Ancient Cartographies as a Basis for Geolocation Models in Public Space: The Case of Giambattista Nolli and its Heritage Application

IOP Conf. Series: Materials Science and Engineering 471 (2019) 092031 doi:10.1088/1757-899X/471/9/092031

Ancient Cartographies as a Basis for Geolocation Models in Public Space: The Case of Giambattista Nolli and its Heritage Application

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Abstract. In 1748, the architect and surveyor Giambattista Nolli mapped an abstract reality of the city of Rome. As a challenge to the inherited projections, it represented the city mixing streets, halls, corridors, churches, baths and markets as part of a unique public space network. A new way to design public space and rethink the whole urban system was opened by the possibility of containing in these representations a single layer with all kinds of public space (including the interior of public buildings). Despite this, Nolli's plan remained as a useless instrument since the hegemony of automobile mobility appeared as a pre-eminent system. This research tries to understand how the application of the ancient cartographies' methodology can improve the pedestrian mobility of historic cities by means of enhancing the graphic value of the system of Giambattista Nolli. Nowadays, free public space is represented as empty and built ones, as solid. This proposal would revert this reified conception of the city, understanding this baroque representation as an instrument of identification and assessment of the transitional heritage. The clues unveiled by Nolli seem to be able to integrate the plans of public buildings within the urban tissue, which would result in a step towards the full integration of cartography and mobility. The success of the comprehensive tools offered by large servers such as Alphabet inc. (Google) or Bing Maps confirm the suitability of the combination of new technologies and Big Data with urban planning, reaching the synchronisation of Smart Cities. Nowadays, open public space can be 'walked in' from any electronic device, consequently, the application of the "Nolli methodology" would implement the model of urban geolocation with the assimilation of inner public spaces. In the creation of a great global map of the public space, a chimaera could be intuited. This would be discussed within a tangible reality: every open public space is already housed in the Big Data and it is accessible through geolocation tools. The inclusion of the of the public buildings' interiors would contribute to develop a greater permeability between city and citizens. Furthermore, this representation would optimize pedestrian travel times and would be able to expand the geolocation system network as a documentary repository.

1. Introduction

Using the inherent humanistic component of the city, the research seeks to implement the model of urban geolocation (geoportals) by adapting the cartographic system implanted by Giambattista Nolli (1748) to digital tools based on Big Data. The Italian architect and surveyor represented (in one of the first urban cartographies carried out with methods of scientific measurement) the public space of Rome in an integral way. All those places that can be stepped on by the pedestrian appear with the same graphic treatment as the streets, avenues, squares, halls, corridors, interior of churches, bathrooms, markets and courtyards. Integrating the walkability of floors in public buildings, as a basic instrument in geolocation systems, would suppose an advance towards a full integration of cartography and mobility, public and private.

As main objective, the research will be delved into the functional alternatives that allow the implantation and synchronization of a neocartography proposal with the geolocation and LBS systems. This would bring users inside public buildings as well as provide peremptory information (geodatabase) for the optimization of the means of urban mobility.

2. Cartography as a useful tool: a necessary theoretical revision.

Abraham Ortelius, with the help of Gerardus Mercator, built the first Atlas of the World between 1567 and 1570 (figure 1.). This appeared to be a key moment, when the pieces of a world distorted by the fantasies of each traveller began to fit in (already in 1500 Juan de la Cosa had faced in his world map the New and Old World). The perspective of the territory was widened between borders, limits, seas and mountains draws veiled routes so far. Travelers, many of them dedicated to cartography, are responsible for correcting each of the salient, incoming and geographical aspects, while the idea of belonging to a land, to a tangible and comprehensive world, is based on collective thinking. The main objective was, then, "to show the curved lines as straight lines, to facilitate the work of the pilots: we had to proceed to make a geographical projection - cartographic - relating the points located in a rough spherical surface (the Earth) on a canvas, on a flat surface, [1]"

Two hundred years later, in 1748, Nolli mapped an abstract reality of the city challenging, like Ortelius and Mercator, the inherited projections. The twelve engraved copper plates that compose the map, 1.76 m wide by 2.08 m long, condense two thousand hectares of urban land and part of the territory surrounding Rome, subsequently, opening the doors of the Baroque and witnessing a renewed conception of the city. The Russian avant-garde, integrated by eccentric bourgeois with metaphorical concerns as well as several philosophers and writers, such as Saint-Exupéry, will capitalize on the discovery of the world from a bird's eye view three centuries later. In this way, flight and aviation would become creative acts alien to reality, detached from the human scale. The cartographer leaves the physical world for a journey through abstract drawing as a tool, a practice inherited in contemporary times and which, without being conscious, bifurcates the paths of city and society, of space and subject. The decision taken, on which lines are captured on the map and which are forgotten in absent lines, leads to a landscape common to almost all ideological cartographies, with projections that explain the look and intention to whom the perspective of the time is conditioned to.

