附件二　　被提名：是　自荐：____

青年人才托举工程
提 名 书

被托举人姓名　　黄　　洁

工作单位　　中国科学院地理科学与资源研究所

提名机构　　中国地理学会经济地理专业委员会

提名专家姓名 _____

中国地理学会　制

2019 年 12 月

基本情况

1.个人基本信息

姓　名	黄洁	性别	女	出生年月	1988 年 9 月
民 族	汉	职务	无	学　位	博士
身份证号	450305198809221544		会员证号	S110011322M	
专业方向	人文地理	专业技术职称		副研究员	
工作单位	中国科学院地理科学与资源研究所				
通讯地址	北京市朝阳区大屯路甲 11 号			邮　编	100101
单位电话	64889302	手 机		18701379920	
Email	huangjie@igsnrr.ac.cn				

主要教育经历（从大学填起，包括国外学历）

起止年月	学校（院）及系名称	专　业	学　位
2007.9-2011.6	中南大学（985）	交通运输规划与管理	学士
2011.9-2015.12	英国利兹大学	交通工程	博士

主要工作经历（毕业以后从事科技第一线工作的经历）

起止年月	工作单位及部门	职务/职称
2016.6-2018.12	中国科学院地理科学与资源研究所	助理研究员
2018.12 至今	中国科学院地理科学与资源研究所	副研究员

在国内外学术组织任职、后备情况

（1）SSCI 期刊 Journal of Transport and Land Use 编委

（2）世界交通运输大会（World Transport Convention）专业委员会委员

（3）Regional Science Policy and Practice 期刊专刊“Modelling place attractiveness in the era of Big and Open data”客座主编

（4）Nature 子刊、Journal of Transport Geography、Environment and Planning B 等期刊审稿人

主要科研项目介绍（限 800 字以内）

提名人从事大数据与城市交通研究，围绕该研究方向主持国家自然科学青年基金 1 项，参与面上基金、中科院 A 类先导、部委委托的省级空间规划、城市群交通发展战略等课题 10 余项。

基于以上科研项目研究，已发表学术论文 20 余篇，其中 SCI/SSCI 第一或通讯作者 11 篇（一区 6 篇），CSCD 论文 6 篇（含已接收），代表性论文发表在 PNAS（第一作者）、Journal of Transport Geography、 Transportation Research Part A、Cities、地理学报、地理科学进展等国内外高水平期刊。主要学术贡献如下：

（1）发现了居民地铁通勤的 45 分钟定律

虽然大数据已经广泛应用与城市交通研究，但是以往的研究多局限在短期观测、横向对比、整体研究的角度，忽略了长期演化、纵向分析、分群体研究的重要性。因此，提名人构建了个人出行链的研究体系，采用 2011-2017 年连续七年北京市地铁刷卡数据，追踪居民长时序的个人通勤链和职住地变化动态特征，发现了地铁通勤时间的 45 分钟定律，剖析了通勤时间与住房成本的均衡博弈过程，刻画了四类人群的社会经济概况、地铁通勤、职住搬迁的相互影响机制。该研究为特大城市轨道交通规划、职住中心布局、城市精细话管理提供了的理论依据。

这一研究解决了大数据纵向分析的难点和缺乏社会经济属性内涵等问题，研究成果以第一作者发表在美国科学院院刊 PNAS，被美国科学促进会、英国电讯报、亚洲科学家杂志、新华网、中国科学院、国家自然科学基金委等国内外媒体机构报道。

（2）揭示了居民通勤与城市职住空间结构关系及演化机制

提出了基于地铁刷卡数据的职住空间格局研究方法，从理论上定义了职住动态变化的 8 种关系，偏职趋缓、偏职加剧、偏住趋缓、偏住加剧、职住倒置等。从微观尺度剖析了 2011-2015 年北京市职住分布格局的动态演化规律，剖析了北京市同心圆空间模型，为特大城市空间规划和轨道交通建设提出了政策建议。

这一系列研究成果发表在 Cities、地理科学进展等国内外地理学著名期刊；学术论文《北京市地铁客流的时空分布格局及特征》获得第八届钱学森城市学金奖提名奖。

2.学术成果情况（以下信息请附有关证明材料复印件）

发表论文、专著的情况（限填有代表性的论文和著作），不超过 8 项						
序号	论文、论著名称	年份	排名	发表刊物或出版社名称	是否被SCI/EI/SCOPUS检索收录	被引用次数
1	Tracking job and housing dynamics with smartcard data	2018	1	PNAS	SCI，顶级期刊	19
2	Circuity in urban transit networks	2015	1	Journal of Transport Geography	SSCI，Q1	28
3	A comparison of indirect connectivity in Chinese airport hubs: 2010 vs. 2015	2017	1	Journal of Air Transport Management	SSCI，Q2	13
4	Job-worker spatial dynamics in Beijing: Insights from Smart Card Data	2019	1	Cities	SSCI，Q1	7
5	Circuity in China's high-speed-rail network	2019	2（通讯）	Journal of Transport Geography	SSCI，Q1	1
6	Competition between high-speed trains and air travel in China: from a spatial to spatiotemporal perspective	2020	2（通讯）	Transportation Research Part A	SSCI，Q1	
7	Inter-city connections in China: High-speed train vs. inter-city coach	2020	3（通讯）	Journal of Transport Geography	SSCI，Q1	1
8	北京市地铁客流的时空分布格局及特征——基于智能交通卡数据	2018	1	地理科学进展	CSCD	9

获奖情况，不超过 3 项				
序号	获准时间	奖项名称	奖励名称/等级	排名情况
1	2018 年	第八届钱学森城市学金奖提名奖	金奖提名奖	1
2	2016 年	第 33 届国际地理大会组织工作	突出贡献奖	
3	2011 年	国家留学基金委公派留学奖学金	博士奖学金	

专利情况，不超过 5 项			
序号	专利名称	专利号/专利状态	排名情况
1	一种基于中转航班的机场航班波识别方法及系统	201910688256.9/初审合格	1

2019-2021 年青年人才托举工程重点评审内容

托举工程实施内容

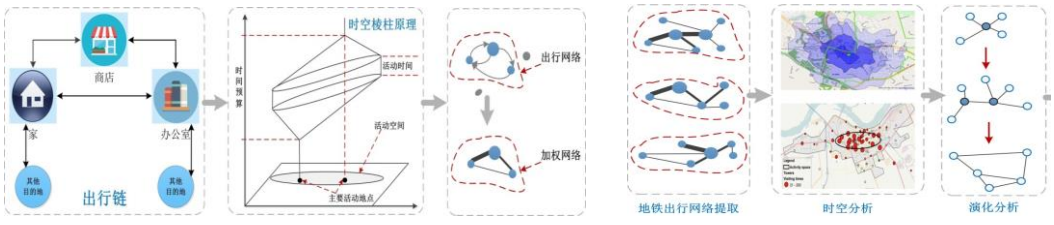
重点介绍 2019-2021 年度科研工作设想与创新性、可行性以及需要“托举”的迫切性（800 字以内）。

