**“Territorial Smartness” and Emergent Behaviors**

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**Abstract**— The increasing smartness of personal devices and territories are rapidly changing the scenarios of data production. Data access and/or data possession can determine positions of privilege, but the real competitive advantage will derive more and more from the ability to identify relevant dimensions and flows and, of course, from that to extract meaningful multidimensional descriptions aimed at detecting and foreseeing emergent behaviors (particularly relevant those concerning small communities) or, in other words, from the ability to transform "big data" into "smart data".

Prerequisite for obtaining this goal is the identification of appropriate models and adequate spaces of representation that may inspire the development of appropriate strategies and methods of analysis. Few examples will be provided.

I. INTRODUCTION

Waiting for the advent of an usable and safe implementation of Internet-of-Things, able to transform "future visions" [1,2] into reality, at present information on the behavior of large amount of people can be collected in four different manners: a) by means of voluntary insertion of data (e.g. by filling forms or by performing on-line activities like when you use an ATM, obliterate a bus ticket, etc.); b) by means of sensors placed at key points of the flux "pipes" (e.g. energy or water consumption meters, detectors of environmental parameters, etc.); c) by associating appropriate transmitters of position to moving entities (e.g. cars, to detect the flow of traffic; waste, to follow the flow of waste recycling chains; goods, to monitor their movements, etc.); d) by means of personal devices that nowadays, due to their high level of penetration, smarteness and "always on" state, not only enable to locate the user through cell phone triangulation but also to get multidimensional information ranging from precise geolocation, to accelerations and orientations and, thanks to the cooperation of the individuals, to real time acquisition of any kind of multimedia signals.

All data collected according to the above strategies are the result of individual actions but the big difference between the dataset produced by a), b), c) and most of those produce by d) resides in the different degree of access to the datasets. Those produced by a), b), c) are usually collected and owned by companies (service providers) that do not disclose the datasets because their possession is considered, in most cases, strategic; as consequence the knowledge is a prerogative of a few. Strategy d), on the other hand, produce datasets that, by means of suitable apps, are potentially accessible to anyone and could allow for a collective production of open datasets.

As we will see, the geolocation and time dependence of datasets could allow anyone to perform a multidimensional and dynamical monitoring of the territory and, therefore, to study in real time emerging phenomena, also for the purpose to formulate strategies that may help to support closer the expectations of the people.

Collective dataset obtained according to d) may also allow to perform a more meaningful benchmarking of what one may define experience of "smart city/territory", as shown by means of few examples in the next paragraphs.

We have chosen to apply our considerations to the Smart City domain because cities due to their anthropogenic concentration will be the places that, in few years, will produce more than 75% of the world's datasets, not only the places that will consume 75% of the world resources by producing, in turn, 75% of the Earth's pollution..

II. SMART CITY: CONCEPT AND MODELS

Before to discuss the typical approach adopted to benchmark the smartness of a city, it is necessary to provide a brief introduction to Smart City: definition and models.

The "Smart City" concept was created around 2007 to:

i) include within the city's capitals also the intellectual and social ones [3,4], considered as important as hard infrastructures (i.e. physical capital);

ii) exploit ICT as infrastructural backbone to support all our behaviors and improve of all key factors contributing to the regional competitiveness [5].

According to the definition given in [6] a Smart City should be a "city well performing in a forward-looking way in six "smart" characteristics (also called 'soft factors': "smart economy", "smart mobility", "smart environment", "smart people", "smart living", "smart governance"), built on the "smart" combination of endowments and activities of self-decive, independent and aware citizens”.

