices and be employed to recognise different "communities of practice". Mobile traffic data were treated as the effect of individual behaviours and habits that become aggregates, offering information about the features of usage of urban spaces that vary in time. The outcomes permit a visualisation of the spatial distribution of mobility flows, in addition to describing the experiential dimensions of commuting rhythms. It is possible to argue that commuting can be conceived as a mobile practice that exploits a rich variety of places of use in accordance with the temporal organisation of a day. The processing of mobile phone data, by offering new maps of site practices in Lombardy and information on temporary populations and city usage patterns (daily/nightly practices, non-systematic mobility), made it possible to trace 'fuzzy boundaries' as perimeters of practice. These practices are proposed as a tool for supporting and increasing the efficiency of urban policies and mobility services.

Keywords: Mobile phone data. Mobility practices. Communities of practice.

Resumo

Este trabalho consiste em evidenciar as potencialidades oferecidas mediante os dados da rede de telefonia móvel como instrumento de leitura dos ritmos de vida da cidade, induzidas pelos usuários e por suas diferenças espaciais, com o objetivo tanto de identificar o perfil das principais práticas móveis, quanto de explicar os fatores que definem as relações entre o espaço urbano e a mobilidade. A partir dos resultados de uma pesquisa realizada na Região da Lombardia, usando dados de telefonia móvel de Telecom Itália, verificou-se como tais

dados possam tanto restituir as densidades de uso do território, que as variações dos padrões temporais e espaciais de um lugar, consequentemente originando novos elementos interpretativos, úteis ao reconhecimento das diversas "comunidades de práticas". Na pesquisa, os dados do tráfico de telefonia móvel foram tratados como se fosse um resultado dos comportamentos e dos hábitos individuais que agrupados formam uma informação única sobre as características do território, e ao mesmo tempo, uma propriedade intrínseca do mesmo e como tal variável no tempo. Os experimentos realizados confirmem a utilidade desses dados de telefonia móvel em explorar não somente a distribuição espacial dos fluxos, mas as dimensões dos deslocamentos e dos ritmos. A argumentação consiste em que o deslocamento pode ser concebido como uma prática móvel, que oferece uma variedade de locais de uso, de acordo com a organização temporal de um dia, relacionados não somente com os eventos fixos (de trabalho), mas também com outras atividades.

Palavras-chave: *Dados de telefonia móvel. Práticas de mobilidade. Comunidades de prática.*

Riassunto

Il paper esplora le potenzialità offerte dai dati di telefonia mobile per leggere i ritmi delle pratiche d'uso della città contemporanea e le loro differenziazioni spazio-temporali, difficilmente restituibili attraverso fonti tradizionali. A partire dai risultati di una ricerca condotta sui dati di telefonia mobile della rete Telecom Italia in Regione Lombardia, abbiamo verificato se e come tali dati possano restituire le densità d'uso del territorio e la variabilità delle pratiche spazializzate d'uso della città, così da offrire elementi interpretativi utili a riconoscere diverse "comunità di pratiche". Nella ricerca condotta, i dati di traffico telefonico sono stati trattati come l'effetto di comportamenti e abitudini individuali che diventano, aggregati, un'informazione sulle caratteristiche del territorio, in qualche modo, una sua intrinseca proprietà, che varia nel tempo. Le mappe prodotte, anche grazie al confronto con dati di fonti statistiche tradizionali, offrono non solo informazioni utili sulla distribuzione spaziale dei flussi e sulle densità d'uso del territorio, ma rappresentano anche una importante fonte per leggere le modalità con cui differenti comunità di pratiche usano il territorio. Il trattamento dei dati di traffico telefonico, restituendo la variabilità spazio-temporale delle pratiche,consente di configurare territori contingenti, generati dalle pratiche di diverse popolazioni temporanee, come parte di un nuovo paesaggio istituzionale.

Parole-chiave: *Dati di telefonia mobile. Pratiche di mobilità. Comunità di pratica.*

Practices and urban rhythms through spatial mobility

The contemporary city is a "site of sociability" whose understanding is made possible through the reading of the routinization of site practices that follow their own rhythms[1] of appearance and disappearance (AMIN; THRIFT, 2002).

Sharing the position suggested by Amin and Thrift leads toward a heuristic value of the interpretation of site practices and rhythms of usage of the contemporary city.

The hypothesis of the research team is that mobility practices are among those that best reflect the complexity of urban processes and rhythms in contemporary cities.

Spatial mobility, interpreted as a "total social phenomenon [...], that is, not only as a movement, but as the action at the heart of social processes of operation and change"[2] emerged in the 1980s in the works of Michel Bassand and Marie Claude Brulharft (1986, p. 25), laying the foundation for a critical review of a reductive vision of mobility operated by both the social sciences and transport engineering.

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[1] Borrowing from the work of Lefebvre, Amin and Thrift argue that the rhythms of the city are "the coordinates through which inhabitants and visitors frame and order the urban experience" (AMIN; THRIFT, 2002, p. 17).

[2] My translation of "la mobilité spatiale est un phénomène social total, c'est à dire qu'elle n'est jamais seulement un déplacement mais toujours une action au coeur de processus sociaux de fonctionnement et de changement" (BASSAND, 1986, p. 25).

The gradual shift towards a more complex conceptualisation of the notion of mobility as a "translation" of heterogeneous practices that modify places, and also as the management of time-space resources (KAUFMANN, 2002), can be read in the contribution of several authors.