提名人将围绕“**移动轨迹数据支撑下的居民出行网络时空特征与影响机制研究**”开展工作，提出个体尺度下的出行网络（Human-Scale Activity Network）及研究方法，并应用于北京市地铁刷卡数据，开展基于智能手机的出行调查以收集移动轨迹数据，运用数据融合技术以剖析地铁出行的网络化属性、时空演化规律、群体特征及主观体验变化，为以人为本的城市交通规划提供政策意见。

出行行为的研究范式多基于单一属性（如性别、年龄）等将居民视作同质体进行群体特征分析，往往忽略了多重属性（包括社会经济属性、主观体验等）共同作用产生的个体差异。因此，新研究方法将基于个体出行的时空分异对样本进行群体划分，再链接到个体尺度的移动轨迹数据，阐明促使出行群体时空分异产生的多重属性。综上，**项目的创新性在于发现不同社会群体出行网络与多重社会属性、主观体验的交互过程。**工作设想及可行方案如下：

（1）个体尺度的出行网络构建方法

基于人与人的交互网络、人地交互网络等理论，将居民活动空间研究拓展到基于出行行为的活动空间内部，构建居民地铁出行的时空棱柱，进而提取活动空间内的出行网络。



（1）　　（2）

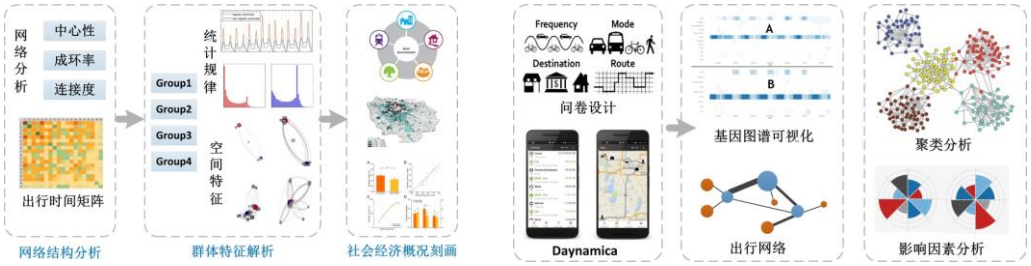
研究框架示意图

（2）出行网络的时空特征与演化分析

设计个体尺度出行网络的时空分析框架，包括最小核面积、潜在出行最大面积、网络连通性、关键站点等指标的测算方法。以北京为例，解析出行网络时空演化规律。

（3）出行网络群体特征识别

识别个体尺度的出行网络，剖析时空特征及演化模式，选取适宜的聚类分析方法提出群体划分的指标、阈值及技术方法。



（3） **（4）**

研究框架示意图

（4）基于智能手机出行记录的出行行为影响机制

基于智能手机应用 Daynamica 出行调查收集的数据称为“智能手机出行记录”，包含居民出行的全过程轨迹，场景、主观体验、社会经济属性等数据。运用 Daynamica 设计调查方案并收集数据。构建图神经网络模型将地铁出行网络与手机出行记录提取进行匹配和聚类。结合出行记录的社会经济属性、实时主观体验数据等剖析出行网络时空动态变化。

科研和职业生涯三年规划

（须明确在托举周期中每一年度的主要规划目标和完成计划，说明主要科研方向、个人成长规划、参加国内外学术交流活动计划、托举方向、专家指导和帮扶需求等。 800 字以内）

提名人的托举方向是**大数据与城市交通**，年度规划如下：

- **2019 年**

完成文献和数据收集，完成个体尺度的出行网络构建方法研究，撰写相关论文并投稿。参加国内外学术交流活动 2 次，邀请领域内专家并组织学术研讨会 1 次，协助团队申办 2023 年世界交通与土地利用大会。

- **2020 年**

完成出行网络的时空特征与演化分析、群体特征识别，撰写相关论文并投稿。申请相关科研项目，并参与国内学术会议 1-2 次，邀请领域内专家并组织学术研讨会 1-2 次，进一步完善课题研究。

- **2021 年**

完成基于智能手机出行记录的出行行为影响机制，撰写相关论文并陆续发表相关成果。总结项目研究成果，制定下一步的工作计划，参加国内外学术交流 1-2 次。

托举经费使用情况

须明确在托举周期中每一年度的资金用途和预算计划，如有自筹资金资助须明确经费来源。

根据“青年人才托举工程”经费使用要求，每年经费预算 15 万元，具体如下：

（1）2019 年，主要工作是明确科研计划，开展学术交流以细化研究方案，购置项目所需设备。

- 参加国际会议 3 次，每次往返交通、食宿及会议费总计 2 万元，预算总计 6 万。
- 组办国内学术研讨会 1 次，邀请专家 2 位，参与人数 10 人。本着节约的原则，会议地点在提名人所在单位。根据国家规定，会议餐费标准为 130 元/人·天，会议室租费 2000 元/天。预算总计 0.73 万元，2×2000 元专家咨询费/人次+130 元/人·天×10 人次+2000 元/天=0.73 万元。
- 购置具备基本功能的智能手机 15 台反复使用，按 0.15 万元计算，共 2.25 万元。调查结束后，手机归还提名人所在单位管理。
- 购置高性能工作站 1 台用于数据挖掘和 GIS 空间分析，按 2.80 万元/台计算，共 2.80 万元。
- 用于购买图书、资料费用、文献检索总计 2.00 万元。

（2）2020 年，开展项目研究的主要工作。

- 拟参与中国地理学会、经济地理专业委员会等国内会议 2 次，总计 1.2 万元。预算如下：住宿、补助及注册费：（350 元/人·天+180 元/人·天）×3 天×2 人次+（2 人次×1500 元/人次）＝0.6 万元；往返交通费：3000 元/人×2 人次＝0.60 万元；
- 组办国内学术研讨会 2 次，参照 2019 年标准，预算总计 1.5 万元。
- 地铁刷卡数据处理加工费用 5.00 万元。
- 论文版面费预算 2.80 万元。英文论文 1 万元/篇×2+中文论文 0.8 万元/篇=2.8 万元。
- 硕士生、博士生等劳务费 5 万元。