2.1. Mobility dynamic thinking

The drawings of the world and scientific cartographies continued being objective of the members of the Modern Architectural Movement. Among them, the figure of Buckminster Fuller stands out. He had already designed in 1932 the Dymaxion car -Dynamic Maximum Tension-, a prototype of three-wheeled and drop-shaped car, which optimized the aerodynamic conditions of existing models. The rear wheel is the one that directed the car and allowed to describe turns of 180 degrees on itself, reaching speeds of up to 190 km per hour. Despite the initial reluctance, Fuller was forced to introduce a Ford V8 engine. The energy saving was achieved by placing small motors in each of the wheels, but its particular handling, inverse to that of conventional vehicles, ended up hindering its commercialization.

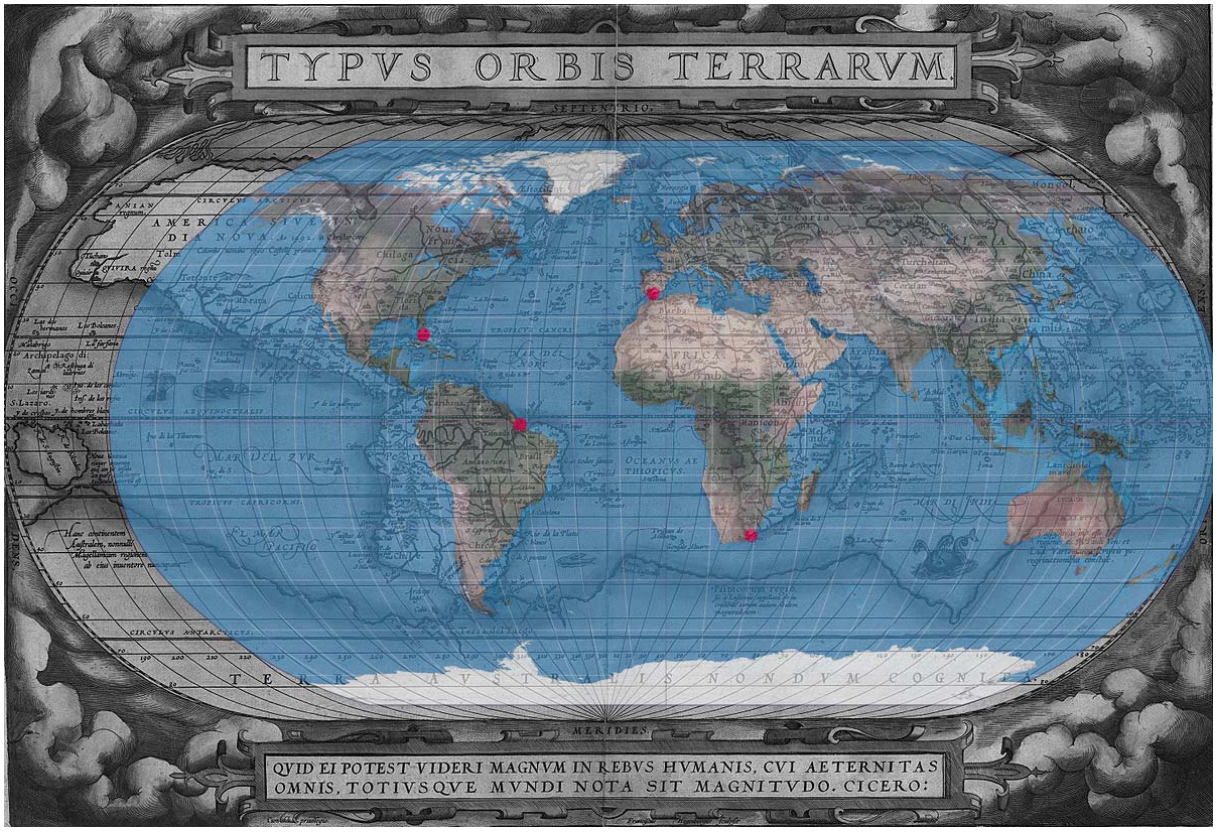

Figure 1. *Theatrum Orbis Terrarum*. Abraham Ortelius (1570), superimposing the current map projection. The accuracy of the cartography is measured through four control points.