Working with the material conditions of mobility and associated practices, John Urry (2002, p. 17) attributes a central dimension in social life to mobility "because the contemporary world is defined by the circulation of goods, more than by stable structures and organisations".

In this sense, spatial mobility contributes to describing the forms and span of different life practices and consumer patterns, which produce diversified uses of the city. Mobility is both a cause and consequence of changes in the organisation of everyday life (URRY, 2002).

At the same time, when describing the transformations of the contemporary metropolis toward a "post-metropolitan" model, Soja (2004, p. 176) recognises that the evolution we are witnessing can be better understood not as a decline in the importance of the geography of sites with respect to the "space of flows", but as an accelerated reorganisation and restructuring of the geography of movements that define the spatiality of human societies.

Analysing urban transformations through mobility consents a movement across various scales of observed phenomena because "mobile practices are associated to different spaces and scales" (CRESSWELL, 2011, p. 5).

Spatial mobilities thus become a useful research tool for understanding transformations in the times, places, social life and work programs structuring contemporary cities (ASCHER, 2004; BOURDIN, 2005; SCHELLER; ULLER, 2006; CRESSWELL, 2006). At the same time, mobility also plays an important role in social integration for its implications in terms of social differentiation, as underlined by certain authors (TARRIUS, 2000; KAUFMANN, 2002; ORFEUIL, 2004). Mobility therefore implies a "project of mobility" (EHRENBERG, 1995) dependent on available resources, abilities, competences, acquired knowledge and organisational capacity, which are either strengthened or weakened by our practices.

In a strengthened theoretical framework, mobility research combines social and spatial theory in new ways (SCHELLER, 2011). In so doing it has provided a transformative nexus for explaining the role of mobility as a "social product" (CRESSWELL, 2006), and an "unquestionable process of urban-creation"[3] (LÉVY, 1999).

Seen from this perspective, the challenge is not to analyse mobility as such, but instead to analyse contemporary society through the realities of mobility (BOURDIN, 2005) or, in our case, the contemporary city through mobility practices. Mobility as a "transversal frame for reading social issues"[4] (BOURDIN, 2005, p. 20) represents an "analyser" (BOURDIN, 2005) useful for describing urban life and identifying "communities of practice" (WENGER, 1998), such as "mobile communities"[5] (LE BRETON, 2006).

The reference to "communities of practice" (WENGER, 1998), as opposed to "urban populations"[6] (MARTINOTTI, 1993), permits the recognition of the variability in space-time of the roles of individuals, who may belong to different communities of practice throughout the day.

If time-related changes in the city can be described through the concept of "temporary populations", the urban population can no longer be regarded as a collection of residents forced to move within the boundaries of the city.

According to Cresswell (2013, p. 92) "we are simultaneously part of different groups, we live our lives across a number of spaces as we move through the splintered city. We belong to many groups that

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[3] My translation from "la mobilité constitue aussi une technique incontestable de "urbanogenèse" et non un problème externe aux pratiques urbaines les plus fondamentales, c'est à dire à ce qui fait d'une ville une ville, à son urbanité" (LÉVY, 1999, p. 157).

[4] My translation from "cadre transversal de lecture du social" (BOURDIN, 2005, p. 20).

[5] "Groupes sociaux définis à partir de leurs inscriptions territoriales, de leurs pratiques de mobilité, des dispositifs techniques qu'ils mettent en oeuvre" (LE BRETON, 2006, p. 26).

[6] Moving away from the classical approach of social ecology, Martinotti (1993, p. 137-139) suggests we "conceptualise metropolitan development and emerging social morphology as the progressive differentiation of four populations (inhabitants, commuters, city users, Metropolitan businessmen) that characterise the metropolis". The four urban populations proposed by Martinotti (1993, p. 139-152) are nonetheless static figures that do not offer an understanding of the variable roles that may be covered by an individual during the course of a day.

rarely intersect. It may be the case that our identity as a national citizen is increasingly likely to be the less important one".

The term "communities of practices" is employed to focus attention on the fact that urban populations cannot be reduced to predefined and fixed categories due to the phenomenon by which they belong to multiple categories. For this reason it is important to consider populations not as static categories (inhabitants, commuters, city users, etc.), but as "groups of subjects that, temporarily and intermittently, share practices of daily life" (PASQUI, 2008, p. 148). Hence they can be considered "communities of practices" that generate particular space-time geographies.

The purpose of our proposition regarding the identification of "communities of practice" through the "lens" of mobility is not only heuristic, focused on describing new urban dynamics and time-variations in the use of urban spaces by temporary populations. It would also like to be a tool for learning about new claims and urban demands, in favour of more efficient and less costly urban policies.

Temporary populations, precisely for their variety and given the impossibility to limit them to logics of identity and representation, may *in fact generate new claims, but also new common goods*, without necessarily operating as intentional actors in public policies.

If we assume urban populations not as users of policies but as potential generators of common goods, the principal problem, more than one of delegation, is that of the "representation" of the pluralisation of identities in a public context (PASQUI, 2008).

Our hypothesis is that, through the study of mobility practices and their inscription in space, it is possible to recognise communities of practices and the intensities with which they utilise territorial services and infrastructures. This makes it possible to gather useful information on urban dynamics as a condition for structuring more effective urban policies.

Mobility can thus represent both a knowledge tool and a policy tool for understanding and regulating the process of transforming the contemporary city. This because mobility is also "part of the process of social production of time and space" (CRESSWELL, 2006, p. 5), including the dimensions of space and time, rarely treated in an integrated perspective by public policies.

Mobility is a knowledge tool because it is able to describe urban rhythms and the space-time dimensions of the practices of using a territory.