（3）2020 年，开展基于智能手机的出行调查，凝结科研成果并发表。

- 参加国际会议 2 次，每次往返交通、食宿及会议费总计 2 万元，预算总计 4 万。
- 硕士生、博士生、临时聘用人员等调研劳务费 8 万元。
- 组办国内学术研讨会 2 次，参照 2019 年标准，预算总计 0.75 万元。
- 论文版面费预算 2 万元。英文论文 1 万元/篇×2 =2 万元。

<table>
<tr><td colspan="5">托举导师团队意向（3 位研究员或教授级专家）</td></tr>
<tr><td>姓名</td><td>职务、职称</td><td>单位</td><td>手机号</td><td>邮箱</td></tr>
<tr><td>金凤君</td><td>中国地理学会经济地理专业委员会主任，研究员</td><td>中国科学院地理科学与资源研究所</td><td>13910803819</td><td>jinfj@igsnrr.ac.cn</td></tr>
<tr><td>刘卫东</td><td>所长特别助理，研究员</td><td>中国科学院地理科学与资源研究所</td><td>13601318419</td><td>liuwd@igsnrr.ac.cn</td></tr>
<tr><td>王姣娥</td><td>中国地理学会经济地理专业委员会副主任，研究员</td><td>中国科学院地理科学与资源研究所</td><td>15811239712</td><td>wangje@igsnrr.ac.cn</td></tr>
<tr><td colspan="5">所在单位在三年内对被托举人选的培养支持情况和培养目标</td></tr>
<tr><td colspan="5">本栏目是被托举人所在单位在其托举过程中提供的科研条件、人才培养的支持计划。

我单位支持黄洁博士参评“青年人才托举工程”。若托举项目获批，将对其从事的科学研究提供更多的政策支持，营造宽松的工作环境，并配备导师团队指导科研工作，确保她打好职业基础，鼓励并支持申报国家基金委、中国科学院等相关青年人才计划。</td></tr>
<tr><td colspan="5">被托举候选人声明</td></tr>
<tr><td colspan="5">本人对以上内容及全部附件材料进行了审查，对其客观性和真实性负责。

被托举候选人签名：　　年　月　日</td></tr>
<tr><td colspan="5">工作单位意见</td></tr>
<tr><td colspan="5">我单位自愿申报“青年人才托举工程”项目。同意　　参评“青年人才托举工程”，保证申报材料真实、合法、有效。承诺若被评上，将给予相应支持，愿与中国地理学会共同做好“青年人才托举工程”，并承担相应责任。

单 位 盖 章：
年　月　日</td></tr>
<tr><td colspan="5">提名机构或提名人意见</td></tr>
<tr><td colspan="5">我（机构）同意提名_____参评“青年人才托举工程”。保证提名材料真实、合法、有效。

提名机构（个人）签 章：
年　月　日</td></tr>
</table>

青年人才托举工程
附件材料

被托举人姓名 黄　　洁

工作单位 中国科学院地理科学与资源研究所

提名机构 中国地理学会经济地理专业委员会

提名专家姓名 金凤君、刘卫东、刘彦随、王姣娥

近五年发表第一或通讯作者

SCI/SSCI 论文首页

Tracking job and housing dynamics with smartcard data

Jie Huang[a], David Levinson[b], Jiaoe Wang[a,c,1], Jiangping Zhou[d], and Zi-jia Wang[e]

[a]Key Laboratory of Regional Sustainable Development Modeling, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China; [b]School of Civil Engineering, University of Sydney, Sydney, NSW 2006, Australia; [c]College of Resources and Environment, University of Chinese Academy of Sciences, Beijing 100049, China; [d]Department of Urban Planning and Design, Faculty of Architecture, The University of Hong Kong, Hong Kong 999077, China; and [e]School of Civil Engineering, Beijing Jiaotong University, Beijing 100044, China

Edited by William A. V. Clark, University of California, Los Angeles, CA, and approved October 19, 2018 (received for review September 18, 2018)

Residential locations, the jobs–housing relationship, and commuting patterns are key elements to understand urban spatial structure and how city dwellers live. Their successive interaction is important for various fields including urban planning, transport, intraurban migration studies, and social science. However, understanding of the long-term trajectories of workplace and home location, and the resulting commuting patterns, is still limited due to lack of year-to-year data tracking individual behavior. With a 7-y transit smartcard dataset, this paper traces individual trajectories of residences and workplaces. Based on in-metro travel times before and after job and/or home moves, we find that 45 min is an inflection point where the behavioral preference changes. Commuters whose travel time exceeds the point prefer to shorten commutes via moves, while others with shorter commutes tend to increase travel time for better jobs and/or residences. Moreover, we capture four mobility groups: home mover, job hopper, job-and-residence switcher, and stayer. This paper studies how these groups trade off travel time and housing expenditure with their job and housing patterns. Stayers with high job and housing stability tend to be home (apartment unit) owners subject to middle- to high-income groups. Home movers work at places similar to stayers, while they may upgrade from tenancy to ownership. Switchers increase commute time as well as housing expenditure via job and home moves, as they pay for better residences and work farther from home. Job hoppers mainly reside in the suburbs, suffer from long commutes, change jobs frequently, and are likely to be low-income migrants.

commuting pattern | job dynamics | housing dynamics | mobility group | smartcard data

Linking mobility patterns to socioeconomic characteristics of city dwellers is important to economists, sociologists, geographers, and urban planners (1–4). Recent studies have explored the distribution of poverty and wealth, mobility rhythms of returners and explorers, human contact networks, demographic characteristics and neighborhood isolation phenomena from human mobility patterns by mobile phone call records, GPS data, transit smartcard data, and geocoded messages from social media (3, 5–8). In the era of big data, studies have uncovered individual patterns and scaling laws and pose the prospect of predicting human mobility (9–11). Of course, one advantage of big data is volume, but big data rarely include socioeconomic attributes directly and the availability is usually of a short duration. In contrast, household surveys (relatively small data in comparison) provide more socioeconomic attributes and travel information. Investigating human mobility, including travel behavior and the journey to work, has traditionally relied on household surveys (12, 13). Still, some limitations exist in the surveys such as the data resolution of travel trajectories and time use.

Mobility patterns can reflect human movement at various spatial scales so that they can be used to critique and address increasing social challenges. Recently, many researchers have investigated patterns of international or intercity migration (14–16), while fewer have explored intraurban migration or residential mobility (17). In the field of residential mobility, empirical studies often harness the life course framework (18), while theoretical models describe housing choice with the trade-off between commuting cost and housing expenditures (19). Indeed, the jobs–housing relationship, job and housing tenures, and their dynamics affect daily commutes and travel behavior and vice versa (2, 20, 21). However, few studies have assessed the job and housing dynamics with a longitudinal analysis at the individual level.