Other authors are trying to connect the above 'soft factors' with an evaluation of the relevance of the components of so called Triple Helix (the engines of the innovation system: University, Industry, Government) [7,8] and its modified version that includes also the product of the interactions of the three helices, that the proponents suggest to be: i) 'knowledge' stock generated by the interplay of universities and industries; ii) collective 'learning' due to the synergies deriving by the
Figure 1. Principal Component Analysis of medium size European cities rankings, made available by [5]. The ellipses identify areas characterized by a large (++ or a scarce (--) attention to any of the pillars of the smart city functionalist model: green = environment; grey = mobility; light blue = economy; purple = living; orange = people; yellow = governance. The arrows indicate, at large, directions of maximum positive or negative slope. Coordinates of the Y1 and Y2 principal components are in arbitrary units.

According to this model a city is smart “when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance”.

Nowadays, however, typical Smart City operational approaches tend to adopt a top-down functionalist model that aims at optimizing, possibly in a standardized manner, the consumption of primary tangible and intangible resources (energy, water, materials, food, etc.) and to save time which is another important resource, usually associated with both money and individual freedom. To save this time a smart city needs, of course, to optimize and thin the flows of people, goods and data.

In such approaches "smart citizen" are considered, rather, as "smart consumers" that must be educated to take rational behaviors compatible with the policies promoted by the municipalities aimed at promoting a sustainable economical development. Moreover the relevance assigned to learning is not very significant at all: it is relegated to a quantitative measure of the density of the infrastructures and of the products (e.g. PhD students) produced by the educational chain, and/or of the consumption of cultural products.

III. SMART CITY BENCHMARKING AND RELATED PROBLEMS

In this context, the approach that is used to benchmark the smartness of a city is equivalent to take snapshots (thanks to resources made available by many different statistical Institutes) of the yearly average behaviors of a city. The outcomes of the "big data" that have been collected and squeezed are, at the end, a series of ranking lists from which it is difficult to perceive the nature of the cultural diversity that identify a territory. A better insight can be obtained only by reading dozens of pages of reports commenting the ranking lists. Despite the data compression operated to compile the ranking list it would be possible to carry on smarter analysis using, for example, well-known inferential
statistical techniques, such as the Principal Component Analysis (PCA) one. To show how the analysis can assume a smarter look we took the outcomes of the benchmarking that few years ago has been conducted on 70 European cities of medium size [6].

The analysis compared the cities on the basis of the six dimensions that sustain the traditional functionalist models of smart city: smart economy, smart mobility, smart environment, smart people, smart living, smart governance. By taking the data that can be found on [6] and applying a PCA it comes out, and it is not surprising, that all dimensions except ‘smart environment’ are more or less correlated with the ‘smart economy’. ‘Smart environment’, on the other hand strongly influence the position of the cities along Y2 (the second principal component), see fig. 1. From this figure we can deduce many interesting information. It emerges, for example, that in France the attention put into the preservation of the environment is very high while it is much less relevant for the Anglophone area (UK and IE). The environment seems well preserved also in most Romanian and Greek cities, but this is also the consequence of a low rate of industrial development. Finland stands out for the quality of governance, while countries that are characterized by a sufficiently high quality of life (in terms of smart mobility, smart living and smart people) are those located in the BENELUX area, in the Nordic regions (DK and SE) and in Austria. While it is not sufficient to fully explain the top-ranking position, it may be interesting to note that are all geographical area characterized by a reduced dimension of the countries and/or by a favorable orography that help in the managements of fluxes. The limited number of people living is such area make sometime also more manageable the application of participatory approaches. Most of these countries distinguish themselves also for their Smart Economy that is strongly correlated to all other pillars of the model, except for the smart environment. In fact the cities located in the Anglophone area are top ranked in smart economy. Italy is particularly bad ranked in mobility while the "black shirt" of the city smartness is the prerogative of most of the Eastern Europe countries (Bulgaria, Hungary, Romania, Poland, etc ...).

