The syntactical value of a spatial sign

空间符号的句法价值

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ABSTRACT

The main purpose of this paper is to contribute to the debate over the relation between Rio de Janeiro's favelas and formal city by questioning if, and to which extent, their lines of mutual connection mould the structure and accessibility of both the local and global networks. More specifically, the study applies space syntax segment angular analysis to shed new light on the role played within the city's network by the entrances of favelas. By examining and discussing the outcomes of previous syntactical, historical and ethnographical analysis of Rio de Janeiro, the paper finally argues that entrances work as thresholds, gates, that filter the movement and structurally define an inside-outside distinction between favelas and the planned city.

抽象

本文的主要目的是通过质疑里约热内卢的贫民窟和正式城市之间的相互关系，以及在何种程度上相互影响着本地和全球网络的结构和可及性，从而为辩论做出贡献。 更具体地说，这项研究应用了空间句法片段角度分析，以进一步了解贫民窟入口在城市网络中扮演的角色。 通过检查和讨论先前对里约热内卢的句法，历史和人种学分析的结果，该论文最终认为，入口是门槛，大门，它们过滤运动并在结构上定义了贫民窟和计划中的城市之间的内外区别。

KEYWORDS

Network connections, threshold, favela/slum, space syntax, angular segment analysis.

关键词网络连接，阈值，贫民窟/贫民窟，空间语法，角度分段分析。

1. INTRODUCTION

In July 2001, local activists of the Movimento Nacional de Favelas (National Movement of Favelas) installed gates and cameras at the main entrances of Rio de Janeiro's tenth biggest favela, 4 Jacarezinho (Figure 1 and 6). They intended to protect the area against the abuses of police officers. The attempt, stopped by the police as irregular, was to create the first Condomínio-Favela, by provocatively adopting the security model of the city's wealthiest gated communities (Costa Vargas, 2006). In her book, Favela: Four Decades of Living on the Edge in Rio de Janeiro, Perlman (2010) observes that Rio's low-income,self-built settlements, when occupied by militias or drug smugglers, share a “distinguishing characteristic” (p.32) with the city's healthiest neighbourhoods: controlled entrances. That is, entrances work as filters regardless of the nature of their keepers.

1.引言

2001年7月，国民小国民党运动的当地积极分子在里约热内卢第十大贫民窟4 Jacarezinho的主要入口处安装了大门和照相机（图1和6）。 他们打算保护该地区免遭警察的虐待。 试图以挑衅性地采用该城市最富有的封闭式社区的安全模式，试图创建第一个Condomínio-Favela，但遭到警察的不定期限制（Costa Vargas，2006）。 Perlman（2010）在她的著作《贫民窟：里约热内卢的四个边缘生活十年》中指出，里约的低收入自建住区被民兵或毒品走私者占领时，具有“显着特征”（p .32）与城市最健康的街区：入口受控。 就是说，无论门房的性质如何，入口都可以充当过滤器。

By randomly checking the news section or the literature over Rio’s favelas, it is evident that entrances constitute an acknowledged threshold between the outside and inside of favelas (or the formal city,depending on the point of view). The newspaper Folha de S.Paulo (1998) once reported that police blocked the entrances of a group of Rio's favelas, Cantagalo-Pavão-Pavãozinho, until the local drug smugglers get “asphyxiated”. Thus, eloquently suggesting that the connection between every favela and the rest of the city pass throughout these spots.

通过随机检查里约的贫民窟的新闻栏目或文献，很明显，入口构成了贫民窟的外部和内部（或正式城市，视角度而定）之间的公认门槛。 Folha de S.Paulo报纸（1998年）曾经报道说，警察封锁了里约热内卢的一个贫民窟，即Cantagalo-Pavão-Pavãozinho，直到当地的毒品走私者被“窒息”。 因此，雄辩地暗示，每个贫民区与城市其他地区之间的联系贯穿了这些景点。

Nevertheless, to the knowledge of the authors, there is virtually no literature that focuses on this critical spatial issue. This paper aims at filling this critical gap. The primary objective is to contribute to the debate over the relation between favelas and formal city by questioning if, and to which extent, their lines of mutual connection mould the structure and accessibility of both the local and global networks.

然而，据作者所知，几乎没有文献关注这一关键的空间问题。 本文旨在填补这一关键空白。 主要目的是通过质疑相互联系的路线是否以及在何种程度上塑造了本地和全球网络的结构和可及性，从而促进了关于贫民窟和正式城市之间关系的辩论。

For consistently comparing the different scales and parts of the city of Rio de Janeiro and point out local structures that are not evident, the study uses Depthmap's segment angular analysis. More specifically, the examination of the outcomes adopts choice (NACh) and integration (NAIn) as normalised measures.Rio de Janeiro's segment map, obtained by the simplification of the city's road centre-line (RCL)georeferenced map (IPP, 2018), is the base for the analysis. The outcomes of the analysis are examined in QGis, together with the spatial dataset of favelas areas (IPP, 2018).

为了一致地比较里约热内卢市的不同规模和部分地区，并指出不明显的局部结构，本研究使用了Depthmap的线段角度分析。 更具体地说，对结果的检查采用选择（NACh）和整合（NAIn）作为归一化的方法。里约热内卢的路段图，是通过简化城市道路中心线（RCL）地理参考图获得的（IPP，2018）， 是分析的基础。 分析结果在QGis中进行了检验，并与Favelas地区的空间数据集一起进行了检验（IPP，2018）。

The paper is structured in four sections. First, the problematisation section presents and relates the conclusions of two applications of segment angular analysis to Rio de Janeiro (Hillier et al., 2012; Krenzet al., 2015) with the historic urban studies of Abreu (1987; 1994) and the ethnology of Perlman (2010).Specifically, it focuses on the relation between the foreground and background and on the marginality of favelas within the city's network. Second, the dataset and methods section presents and discusses the data, criteria and methods adopted for simplifying the road centre-line map into a segment map and run the analysis. Furthermore, it illustrates the criteria for selecting a sample among the 1018 Rio's favelas, considering the critical lack of homogeneity in the mapping of their network. Third, the results section presents and discusses the values of favelas entrances within the issues highlighted in the problematisation section. Finally, the conclusions summarise the objectives, problems and outcomes of the study and suggest further research development.