Transit station choice can be a proxy to capture patterns of individual mobility in a city (22). With the help of smartcard data, we probe consecutive trajectories of workplaces and residences over 7 y in Beijing to understand urban dwellers' job and housing dynamics. We identify the most preferred station near each traveler's workplace and residence (i.e., the work and home stations) according to individual commuting regularity (23). As transit use is a major part of commutes in megacities, regular public transport commuters present higher temporal regularity than nonregular commuters (Fig. 1*A*). From 2011 to 2017, the annual proportion of regular commuters rose from 23.74% to 31.40%, and their trip records account for over 80% of transit trips. We observed that 5,001 regular commuters retained their smartcard for seven consecutive years. The sampling process is shown in Fig. 1*B*. After assessing the spatiotemporal regularity of trips, we find 4,248 sample commuters whose workplaces and residences can be identified successively. The sample size is more than equivalent to a travel survey. Each sample commuter

Significance

This paper uses transit smartcards from travelers in Beijing retained over a 7-y period to track boarding and alighting stations, which are associated with home and work location. This allows us to track who moves and who remains at their homes and workplaces. Therefore, this paper provides a longitudinal study of job and housing dynamics with group conceptualization and characterization. This paper identifies four mobility groups and then infers their socioeconomic profiles. How these groups trade off housing expenditure and travel time budget is examined.

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Data deposition: The dataset about home stations, work stations, average travel time in the subway, and housing expenditure estimated from 4,248 regular commuters from 2011 to 2017 has been deposited at english.igsnrr.cas.cn/sd/dataset/201811/t20181108_201066.html.

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Job-worker spatial dynamics in Beijing: Insights from Smart Card Data

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ABSTRACT

As a megacity, Beijing has experienced traffic congestion, unaffordable housing issues and jobs-housing imbalance. Recent decades have seen policies and projects aiming at decentralizing urban structure and job-worker patterns, such as subway network expansion, the suburbanization of housing and firms. But it is unclear whether these changes produced a more balanced spatial configuration of jobs and workers. To answer this question, this paper evaluated the ratio of jobs to workers from Smart Card Data at the transit station level and offered a longitudinal study for regular transit commuters. The method identifies the most preferred station around each commuter's workpalce and home location from individual smart datasets according to their travel regularity, then the amounts of jobs and workers around each station are estimated. A year-to-year evolution of job to worker ratios at the station level is conducted. We classify general cases of steepening and flattening job-worker dynamics, and they can be used in the study of other cities. The paper finds that (1) only temporary balance appears around a few stations; (2) job-worker ratios tend to be steepening rather than flattening, influencing commute patterns; (3) the polycentric configuration of Beijing can be seen from the spatial pattern of job centers identified.

1. Introduction

As a megacity, Beijing has experienced traffic congestion, air pollution, and unaffordable housing issues. Many residents have endured a long commute every day (Feng, Zhou, & Wu, 2008; Zhao, 2015). Many still work in the CBD where housing remains expensive, and so dwell in the suburbs where housing is more affordable. While Beijing was once a monocentric city, recent decades have seen policies and projects aiming at decentralizing urban structure and job-worker patterns. For example, a series of projects to decentralize non-capital functions included the relocation of universities and large firms (Pan, Guo, Zhang, & Liang, 2015). Policy makers have advocated commuting by public transportation to alleviate traffic congestion. For instance, sub-center construction started in the Tongzhou district in 2012, followed by the extension of Line 1 in Beijing subway system. Overall, both government-led and market-oriented projects have affected job-worker patterns in Beijing.

With the suburbanization and economic growth in Beijing, estimates of the travel time for the journey-to-work vary widely. The journey-to-work was reported at about half an hour in 2001 (Zhao, Lü, & De Roo, 2011). According to the household survey, the duration of home-to-work journey was 38 min in 2005 (Bin, 2009), and it was almost constant in the analysis of Smart Card Data (i.e. SCD) in 2008 (Zhou & Long, 2014). In 2010, one report even has it increasing to 52 min (Wang & Xu, 2010). Ta, Chai, Zhang, and Sun (2017) reviewed jobs-housing patterns and they found that the commuting time and

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Circuity in urban transit networks

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ABSTRACT

This paper investigates the circuity of transit networks and examines auto mode share as a function of circuity and accessibility to better understand the performance of urban transit systems. We first survey transit circuity in the Minneapolis–St. Paul, Minnesota, region in detail, comparing auto and transit trips. This paper finds that circuity can help to explain mode choices of commuters. We then investigate thirty-five additional metropolitan areas in the United States. The results from these areas show that transit circuity exponentially declines as travel time increases. Moreover, we find that the circuity of transit networks is higher than that of road networks, illustrating how transit systems choose to expand their spatial coverage at the expense of directness and efficiency in public transportation networks. This paper performs a regression analysis that suggests the circuity of transportation networks can estimate transit accessibility, which helps to explain mode share.

1. Introduction

The design of public transportation networks is not independent of their use. For example, how long a journey by transit takes (compared to alternatives) and how easily destinations are accessed by each mode explains much of the share of public transit use (Owen and Levinson, 2015). Based on studies of self-selection in residential relocation, the preference for transit mode is an important factor (Krizek, 2003; Mokhtarian and Cao, 2008; Cao et al., 2009). People who prefer commuting by transit may choose residences where they can easily access transit stations that are served by routes connecting directly with desired destinations. Following the discussion in these studies, this paper hypothesizes that people who commute by transit select residential locations with less circuitous transit routes than those who do not. This paper compares the circuity of transit and auto home-to-work trips. Investigating this hypothesis can help us understand the self-selection in mode choice by commuters and the need of travelers for direct routes. Hence, the paper first posits the hypothesis (H1) that the transit network circuity of actual transit trips is lower than that of travelers who chose to use a car.

Public transportation networks (including bus and rail) have been built, improved, or expanded in many cities to align network investment policies with transit-oriented development to maximize access to transit systems and encourage transit ridership (Cervero, 2004). In transport planning, urban transit networks are often designed to ensure a large spatial coverage for political or policy reasons (Taylor, 1991), resulting in circuitous lines (Black, 1995; Murray et al., 1998). However, the high indirectness of transit lines that trades off coverage for frequency (Walker, 2012) may discourage ridership, because people could commute by other modes to reduce trip circuity (and thus travel time). A question arises: to what extent do travelers accept the circuity of transit trips?

Increasing transit ridership implies reducing automobile mode share, presently the most widely used commuting mode in every US metropolitan area (American Community Survey, 2012). One reason that more people commute by car instead of by transit is that routes on public transportation networks are more circuitous. Indeed, road networks are typically denser than transit networks, so road networks almost always provide less circuitous routes. With this topological difference in mind, the paper proposes a second hypothesis (H2): that circuity on transit networks is higher than that on road networks for the same trips (Table 7).