Mobility is a policy tool for its ability to root political action within the observation of daily practices, in order to construct *policies coherent with the emerging demands* being made by diverse populations using the city and its services, at varying rhythms and intensities.

The need to recognise the different profiles and practices of urban populations often constituted as "communities of practice", challenges the analytical tools and sources available to urban studies. While offering a representation of various urban rhythms[7] and identifying different mobile populations, the analysis of the space-time variability of the practices of using the city remains difficult to achieve with traditional data sources.

According to Sheller and Urry's article "The new mobilities paradigm", which called for new research methods "on the move" and able to "simulate intermittent mobility" (SHELLER; URRY, 2006, p. 217), it is important to formulate pertinent analytical approaches aimed at describing different densities in the use of the city and the combined movements of people, objects and information in all of their complex relational dynamics[8].

The heuristic and design possibilities offered by the "new mobilities paradigm" (SHELLER; URRY, 2006) question available analytical tools and data sources. They must describe different patterns of

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[7] Because the time of urban populations oscillates and is comprised of cyclical temporalities intertwined with a plurality of uses of spaces and places" (PASQUI, 2008), the rhythm of the city can be defined – according to Lefebvre – as "localised time" and "temporalized place".

[8] "Mobile methods" proposed by Sheller and Urry (2006) include: interactional and conversational analysis of people as they moved; mobile ethnography involving itinerant movement with people, following objects and co-present immersion in various modes of movement; after the fact interviews and focus groups about mobility; the keeping of textual, pictorial, or digital time–space diaries; various methods of cyber-research, cyberethnography and computer simulations; imaginative travel using multimedia methods attentive to the affective and atmospheric feeling of place; the tracking of affective objects that attach memories to place; and finally methods that measure the spatial structuring and temporal pulse of transfer points and places of in-between-ness in which the circulation of people and objects are slowed or stopped, as well as facilitated and speeded (SCHELLER, 2011, p. 7).

mobility in the form of "active biographies", which increase the range of "post-Fordist living and labour styles" (NUVOLATI, 2003, p. 71).

The new forms of mobility emerging in the contemporary city require interpretative tools for the identification of mobility practices. What is more there is a decline in the importance of commuter movements to the description of daily mobility practices. New forms of mobility, similar to daily mobility, are based on both the use of transportation systems and the efficient appropriation of information technologies. These elements have intensified the density and typologies of movements that traditional sources are unable to describe with continuity.

These mobility practices result from the combination of physical and virtual mobility, leading to new, mixed forms of daily, residential, and travel mobility (FLAMM; KAUFMANN, 2006). No longer referable to traditional categories (daily commuters, city users, businessmen, tourists, but also long-distance commuting and multiple residences) they now speak of "communities of practice" (WENGER, 1998). These populations use transport services and methods of communication in relationship not only to their real availability, but also in reference to their personal projects, to their preferences and their abilities[9] (access, skills in researching information, ability to adapt to short term changes, cognitive appropriation).

There is in fact an emergence of new forms of mobility, defined by particular authors (KAUFMANN, 2005) as "reversible" because they are relative to "practices of movement that describe a reversible use of territories and networks" (VINCENT GESLIN; KAUFMANN, 2011, p. 40).

These transformations to practices of mobility question available sources and open up toward operative challenges. They are measured in terms of their capacity to integrate different approaches. One approach employs the aggregate method (O/D flows) to study mobility as geographic displacement, recognising a proportional relationship between the utility and cost/time of movement. Another approach explains mobility as a spatialized form of social interaction (considering mobility as social capital and the territory as a space of social interactions facilitated by mobility).

The operative challenge to describing the different dimensions of mobility and its rhythms in urban spaces, as a condition for identifying communities of practice, lies in the integration between these two approaches.

In this perspective, an interesting contribution may be provided by mobile phone network data as a potential tool for the real-time monitoring of urban dynamics and mobile practices, as tested in several experimental studies.

Using mobile phone data to describe urban practices

Over the past decade, new approaches to estimating human movement through urban spaces using mobile phone data has been gaining ground in the fields of computing, interaction design and the social sciences (urban geography, social studies). This practice involves research into the use of aggregated and anonymous cellular network log files for reading fine-grained variations in urban movements over-time (AHAS; MARK, 2005; RATTI et al., 2006; KWAN; DIJST; SCHWANEN, 2007; READES et al., 2007).

Within these studies — focused on the analysis, visualisation and interpretation of human presences and movements in urban spaces through mobile phone traffic — the users generating telephone traffic can be considered the "sensors of a network". Distributed across urban space they provide information that traditional data sources for urban studies (census data, surveys and interviews or the deployment of sensor networks) are unable to produce.

This is why many authors consider the passive and anonymous monitoring of cell phone traffic to be a valid complement to traditional methods. This data can simultaneously overcome limitations in the detection of latency typical of traditional data

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[9] Drawing inspiration from the works of Kaufmann (2002), we consider the concept of motility, introduced by Kaufmann, to be highly effective for describing the capacity to be mobile. Motility powerfully express the way in which entities (persons, goods, information) access and appropriate the capacity for social-spatial mobility according to their circumstances, relating to access to different forms and degrees of mobility, the ability to recognise and make use of access and the appropriation of a particular choice (including the option of non-action, because this potential is not necessarily transformed into travel).

sources, and exploit the pervasiveness of the detection area guaranteed by the ubiquity of mobile phone networks.