本文分为四个部分。首先，问题化部分介绍了分段角度分析在里约热内卢的两种应用（Hillier等，2012； Krenzet等，2015），并将其与阿布鲁乌（1987; 1994）的历史性城市研究和民族学联系起来。 （Perlman（2010））。具体地说，它着眼于城市网络中前景与背景之间的关系以及贫民窟的边缘性。其次，“数据集和方法”部分介绍并讨论了用于将道路中心线图简化为线段图并进行分析的数据，标准和方法。此外，它还考虑了在其网络映射中严重缺乏同质性的情况，阐明了在1018年里约热内卢贫民窟中选择样本的标准。第三，结果部分介绍并讨论问题化部分突出显示的问题中的贫民窟入口的价值。最后，结论总结了研究的目标，问题和成果，并提出了进一步的研究进展。

2. PROBLEMATISATION

This section aims to discuss the outcomes of the previous applications of space syntax segment analysis to Rio de Janeiro (Hillier et al., 2012; Krenz et al., 2015). The purpose is to highlight their critical points concerning the object of this study, i.e., the connections between favelas and the global city's network. By this means, this section relates the hypothesis and conclusions of the analyses mentioned above with the argumentations of two extensive urban studies of Rio de Janeiro, i.e., Abreu's history of the urban evolution (1987; 1994) and Perlman's forty-years-based ethnology on Rio's favelas (2010).

2.问题

本节旨在讨论先前在里约热内卢应用空间句法片段分析的结果（Hillier等，2012； Krenz等，2015）。 目的是突出他们关于本研究目标的关键点，即贫民窟与全球城市网络之间的联系。 通过这种方式，本节将上述分析的假设和结论与里约热内卢的两项广泛的城市研究的论点联系起来，即阿布鲁乌的城市演变史（1987年； 1994年）和佩尔曼基于四十年的民族学 在里约热内卢的贫民窟（2010）。

The main points we discuss here are the following: the historical and economic relation between the residential background and foreground and, by which means, this relation causes different levels of marginalisation between the favelas and the urban system as a whole.

我们在这里讨论的要点如下：居住背景和前景之间的历史和经济关系，并通过这种关系在贫民窟和整个城市系统之间造成不同程度的边缘化。

To relate the configuration of a given spatial system with its broader social contest is one the main objectives of space syntax theory and method of analysis. The effort of Hillier et al. (2012), to normalize the measures of choice and integration, is part of such an effort. Indeed, the authors examine a sample of fifty cities of different size to detect the structures of movement (to-movement with integration, and through-movement with choice) within the chosen sample. What the authors mean to do by normalizing the numerical values of movement is to define new instruments for comparing heterogeneous networks and predicting how, by varying the structure of movement, it is possible to mould different cities.

Eventually, it is the consistency with the characteristic of the represented networks that allows the authors to validate the outcomes of their research. Precisely, what the findings of Hillier et al. (2012) notably reflect is the relation between the lines that led the economic growth (foreground) and the ones that structured the residential areas (background).

将给定空间系统的配置与其更广泛的社会竞争联系起来是空间语法理论和分析方法的主要目标之一。希里尔等人的努力。 （2012），标准化选择和整合的措施，是这种努力的一部分。的确，作者检查了五十个大小不同的城市的样本，以检测所选样本中的移动结构（整合移动，选择性移动）。通过对运动数值进行归一化，作者的意思是定义新的工具，用于比较异构网络并预测通过改变运动结构如何塑造不同的城市。

最终，与代表网络的特征的一致性使作者能够验证其研究成果。确切地说，希利尔等人的发现。 （2012年）特别反映出引导经济增长的线（前景）与构成居住区的线（背景）之间的关系。

By comparing the measures of Rio de Janeiro with the other cities in the sample, the authors point out some fundamental points for the study we present. Indeed, they place Rio among the group of 'organic' cities, together with London, Tokyo and Istanbul. The authors point out that these cities differ from the others in the sample because they lack geometry, but just apparently. Indeed, the structure is “geometrically informed at the level of the line, not the area or the urban whole” (Hillier et al., 2012,p.187). Meanwhile, the relation between the background (mean NACh) and foreground (max NACh) of each city moulds some differences within the same group. London and Tokyo have a strong foreground network, created by a linear growth, where the background fills the interstitial areas. It is probably this same process of growth, led by the sequential addition of lines, that defines a strong connection between the local microeconomic structure and the residential areas.

通过比较里约热内卢和样本中其他城市的测量，作者指出了我们目前研究的一些基本点。 实际上，他们将里约热内卢与伦敦，东京和伊斯坦布尔一起列为“有机”城市之一。 作者指出，这些城市与样本中的其他城市有所不同，因为它们缺乏几何形状，但是显然。 的确，结构是“在线的水平而不是区域或城市整体的几何信息”（Hillier等，2012，第187页）。 同时，每个城市的背景（平均NACh）和前景（最大NACh）之间的关系塑造了同一组内的一些差异。 伦敦和东京拥有强大的前景网络，它由线性增长创建，背景填充了间隙区域。 可能是由线的顺序添加导致的同一增长过程，这定义了当地微观经济结构与居民区之间的紧密联系。
 On the contrary, the analyses of Istanbul and Rio present stronger local backgrounds, lacking global-to-local structures. The authors suggest a possible explanation for this kind of structure. That is the rapid residential growth led the construction of the city, by subordinating the economic logic of the foreground to the social logic of the background.