This exercise, although based on and make use of a traditional approach to the benchmarking of the city smartness, shows that also the European continent is characterized by relevant infrastructural and cultural differences and, therefore, that no smart city model can be considered universal because local cultures and constraints have a key role in determining the route toward the development of a smart city. The above type of considerations, derived from a smarter analysis of the compressed data (ranking lists), is by itself able - beyond providing useful hint for planning – to warn policy and decision makers against the adoption of universal solutions that may reveal not be the most suited ones for a given territory and can "inspires" companies to design, develop and propose solutions that can flexibly adapt to the context, to better meet its peculiarity and the propensity of its inhabitants, according to the “dochakuka”, i.e. glocal, vision [10].

A second problem arising with the standard approach to the benchmarking of the city smartness is the disappearance of the temporal dimension, i.e. the dynamics.

The dynamics is important not only because it allows you to identify the pulse of a city - and, therefore, emerging behaviors and critical situations - but also because it allows you to provide a more appropriate definition of smartness. As well known, the physical space and the "place" are not equivalent [11] this latter acquires its 'identity' through the relationships that people establish and the activities that take place and put in relation entities belonging to different physical spaces, the rules and conventions that permeate it, the cultural layers (cultural DNA) that are deposited in there, the emotions and memories that is able to evoke in each of us.

In a nutshell a 'place' is an anthropological space that exists due to the presence of actors and artifacts, the relationships that are established between them, the processes that take place within and among the physical spaces and the related services. A 'place', moreover, does not exist as an isolated entity but is able to generate around itself what we may define a 'field', that drive all long range process and interactions needed for its 'functioning'.

Because of this we can not identify the boundaries of a "smart city" with, for example, those of its 'center' or of its peripheral ring but we must include all areas that are connected by flows of significant intensity (see Fig. 2). For this reason, the space relevant for our purposes is the "space of flows", i.e. a space that is constantly redefined by its dynamics.

![Figure 2. The boundaries of a “smart territory” are constantly redefined by the fluxes relevant to its functioning.](image)

Examples in this regard can be found in the work of the SENSEable City group at MIT [12], whose members had the possibility to access large datasets collected by big
companies (mobile phone companies, banks, etc.): use of mobile phones in given geographic areas, business transactions profiled by product category (Spain), the usage of taxis, etc..

Particularly interesting from the point of view of the analytics of fluxes that can redefine the territories are the works devoted to the analysis of mobile phone traffic in the United Kingdom [13] or in the United States [14]: new region appears, other squeeze or disappear. The authors were able to detect the "pulse" of a territory and, therefore, the behavioral patterns characterizing and narrating about the on going events in areas of various dimension - from a campus, to a district, to cities (Rome, Graz, Singapore, etc.) and even the whole world with respect to a city of reference (e.g. New York, Singapore) [12].

Interesting from the point of view of the strategic approach was the work aimed at tracking the waste, because it required a physical intervention [15]: the application of a transmitter able to geolocate the object. The result of such work demonstrated once more how the interaction goes well beyond the boundaries that are supposed to identify physically a given portion of space (e.g. a smart city). From these experiments it was also possible to make emerge how the interaction, and thus the redefinition of the territorial boundaries, is actually a multilevel one: the range of interaction and territorial boundaries that depend heavily on the specific object that is at the core of the monitored interaction.

Studies of this kind can be used for improving logistics, time and the intensity of services and are functional to the optimization of the fluxes. They are also very useful to mitigate the top-down approach to the design and monitoring of territories thanks to an accurate visualization and analysis of the behavior of the masses, as a result of individual behavior. The individual, therefore, starts to assume a greater relevance, although one can certainly go further in the design of a "people centered" smart city/territory.

IV. A PEOPLE-CENTERED VISION AND THE NEED TO DEVELOP A MODEL OF THE EXPERIENCE

To counterbalance the technocratic visions of "cold cities" and going beyond the framework and analytics described in the previous paragraphs, one needs to put the citizens at the heart of the Smart City vision as individuals feeling smart not only because they have learned to optimize resources' consumption and preserve the city's capital but, rather, because, they experience high standard living from all relevant dimension of the human experience at both individual and collective levels. Individuals who live in the city, in fact, are persons who, in their work, are driven by motivations and expectations, desires, needs, persons who have their own styles. It is pretty obvious that the challenge is to promote a more social oriented and inclusive bottom-up vision driven by a "person centered in place" design approach, supporting the harmonious and continuous development of all experiential dimensions relevant to individuals, to the community of belonging and to the contexts of reference. A model of the individual experiences, a model that has to include individual styles, social characteristics (interaction among individuals), context peculiarities and process characteristics. The model should be as general as possible to serve as reference framework, but as flexible as possible to be adapted to the cultural peculiarities of each territory.