If we consider observed and aggregated telephone traffic as the result of individual behaviours and habits, mobile phone data can be treated as a useful source of information on the *real* use of cities. This data captures traces of temporary populations and densities in the use of urban spaces (AHAS et al., 2010). Though difficult to intercept using traditional data sources, at the same time these populations have an increasing quantitative and qualitative affect on urban practices.

Human presence and its variability over time is an index of urban vitality and the liveability of urban spaces over time (temporal extension of urban activities). However, there is not necessarily a reference to functional patterns. This confirms the importance of mobile phone data in urban analyses and planning (BECKER et al., 2011) and to the classification of urban spaces according to their users' practices and behaviour (READES et al., 2007; SOTO; FRÍAS-MARTÍNEZ, 2011).

Placed within the stream of studies on the use of mobile data, the research presented below sought to verify whether mobile traffic data could be used to describe the rhythms of the city and its spatial differences in terms of the density of practices.

Mobile communities in the region of Lombardy read through mobile phone data

The research[10] carried out in the Northern Italian Region of Lombardy, employing mobile phone data provided by Telecom Italia, explores how new maps, based on unconventional data sources and better tailored to the dynamic processes taking place, can represent spatialized urban practices and provide new insights for understanding urban practices and lifestyles (MANFREDINI; PUCCI; TAGLIOLATO, 2012; PUCCI; MANFREDINI; TAGLIOLATO, 2013).

Two different types of mobile phone data were employed in the analysis of complex temporal and spatial patterns.

The *first type of data* concerns mobile phone traffic registered by the network across the entire region of Lombardy. Data are expressed in Erlang, namely the average number of concurrent contacts in a time unit. They describe the density of mobile phone traffic every 15 minutes across areas measuring 250 x 250 meters. From the telephone traffic recorded by each cell of the network, Telecom Italia distributed the measurements, by means of weighted interpolations, across a tessellation of the territory divided into 250 x 250 meters square areas (pixels). The research does not consider the Erlang data directly[11]: it takes into account the ratio between the Erlang of traffic in these pixels and the total amount of traffic, at the same moment, in the "universe" (i.e. the sum of traffic across all the pixels of the entire matrix, in this case representing the region of Lombardy). This relative measure provides the amount of telephone traffic in a certain spatial region with respect to the total telephone traffic. This information is more likely to provide information about the variation in the number of people.

This information was treated statistically in order to be compared with the variables that can be derived from consolidated data sources (census data, land use). This data was used to evaluate the possible correlations between variations in the intensity of cellular network phone calls and land-use conditions (MANFREDINI; PUCCI; TAGLIOLATO, 2012).

This preliminary evaluation of data related to the density of phone calls (Erlang) brought to light a number of evident limits[12], together with relevant potentialities for urban studies.

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[10] "Utilizzazione di dati di traffico telefonico nell'ambito di applicazioni urbanistiche e territoriali" ("Utilisation of telephone traffic data for urban and territorial applications"), research contract between the Politecnico di Milano and Telecom Italia, coordinated by Paola Pucci and Fabio Manfredini, with Paolo Tagliolato.

[11] Erlang raw data describe the quantity of absolute mobile phone traffic in one pixel at a certain moment.

[12] This data does not consent the establishment of a direct correlation between the density of phone calls (Erlang data) and the number of people present in a cell. This is also because, as known, the use of the cellular telephone is conditioned by socio-professional user profiles (age, sex, profession). Hence, the Erlang value registered in a cell during 15 minutes of telephone activity, may be produced by 3 people speaking for 5 minutes, or by one individual speaking for 15 minutes.

A novel, unsupervised geo-statistical learning technique aimed at identifying useful information on hidden patterns of mobile phone use, over a period of 14 days in September 2009, revealed data of great interest regarding the usages[13] of the city at different times and in different spaces. This information was also related to the organisation of important temporary events (i.e. the International Design Week). During temporally circumscribed periods, these events attract large numbers of tourists, *city users* and temporary populations distributed across the city with diversified rhythms. These groups make intense use of particular urban services, though it is difficult to gather data using traditional sources (MANFREDINI; PUCCI; TAGLIOLATO, 2012).

The second type of data consists of origin-destination matrices derived from localised and aggregated tracks of anonymous mobile phone users. The data set was collected on different working days (five Wednesdays in July, August, September, October and November 2012). In this case the available information was based on the time-space geo-location of mobile phone activity. The expression "mobile phone activity" describes each interaction of a mobile device with the mobile phone network (i.e. calls received or made, SMSs sent or received).

This information was available at the level of the antenna handling the activity. This capillary information (not directly accessible for privacy policy constraints) was used to extract data in hourly time series of origin-destination matrices, describing the number of users at each hour of a day from an origin to a destination zone[14]. Origin-destination zones were determined as tiles of three different tessellations[15]: the present study defined a tessellation related to the density of antennas[16], consisting of 526 zones in the region of Lombardy (TAGLIOLATO et al., 2013).

Data on the origin-destination of the traces of cellular phone users made it possible to map[17] the distribution of movements undertaken for professional and personal reasons, between origins and destinations, at diverse hours of the day, using a realistically significant sample of people (more than one million per day based on a population of 9.7 million inhabitants).

While recognising the value and limits[18] of the available experimental data, the data processed by the research was used to describe the space-time variability of presences in the study region, also taking into account traditional statistical sources[19].

Solely for their characteristics, these two data types allowed the team to develop representations of the dynamics of several on-going processes.

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[13] The term usages of the city intends the inscription within space of the urban practices that mobile telephone data allow to be measured, including density of presences (Erlang) or flows (O/D matrix) with an important spatial-temporal resolution.