相反，对伊斯坦布尔和里约热内卢的分析具有较强的地方背景，缺乏全球对地方的结构。 作者提出了这种结构的可能解释。 那就是通过将前景的经济逻辑从属于背景的社会逻辑，快速的住宅增长引领了城市的建设。

Krenz et al. (2015), some years later, reports the same hypothesis about the evolution of Rio de Janeiro's structure. This time the segment analysis runs on a new, more detailed map of Rio de Janeiro, which included the networks of the majority of favelas. The segment analysis run on this new representation of the city points out a higher maximum of NACh and, consequently, a more structured foreground network, when compared to Hilliers et al. (2012). The latter detects a broken-up structure. At 1.4 of NACh, it points out a “large-scale tree-like pattern” in the northern part of the city, without ringsappearing in the main area until 1.3 structure. Differently, Krenz et al. (2015) detect a complete ring structure at 1.3, connecting all the suburban areas with the broader whole. Nevertheless, their analysis confirms the relationship between the values of mean and maximum NACh, thus confirming that the movement in the global structure is distributed equally between background and foreground (Krenz etal., 2015).

克伦茨等。几年后（2015年），报告了关于里约热内卢结构演变的相同假设。这次，细分分析是在新的，更详细的里约热内卢地图上进行的，其中包括大多数贫民窟的网络。与Hilliers等人相比，对城市的这种新表示法进行的细分分析指出，NACh的最大值更高，因此，结构化的前景网络也更多。 （2012）。后者检测到破碎的结构。在NACh为1.4时，它指出了城市北部的“大型树状图案”，直到1.3结构之前，主要区域都没有出现环。不同的是，Krenz等。 （2015年）在1.3处检测到完整的环形结构，将所有郊区与更广阔的整体连接起来。然而，他们的分析证实了平均NACh值和最大NACh值之间的关系，从而确认了全球结构的运动在背景和前景之间均等分布（Krenz等，2015）

Moreover, Krenz et al. (2015) argue that the global NACh analysis of Rio de Janeiro shows that favelas are not segregated. On the contrary, they are found close to the foreground. With a focus on the 100 largest favelas out of Rio's 1049, the authors report that 57% is in next or immediate proximity to a high choice value road (>1.4). A 34% is in a distance of at least 500 meters from a second range high value (>1.2), while 9% has no proximity to the foreground. These findings suggest the authors that favelas settle on ‘beneficial locations in terms of relation to the formal city rather than following the principle of unclaimed land’. Moreover, the local analysis of NACh detects a wide spread of potential local centres all over Rio's territory, including both favelas and formal areas.

此外，Krenz等。 （2015年）认为，对里约热内卢的全球NACh分析表明，贫民窟不是隔离的。 相反，它们位于前景附近。 作者集中研究了里约1049年最大的100个贫民窟，他们发现57％的人紧邻高选择价值道路（> 1.4）。 34％的人与第二个范围的高值（> 1.2）至少相距500米，而9％的人与前景没有距离。 这些发现表明作者认为，贫民窟在“相对于正式城市而言有利的位置，而不是遵循无人认领土地的原则”。 此外，对NACh的本地分析发现，在里约全境（包括贫民窟和正式地区），潜在的本地中心分布广泛。

Yet, while the formal areas present a continuous linear network, favelas are characterised by segregated central cores. This segregation is confirmed and becomes even more evident with the global and local NAIn analysis. That is, the local NACh and global and local NAIn detect the segregation of favelas while the global NACh shows their proximity to the foreground network. This apparent inconsistency set a critical point for the rejection of favelas as marginalised areas within the city's network. Nevertheless, it finds evidence and explanations in Abreu's history of Rio de Janeiro's evolution.

然而，虽然正式区域呈现出连续的线性网络，但贫民窟的特征是中央核心分隔。 通过全球和本地NAIn分析，这种隔离得到了确认，并且变得更加明显。 即，本地NACh以及全局NAIn和本地NAIn检测到贫民区的隔离，而全局NACh显示它们与前景网络的接近度。 这种明显的矛盾为拒绝将贫民区当作城市网络中的边缘化地区设置了关键点。 尽管如此，它还是在阿布鲁乌（Abreu）里约热内卢（Rio de Janeiro）演变的历史中找到了证据和解释。

Indeed, if we weigh up the conclusions of the researches mentioned above with Abreu (1987), some crucial points emerge. First, the city planning policies intentionally defined a marginality, establishing a spatial dichotomy between the low-income and the wealthier residential areas. Second, the city residential background grew fast, but it follows the economic logic of the foreground.

确实，如果我们权衡上述关于Abreu（1987）的研究结论，就会发现一些关键点。 首先，城市规划政策有意地界定了边缘性，在低收入和较富裕的居民区之间建立了空间二分法。 其次，城市居民背景增长迅速，但遵循了前景的经济逻辑。

According to Abreu (1987; 1994), the occupation of the suburban areas grew along railway lines since the beginning of the expansion of the city, in the second half of the 19th century. New settlements gathered around the train stations. Meanwhile, new roads were built by privates perpendicularly to the railway lines. This first phase already produced a socio-economic polarisation between the city centre and the suburbs. However, it is in the passage from slavery to a capitalist system of production, when Rio became the capital of the new Brazilian Republic, that the polarisation became structural. Low-income dwellers were removed from the city centre, according to the new modernist plans, and set themselves up in the suburbs or unclaimed areas on the steep slope hills surrounding the wealthiest areas.

根据阿布雷乌（1987; 1994）的说法，自19世纪下半叶城市扩张开始以来，郊区对铁路沿线的占领就增加了。 新的定居点聚集在火车站周围。 同时，私人修建的新道路垂直于铁路线。 第一阶段已经在市中心和郊区之间产生了社会经济分化。 但是，正是在从奴隶制到资本主义生产体系的转变中，里约成为新的巴西共和国的首都时，两极分化就变成了结构性分化。 根据新的现代主义计划，低收入者被从市中心撤离，并在郊区或最无人居住的地区建立，这些地区位于最富裕地区周围的陡峭山坡上。

The city kept growing along the “tentacular” (Abreu, 1987, p. 94) structure that surrounded the coastal mountains. Favelas moved together with industries on public or unclaimed lands, within an 'anarchic' industrial development in the north-east. In the '40s, during the construction of the first branch of Avenida Brasil (the expressway defining the most significant part of the 1.4 structure in the space syntax analyses mentioned above), from the port area up north, favelas invaded the surrounding areas. In some cases, new factories chose to settle in this same area to stay nearby both to the new expressway and to favelas (e.g., Jacarezinho), considered a reservoir of the workforce. The infrastructure kept developing along the northern city border, on the east-west direction, and on the flat northern area of the Baixada

Fluminense, to guarantee a connection between the city and the farms in the rural areas that supply it. In the meanwhile, the use of reinforced concrete led to a fast high-rise development and upgrading interventions in the wealthiest southern regions. Real estates and public interventions attracted, as workforce, a growing number of immigrants, that settled their house nearby. This process led to the fast growth of favelas in the surrounding areas.