Moreover, the correlations between automobile mode share and accessibility in road and transit networks have been previously tested with a local example (Owen and Levinson, 2015) and in multiple metropolitan areas (Levinson, 2012). It has been reported that an increase in transit accessibility may reduce commute time by transit (because jobs are closer to workers and because transit service is thicker), which should reduce automobile mode share. Correlations of circuity, accessibility, and automobile mode share are valuable to investigate. Closing the circle, we propose a third hypothesis (H3): that automobile mode share depends significantly on network circuity and accessibility in road and transit networks.

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Competition between high-speed trains and air travel in China: From a spatial to spatiotemporal perspective

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ABSTRACT

Scheduling strategies are important to improve network efficiency and optimize time slots for both high-speed train (HST) and air travel. Although many scholars have studied HST and air travel competition from the perspectives of the spatial patterns and travel costs of the two transportation modes, few studies have investigated their potential temporal competition. To fill this research gap, this paper uses a time window method to examine the relationship between HSTs and flights operating between city-pairs. From the perspective of departure time, an analysis was conducted in the overlapping network of HSTs and flights at the city-pair level in China, based on one-day schedules. The results show that (1) HSTs and flights were temporally scheduled differently according to their within-day dynamics, and (2) HSTs and flights experienced fierce competition from 7 am to 9 am on average. Furthermore, the proposed classification method identifies city-pairs in a single-mode dominant market, full competition market, partial competition market, and complementary coordination market. Spatially, 24 city-pairs operating 343 flights with 533 train competitors in one day formed the full competition market with high-frequency schedules, including such city-pairs as Beijing-Shanghai, Guangzhou-Shanghai, and Shanghai-Xi'an. The method to classify city-pairs according to the similarity and diversity of HST and flight schedules may be generalized for allocating time slots for two modes. This work may help to schedule HSTs and flights in future transportation management.

1. Introduction

Time slots are an important factor in scheduling strategies for both High-Speed Train (HST) and air travel, as it determines the operation and management in those transportation networks from the supply perspective (Borenstein and Netz, 1999; Sun, 2015). For hub airports, many factors affect the allocation of time slots among city-pairs, such as the airport capacity and passenger demand. With the limit of airport capacity, airport hubs need to maximize the utility of time slots to serve demand. In terms of HSTs, operators may decrease the train frequency when passengers are less likely to depart/arrive in a certain time slot, while enhancing the frequency during the 'golden' periods. Therefore, for the two transportation modes, how daily time slots are arranged has reflected the travel demand of inter-city trips as well as the scheduling strategies of operators, policymakers, and transport planners.

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Circuity in China's high-speed-rail network

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ABSTRACT

This study investigates the circuity of China's high-speed-rail (HSR) network from 2014 to 2016 and analyzes the network performance. The concept of circuity has been redefined in terms of travel time so that various speed levels of HSR lines can be measured systematically. In this study, circuity is redefined as the ratio of actual travel time to ideal travel time. By using actual HSR trip records, the influence of passenger demand and the circuity of transfer trips have been examined. At the node level, we find that the circuity of principal stations has significantly decreased overall. For stations with lower circuity, transfer trips from/to them tend to be more circuitous. Although stations along the intercity rail lines show higher circuity, they contribute to regional coverage and connectivity. Finally, we find that circuity tends to increase with a decreasing passenger flow for OD pairs within a certain distance range, and the passenger flow may decline as the OD distance increases.

1. Introduction

Since the introduction of Shinkansen between Tokyo and Osaka in 1964, the technology of high-speed-rail (HSR) has been implemented in many countries and regions. Owing to its speed advantage, superior quality of service, and large transportation capacity, HSR plays an important role in substituting conventional railway (Givoni, 2006; Campos and Rus, 2009). Therefore, evaluation of HSR network efficiency and performance caused concern recently (Xu et al., 2017; Hu et al., 2017; Janić, 2018). Differently from regions where one or several HSR lines operate independently, China, Spain, and Germany have constructed HSR networks at a regional or national level. The planning and construction of a large-scale HSR network are affected by economic, geographical, and even political factors (Tierney, 2012; Ashiabor and Wei, 2013; Culver, 2016). In transportation planning, HSR networks are often built or expanded to ensure a large spatial coverage so that the regional development gaps may be narrowed (Vickerman, 2015; Wang et al., 2015). Several studies have focused on analyzing and evaluating HSR network efficiency at the national level (Xu et al., 2018a; Xu et al., 2018b; Moyano et al., 2018). However, research on the actual HSR trips at a large-scale network is still limited owing to data availability.

In China, the first HSR line was the Beijing-Tianjin intercity railway that was opened in August 2008. A national HSR network has been gradually constructed since 2012 according to the "four vertical and four horizontal" transportation corridor plan. By the end of 2017, the operating HSR route length exceeded 25,000 km. The total number of passengers transported by HSR has exceeded that of air travel since 2012, and reached conventional railway passenger volumes in 2017; HSR has become an important inter-city travel mode in China, which has been constructed by the national railway department, and experienced network expansion recently (Jiao et al., 2014; Yue et al., 2015). Using the ticket sales data available from China Academy of Railway Sciences Corporation Limited (i.e., CARSCL, a subsidiary corporation of China Railway), this study will investigate the geographical characteristics of China's high-speed-rail network (CHSRN) from 2014 to 2016 in order to observe its recent network efficiency and evolutionary performance at a national scale. Evaluating the geographical characteristics and evolution process of China's HSR will help to have a better understanding of deficiencies in network design, and improvement in accessibility and connectivity. Furthermore, strategic guideline can be provided for HSR development.

There are trade-offs among coverage, accessibility, connectivity, and directness in transportation networks (Levinson, 2012; Costa et al., 2016; Wang et al., 2016a, 2016b). High levels of indirectness may decrease network efficiency, discourage ridership, and eventually negatively affect revenue because passengers could shift to other competitive modes (e.g., airlines). Circuity is generally defined as the ratio of network distance to Euclidean distance (Barthélemy, 2011). This indicator has been widely employed for investigating the directness of

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Inter-city connections in China: High-speed train vs. inter-city coach

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ABSTRACT

High-speed train (HST) and inter-city coach (ICC) have been two important ground transportation modes for travelling between cities in China. They influence inter-city connections significantly. This study uses HST's and ICC's timetable data to construct networks; evaluates city centrality and city-pair connectivity to compare the hierarchical structures. The results show that the HST network shows linear distribution characteristics while ICC network presents regional "core-periphery" structure. Provincial administrative boundaries have an obvious constraint on the ICC network, while the HST community structure follows the railway lines' distribution. Finally, this study illustrates the spatial organization model and gives implications for regional transportation planning.