To this end, in the past we has developed the model of contextualized experiential processes, represented in fig. 3, that define a set of dimensions describing the individual styles and, as well, the characteristics of the context with respect to the process' layers [16]. On the third axis we have represented the three functional layers of the organic process [17] that summarize the essence of the development of any experience: exploration and collection of relevant information; processing of data followed by development (design & development); communication.

Resuming shortly, the individual experience's styles include: sensory-communicational preferences (in/out), information processing peculiarities (sequential/global; by contrast), interaction styles (physical, social, emotional, cognitive), game attitude (divided into propensity for competition, risk, vertigo, and mimicry [18]), creativity, propensity for divergence and innovation, motivations. Of course, many experience styles could be further detailed through a subdivision of the space of representation. Where necessary, for example, the cognitive characteristics (under interaction styles) can be exploded in attention, memory, interpretive strategies, self-control, etc. The affective perception can be specified through appropriate dimensional [19,20] or finite state models [21] of emotions to compose a given mood. Similarly it is possible to explode the propensity towards the various perceptual channels, specific media and/or languages. The mode of interaction may be described by specific quantities and/or qualities such as the degree of connectivity, resolution and proximity, directeness, etc.[22]. Each sub-categorization, however, implies, an increase of the "dimensionality" of the space of representation and
complicates further the use of the model. Case by case, therefore, it is necessary to select the subspace of representation most appropriate to a given experiential process.

The description of the place within which the process takes place and with whom the individual interacts include the following meaningful elements (see Fig. 3): the average characteristics of people (different from our main actor, and possibly representing the community) that populate the place, the own characteristics of the place (cultural stratifications, typology, etc.), the characteristics of physical and/or virtual spaces (lighting, noise level, weather conditions, location, size, etc.), associated activities/services, interactions with other contexts/place (modalities and intensity), the contextual characteristics of time (season, month, day, hour, etc.), the characteristics of artifacts relevant to the process considered. A fourth dimension, the time dimension, will allow to represent the dynamical evolution of the experiences’ characteristics. Of course, to this generalized model of the experience one has to apply appropriate filters to select, each time, the features that we deem most relevant for the specific territorial context in which the individual experience takes place.

The complex and multidimensional essence of the experience demands, of course, for a special ability in developing strategies aimed at monitoring the significant dimensions of the experience and to work out, by mean of an accurate and multidimensional analysis of the traces produced, equally significant indicators and visual representations, in order to evaluate the ability to support expectations of individuals and small communities.

Here, as an example, we show how it is possible to monitor the emotional state of a community (engaged in a learning process) and visualize the emotional quality of the interaction, together with the social emotivity. To achieve these goals one has to monitor the intensity and contents of those exchanges (e.g. messages posted in a forum or messages exchanged privately; in the case of an urban context messages exchanged by means of smart personal devices and eventually left into social environment like Facebook or Twitter) from which, then, by anonymous automatic text analysis, you can extract the emotional content. To do this one has to identify meaningful markers, i.e. a corpus of words that convey emotional states [23]. To make the analytics support at the best a bottom-up approach one can select a quite large sample of candidate words and then set up a test procedure that allow people to indicate the emotion/s conveyed by each single word (in our case according to the Plutchik model [19]). Once that the histograms of the emotions conveyed by each word has been obtained (a convolution of emotions conveyed in many different contexts) one can extract the average distributions of emotion conveyed by all texts selected, written by the members of a given community. For example the strip of histograms, row a, in fig. 4 shows as, for the process considered, the emotional state of the community stabilizes and remains unchanged over time. The high levels of all positive emotions indicate a general satisfaction of expectations of the majority of the community members.