[14] The research aggregated information related to individual cells (antennas) in order to obtain useful polygon elements that would offer the possibility to map and interpret primary spatial patterns of mobile phone user mobility. The aggregation was determined by applying an algorithm of hierarchical clustering to the location of the antennas, resulting in 526 polygons. Through a process of tessellation, we defined a set of polygons that made it possible to map the direction and intensity of mobile phone user movements on an hourly basis. Using this data, we performed an analysis aimed at evaluating the overall mobility of cell phone users in the region of Lombardy (TAGLIOLATO et al., 2013).

[15] Three tessellations are defined as: automatic aggregation of municipalities with at least 13 antennas per area (313 zones); Manual aggregation according to the characteristics of urban settlement (202 zones); clustering of antennas (526 zones). This final zoning was obtained by calibrating the algorithm to reach sufficiently balanced clusters (i.e. with a homogeneous number of antennas per polygon).

[16] The spatial distribution of antennas depends on the amount of mobile phone traffic to be managed. In dense urban areas we therefore observe a high concentration of antennas, while in the suburbs the density of antennas may be very low.

[17] The interactive maps can be found at: www.ladec.polimi.it/maps/od/fluxes.html

[18] In addition to the specific limits of the data (i.e. missing the modal split), establishing a "direct" link between phone calls and the number of people or trips, encounters some major limitations. To begin with, the use of the mobile phone depends on age, sex, profession, time and activities, hence it is difficult to take into account the possible cross effects: the elevated number of situations means that it is almost impossible to reach a conclusion on a purely quantitative basis derived solely from mobile phone data. This is particularly important if we wish to use mobile phone data for urban investigations aimed at planning the provision of personal services, for which statistical data are required. Secondly, long term effects may diverge from short term effects, in particular because as individuals gain familiarity with technologies, they may begin to combine them, or because the equipment rate increases and available functionalities change rapidly, as has been the case with mobile phones.

[19] Including O/D flow matrices from the Regione Lombardia (2002) and a qualitative survey by the Provincia di Milano (2006), together with land use maps and demographic census data.

The first type of data: densities of use of the city

In order to analyse the differences between specific hourly, daily and weekly distributions of mobile phone density (using Erlang data), the team specified a statistical processing (spatial clustering) focused on recursive trends over the period considered and containing different temporal patterns of mobile phone activity (i.e. daily, workday versus weekend) (MANFREDINI et al., 2012).

This model produced a selection of maps of the spatial distribution of mobile phone traffic. This information was superimposed over a mapping of the primary facilities of each urban area (infrastructures, large shopping centres, railway and underground stations, trade centres) with the purpose of interpreting the concentrations in densities, also in relation to key activities and urban supplies.

The outcomes, described by the maps (Figure 1), highlight particular urban districts characterised by specific mobile patterns compatible with the region's urban structure.

Furthermore, they offer new time-varying maps of the region that permit the spatialization of different communities of practice using the same places for diverse purposes and in different ways throughout the day.