The second prototype of the Dymaxion included the possibility of handling each wheel independently to adapt the movements of the vehicle to the streets of each city. Doubling the length of a conventional car, its six meters allowed it to accommodate up to eleven passengers, without losing its lightness. But in 1933, during World's Fair in Chicago, an accident would rule the future of the Dymaxion. The crash seriously damaged the car, the driver died and the passengers were injured. Although it was subsequently shown that the cause of the accident was unrelated to the vehicle, production become suspended: the company that had produced the three prototypes of the Dymaxion, the 4D Company of Connecticut, went bankrupt a year later and Fuller renounced to the vehicles and yielded them to its employees as a reward. Of the two remaining prototypes after the accident at World's Fair, one of them was found abandoned in California, in the sixties, and was acquired by the National Automobile Museum, who restored it, following the scarce graphic information available. Norman Foster, admirer of Fuller's work, took up the unfinished Dymaxion, being reconstructed in an English workshop in East Sussex, in what would be the fourth Dymaxion in history. Buckminster Fuller, with this prototype, recovers the moment in which memory has not yet codified the facts and has not taken any ownership of the descriptive identification of the object, enveloping it in an uncertain and malleable reality.

The explanation of the journey of Fuller supposes the first clear and radical example of the links between new cartographies and new means of transport. At the same time, the design of the Dymaxion car allows the architect to apply a new way of thinking and seeing the world. In 1943, Fuller drew a map of the complementary world, which would guide himself when using the Dymaxion car (figure 2). The map, to which its creator granted innumerable advantages over other geographical projections, maintains the relative sizes of the regions (Fuller himself strove to compare it with the one of Mercator) and minimally distorted the forms (arguing that the standardized map-world improves of Gall-Peters). However, the most characteristic feature is the absence of a fixed and clear direction.

Fuller explained on several occasions how in the universe there is no "up" or "down" or "south" or "north", only "inside" and "outside", claiming that the north-south distribution was nothing more than a bias cultural. There is no correct address on the Dymaxion map; unfolding the triangular faces of the icosahedron that compose, ending in a network of contiguous landmasses, instead of groups of continents divided by oceans. On the other hand, if it is deployed in reverse, the world is shown dominated by a body of water surrounded by land. Although the map entails the objective representation of reality, it retains the utopian enthusiasm for the exploration of unusual territories and spaces through cartography.

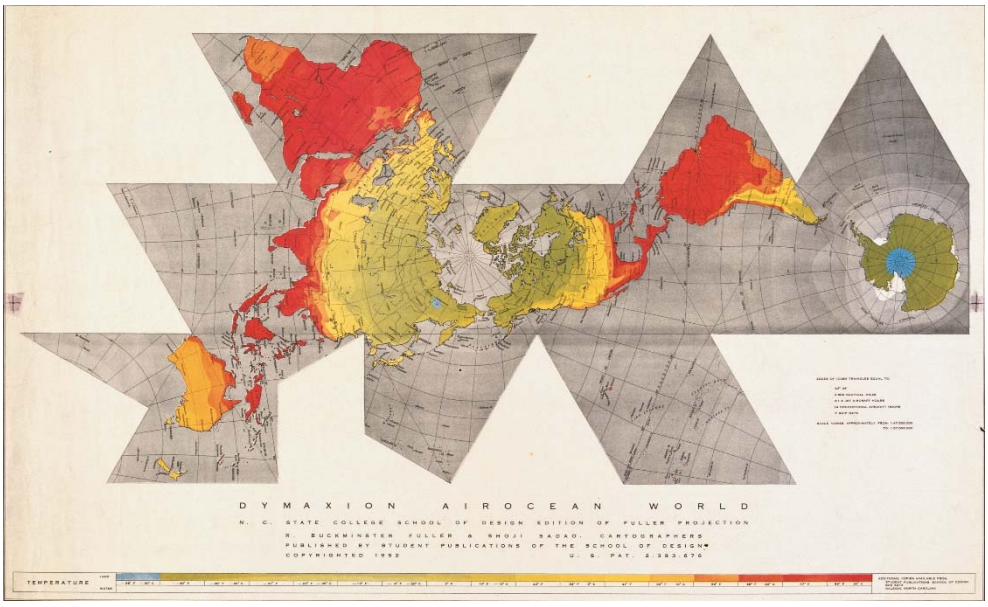

Figure 2. Dymaxion map. R. Buckminster Fuller (1943)