Figure 4. Time evolution of the distributions of emotions as detected by means of automatic text analysis: evolution of the average emotions of the group (row a); evolution of the distribution of emotions for a sample of individuals (row b-d).

Figure 5. An example of representation of the social emotivity developed during a learning process. Colored halos represent the average emotion of each individual. Band histograms and circle on the links represent, respectively, the distribution of and the average emotions characterizing the exchanges among the member of the community. Colors have been assigned according to the Plutchik model (see legend).

The other strips of histograms of fig. 4 shows how the emotional state of the individuals tends to synchronize with that of the community. In the example considered, the
synchronization occurs at different time for each different individual and it is maximum in the fifth month. This observation makes us understand that it is possible to go further and combine quantity (Social Network Analysis [24]) and quality (automatic text analysis) analytics to monitor the modification and development of the social emotivity.

Fig 5 shows a "small world" representation of the social emotivity, for brevity averaged on the whole time window of the process considered here as case study. This representation shows how it is possible to visualize, at the same time, the mean emotional state of each individual and that of her/his relations with the other members of the community. Such analytics allow, of course also to monitor the possible development of critical situations. From the figure, for example, it is quite evident that the most problematic situations are found in individuals who are at the periphery of the social group. By mean of a timely and accurate monitoring, it would be possible to identify such situations and take appropriate actions to better support the expectations of all members of the community.

The methodology illustrated here above is not specific to learning processes and can be used in a very general manner also to monitor the experiences of a territory for the purpose of improving the quality of social interaction (inclusion, satisfaction expectations, etc...) or, for example, to support a touristic experience.

V. CONCLUSION

To resume this contribution has been intended to convey the following messages:

a) are not the "big data" to be relevant but what we may define the "right data": a selected and well focused collection of traces that can be transformed in "smart data" by smart analytics, i.e. into truly informative dataset able to disclose path and characteristics of an on going process (or experience);

b) ranking lists provide a limited and not direct insight of the propensities of a given context (in our case a territory) and in particular of their cultural and developmental models; ranking lists, in fact are not only difficult to interpret but often appear to consider parameters strongly correlated each other; the search for a more appropriate representational spaces is needed to make emerge the correlations existing among the dimensions considered for benchmarking and, what is more relevant, to provide a straightforward picture of the differences existing among policies and cultural factors that shape territorial developments;

c) static analytics is not enough and risk to be functional to the benchmarking of top-down approaches to smart cities; nowadays the rate of penetration of the personal devices allows to observe geolocalised dynamics of a lot of phenomena and make emerge not only behavioral patterns but, above all, to redefine - as function of range and intensity of the relationships - the borders of the territories; borders that may result to be different as function of the parameter that have been considered, to point out the multi-layered nature of the territory and of the society; an important aspect of such dynamical analytics, worthwhile to stress, is the relevance assumed by the individual contributions: the analysis, in fact, develop from the monitoring of the individual behaviors of the members of a community;

d) in order to give more relevance to individuals and their expectations with respect to territorial experiences, and thus to strengthen the bottom-up approach to starting cities, a model of experience is needed; such model, in fact, allows for the identification of a significant set of dimensions, either at individual, community and environment level, and to follow for a significant traces ("right data");

e) the identification of meaningful traces require the development of appropriate monitoring, analytics and visualization techniques, aimed at extracting those indicators that are able to identify at the best critical situations and to measure the ability to meet the expectations of a community with respect to a given place/territory.

It is quite obvious that the one described in the previous paragraphs is a medium-long term program that requires important efforts for its implementation, but, it should be also quite evident that the adhesion to such a program could help to avoid efforts in producing documentation of limited "relevance".

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REFERENCES