



Yisheng Lv, Editor

TransLab: Transportation Intelligent Computing Laboratory at the University of Brasilia, Brazil

EDITOR'S NOTE

Please send your proposal on profiling research activities of your or other ITS research groups and labs for the "ITS Research Labs" column to Yisheng Lv at yisheng.lv@ia.ac.cn.

This report introduces the 24-year R&D experience of the Transportation Intelligent Computing Laboratory (TransLab) of the University of Brasilia (UnB) in intelligent transportation systems (ITSs), with an emphasis on air transportation and other fields related to artificial intelligence (AI), see Figure 1.

Mission

The TransLab is an R&D center for development of ITS in the Department of Computer Science from the UnB, which is one of the top universities in Brazil. TransLab aims to be a bridge between academia and society, applying AI techniques to air transportation and related fields. Furthermore, its members have a vision of developing world-class research works through cooperation with academia, industry, government, and research institutes worldwide.

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TransLab's work is driven by innovation, partnership with industry/government, and international cooperation. In an R&D innovation, we proposed the "Once Learning" mechanism at the International Joint Conference on Neural Networks 1999 (IJCNN 1999) to contribute to few-shot learning and also first used reinforcement learning in air traffic control and management (2009–2012). TransLab is one of five Brazilian laboratories supported by the Boeing Company (2015–2018) to carry out advanced technology research. Also, Prof. Li Weigang was invited to take part in the postgraduate program as a tutor at the French National Civil Aviation Institute (ENAC) to train civil aviation talents from 2019 to 2021.

History

TransLab was founded by Prof. Li Weigang and his colleagues in 1998. After that, some notable activities by the members of TransLab can be seen in the timeline depicted in Figure 2.

- In 1998, TransLab got the first financially supported project from the Brazilian National Council for Scientific and Technological Development (CNPq), including fellowships for the researcher and students. Likewise, Prof. Li Weigang realized one year of visiting research at the Univer-

sity of Calgary. The cooperation result was presented at the IEEE International Conference on Intelligent Transportation Systems (IEEE ITSC) 2002 and considered as an earlier ITS study in Brazil.

QUICK FACTS

Lab name: TransLab
Affiliation: University of Brasilia
Website: <http://www.translab.unb.br>
Established: 1998
Research focus: Air ITS, air traffic management, and machine learning
Director: Prof. Dr. Li Weigang



As a professor and the chair (2018–2022) of the Department of Computer Science at the University of Brasilia, Prof. Li holds a Ph.D. degree from the Aeronautics Institute of Technology. He is also a Senior Member of IEEE and the director of the Brazilian Air Transportation Research Association.

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- In 2006, TransLab organized the National Symposium of Air Transportation Research—SITRAER 2006 in Brasilia with financial support from the National Coordination for the Improvement of Higher Education Personnel (CAPES) as well as from other institutions.
- In 2008, TransLab was recognized and listed in the National Directory of Research Groups organized by CNPq.
- From 2011 to 2013, an institutional cooperation was established among Atech Foundation (an industry developer), the Commission for the Implementation of the Airspace Control System (CISCEA) of the Brazilian Air Force (a government user), and TransLab/UnB with financial support from the Brazilian Innovation Agency (FINEP).
- In 2015, Boeing Company in Brazil invited TransLab/UnB to establish a strategic cooperation in the R&D of 4D-Navigation in air traffic management (ATM). Then, the first TransLab doctoral student, Dr. Cicero Almeida, successfully defended his research and won the 2016 Best Dissertation Award of the Brazilian Civil Aviation Department (SAC) (see Figure 3).
- Invited by ENAC, France, Prof. Li Weigang served as the tutor of the school's aviation management post-graduate program (2019–2021) and was invited as a jury member of the

school's doctoral defense committee three times in 2013, 2019, and 2022.

R&D Areas

The main research focus of TransLab is to solve problems related to ITSs, with an emphasis on air transportation and other fields related to AI. Our main R&D topics are summarized as follows.