Fuller's impulse to define a heterodox way of representing the world is a reflection of Nolli's. With three centuries of difference, both rethink the cartography (in the Italian case, unconsciously) as a complementary tool to urban mobility. In recent years, the advancement of geo-strategic technologies has been applying its successes to urban mobility, offering crucial improvements that facilitate the habitability, use and access of public space, as well as creating a renewed way of representing and perceiving the city. The first cartographic projects in geo-portals were born from informal communities [2] to evolve into cyclopean tools such as Google Maps and Street View, among which the Google Art Project stands out, which allows us to go inside some of the most famous museums in the world. Collective mapping projects such as Open Street Map, are accompanied by the development of the global positioning system (GPS). In the dawn of this theme, the doctoral thesis "Heuristic Nolli map: a preliminary study in representing the public domain in urban space" [3] stands out, research in which the geographical information system GIS is paradigmatically introduced as an analysis tool capable of generating a joint perspective of urban context and architectural semantics. As a prelude to this work appeared "Urban infoscapes: new tools to inform city design and planning" [4], which, despite being written in a period prior to the development of geo-technologies urban application, was able to provide for the collection of big data as a justifying quarry of new planning formulas and urban logic.

2.2. Mediterranean city as a field of application

In the historic Mediterranean city, the free spaces hold both symbolic and patrimonial values, that position them as referents of the local imaginary and of individual and collective sociability [5]. Public space emerges as the first and last link in the relations between its inhabitants, and therefore, it is

widely considered as own and of collective use. Despite the **historic tissue** and the instrumental advances for its treatment, a clear gap appears between the humanistic conception of the city and the globalized technological reality. Being the public space the motor that balances the mobility between private spaces, it has the capacity to model a reality that "begins to dissociate, in the last five years, from its only known matrix until now: physics", [6]. The repository of public places that draw the 'empty reality' of the city is considered as a strategic area of study, analysis and intervention. The fundamental role of geolocation and interconnection between urban users is justified by a growing technological instrumentalization of mobility, a parameter that has not been taken into account in none of the ranges of the current urban legislation. The need to amend this technological-legislative gap is especially relevant in a context of population condensation in cities -with a forecast of a 66% global by 2050 [7]; in the case of Andalusia, it currently exceeds a 55%-. This forces to look for new formulas of reading and considering the public space through alternative systems of mobility, able to manage this increase of flows, spatial tensions and social frictions. The new technologies applied to contemporary urban development are mostly processes, measuring instruments, simulators, equipment, software systems and hardware [8], that make up the instrumental map of intervention in cities: the city abandons the flatness of the two dimensions until reaching the level of interconnected information system. Being a consubstantial vector of European culture (across the Mediterranean arc), public space stands out as a core object of study, "a fundamental subject in the construction and viability of future cities", [9].

As Rob Kitchin [10] points out, "Real-time analysis of urban life and new modes of urban management provide the raw material to imagine and enact a more efficient, sustainable, competitive, productive, transparent and open city". Following the same initial approach, but with diametrically opposed conclusions, Kenneth Currier and Viktor Mayer-Schoenberger describe five new concerns in the prevailing technological reading of public space: "the policy of large volumes of urban data in friction with privacy, the technocratic government and the development of the city as new authoritarian formulas, technological enclosures and disconnection with physical space, fragile and hackable cities, and an extremely panoptic city", [11]. This strategy of superimposing timeless tools aims to provide urban planning with a new instrument, capable of "improving mobility in the city", [12] through the application of technological tools. Without losing the solid root of the patrimonial and collective values of the public space, they may motivate an integral conception of public space and free circulation and accessibility of person as in the city. Fixing the final subject of pedestrian research could reverse the planning strategies based on the optimization of roped mobility.