这座城市沿着围绕沿海山脉的“触角”式结构（Abreu，1987年，第94页）保持增长。在东北的“无政府状态”工业发展中，Favelas与公共或无人领地的工业一起移动。在上世纪40年代，在巴西大道（Avenida Brasil）的第一个分支的建造过程中（高速公路在上述空间语法分析中定义了1.4结构的最重要部分），从北部的港口地区，贫民窟入侵了周围地区。在某些情况下，新工厂选择在同一地区定居，以留在新高速公路和贫民窟附近（例如Jacarezinho），后者被视为劳动力的储备库。基础设施沿着北部城市边界，东西方向以及Baixada平坦的北部地区不断发展

Fluminense，以确保城市与提供城市的农村地区的农场之间的联系。同时，钢筋混凝土的使用导致了南部最富裕地区的快速高层建筑开发和升级干预措施。随着劳动力的增长，房地产和公共干预吸引了越来越多的移民，他们在附近定居。这个过程导致周围地区的贫民窟迅速增长。

The extension of the railway system, the lack of a consistent plan of social housing and land use, made favela a structural, yet unacknowledged solution. Indeed, both the policies of eradication of favelas or planned resettlement mostly failed to attend the housing demand and gave rise, respectively, to new displaced settlement the former, and to grid-shaped favelas the latter, e.g., Complexo da Maré (Figure1 and 6).

铁路系统的扩展，缺乏一致的社会住房和土地使用计划，使得贫民窟成为一种结构性但尚未得到认可的解决方案。 实际上，根除贫民窟的政策或计划中的重新安置政策大多未能满足住房需求，并分别导致了前者的新流离失所定居点和后者的网格状贫民区，例如，Complexo daMaré（图1和图6）。

In the '90s, responding to the 1988 New Democratic Constitution of Brazil, Rio de Janeiro's master plan recognised favelas as parts of the city and established upgrading interventions. Nevertheless, Perlman(2010) argues that even after this big plan of urbanisation, there is no doubt where the asfalto ends and the morro begins. 5 Armed guards, by the entrances of favelas occupied by crime or militias, control and permit access to all those who are not recognised as residents. Properties nearby the entrances of favelas are depreciated because of constituting areas of drug-dealing or armed conflict, leading to social stigmatisation and conflict with the neighbours. Moreover, the least accessible areas within favelas are even more segregated because they are utterly unlinked to public services and infrastructure. This inequality creates a further spatial, economic and social differentiation within the same favela.

According to Perlman (2010, p. 150), favelas dwellers are not marginal but structurally included in a society that worked against their interest, so far.

在上世纪90年代，为响应1988年的巴西新民主宪法，里约热内卢的总体规划承认贫民窟是城市的一部分，并建立了升级干预措施。尽管如此，Perlman（2010）认为，即使在这一大规模的城市化计划实施之后，毫无疑问，阿斯法托在哪里结束而桑ro开始了。 5名武装警卫在被犯罪或民兵占领的贫民窟入口处控制并准许所有不被视为居民的人进入。由于贩毒或武装冲突的构成区域，在贫民窟入口附近的物业被贬值，导致社会受到侮辱和与邻居的冲突。此外，贫民窟中最不容易接近的区域更加隔离，因为它们与公共服务和基础设施完全没有联系。这种不平等在同一贫民窟中造成了进一步的空间，经济和社会分化。

根据Perlman（2010，p。150）的观点，到目前为止，贫民窟居民并不处于边缘地位，而是在结构上纳入了不利于他们利益的社会。

To sum up, Rio de Janeiro grew organically along the lines of agricultural and industrial productive expansion (Figure 2). The broken-up structure detected by Hillier et al. (2012) finds evidence in the growing process. Both residential and industrial areas “leapt” (Abreu, 1987, p. 115) along the railway to gather around the train stations. Later, the formal real estate market developed a continuous local network (sometimes by forced eviction of low-income settlements), as founded by Krenz et al. (2015). In turn, as the outcomes of both global and local integration show, favelas were pushed to the least valued, nearby areas.

综上所述，里约热内卢沿着农业和工业生产扩张的路线有机增长（图2）。 希利尔等人检测到的破碎结构。 （2012）发现了成长过程中的证据。 铁路沿线的住宅区和工业区都“跳跃”（Abreu，1987，第115页），聚集在火车站周围。 后来，由Krenz等人建立的正式的房地产市场发展了一个连续的本地网络（有时是通过强行驱逐低收入定居点）。 （2015）。 反过来，随着全球和地方一体化的结果表明，贫民窟被推到价值最低的附近地区。

The characteristic of Rio de Janeiro's self-built settlements, of being segregated while close to the structure of movement is what motivates a further examination of their system of connection. Specifically, some evidence for focusing the study on the entrances is suggested by the comparison of favelas with the wealthy gated communities (Perlman, 2010) that are intentionally segregated, while staying near the system of movement.