In particular, it is possible to observe differences in the spaces of mobility during morning and evening rush hours in the urban region of Milan. Using accurate space-time information, our findings describe a trend discussed in literature and regarding the non-coincidence between mobility practices during peak morning and afternoon hours, when the chains of displacements, generated by the same populations, are more articulate and complex (Figure 2). Comparing these two maps on mobility patterns (Figure 2) it is possible to deduce that those commuting between 8:00 a.m. and 9:00 a.m. (morning rush hour) become city users between 5:00 p.m. and 7:00 p.m.
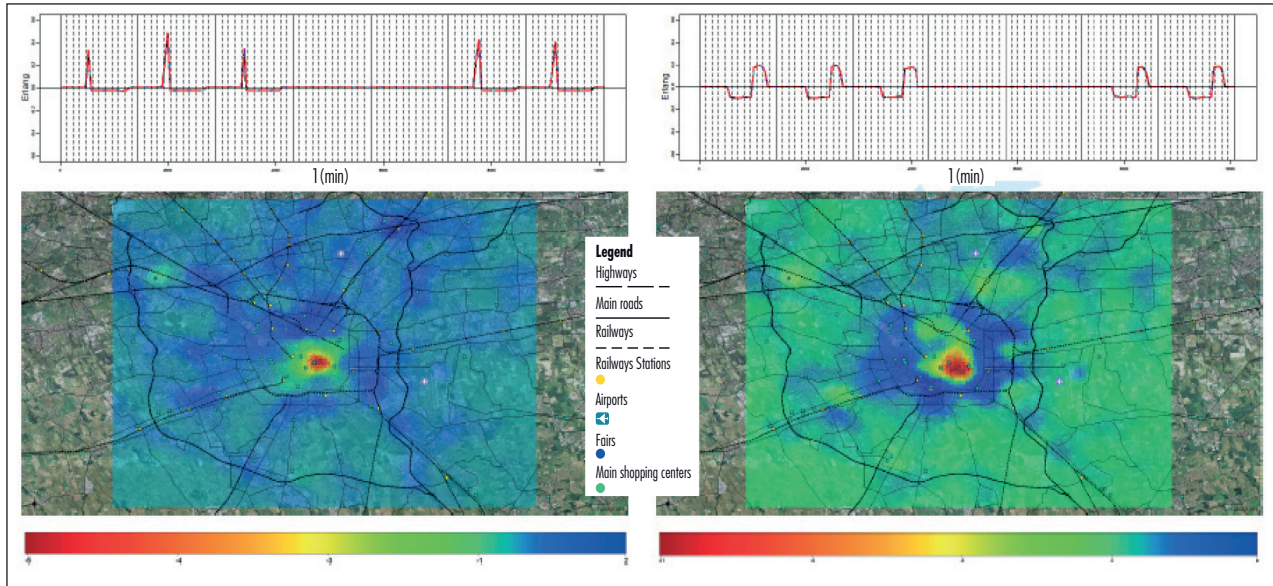
The map of evening rush hour mobility patterns (5:00 p.m. to 7:00 p.m.) describes detailed places linked to social practices (shopping, going to the gym, picking up a family member or friend). The result is a dense and widespread use of the territory that traditional sources fail to capture, with consequences on infrastructural networks and demands for public transport.
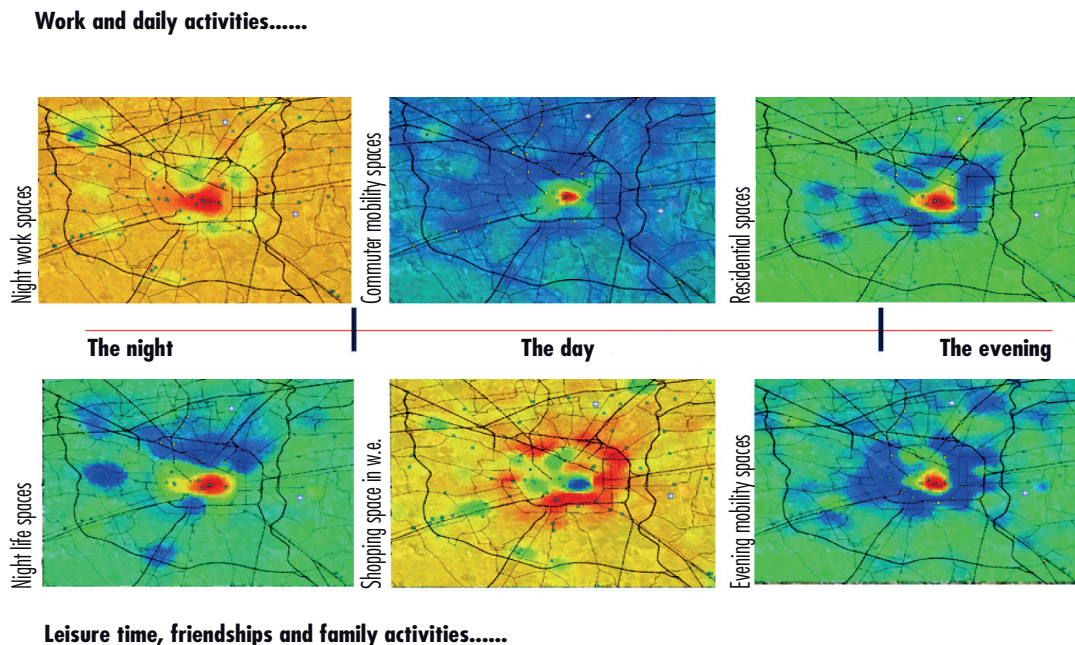
Figure 1 - Site practices through mobile phone data
Source: DASTU; MOX, 2013.

Figure 2 - Daily mobility spaces: morning rush hour map (left), evening rush hour map (right)
Source: DASTU; MOX, 2013.

In our opinion, these maps effectively represent the mobility patterns of those working in the city as they return home, but also the places where these practices are occurring recursively. It is this feature (repetitiveness) that allows us to speak of "communities of practice" or "mobile communities"[20].

The use of urban spaces described in our maps questions policies for the provision of public transport, as well variations in the use of urban spaces in space-time, according to unexpected features.

This makes it possible to clearly distinguish hourly, daily and weekly activity distribution patterns in the urban region of Milan: shopping and leisure spaces during the weekend (between 10:00 a.m. and 8:00 p.m.) privileged in the inner city centre of Milan and the western part of the city, while commercial malls along ring roads do not appear to have a remarkable weight in Saturday practices (Figure 1), despite being referred to as the most

popular places for weekend leisure activities. The geography of densely crowded sites on a Saturday night show a clear difference with respect to the territories of evening/night work during the week (Monday to Friday night) (Figure 1), unknown by other sources.

The mobile phone data and methodology presented were able to explore a much finer and more extensive pattern of distribution of urban activity than that allowed for by traditional travel surveys. The same data raise questions about particular theoretical interpretations of the "erratic and nomadic behaviour of metropolitan populations"[21] that characterise urban practices, already confirmed by well-known studies (SONG et al., 2010). Indeed, while the data confirm the important density of daily movements, the same data also show a strong recursion path: while we move a lot during the day, we tend to do so along familiar and habitual paths.

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[20] This approach is complementary to existing methods proposed in literature, also with respect to the use of tracking technologies and/or other digital data. The individual traces of a sample detected using tracking technologies (i.e. GPS, SMS) offer a more precise result because it is possible to record the origin and destination track of individual movements. On the other hand, this means a greater cost for data processing and the necessity to build a statistical sample of users. Moreover, problems related to individual privacy raised several ethical questions for this type of research. Instead, the use of aggregated data collected from the network (mainly cell towers) allows the research to move away from the individual level, focusing on the emergence of complex urban dynamics related to the places that people use and frequent (GONZALEZ et al., 2008).