Conflict Detection and Resolution for 4D-Navigation in ATM (2015–2019)

The legacy problem of conflict detection and resolution (CD&R) is to find an efficient scheme to present the trajectories in the complex network and further detect and resolve conflicts. This research intends to develop a CD&R framework based on the management of predicted 4D trajectories using a Not Only SQL (NoSQL) database and AI algorithms for conflict resolution. With the Trajectory Prediction simulator, supported by Boeing, using the Brazilian flight plan database, the results from the case study show the effectiveness of the proposed methods for this sophisticated problem and were presented at the IEEE ITSC 2019.

System Wide Information Management Brazil Demonstration (2015–2018)

System Wide Information Management (SWIM), including the SWIM Registry for ATM, has been successfully developed and applied in Europe

and the United States. In this research, we worked with the Airspace Control Institute (ICEA), Aeronautics Institute of Technology (ITA), and IACIT (a company) to introduce the experience of the development of the SWIM Registry Brazil. For better registration and utility of the information in the SWIM Registry, we proposed a model based on blockchain for managing services currently provided by the Brazilian ATM to certificate operations performed by consumers, authorities, and involved stakeholders. Figure 4 shows the SWIM Brazil Demonstration, which was presented at the IEEE ITSC 2018 by TransLab and partners.

Satisficing Collaborative Decision Making Was Developed Based on the Satisficing Game Theory (2013–2016)

The collaborative decision-making (CDM) model includes three main entities [air traffic control (ATC), airlines, and airport management] in air traffic flow management (ATFM). The complete set of functions (preference, rejectability, and selectability) is established for each entity. Because the delay due to ground or air holding potentially alters the takeoff or the landing order of a flight, the sequence of takeoff and landing is determined through the satisficing negotiation process. With real air traffic in the terminal area of Sao Paulo, the experimental results show the importance and effectiveness of including airport management services in CDM. The result was published in *IEEE Transactions on Intelligent Transportation Systems* in 2016.

CDM to Provide Efficient Departure Sequencing (2013–2016)

CDM is an operational paradigm where the decisions are based on complete, shared, and up-to-date information among all the stakeholders involved in ATFM. Such stakeholders include air traffic controllers and airlines. Using game theory, the collaborative departure management (CoDMAN) system was designed to provide



FIG 1 A drone experiment by the researchers of TransLab/UnB in 2019.

efficient departure sequencing based on the negotiations among the aircrafts in a dynamic scenario modeled under the Rubinstein protocol and CDM principles. Using CoDMAN for departure sequencing reduces the observed delays of aircraft in the Brasilia terminal control area (Figure 5). The result was published in *IEEE Transactions on Systems, Man, and Cybernetics: Systems* in 2016.

Reinforcement Learning Agents Developed for Tactical ATFM (2010–2013)

Multiagent systems with reinforcement learning have the ability to suggest actions, typically taken by human agents, to solve an extremely relevant problem in ATFM. TransLab developed a distributed decision support system for tactical ATFM with two types of reward functions: 1) to consider the safety separation and fairness impact among different commercial entities in the ground holding problem and 2) to consider safety separation in the air holding problem. Real case studies in Brazil show the effectiveness and efficiency of the developed reward functions in ATFM. The models and experiment results were published in *Transportation Research Part C: Emerging Technologies* in 2010 and 2013.

Information System of Urban Public Bus Transportation with Business Intelligence Solution (SITCUO) (2002)

A dynamic information system for urban bus passengers in Brasilia was developed to optimize bus operations and increase the satisfaction of urban transportation users. The system involves the convergence of several different technologies, including GPS, geographic information systems, database, data mining, the Internet, and telecommunications. The system includes communication among the GPS, the database, the control center, and the user interfaces, which provide estimated bus arrival times via the information display panels and the Internet. The research was