1. Introduction

The geography of inter-city connections or city-pairs can reflect the spatial pattern of urban systems and influence the externalities of cities (Rodrigue et al., 2013). As one of the most important basic conditions for regional development, transport networks are representative physical links that can help to understand the interaction of cities at the global, national, and regional scales (Jiao et al., 2017). Compared with road, air, and conventional railway, high-speed rail is a brand-new transportation mode, which would influence the inter-city flow of passengers. In China, the high-speed rail went through a period of rapid development in recent years and has become the largest network in the world.

High-speed rail can generate an unprecedented shrinkage of space and time by greatly shortening inter-city travel time (Spiekermann and Wegener, 1994), which in turn impacts the inter-city travel and changes the market shares of other transportation modes (Vickerman, 1997). For example, 23% of the passenger traffic of Japan's Sanyo Shinkansen line came from air travel, and 16% came from cars and buses (Givoni, 2006). In China, three high-speed rails originating from a provincial capital (Nanning, located in Guangxi in the south of China next to Guangdong) to three cities in the same province (Beihai, Fangchenggang, and Guilin) have been opened since 2013. Subsequently, during the 2014 Spring Festival, Nanning's road passenger traffic volume decreased by 22.1% compared with 2013 (Nanning Municipal Bureau of Statistics, 2014). Therefore, it is a significant research issue to compare the high-speed rail and other transportation modes, analyze their similarity and diversity, and explore the influence of the high-speed rail.

Many studies showed how the high-speed rail affects the spatial interaction of cities (Cheng, 2010; Jiao et al., 2014; Shaw et al., 2014), and in the existing literature, the high-speed rail network is generally compared with the airline network (Wang et al., 2015; Yang et al., 2018c; Zhang et al., 2019). Givoni and Dobruszkes (2013) found that the competition of high-speed rail with air and road transport diverge according to some differences in the factors. Sun et al. (2017) suggested that multimodal transport system, including coaches, is one of the future research agenda on high-speed rail and air transport competition and cooperation. Chang and Lee (2008) also considered road transportation for the analysis of Korean high-speed rail accessibility. Several studies have measured and compared rail and road network and considered the influence of the high-speed rail operation (Kotavaara et al., 2011; Song and Yang, 2016). High-speed rails are usually operated with higher frequencies between city-pairs than traditional trains, and could provide an alternative and competitive transport mode except coaches for passengers. However, few studies conducted a direct comparative investigation for high-speed rail networks and road networks because of the following reasons. First, it is difficult to find a study area where the two developed infrastructure networks are of similar size. Second, a comparison from the perspective of supply has rarely been conducted due to lack of data. Our research attempted to

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A comparison of indirect connectivity in Chinese airport hubs: 2010 vs. 2015

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ABSTRACT

Airport hubs' indirect connectivity is important for any aviation network. Indirect connectivity describes the capacity of airport hubs to provide indirect connections over the airline network. As the Chinese aviation industry has experienced development, this paper offers a comparative analysis of indirect connectivity for Chinese airport hubs between 2010 and 2015. We investigate wave-system structures, weighted indirect connectivity (WIC) and indirect connections of the top ten airport hubs in China. In the spatial analysis, this paper surveys the spatial patterns of indirect connections at four important airport hubs. Beijing-Capital airport has strong indirect connectivity worldwide. Pudong and Hongqiao airports worked together to maximize the spatial coverage of Shanghai. Guangzhou-Baiyun airport has sufficient indirect connections across southern China, and it intends to expand its spatial influence into northern cities.

1. Introduction

The Chinese aviation industry has developed in recent years; it has experienced a stable 9% per year increase in the rate of total passengers (China statistical yearbook, 2016). Some airport hubs then emerged. The top 10 airports served more than 55 percent of passengers in 2010. That percentage decreased to 46 percent in 2015 under air deregulation. The flight schedules of these airport hubs influence approximately half of the traffic flow across the Chinese airline network. Hence, the main goal of this paper is to examine the temporal operation of these airport hubs and their connectivity.

The Chinese aviation market and the connectivity amongst airport hubs have been influenced by air deregulation (Wang et al., 2016). Zhang and Round (2008) emphasized that flight scheduling is important in the process of air deregulation in China. For example, airline companies have freedom of scheduling and tighter flight schedules, under air deregulation in Korea and Brazil (Sun, 2015; Oliveira et al., 2016). Because airline companies had to maintain their competitiveness by offering good quality indirect flights at airport hubs, wave-system structures were adopted for flight scheduling. Burghouwt and de Wit (2005) found that wave-system structures were implemented or intensified in the European market under air deregulation. However, few studies to date have examined wave-system structures in Chinese airport hubs. To this end, this paper's first objective is to examine whether Chinese airports have adopted wave-system structures in scheduling.

The second objective is to evaluate the weighted indirect connectivity and spatial distribution of indirect connections at airport hubs in China. Consistent with the study of wave-system structures, this indicator represents the overall performance of flight schedules. Danesi (2006) evaluated the weighted indirect connectivity of large airlines and reported the number of possible indirect connections at European hubs. However, the spatial distribution of indirect connections has not been studied. This research will use a spatial analysis to compare whether airport hubs win or lose indirect connectivity in China between 2010 and 2015.

The paper is organized as follows. Section 2 provides the literature review. Section 3 introduces the period studied and dataset. Section 4 provides the analysis of wave-system structures. Section 5 investigates the weighted indirect connectivity of airports in 2010 and 2015 and then examines the spatial patterns of indirect

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A self-learning system for local ramp metering with queue management

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ABSTRACT

This paper presents the design and evaluation process of a self-learning system for local ramp metering control. This system is developed on the basis of reinforcement learning (RL) and can deal with the problem of on-ramp queue management through a continuous learning process. A general framework of the system design including the definition of RL elements and an algorithm that can accomplish the learning process is proposed. Simulation tests are carried out to evaluate the performance of the new system. In terms of the total time spent by road users, the new system can achieve a 30% reduction from the situation of no control, a result which is competitive with the widely accepted algorithm ALINEA. Meanwhile, simulation results show that the new system can keep on-ramp queues strictly under a series of pre-specified constraints, which proves its capability of managing on-ramp queues.