里约热内卢自建居民点的特点是，在靠近活动结构的同时予以隔离，这促使人们进一步研究其联系系统。 具体而言，通过将贫民窟与富裕的有门隔离社区隔离在一起，同时保持在运动系统附近，可以发现一些将研究重点放在入口上的证据（Perlman，2010）。

3. DATASET AND METHODS

A crucial issue in applying space syntax theory and methodology is the setting up of a map that can consistently represent the spatial relations within the object of the analysis. In the process of defining the segment map of Rio de Janeiro's network for the proposed analysis, we follow three main steps. Each one relates to a specific problem: the simplification of a road centre-line (RCL) map to a segment map; the selection, from the network, of the segments corresponding to the entrances of each favela; the definition of a sample among favelas. The spatial datasets for all these steps are obtained from the online open database of the Municipality of Rio de Janeiro (data.rio), developed by its urban institute, the IPP (Instituto Pereira Passos).

3.数据和方法

应用空间语法理论和方法学的一个关键问题是建立一个可以始终代表分析对象内空间关系的地图。 在为拟议的分析定义里约热内卢网络的线段图的过程中，我们遵循三个主要步骤。 每个问题都涉及一个特定的问题：将道路中心线（RCL）地图简化为线段地图； 从网络中选择与每个贫民窟的入口相对应的部分； 贫民窟中样本的定义。 所有这些步骤的空间数据集都可以从里约热内卢市的在线开放数据库（data.rio）中获得，该数据库由其城市研究所IPP（Pereira Passos研究所）开发。

It is important to report that, although the IPP is the same source of Krenz et al. (2015), we observe a difference between the number of favelas, i.e, 1018, in our database and the number, 1049, reported by Krenz et al. (2015). However, we do not observe any relevant effect produced by this incongruency.

重要的是要报告，尽管IPP与Krenz等人的来源相同。 （2015年），我们观察到数据库中的Favelas数量（即1018）与Krenz等人报告的1049之间存在差异。 （2015）。 但是，我们没有观察到这种不一致产生的任何相关影响。

As for the first step, to set up the segment map of Rio de Janeiro's network, we follow the methodology defined in Kolovou et al. (2017). In this process, we adopt slightly different criteria for the simplification of multiple lanes. Specifically, when the multiple lanes mould important discontinuities within the network, we try to preserve the representation of this discontinuities. This is the case when two local roads run along the two sides of a canal or an expressway with few interconnections. The simplification preserves the two local roads while, in the latter case, representing the expressway and its branches with a single line (Figure 3).

关于第一步，要建立里约热内卢网络的线段图，我们遵循Kolovou等人（2005年）定义的方法。 （2017）。 在此过程中，我们采用略有不同的标准简化多条车道。 具体来说，当多条通道在网络中塑造重要的不连续性时，我们尝试保留这种不连续性的表示形式。 当两条本地道路沿运河或高速公路的两侧相互连接很少时，就是这种情况。 为简化起见，保留了两条局部道路，而在后一种情况下，用一条直线表示高速公路及其分支（图3）。

On the last stage, running the Douglas Peucker algorithm, we find the tolerance of 10 best preserving the relations within the network as a whole and, especially, within the favelas. Indeed, the tolerance of 15 might work in the simplification of the formal network but significantly modify favelas (Figure 3).Finally, the angular segment analysis was set on the 1024 Tulip Analysis, including choice, with metric radius (n, 800,1200, 2000, 3000, 5000, 8000, 10000) and segment length as the weighted measure.

在最后一个阶段，运行道格拉斯·皮克（Douglas Peucker）算法，我们发现在整个网络中，尤其是在贫民窟中，可以最佳保留10个关系的容差。 的确，15的公差可能会简化形式网络，但会显着修改favelas（图3）。最后，在1024 Tulip Analysis上设置了角段分析，包括选择，公制半径（n，800,1200） ，2000、3000、5000、8000、10000）和段长度作为加权度量。

Next, after the analysis, we import the result on QGis and collect the entrances of favelas within a new vector. The first attempt tries to partly automatise the selection by identifying the segment, within the network, that intersects the perimeter of favelas, as represented in the spatial dataset of IPP (2018).Unfortunately, this selection detects many tangential segments that, in the representation wrongly intersect favelas. Consequently, some entrances connected to these segments are ignored, as within the areas but not crossing their perimeter.

接下来，经过分析，我们将结果导入QGis并在新向量中收集Favelas的入口。 如IPP（2018）的空间数据集所示，首次尝试尝试通过识别网络中与Favelas周边相交的线段来使选择部分自动化，但不幸的是，此选择检测到许多切向线段 错误地相交了贫民窟。 因此，与这些路段相连的一些入口将被忽略，例如在区域内，但不会越过其周边。

Therefore, we opted for manually select the entrances from a new vector representing the favelas network, obtained by cropping the map with the polygons of the settlements. This laborious operation collects the entrances by isolating those segments, along favelas borders, which connect directly with the outside network.

因此，我们选择从代表Favelas网络的新矢量中手动选择入口，该矢量是通过使用定居点的多边形裁剪地图而获得的。 这种费力的操作是通过隔离沿直接与外部网络相连的Favelas边界的那些段来收集入口的。

During this last process, we find deeper evidence of the lack of homogeneity in the representation of favelas. Some settlements, indeed, have not even one entrance. This, obviously, points out a crucial issue for the purpose of the study. Indeed, as it appears evident, by overlapping the map with the Google Satellite map, the inhomogeneity depends on a deficiency of the original RCL. Which, in turn, constitutes the most accurate representation of the city network, so far. However, we are still left with a significant number of favelas without this type of inconsistences and therefore be left with a significant number of valuable cases for this study.

在这最后一个过程中，我们找到了更进一步的证据，表明小牛肉派的代表性缺乏同质性。 实际上，有些住区甚至没有一个入口。 显然，这指出了研究目的的关键问题。 实际上，很明显，通过将地图与Google卫星地图重叠，不均匀性取决于原始RCL的不足。 到目前为止，它构成了城市网络的最准确表示。 但是，我们仍然有大量的贫民窟，没有这种类型的不一致，因此，对于这项研究，还有大量有价值的案例。

By this means, we select among the spatial dataset of favelas the ones having at least one entrance, coherently with the purpose of the study. Then, we use this first selection to calculate the value of network density for each favela, by dividing the total length of the isolated networks by the value of their respective area (Berghauser Pont and Haupt, 2010). The minimum and maximum obtained are, respectively, 0.0001 and 0.09 m/m², with a mean of 0.02 and a median of 0.017. The comparison between these results and the value of the city's global network density (again, the total length of the city's network divided by the urbanised area, as in the spatial dataset of the city land use) suggests a possible solution. As we find the mean value of the city's network density to be equal to the median of this first selection, we checked the set of favelas above 0.017. The set appears to define a detailed representation of the favelas network. Finally, we opted to expand the selection to 0.016 to include some elements that have a similar grain but fall out of the set. Consequently, we obtained a sample of 406 favelas with a mean network density of 0.03.