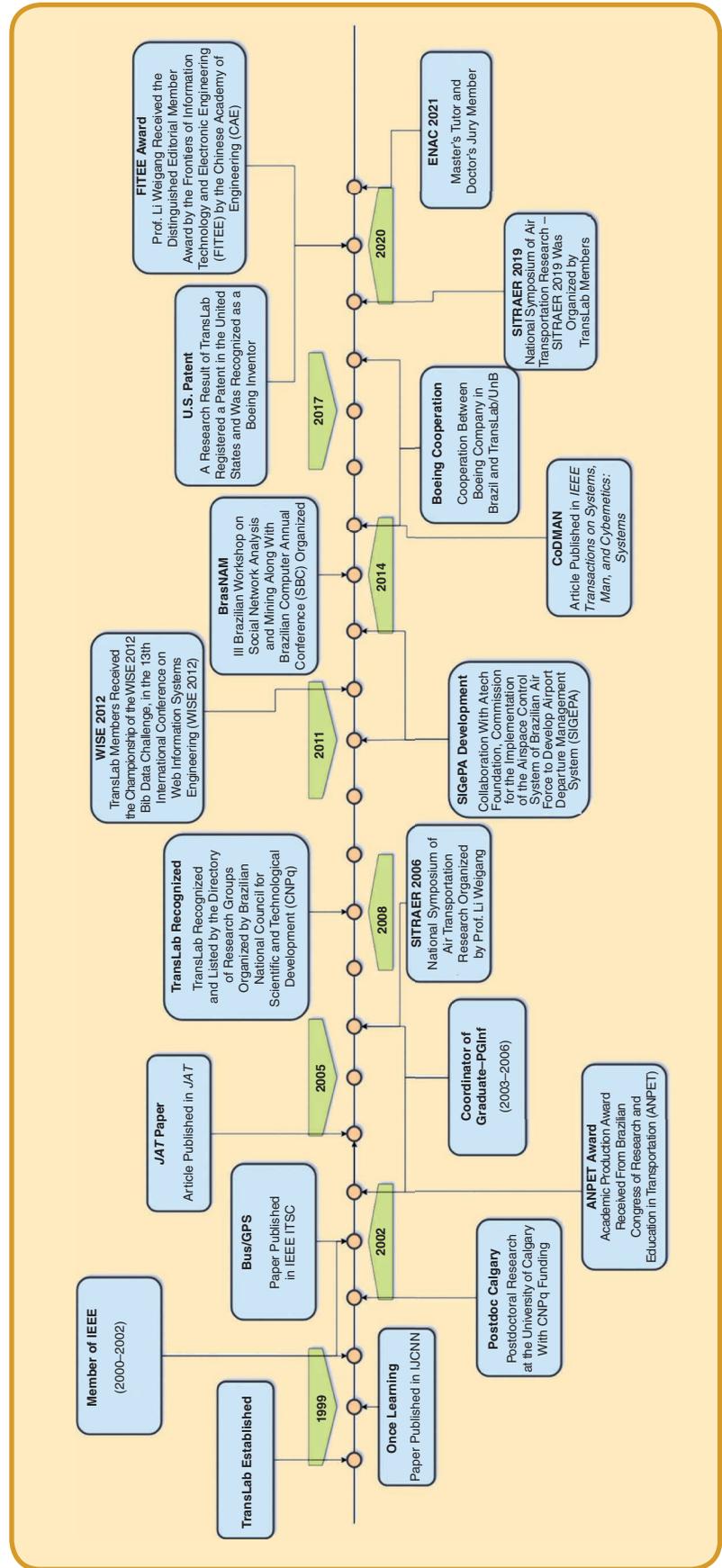


FIG 2 The timeline of TransLab/UnB, from 1998 to 2022. JAT: *Journal of Advanced Transportation*. IJCNN: International Joint Conference on Neural Networks.

supported by CNPq and published in the proceedings of the IEEE ITSC 2002 and the *Journal of Advanced Transportation* in 2004.

Exchange and Events

The achievements of TransLab are inseparable from the strengthening of international cooperation and exchanges. These activities are mainly through the following:

- We invite internationally renowned scholars to participate in the conference held by TransLab in Brazil to give keynote speeches, such as Prof. John-Paul Clarke of the Georgia Institute of Technology, an American Institute of Aeronautics and Astronautics fellow; Prof. Daniel Delahaye of ENAC; Prof. Renbiao Wu of the Civil Aviation University of China; and others.
- Taking advantage of the opportunity for internationally renowned scholars to visit Brazil, we also invite them to visit TransLab: for example, Prof. Azzedine Boukerche of the University of Ottawa, Canada Research Chair, and IEEE Fellow; Prof. Helen Li of Duke University, IEEE Fellow; and others.
- We select TransLab Ph.D. students and scholars to visit international famous research centers. For example, Dr. Leonardo Cruciol, a former doctoral student of TransLab, went to the Georgia Institute of Technology to perform postdoctoral research under the funding of CNPq.
- We have established cooperative relationships with former students of TransLab, such as Dr. Antonio Crespo of McGill University, Canada, and Dr. Alessandro Leite of Université Paris-Saclay, France, and so forth.
- In addition, TransLab scholars take advantage of opportunities to actively visit world-renowned schools; for example, Prof. Li Weigang visited Harvard University, Zhejiang University in 2019, and others.



FIG 3 TransLab won the 2016 Best Dissertation Award of the Brazilian Civil Aviation Department (SAC).

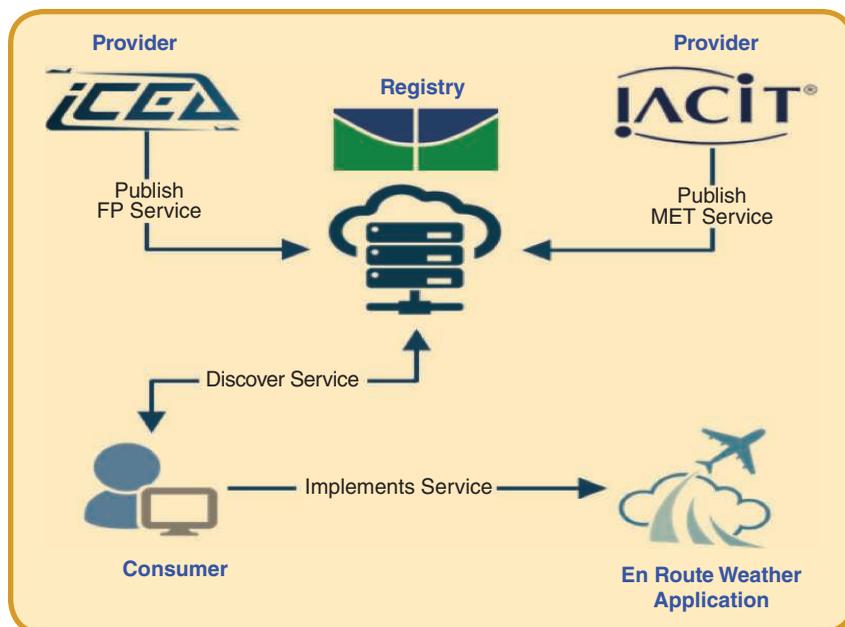


FIG 4 A demonstration of SWIM Brazil among ICEA, IACIT, ITA, and TransLab/UnB in 2017.

TransLab has organized the SITRAER (2006, 2012, and 2019) in Brasilia, and Prof. Li Weigang served as the general coordinator and vice president of the Brazilian Air Transportation Research Association (SBTA). The annual conference invited scholars and students from more than 10 countries, including Australia, China, France, Germany, Portugal, the United States, and others. SITRAER was funded by and with the participation of the National Civil Aviation Agency of Brazil (ANAC), Brazilian Air Force, SAC, Infraero, CNPq, CAPES, Atech, Boeing, and others. Through SITRAER, TransLab organized 11 workshops yearly on the application of information technology in ATC/ATM.

The members of TransLab, Dr. Antonio Crespo, Prof. Li Weigang, and Dr. Alexandre Barreto, organized a Special Session on Aviation Systems

Intelligent Computational Models at IEEE ITSC 2018 and 2019. Also, Prof. Li Weigang has served as the associate editor of the proceedings of the IEEE ITSC for more than 15 years as well as a reviewer of *IEEE Transactions on Intelligent Transportation Systems*.

In 2014, TransLab organized the III Brazilian Workshop on Social Network Analysis and Mining (BrasNAM) together with the Brazilian Computer Annual Conference (SBC) in Brasilia. Dr. Fabrício Benevenuto (the Federal University of Minas Gerais) and Prof. Li Weigang served as the coordinators of BrasNAM. Moreover, Prof. Li Weigang has been a member of the program committee of the Brazilian Artificial Intelligence Annual Conference (SBIA/SBRN and BRACIS) for many years.