It is precisely in a sinuous urban tissue where it is more evident that the intermediate spaces between public and private are part of the political-public reality of the city. The application of technical advances in cartography is a fundamental fact to understand the logic of G. Nolli. (figure 3.). The "Open Rome" plan is drawn up by an extensive team of assistants and apprentices for twelve years (1736-1748), which implies a huge technical effort. This concern demonstrates the importance of mapping these spaces for three main reasons:

- The discovery of hidden interstitial spaces in traditional cartography
- The optimization of pedestrian mobility in the historic city, optimizing consequently the journey times.
- The improvement and enrichment of the built architectural heritage.

Figure 3. Area Piazza Navona-Pantheon (Rome, Italy). Overlay of the Nolli plan (1748) and the current plan of the city of Rome (source: Google Maps). The millimeter precision of the nineteenth-century plan shows how scientific methodology is introduced in cartography.

The use of the keys given by Nolli has already been applied, in first instance, by the large companies of open geolocation that in a hegemonic way serve as a tool for urban mobility. There are several studies developed by Alphabet Inc. focusing on the mapping of intermediate spaces, without deepening in its application globally.

3. Mapping the public and semipublic space in an open source context

Among the latest advances, the 4G multisensory technology developed by the Telefónica company stands out, presented at the Mobile World Congress in Barcelona in 2016. The tool allows detecting the perimeter boundaries of interior spaces from a mobile device and drawing, in real time, the space inside where it is. At the same time the person is moving, the smartphone sends all data through the 4G network to a server in the Telefonica cloud for later, thanks to a series of artificial intelligence algorithms, selecting the most relevant data depending on the scenario.

By combining all the data, the system is able to estimate the position and behavior of the user with an amazing accuracy. In an administrative building, for example, each user will be able to find exactly where the office is that he has to go. The same system could also be used in bus or train stations to prevent agglomerations.

This technology will also make marketing possible, which will allow, for example, customers who wander through a shopping center to receive advertisements or messages associated with the trade in their terminals compared to what is happening at that moment. The precision is so great that it will even be possible to know if the customer is in a corridor next to the exhibitors on the left or on the right. Precision, again, appears as an indispensable element as it happened in the original recognition of G. Nolli.

Indoor positioning systems that use communication infrastructure usually use a system of combined technologies, which include Wi-Fi, Bluetooth, RFID, infrared, ZigBee, ultra-wideband, visible light, telephony antennas or NFC. The triangulation that occurs with the application of these systems calculates the distance to the reference devices. Despite the widespread use of this multi-

signal strategy, the use of low-power Bluetooth-based nodes (BLE) is expanding, such as Google's Eddystone and Apple's iBeacons.

As in the case of outdoor positioning, in addition to knowing the position, it is necessary to have the corresponding map of the environment that allows navigation; reason that motivates and justifies the rescue of the logic applied by G. Nolli. With the fusion between the humanistic of baroque cartography and open source technologies, a macro-service appears to be available to the users of the cities.

The consolidation of Smart Cities continues in a trend towards the traditional public space (confining itself exclusively to free space), so that the opening of the concept of the public seems necessary. As B. Fuller applied dynamism as a crosscutting theoretical basis, global development policies will tend to encompass interior spaces. This delimitation of the boundaries of public and private spaces must be accompanied, as it has been said, of a specific legislative definition that explains the limits between security, data protection and optimization of mobility.