通过这种方式，我们根据研究的目的，在贫民窟的空间数据集中选择至少有一个入口的那些。然后，通过将孤立网络的总长度除以它们各自面积的值，我们使用第一个选择来计算每个贫民窟的网络密度值（Berghauser Pont和Haupt，2010年）。获得的最小值和最大值分别为0.0001和0.09 m /m²，平均值为0.02，中位数为0.017。将这些结果与城市全球网络密度的值（同样，城市网络的总长度除以城市化区域，如城市土地利用的空间数据集）之间的比较提出了一种可能的解决方案。当我们发现城市网络密度的平均值等于第一次选择的中位数时，我们检查了0.017以上的贫民窟。该集合似乎定义了Favelas网络的详细表示。最后，我们选择将选择范围扩展到0.016，以包括一些具有相似纹理但不属于集合的元素。因此，我们获得了406个蚕丝的样本，平均网络密度为0.03。

To complete the setting-up, we cut off from the map those segments having a Node Count value under 20% of the mean as suggested by Hillier et al. (2012). This operation was, obviously, iterated for both favelas and city's global map, at all metric radii included in the analysis. These vectors constitute the base for examining and discussing the values of NACh and NAIn within the purpose of the study, as follows in the next section.

为了完成设置，我们从地图上切除了节点计数值低于均值20％的那些段，如Hillier等人所建议的。 （2012）。 显然，在分析中包括所有度量半径的情况下，此操作对于favelas和城市的全球地图都是重复的。 这些向量构成了在研究目的下检查和讨论NACh和NAIn值的基础，如下一节所述。

4. RESULTS

In the problematisation section of this paper, we reference the space syntax segment analysis of Krenz et al. (2015) for questioning a particularity of Rio de Janeiro concerning the relation between the favelas and formal network. To briefly summarise, Krenz et al. (2015) point out that favelas are mostly located near the global foreground network and locally define strong central cores. Nevertheless, they constitutean “archipelago of isolated islands” (Krenz et al., 2015, p. 630), segregated from the formal network (with few exceptions, e.g., Complexo da Maré).

4.结果

在本文的问题化部分，我们引用了Krenz等人的空间句法片段分析。 （2015）质疑里约热内卢关于贫民窟和正式网络之间关系的特殊性。 简而言之，Krenz等。 （2015年）指出，贫民窟主要位于全球前景网络附近，并在本地定义强大的中央核心。 然而，它们构成了一个“孤立岛屿的群岛”（Krenz等人，2015年，第630页），与正式网络隔离开来（几乎没有例外，例如Complexo daMaré）。

In a city shaped by discontinuous centres that occupy the flat areas around the coastal mountains and bodies of water, the global “broken up structure” (Hillier et al., 2012. p.185) suddenly comes out. Such structure curiously restricts the strongest foreground movement to a “large-scale tree-like pattern” (Hillier et al., 2012, p.185) running east-west on the northern half of the city (NACh > 1.4), while poorly integrating the south in a global ring shape (NACh > 1.3). It is important to remember that both sides present a stronger and more connected structure (Figure 2) if we run the segment analysis on a map including favelas, as already observed by Krenz et al. (2015). In turn, the analysis run on the formal network (Hillier et al., 2012) shows a weaker and more discontinuous foreground, especially on the southern half. This point already detects a global influence of favelas on the structure of the city as a

whole.

在一个由不连续的中心构成的城市中，这些中心占据了沿海山脉和水域周围的平坦区域，突然出现了全球性的“分解结构”（Hillier等人，2012年，第185页）。 这种结构奇怪地将最强的前景运动限制为“大型树状图案”（Hillier等人，2012，p.185），在城市的北半部以东西向（NACh> 1.4）延伸。 将南部整合成整体环形形状（NACh> 1.3）。 重要的是要记住，如果我们在包括贫民窟的地图上进行线段分析，双方都将呈现出更强大，更紧密的联系结构（图2），正如Krenz等人已经观察到的那样。 （2015）。 反过来，在正式网络上进行的分析（Hillier等，2012）则显示出一个较弱且不连续的前景，特别是在南部地区。 这一点已经发现，贫民窟对城市结构的全球影响是整个。

Besides, it is possible to cross the outcomes of the referenced researches (see Abreu, 1987; Hillier etal., 2012; Krenz et al., 2015) for explaining the difference, mentioned above, between the two halves.The detected bipartition of the global foreground structure corresponds to a historical dichotomy (Abreu, 1987): while the residential real estate has mostly shaped the southern part, the expansion of the north has been economically led by the growth of the industrial system.

此外，有可能跨越参考研究的结果（见Abreu，1987; Hillier等，2012; Krenz等，2015），以解释上述两半之间的差异。 全球前景结构与历史上的二分法相对应（Abreu，1987）：虽然住宅房地产主要塑造了南部地区，但北部地区的扩张在经济上是由工业体系的增长带动的。

Moving forward from the global to the local system analysis, we decide to look for a local radius that can detect the central cores of the city's historical development. Rio's favelas positioning within the global network motivates this choice (Figure 2). As favelas spread in a close spatial (and economic) interdependency with the formal areas, the hypothesis was that we could dig up new evidence for understanding their mutual connection at the scale of the historically leading poles. By comparing the max NACh and NAIn at different local radii (800,1200, 2000, 3000, 5000, 8000, 10000), we find the radius of 5000 best fitting our purpose. Indeed, it is the largest radius that first detects the central cores of the city's expansion, while still representing a reasonable walking distance (Figure 4).