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Intelligent transport systems; traffic flow model; ramp metering; reinforcement learning; simulation

1. Introduction

Motorways – inter-urban road networks – are designed to ensure high mobility and orderly traffic operation, while the arising traffic congestion becomes one main issue affecting their functionality. Proper control and management of traffic congestion are urgently needed to guarantee an efficient motorway system. To this end, under the umbrella of intelligent transportation systems (ITS), many traffic control devices have been developed, such as ramp metering, variable speed limits and variable message signs. In practical applications, ramp metering has been recognised as an effective method to control motorway traffic and alleviate congestion (Papageorgiou and Kotsialos 2002). Meanwhile, a large number of ramp metering systems have been proposed, from the early fixed-time systems (Wattleworth 1965), to traffic responsive strategies (e.g. the capacity-density method, Masher et al. 1975; ALINEA and its variations, Smaragdis and Papageorgiou 2003), up to optimisation-based approaches (e.g. optimal control, Gomes and Horowitz 2006; Li and Chow 2015; and model predictive control systems, Hegyi, De Schutter, and Hellendoorn 2005; Papamichail et al. 2010). Recently, there has been

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REINFORCEMENT LEARNING FOR RAMP CONTROL: AN ANALYSIS OF LEARNING PARAMETERS

ABSTRACT

Reinforcement Learning (RL) has been proposed to deal with ramp control problems under dynamic traffic conditions; however, there is a lack of sufficient research on the behaviour and impacts of different learning parameters. This paper describes a ramp control agent based on the RL mechanism and thoroughly analyzed the influence of three learning parameters; namely, learning rate, discount rate and action selection parameter on the algorithm performance. Two indices for the learning speed and convergence stability were used to measure the algorithm performance, based on which a series of simulation-based experiments were designed and conducted by using a macroscopic traffic flow model. Simulation results showed that, compared with the discount rate, the learning rate and action selection parameter made more remarkable impacts on the algorithm performance. Based on the analysis, some suggestions about how to select suitable parameter values that can achieve a superior performance were provided.

KEY WORDS

reinforcement learning; Q-learning; ramp control; agent; macroscopic traffic flow model;

1. INTRODUCTION

After more than 50 years of application, ramp control (or ramp metering) has been identified as one of the most effective control methods on motorways [1]. The ramp control mentioned here refers to the on-ramp control. This control method uses signal devices named ramp meters at on-ramps to regulate the ramp metering rate which is usually defined as the number of vehicles entering the motorway mainline during each signal cycle. Through suitable regulations on the metering rate, a ramp control strategy aims to alleviate motorway congestions, improve motorway throughput, and thus reduce the travel time spent by road users [2]. Over the last decades, a number of control strategies have been proposed to achieve this goal, such as capacity-density method [3], ALINEA [4] and the model-based optimization approaches (e.g. model predictive control methods [5, 6]). Among these strategies, the model-based optimization method has become increasingly popular in recent studies, as it is sound and can solve the ramp control problems based on the optimization theory. However, this method is dependent on the model accuracy and usually requires high computational demand, which limits its field of application [7].

In order to overcome these limitations, reinforcement learning (RL) was recently proposed by Jacob and Abdulhai [7, 8] to solve ramp control problems based on the Markov decision process (MDP) and dynamic programming (DP). After this contribution, some recent studies have also shown the effectiveness of RL for ramp control under different settings and conditions. For instance, coordinated ramp control using RL is considered in [9], continuous state space was analyzed in [10], and indirect RL was tested in [11, 12]. Although some efforts have been made to explore the application of RL in the ramp control domain, the issues of how to set the parameters for RL based ramp control strategies and how these settings influence the algorithm performance have not been widely studied. In most of these studies, the learning parameters are set according to experience without analysis. To our knowledge, the only published work related to the analysis of learning parameters for ramp control is shown in [13]. This work provides some useful suggestions about how to select suitable parameters in a continuous-state case with some adaptive settings. However, the behaviour of different parameter values

其他第一作者/通讯作者论文首页

北京市地铁客流的时空分布格局及特征
——基于智能交通卡数据

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摘 要:城市轨道交通是居民绿色出行、缓解大城市交通拥堵的重要交通方式。研究大城市地铁客流时间和空间的分布特征,有利于深入了解大城市公共交通的需求,进而制定合理的交通需求管理政策。本文以北京市地铁为例,计算了431万条智能交通卡数据的出行时间和OD矩阵(Origin-Destination Matrix),研究其客流的时间和空间分布特征。研究发现:①全天、早高峰和晚高峰的出行时间分布符合Gamma分布,总体上离城市中心越远,平均出行时间越长;②从市辖区尺度和环路尺度分析,乘客流向和流量均呈现对称性;③从街道尺度来看,居民地铁出行强度的空间不均等性很强。

关 键 词:城市轨道交通;大数据;客流分布;时空格局;北京市

1 引言

大城市人口规模庞大、交通需求巨大,需要高效、便捷的公共交通系统。目前,中国一线城市居民对交通便捷性和通畅性的评价普遍较差,交通需求分布的不合理引发长距离绕行、客流拥堵等问题。因此,宜居城市的建设应包括完善城市公共交通体系的建设,倡导居民绿色出行(张文忠等, 2016)。城市轨道交通是合理利用有限的城市土地资源、解决大城市交通拥堵的重要措施之一。研究大城市地铁客流的时空分布特征,有利于甄别大城市公共交通需求,进而制定合理的交通需求管理政策,实现公交优先发展。

从小世界网络模型提出以来(Watts et al, 1998),轨道交通网络的复杂性成为国内外学者的研究热点。国外学者运用无标度和小世界网络模型分析了30个大城市轨道交通网络的鲁棒性;梳理了波士顿、首尔、北京、南京、上海等城市的网络结构特征参数(Barthélemy, 2010; Derrible et al, 2010)。借鉴国际大城市轨道交通发展的经验和教训,基于可持续发展的框架和公交导向模式,国内学者研究了轨道交通对人口的聚集效应和运输效率,并且初步肯定了轨道交通对城市空间布局的引导和支撑作用(陆化普, 2006; 曹小曙等, 2008; 赵鹏军等, 2016)。

大城市轨道交通普遍采用自动收费系统,智能交通卡已被广泛使用。智能卡数据(Smart Card Data)作为具有地理标识和时刻信息的大数据(龙瀛等, 2012),在数据量、种类和准确性3个方面具备以下特点(Laney, 2001):①通常由大量的便携移动信息感应装置收集(例如,手机、交通卡、出租车GPS装置、SCD数据),数据的收集速度十分迅速,因此其第一个重要特征是数据量大;②大数据的兼容性逐渐提高,多种数据运用在同一研究问题中的方法

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黄洁,王姣娥.枢纽机场的航班波体系结构及其喂给航线的空间格局研究[J].地理科学,2018,38(11):1750-1758.[Huang Jie, Wang Jiaoe. Wave-system Structures of Airport Hubs and Spatial Patterns of Possible Indirect Connections. Scientia Geographica Sinica,2018,38(11):1750-1758.] doi: 10.13249/j.cnki.sgs.2018.11.002