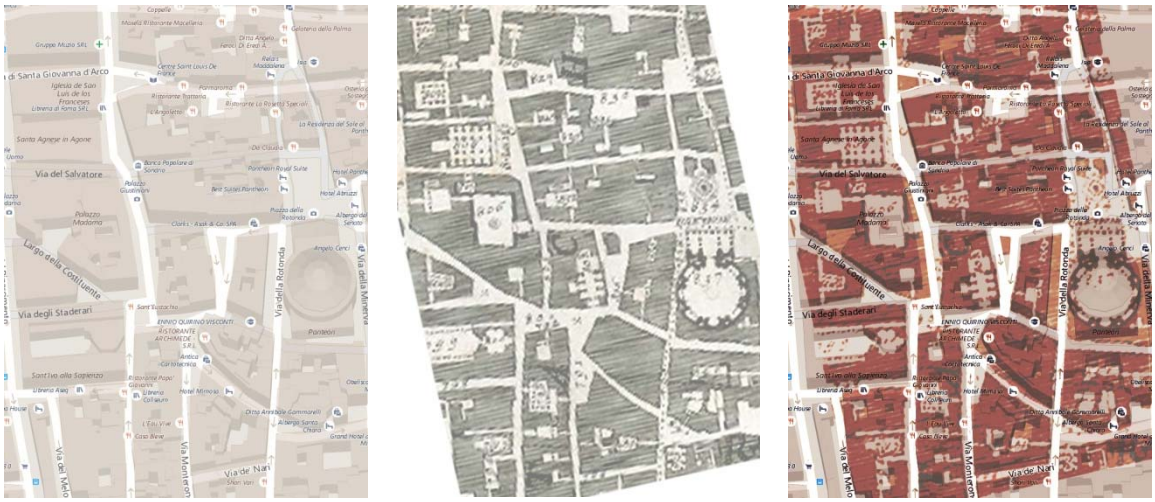

Figure 4. Pantheon Area (Rome, Italy). Process of incorporation of the representation logic of G. Nolli to the Bing maps service.

The need to outline a common legal strategy is essential for the development of social security and stability objectives. The generation of a "total cartography" capable of integrating the entire public space could be achieved through two radically different strategies:

1) The establishment of a Big Data information accumulation system, integrating the data provided by personal mobile devices. This tool would conflict with the data protection law present in most developed countries, despite being the most plausible way to achieve a consistent database, according to events and technological development.

2) The implementation of an integrated global cartography following the parameters described by G. Nolli, in order to establish some common criteria. This delimitation should combine the benefits of the contribution of knowledge of urban heritage and the accessibility to interior public spaces and private property. This criterion would serve to delimit the lack of control in the generation of information exported from mobile devices. In this case, the use of 2D drawing would be indispensable. Despite being considered an expensive and outdated tool, it allows the generation of a highly controlled material, in addition to providing millimeter accuracy that is difficult to achieve through the application of Big Data.

In addition to mobility, the juxtaposition of global public spaces within the historical framework of Mediterranean cities allows for bringing heritage closer to citizens and researchers. Observing how the floor plant of urban buildings is part of the city and of the space that can be traced by citizens, allows us to understand how those places are unquestionably a common heritage.

4. Results and discussions

There is a clear relationship between thought, design and mobility. Evidencing how the work of B. Fuller is able to combine a common strategy from technology, cartography and means of transport, shows a lack of concern about the new tools of geolocation when rethinking the cartographic systems. The absence of historical and humanistic references in the development of these new instruments begins to lead to a clear distortion of the limits of the public, security and privacy of the collective.

Despite this, the recovery of G. Nolli's methodology applied to geolocation in Mediterranean historic cities appears as a feasible opportunity through a simple axiom: drawing the city using 2D tools. The key would be set in developing a system that combines the exportability of 2D drawing files in geographic information systems (GIS) and, in turn, the applicability of GIS tools in open geolocation systems (Google Maps or Bing Maps). This technical recovery would allow, in addition to being an executive tool of legislation with a place in international law, the improvement of pedestrian mobility and the approach of heritage to its citizens. Combining the drawing of the city -according to the legislative limits- with the georeferenced databases of the large map companies, a new useful application tool would appear. It presents a very limited consumption of resources and a decrease in radiation, by means of the use of data and the rationalization of Big Data consumption, in addition to the preservation of privacy.

The human impulse to improve its mobility is born from its own genesis. The evolution in cartography has always had an indissoluble matrix: the improvement of knowledge of its environment. It is precisely this question that justifies and supports the need to move towards a next step towards the union between city, technology and heritage.

5. Conclusions

The update of the cartography of universal access through urban geolocation services must go through a double decision: the establishment of legal criteria capable of separating the public from the private sphere and the application of an instrumental logic matured, based on criteria that appear successively in the historical representations of the world and the city. The possibility of incorporating the public space of the buildings appears as an opportunity to generate an open patrimonial content as well as the so-called improvement of pedestrian mobility and optimization of time management, having proven as feasible and appropriate.

Acknowledgments

Acknowledgments to the Ministry of Education, Culture and Sports of the Government of Spain, main funder of the research work through a FPU Scholarship.

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