从全局分析到本地系统分析，我们决定寻找可以检测城市历史发展中心核心的本地半径。 力拓在全球网络中的偏爱定位促使了这一选择（图2）。 随着贫民窟与正式地区之间在空间（和经济）上紧密的相互依存关系蔓延，这种假设是，我们可以在历史上领先的两极范围内挖掘出新的证据来理解它们之间的相互联系。 通过比较不同局部半径（800,1200、2000、3000、5000、8000、10000）下的最大NACh和NAIn，我们发现最适合我们目的的5000半径。 的确，它是最大的半径，它首先可以检测到城市扩张的核心，同时仍然代表了合理的步行距离（图4）。

What the NACh (radius of 5000) intriguingly points out, within all the areas, is that the local foreground branches off to favelas or passes them through (Figure 4 and 5). More precisely, among the selected sample of 406 favelas, the structure above the value of 1.4 reaches 28% of settlements (which represents 62% of the total area of the selected sample, and 40% of the area of favelas as a whole). Between the values of 1.3 and 1.4, we find another 28% (representing the 26% of the total area of the sample, and the 17% of the area of favelas as a whole). Next, between 1.2 and 1.3, the structure reaches 20% of the sample (equal to an 8% of the area of the sample, and to 4.5% of the area of Rio's favelas). Finally, under 1.2 we find 23% of the sample (corresponding to 4% of the area of the sample and 2.5% of the area of favelas as a whole).

有趣的是，在所有区域中，NACh（半径为5000）指出的是局部前景分支到Favelas或使它们通过（图4和5）。 更准确地说，在406个贫民窟的选定样本中，高于1.4的结构达到定居点的28％（占选定样本总面积的62％，占贫民窟总面积的40％）。 在1.3和1.4的值之间，我们发现另外28％（代表样本总面积的26％和整个小牛肉的面积的17％）。 接下来，在1.2到1.3之间，结构达到样本的20％（等于样本面积的8％，和Rio的贫民窟的面积的4.5％）。 最后，在1.2以下，我们找到了23％的样本（相当于整个样本区域的4％和整个小牛肉馅饼的区域的2.5％）。

When we examine this latter group, we see that it has a relatively small mean area (equal to a tenth of the ones detected within the 1.4 structure, and to a fourth of the mean area of Rio's favelas). What we can easily see within such a group is that it defines three different types of position: (1) favelas invading completely a block limited by the local foreground; (2) favelas that invade the linear interstices between the local foreground and a body of water or a mountainside, with entrances constituting a comb of blind alleys perpendicularly to the foreground; and finally (3), favelas at the edge of the local foreground on a poorly urbanised area.

当我们检查后一组时，我们发现它的平均面积相对较小（等于在1.4结构中检测到的平均面积的十分之一，并且等于里约贫民窟的平均面积的四分之一）。 在这样的组中我们可以很容易地看到，它定义了三种不同类型的位置：（1）蚕食完全侵入了受局部前景限制的街区； （2）蚕豆入侵当地前景与水域或山腰之间的线性空隙，入口构成垂直于前景的盲巷。 最后（3），贫民窟位于城市化程度较差的地区的本地前景边缘。

To sum up, what we first detect by examining the max NACh of the entrances of each favela at a local radius of 5000, is that 28% of the favelas within the sample (again, 62% of the total area of the selected sample, and 40% of the area of favelas as a whole) intersects the significant local centre (>1.4). Besides, 58% is in close connection to it. What is more, within the group connected by entrances with a max NACh under 1.2, the local foreground is tangential to, at least, one side of their perimeter.

综上所述，我们首先通过检查局部半径为5000的每个贫民窟入口的最大NACh来检测到，样本中贫民窟的占28％（再次是所选样本总面积的62％， 和整个Favelas区域的40％）与重要的本地中心相交（> 1.4）。 此外，有58％与之密切相关。 而且，在由最大NACh小于1.2的入口连接的组中，局部前景至少与其周边的一侧相切。

Moving forward, the same local analysis (radius of 5000) suggests a hierarchy among the entrances of every favela, as NACh measures the potential quantity of movement that passes through an element (Figure 6). Possibly, it detects, at the same time, the lines that led the invasion of every area, but we do not have enough evidence for arguing it. Nevertheless, this hypothesis represents possible further research.

向前迈进，相同的局部分析（半径为5000）建议在每个贫民窟的入口之间形成一个等级，因为NACh衡量穿过某个元素的潜在运动量（图6）。 它可能同时检测出导致入侵每个区域的线路，但是我们没有足够的证据来争论它。 尽管如此，这种假设代表了可能的进一步研究。

Following, we compare the outcomes of this analysis (radius of 5000) with the local one (radius of 800) presented by Krenz et al. (2015). The result is that the strong central cores of favelas that constitute an “archipelago of isolated islands”, segregated from the formal network at the radius of 800 (Krenz et al.,2015, p. 630), overlap the ending segments of the foreground structure as found at the radius of 5000.Here we find the connection between the central core of favelas (radius of 800) and the central cores of the city's historical development (Figure 7).

接下来，我们将这一分析的结果（半径为5000）与Krenz等人提出的局部结果（半径为800）进行了比较。 （2015）。 结果是，构成“孤立岛屿的群岛”的贫民窟的强大中心核心与半径为800的形式网络隔离开来（Krenz等，2015，第630页），与前景的末段重叠 半径为5000的建筑物。在这里，我们发现了贫民窟的中心核心（半径为800）与城市历史发展的中心之间的联系（图7）。

Finally, what this representation might explain is why most favelas have a low degree of accessibility, both at global and local radii, while in close proximity to the global foreground structure. First, within the smaller favelas, entrances mostly correspond to dead alleys, thus defining poorly integrated areas.Second, favelas present a higher network density than the formal areas (as described in the dataset and methods section), but few lines along their border connect with the external network. This disproportion creates a bottleneck effect between the inside and outside. Such an effect is what structurally asphyxiates the movement from the inside-out and vice-versa.