枢纽机场的航班波体系结构及其喂给航线的空间格局研究

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摘要:基于航班波的概念,提出了航班波识别的技术流程和喂给航线的研究方法,并对全国十大枢纽机场的航班波体系进行了研究与甄别。在此基础上,进一步分析了拥有明显航班波体系的枢纽机场的喂给航线空间格局演化。研究发现:① 北京首都、上海浦东、广州白云和昆明长水机场拥有较为明显的航班波体系;成都双流、深圳宝安、西安咸阳机场的航班波体系尚不清晰。② 首位航空公司拥有足够的航班数量是机场构建航班波的必要但非充分条件,时刻资源的优化配置更为关键。③ 北京首都、上海浦东和广州白云三大枢纽机场的国际喂给航线和国内喂给航线在空间上存在显著的差异,且总体上与地理临近性无关,更多地与首位航空公司的航线网络扩张相关。

关键词:航班波;航班波体系;枢纽机场;喂给航线;时刻资源

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枢纽机场是航空运输网络的重要组成部分,主要功能可以概括为:第一,提供密集的航线和高质量的服务,运送大量的旅客。因此,一些研究从航线布局的角度出发,构建轴辐网络的航空组织模式,优化布局枢纽机场与支线机场[1,2]。第二,有效运用高频率的航班为旅客提供便捷高效的中转航班,形成喂给航线(feeder route)。枢纽机场形成喂给航线的关键是构建航班波体系(wave-system structure)。从航班时刻资源优化的角度出发,部分研究围绕枢纽机场构建航班波体系展开,以提升枢纽机场的航班连通性[3]。针对枢纽机场的两大功能,第一部分研究侧重从空间的角度提升航空网络基础设施的连通效率,而第二部分研究侧重从时刻资源和喂给航线的角度提升枢纽机场的连通性。在跑道、塔台、枢纽机场数量等基础设施资源有限的情况下,构建航班波体系成为提升航空运输网络连通性的重要手段。可以说,航班波的研究将航空运输网络的连通性从单一的空间维度转变为时间、空间的双重维度。

自2010年以来,航空运输快速发展,围绕枢纽机场均已形成了密集的航线网络,航班数量逐渐达到饱和。鉴于此,航班波的构建不仅能够从时间层面优化枢纽机场的航班时刻资源,而且能够从空间层面提升喂给航线的连通性,有利于提升整个航空运输网络的效率[4]。自1998年Bania等从理论上提炼出航班波的结构后,学者将其理论运用到20多个枢纽机场时刻资源配置的研究上,并且分析了枢纽机场的中转能力[5,6]。研究发现,只有大型航空公司具备在枢纽机场构建航班波体系的能力。因此,航班波的研究普遍聚焦到在枢纽机场航班数量最大的航空公司。例如,德国汉莎航空公司、荷兰皇家航空公司就分别在慕尼黑机场、阿姆斯特丹机场形成了完整的"四进四出"航班波体系;美国航空公司和美国联合航空公司均在芝加哥奥黑尔机场构建了各自的航班波体系[7,8]。

目前,国际学者研究枢纽机场的中转能力主要分为两类:一是聚焦在设施网络、航线布局和拓扑网络连通性研究[9,10],二是分析枢纽机场的时刻

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交通发展新趋势与新区位测度
——理论、方法与数据

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摘要：交通建设所引致的区位条件改善对促进各类生产要素集聚和地方经济发展,重塑区域空间结构具有重要作用,因此交通区位的测度一直是地理学的核心议题之一。随着交通网络的不断发展与完善,以及新技术、新模式、新因素和新业态的出现,地方传统区位条件被重构,个人出行理念和模式发生了一系列变化。交通区位的测度逐渐从依托空间位置和交通设施发展水平的传统地理区位扩展到依托网络连通性、可靠性与出行便捷性的“流空间”新区位;研究对象从关注不同地方的区位特征扩展到关注群体出行规律和个体行为差异的微观区位选择;研究内容从交通设施网络的可达性扩展到基于“门到门”的全链条出行服务;大数据挖掘技术和GIS-T技术的发展也使得交通区位的测度朝着更加精确化和精准化的方向迈进。

关键词：区位;信息技术;大数据;复杂网络;GIS
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1 引言

早在1955年，吴传钧先生就在《地理学报》上发表了“铁路选线调查方法的初步经验”，明确了铁路设计与地理调查需要关注的问题[1]。由于地理工作者既具有自然地理背景，又拥有丰富的经济地理知识，吴先生认为地理学者适合担任铁路选线调查工作，其提出的铁路选线调查方法更是为地理学者参与交通选线工作提供了宝贵的经验，也是吴先生早期对于交通地理学发展的重要贡献。吴先生最核心的学术贡献是提出了人地关系地域系统的理论及主要研究内容[2]。人地关系地域系统的核心宗旨是研究人类和地理环境的相互作用关系，而交通基础设施的建设一方面需要遵循自然系统的分布格局，另一方面又要服务于国民经济发展需求，并最终体现为人类活动所引致的地球表面物质环境再建构和空间秩序再安排[3]。

交通建设主要通过改变区位条件，再进一步对城市和区域发展产生影响，因此，区位成为地理学研究的核心内容之一。理论层面，古典区位论、新古典区位论、现代区位论和新经济地理学中均将运输成本作为解释经济活动空间布局、空间变化及空间相互作用的核心变量[4]。实践层面，随着全球化和信息化的快速推进，“流”、网络和节点逐渐成为影响世界经济体系空间结构、区域空间结构和城市空间结构的重要因素[5]。交通网络作为承载区域和城市间联系的物理网络，在不同尺度空间结构调整和区位重构中扮演着重要作用。

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其他证明材料

聘 书

Letter of Appointment

黄洁：

被聘任为世界交通运输大会技术委员会委员，任期一年。

This is to certify that you are appointed to serve as member of the Technical Committee of the 2019 World Transport Convention. The term is one year.

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黄 洁

在第三十三届国际地理大会（IGC2016）组织工作中，做出突出贡献，特颁此证。

第33届国际地理大会组委会

中国地理学会代章

二〇一六年十二月

证 书

黄洁、王姣娥、靳海涛、金凤君 同志:

您的作品《北京市地铁客流的时空分布格局及特征——基于智能交通卡数据》

在第八届钱学森城市学金奖“城市交通问题”征集评选活动中荣获

金奖提名奖

特发此证。

钱学森城市学金奖征集评选活动组委会

杭州国际城市学研究中心

二〇一八年十一月十一日