Other Activities and Achievements

The members of TransLab have received numerous invitations for editorial board membership or reviewers, such as the Transportation Research C and conference programming committee memberships, such as IEEE ITSC; for plenary and keynote presentations at international conferences; for seminars for universities, companies, or authorities; and

for lecturing at international courses. Since 1998, TransLab has published three books; 75 articles in scientific journals or book chapters; and 170 articles in conference proceedings. The laboratory has trained 61 undergraduates, 31 masters, five Ph.D. students, and three postdoctoral fellows at the UnB. Also, see “Related Information” for websites, conferences, and journals related to the work of TransLab.

- In 2021, Prof. Li Weigang participated in a Full Professor Promotion Committee of the ITA. Over the past 25 years, he has participated in the defense of 50 master’s theses and 25 doctoral theses in universities such as the University of Western Sydney (Australia), the University of Sao Paulo, and others.
- TransLab was invited to edit the chapter “Air Traffic Flow and



FIG 5 TransLab’s researchers and students visiting the control center of the Brasilia International Airport.



FIG 6 The researchers of TransLab, with partners from Boeing and DECEA in SITRAER 2018.

Capacity Management” for the *International Encyclopedia of Transportation* by Elsevier in 2021.

- In 2020, a research result of TransLab was registered as a patent in the United States, and TransLab was recognized as a Boeing inventor. Also, Dr. Vitor F. Ribeiro (a former Ph.D. student of TransLab) received the Best Thesis Award Honorable Mention (2018 and 2019) of the UnB.
- In 2018, Prof. Li Weigang participated in the Technical Committee on SWIM as the president to elaborate “SWIM on National ATM,” which was published by the Brazilian Department of Airspace Control (DECEA).
- Between 2015 and 2018, Boeing and the UnB established a partner-

ship (see Figure 6), and TransLab became one of five Boeing-funded laboratories in Brazil, focusing on 4D-Navigation in ATM. Boeing also provided TransLab with system simulation software such as Total Airspace, Airport Modeler (TAAM), and others.

- TransLab was funded by two Universal projects of the CNPq from 2007 to 2015, and Prof. Li Weigang has been awarded a CNPq fellowship to study the related applications of ITS, especially in ATM/CDM for Brazil.
- The Atech Foundation and TransLab/UnB reached an agreement from 2007 to 2009 to develop the Application and Management System of Air Traffic Flow Control Measures (SISCONFLUX).

- From 2001 to 2005, TransLab was funded by CNPq’s Universal project to develop the Information System of Urban Public Bus Transportation with Business Intelligence Solution—SITCUO. The research results were published in the proceedings of IEEE ITSC 2002.

Future Directions

Urban air mobility (UAM) is expected to increase significantly in the next few years as electric vertical take-off and landing (eVTOL) aircraft are predicted to play a complementary role to cars in big cities. TransLab is now developing the “Intelligent and Safe UAM System with Deep Reinforcement Learning” to use deep reinforcement learning (DRL) to provide separation between eVTOL aircraft and allow the safe use of the airspace on the urban environment, considering: 1) the complex scenarios, including other eVTOL; 2) the possibility of flight without a human pilot; and 3) the fact that each aircraft must be capable of providing its own separation (see Figure 7).

On the other hand, Brazil’s Ministry of Science, Technology and Innovation (MCTI) and the UnB recently established a partnership with the goal of researching a semiautomatic system based on AI and data science to help scholars find funding sources for technical projects. TransLab has joined this collaboration to develop a solution of natural language processing for text classification to support the financial products portfolio of the MCTI. Besides, we intend to study the human-like learning mechanisms by developing “once learning” aggregation algorithms to deal with multimodal input and few-shot learning and meta learning, thereby contributing to machine learning. International cooperation is also established with George Mason University, the University Paris-Saclay, and other national institutions.