[21] For example, in the influential work of Gilles Deleuze and Felix Guattari (1983), or Paul Virilio's (1997) texts on dromology

The second type of data: the experiential dimensions of commuting rhythms

The second typology of data (the origin-destination matrices derived from localised and aggregated tracks of anonymous mobile phone users) allows for a mapping of the main hourly distribution of origin-destination movements of a vast sample of people (more than one million per day). This data is unavailable from traditional data (census flow data).

Our interest lay in visualising the flows of mobility in the region of Lombardy, without available traditional data, but also in describing the experiential dimensions of commuting rhythms. The argument is that commuting can be considered a mobile practice (EDENSOR, 2011, p. 189) that exploits a rich variety of places of use in accordance with the temporal organisation of a day, linked not only to fixed events (employment), but also with other activities.

The processing maps are heuristically valuable: they describe phenomena — movements carried out for both work and personal reasons — with temporal continuity throughout the day, with an elevated space-time resolution (TAGLIOLATO et al., 2013).

The information derived from the continuous mapping of flows[22] represents an important basis for reading the effective dynamics and impact of spatial mobility. It also assists with the more efficient and fairer management of urban transport and supplies.

The real-time mapping of a daily mobility catchment area of a primary urban centre, proposed in our research[23], offers important information to the management of local public transport and tariff policy, as observed in Milan.

Superimposing the perimeters of the institutional management of local public transport in Milan over the boundaries, varying in time, of mobility practices obtained from mobile phone data traffic (Figure 3) reveals how "the profound structural effects (or destructuring) of spatial mobility on institutional boundaries"[24] (ESTÈBE, 2008, p. 6) expose a clear discrepancy between fixed jurisdictions and "mobile factors".

This map provides considerable indications with respect to the effective catchment area of Milan, to which regulation measures and appropriate costs of public transport services should correspond.

In the urban area of Milan, 8.5% of the municipal budget is intended to cover the costs of supplying urban services (POLA; FERRI, 2012), with public transport accounting for a significant share. The "political price" of a public transport ticket in Milan (€ 1.50 per ticket) benefits not only inhabitants, but also the city users, tourists and commuters intensely using Milan's public transport network. However, these temporary populations do not contribute to covering the real costs of public transport; as non-residents, they are not subject to local taxation.

Conversely, temporary populations make use of urban services, governed by local Authorities in a city (Milan) where they do not live and do not vote; this condition is synthesised by Martinotti (1993, p. 163) as the "paradox of voting".

In this case, the availability of data capable of describing the variability of Milan's sphere of influence is an important prerequisite. It serves not only to improve the supply of public services, but also to legitimise interventions focused on re-modulating pricing policies for public transport services, currently considerable as unfair (tariff policies, public transport services supply etc.).
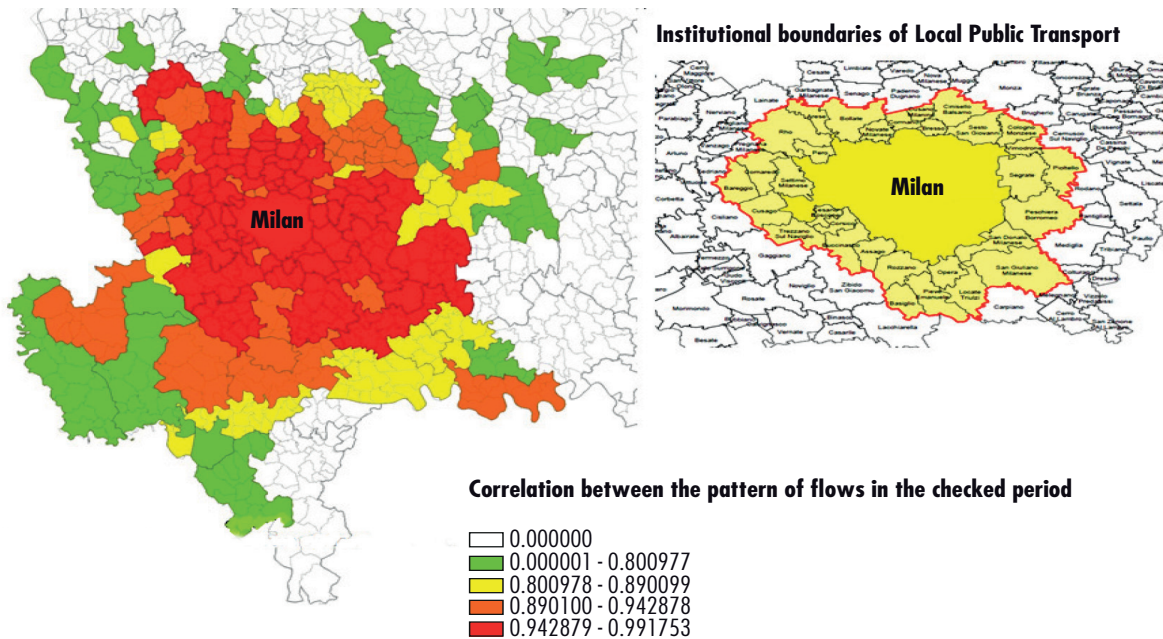
The different types of cell-phone data employed in our research, integrated with one another and inserted in an urban information system can help to provide knowledge about new urban dynamics, which can be used in a practical sense[25]. This also emerged from interviews with institutional players and researchers, with whom we spoke at the outset and during the final

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[22] With the initial purpose of "validating" this new source of data, we drew up a set of maps displaying the sum vector of flows moving from each zone at different hours of a typical working day. The sum vector is the single vector resulting from the sum of each single connection between each zone. It is characterised by two dimensions: magnitude, which is a function of the magnitudes of the original vectors, and angle, which expresses the direction of the flow. The sum vectors were then applied to each zone of the fine-grained tessellation (TAGLIOLATO; MANFREDINI; PUCCI, 2013).