最后，这种表示法可以解释的是，为什么大多数蚕豆在全局半径和局部半径上都具有较低的可访问性，而却与全局前景结构非常接近。 首先，在较小的贫民窟中，入口主要对应于死胡同，因此定义了集成不良的区域;其次，贫民窟呈现出比正式区域更高的网络密度（如数据集和方法部分所述），但沿边界线很少 与外部网络。 这种不均衡会在内部和外部之间产生瓶颈效应。 这种效果是从内到外在结构上窒息运动的，反之亦然。

5. CONCLUSIONS

The curious similarity between the systems of controlled entrances of Rio's favelas and wealthy gated communities (Perlman, 2010) is what drives us to undertake this study. As Krenz et al. (2015) point out, Rio's favelas are mostly located near the global foreground network and locally define strong central cores. Nevertheless, they constitute an “archipelago of isolated islands” (Krenz et al., 2015, p. 630), segregated from the formal network. The evidence of discontinuity of movement between the favelas and the outside city suggests us to focus on the entrances of favelas, their thresholds.

5。结论

力拓的贫民窟入口控制系统与富裕的封闭社区之间的奇怪相似性（Perlman，2010年）促使我们进行这项研究。 如Krenz等。 （2015年）指出，里约热内卢的贫民窟大多位于全球前景网络附近，并在本地定义强大的核心。 然而，它们构成了“孤立岛屿的群岛”（Krenz等，2015，第630页），与正式网络隔离开来。 贫民窟和外面的城市之间的移动不连续的证据表明，我们应该关注贫民窟的入口，即贫民窟的入口。

By examining the angular segment analysis of Rio de Janeiro's network, including a meaningful sample of favelas, we can find some new pieces of evidence for understanding the connection between self-built settlements and planned city, at both global and local metric radii.

通过研究里约热内卢网络的角度分段分析（包括有意义的贫民窟样本），我们可以找到一些新的证据来理解全球和本地度量半径上的自建定居点与规划城市之间的联系。

First, our analysis confirms the results of Krenz et al. (2015) concerning the foreground structure. By including favelas within the analysis, the foreground network acquires stronger importance in the city's global movement. Then, by crossing previous analysis (Abreu, 1987; 1994; Hillier et al., 2012; Krenzet al., 2015) we suggest that the detected bipartition (north-south) of the global foreground structure corresponds to a historical dichotomy (Abreu, 1987). While the residential real estate has mostly shaped the southern part, the expansion of the north has been economically led by the growth of the industrial system.

首先，我们的分析证实了Krenz等人的结果。 （2015年）关于前景结构。 通过将贫民窟纳入分析范围，前景网络在城市的全球运动中变得越来越重要。 然后，通过交叉先前的分析（Abreu，1987； 1994； Hillier等人，2012； Krenzet等人，2015），我们建议检测到的全球前景结构的二分（北-南）对应于历史二分法（Abreu， 1987）。 虽然住宅房地产大部分形成了南部地区，但北部地区的扩张在经济上是由工业体系的增长带动的。

Moving forward from the global to the local system analysis, we find the radius of 5000 the largest one that first detects the central cores of the city's expansion, while still representing a reasonable walking distance. What the NACh (radius of 5000) points out, within all the areas, is that the local foreground branches off to the sample of selected favelas or passes them through. What is more, within the group connected by entrances with a max NACh under 1.2, the local foreground is tangential to, at least, one side of their perimeter.

从全局分析到本地系统分析，我们发现5000半径是最大的半径，它首先检测出城市扩展的核心部分，同时仍代表一个合理的步行距离。 在所有区域中，NACh（半径为5000）指出的是，局部前景分支到选定的贫民窟样品或使它们穿过。 而且，在由最大NACh小于1.2的入口连接的组中，局部前景至少与其周边的一侧相切。

The same local analysis (radius of 5000) suggests a hierarchy among the entrances of every favela, as NACh measures the potential quantity of movement that passes through an element. The consistency of this result, with a socially based differentiation among the entrances of favelas, defines an issue to further research.

相同的局部分析（半径为5000）表明每个贫民窟的入口之间都具有等级关系，因为NACh衡量穿过某个元素的潜在运动量。 结果的一致性，以及贫民窟入口之间基于社会的差异，为进一步研究确定了一个问题。

Following, the comparison between the NACh at 5000 and at 800 points out that the strong central cores of favelas, at the radius of 800 (Krenz et al., 2015), overlap the ending segments of the foreground structure, as found at the radius of 5000. Here we find the connections between the central core of favelas (radius of 800) and the central cores of the city's historical development (radius 5000).

随后，在5000和800的NACh之间的比较表明，半径为800的贫瘠金属纤维的强中心核（Krenz等，2015）与前景结构的末端部分重叠，如半径 为5000。在这里，我们找到了贫民窟的中心部分（半径为800）与城市历史发展的中心部分（半径为5000）之间的联系。

To sum up, we propose that a reason for favelas having a low degree of accessibility, while in close proximity to the global foreground structure, could be found at their borders. As favelas present a higher density than the formal areas, but few lines along their border connect with the outside, the local network filters the movement. It structurally defines spatial thresholds between what is inside-out and vice-versa.

综上所述，我们建议在毗邻全局前景结构的情况下，发现贫民窟的可访问性较低的原因。 由于贫民窟的密度比正式地区高，但沿边界的线很少与外部连接，因此本地网络会过滤运动。 它在结构上定义了由内而外之间的空间阈值，反之亦然。

However, as favelas are complex systems, both spatially and socially, these findings need to be further examined and crossed with a wider range of factors, such as topography, as in Krenz et al. (2015), but also historical evolution, demography and legal framework, among others. Such an analysis constitutes the plan for further research.

然而，由于贫民窟是一个复杂的系统，无论是在空间上还是在社会上，这些发现都需要进一步研究，并与更广泛的因素（如地形）相交叉，就像在Krenz等人的研究中一样。 （2015年），以及历史沿革，人口统计学和法律框架等。 这种分析构成了进一步研究的计划。

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