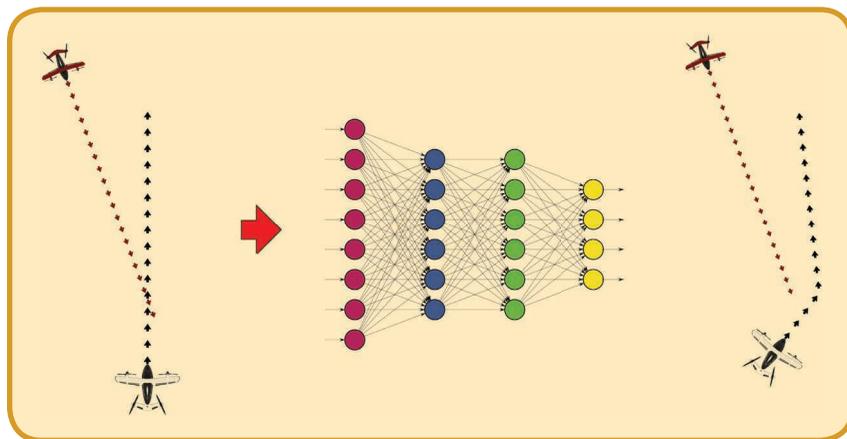


FIG 7 The Intelligent and Safe UAM System with DRL: tactical conflict resolution in 2022.

RELATED INFORMATION

Related URLs

- Website: <http://www.translab.unb.br>
- IEEE Intelligent Transportation Systems Society: <https://iee-itss.org/>
- ITS Podcast: <https://itspodcast.com/>

Related Conferences

- IEEE International Conference on Intelligent Transportation Systems
- International Joint Conference on Neural Networks
- Brazilian Symposium of Air Transportation Research

Related Journals

- *IEEE Transactions on Intelligent Transportation Systems*
- *IEEE Transactions on Systems, Man, and Cybernetics: Systems*
- *Transportation Research Part C: Emerging Technologies*

Acknowledgments

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mashita, and other colleagues from the UnB, and we thank Profs. Alexandre de Barros, Anderson Correia, Carlos Muller, Claudio Barbieri, Claudio Jorge, Felix Mora-Camino, Joao Batista, Jr., Leonardo Sá, Nizam Omar, Paulo Costa, Alessandro Leite, Antonio Crespo, Antonio Timoszczuk, Camila Bassetto, Italo de Oliveira, José Fregnani, and Ricardo Hayashi from other institutions for their cooperation.

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ITS

PH.D. & M.PHIL. THESES' ABSTRACTS *(continued from page 238)*

the driving problems of safety and efficiency by relying only on individual intelligence. Therefore, it is necessary to use vehicle–road collaboration technology to transform from individual intelligence to swarm intelligence. Through swarm intelligence collaboration, it solves the over-the-horizon cognition and knowledge-sharing problems of individual intelligence and realizes the functions containing complex environmental perception, intelligent decision making, collaborative control, and execution so as to achieve safe, efficient, energy-saving, and comfortable intelligent driving.

The main innovations are as follows:

1) In view of the complex and changeable traffic environment, a fine-grained, traffic situation cognition method-based, graph convolutional long short-term memory for road sections is proposed, based

on the idea that the traffic situation of coarse-grained cognition cannot support accurate routing decision-making problems.

- 2) Aiming at the problem of route planning based on historical laws and current road traffic conditions that do not conform to future expectations, causing deviations in route planning and low user compliance, a road topology-oriented, autonomous navigation decision-making method based on a double-rewarded generalized value iteration network is proposed.
- 3) Aiming at the problem that decision making while driving in a dynamic traffic environment with uncertainty and linkage makes it difficult to take into account the global and local optimal conditions, resulting in low traffic efficiency, a cross-domain, collaborative decision-making method

based on vehicle–road collaboration, 2LCoV, is proposed.

- i) Name of the student: Xiaojuan Wei
ii) Name(s) of the supervisor(s): Prof. Dr. Fangchun Yang
iii) Host university: Beijing University of Posts and Telecommunications
iv) Date of the conferral of a Ph.D. degree: April 2021
v) Thesis's web access: https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CDFD&dbname=CDFDLAST2022&filename=1021085995.nh&uniplatform=NZKPT&v=AqKifKJ9z-x_J8Di5S6G0KCt6Zx8dRTdE_bW-JA7tQaT8iKaLggF61uynM1M9p-98

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