[23] An interactive map is available at: www.ladec.polimi.it/maps/od/fluxes.html).

[24] My translation from "Les effets profondément structurants (ou déstructurants) de la mobilité des personnes sur les territoires politiques" (ESTÈBE, 2008, p. 6).

[25] The most interesting aspects are referred to the monitoring and management of large events, variations in the densities of people by day/night, concentrations of activities, the provision of services to different users, the monitoring of mobility flows.

phase of the research. Each of the experiments carried out opened up new questions and research perspectives: the team is currently studying the topic of spatial clustering. The aim of this line of research is to profile and describe a region using its cell phone data, in order to study the usage of the city by means of synthetic Erlang trends and O/D flows, able to characterise prototypical temporal patterns.

Interim conclusions for a research in progress

Far from seeking a deterministic analysis that allows for continuous real-time calculation, referred to by Nigel Thrift as "qualculation" (THRIFT, 2008), we attempted to evaluate the possible implications of two typologies of mobile phone data in order to map the spatial dimension and the density of the use of the city and its services.

If "certain footprints have a personalised value [...], that is, if they indicate the presence of a person implied from the outset"[26] (FERRARIS, 2009, p. 336), in our research these "idiom footprints" are not connected to an individual, but instead to "communities of practice". This is because the nature of the data provides aggregate behaviours related to the intensity of mobile phone use.

Unlike most studies on mobility patterns, analysed by following individuals, our research focused on the longitudinal activity patterns of network cells rather than individual users.

This implies a consideration of telephone traffic data as the effect of individual behaviour and habits. This data becomes an aggregate, offering information about the characteristics of a territory, in some way its intrinsic property, which varies in time.

In this perspective, the maps — produced with mobile phone data — represent the territories made by communities of practice that generate contingent boundaries with a relational and variable value, due to the dynamics we plan to capture and regulate.

[26] My translation from "Certe tracce possiedono un valore individualizzante [...] ossia segnalano la presenza di una persona che ne è all'origine e che vi è implicata" (FERRARIS, 2009, p. 336).

The issue of defining relevant boundaries to deal with the variability of relationships, with rich social networks and the multi-scalar dimension of urban practices that institutional boundaries fail to deal with, is at the core of Spatial Planning debates.

While there is a consensus, in specific literature, on the need to build relevant boundaries as a resource of institutional capital through which new initiatives can be pursued rapidly and legitimately (HEALEY, 1998, p. 1531), questions are being asked about the practical impact of this shift. A different articulation of skills and resources that will improve the regulation of practices and help to generate the new frameworks required for institutional innovation also require the identification of variable boundaries.

The challenge is posed in terms of interpretive tools able to recognise "soft spaces" (such as transversal spaces) and "fuzzy boundaries" (such as fluid perimeters). There is also a need for an operational understanding of the effects on what Haughton et al. (2010, p. 52) refers to as "formal hard spaces of governmental activity".

If the contents and the key dimensions of these notions gather consensus, even in view of their fundamental characteristics[27], which express "the new post-devolution spaces of planning" (HAUGHTON et al., 2010), less obvious are the operational impacts in terms of relationships with institutional perimeters corresponding with powers and strengthened responsibilities.

Interpretations of urban dynamics through mobile phone data, offering a picture of the territoriality of practices that deform institutional boundaries, can provide a useful contribution, not only to the recognition and naming of the territories of urban practices, but also to a "re-scaling" of hierarchies of intervention, and thus to the governance of dynamic processes, as briefly recalled in relation to public transport pricing policies (PUCCI, 2013).

In the relationship between fuzzy boundaries, built on "communities of practice", and institutional spaces, problems related to the temporal variability of the practices at the origin of the fuzzy perimeters, such as the mechanisms of political representation of communities of practice, remain unresolved.

Nonetheless, the 'informal boundaries' defined by these practices may become part of an 'institutional landscape', generating new models of public involvement and actions capable of intercepting and responding more effectively to the emerging social demands that can be read from these practices.

If we accept the condition that "all territorial governments exist in a condition of permanent dissociation between citizens, inhabitants and city users"[28] (ESTÈBE, 2008, p. 17), the possibility to 're-scale', offered by the boundaries defined by mobile communities, may assist with the construction of geographies of partnerships between different stakeholders. They may also promote forms of cooperation, not necessarily and forcibly linked to institutional frameworks.

In this perspective, the processing of mobile phone data, by offering new maps of site practices containing information on temporary populations and city usages patterns, can be considered a valuable support for tracing fuzzy boundaries as perimeters of practices, useful to a reterritorialization of urban policies.

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[27] Among these (HAUGHTON; ALLMENDINGER, 2008):
- "They are representative of a deliberate attempt to generate new thinking and insert new models of public engagement […];
- They are not antithetical to hard spaces, but are intended to work alongside, augment and — where more expeditious — challenge existing institutional frameworks and practices;
- They are becoming more important and more numerous as part of the changing institutional landscape of spatial planning;
- They are predominately defined (or not) in a fluid fashion, and with reference to fuzziness, in order that they are more amenable to a shifting range of issues and actors involved in spatial planning projects".

[28] My translation from "Tous les gouvernements territoriaux vivent sous un régime permanent de dissociation entre les citoyens, les habitants et les usagers de la ville" (ESTÈBE, 2008, p. 17).

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