Roundtable Discussion

Progress of Urban Informatics in Urban Planning

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ABSTRACT

With the rapid development of computer technology, urban informatics, as a new discipline in the field of urban planning, has gradually attracted academic attention. The rise of urban informatics puts new pressures on urban planning, but it also provides a new perspective of analysis. This paper is a summary of a panel discussion among scholars in urban informatics held at the 2020 International Association for China Planning(IACP).In this context, the panel outlines the definition of urban informatics, and the difference between urban informatics and urban analytic and computing, and found that urban informatics pays more attention to end user. This indicates that urban informatics has been more than a supporting role in urban planning or design, and is increasingly integrated with urban planning. The panel also discusses the connotation of urban informatics and its wide application in practice, and illustrates with examples. At the same time, the team identifies the difficulties of its development mainly reflected in the two aspects of resources and talents, and the learners of urban planning discipline have natural advantage in learning urban informatics. Finally, the panel discusses how to improve teaching, and concludes that the promotion of good cases, discipline integration, training data thinking rather than focusing too much on methods and other concepts. All in all, this panel's report contributes to the wider discussion about the role of urban informatics plays in urban planning.

Introduction

The discussion of definitions and roles of urban informatics is important. In the field of computer science, information science consists of information system and information technology, including information recording, calculation, analysis, storage and retrieval (Mikhailov, et al., 1967). The application of information science in urban planning has a long history (Pan, et al., 2020), and there are a lot of practices of using urban information to develop research. Urban information can be categorized into urban governance, community life, industry and public service (Zhu, et al., 2020). There is no unified definition of urban informatics, some scholars viewed it as "the seamless transition between visible and intangible infrastructure" (Foth, 2011), or an extension of the "big data" (Schintler, 2017), and other scholars thought that the field is "the information technology application in urban areas" (Thakuriah, et al., 2017). Chinese scholars proposed that informatization can form a high-quality driving system of the city, and the smooth flow of logistics, resource, and human between the functional nodes of the cities; optimize and improve the allocation of environmental resources and public services such as transportation and employment. This will give the city more flexibility in space and elements, and enhance the city's overall carrying capacity. Most of the existing literature on urban informatics focus on urban computing, computer science and technology, and then explore, describe, predict, and explain city phenomena to a certain extent. Kontokosta (2018) describes urban informatics as the study through a data science framework of urban sensing, data mining, modeling (and analysis), and visualization in order to understand the phenomena while advancing solving urban problems in specific domains with computational science methods. Some scholars believe that urban informatics is the extension of some technologies, and do not consider it as a whole with more technologies.

To this end, a panel at the 2020 International Association for China Planning(IACP) meeting convened to interrogate issues in urban informatics. To guide the panel, we posed a few core questions that help to structure an inquiry into the structure and the future of urban informatics:

1. In the information explosive era, city research is inevitably utilizing the contents and methods of informatics. In this context, what's your definition of urban informatics?

2. What role could, or should, urban visualization and informatics play in the creation of new urban knowledge? Traditional urban informatics plays a supporting role in urban planning. Now it has richer content. What's the role of urban informatics play in current urban planning in your opinion?

3. Regarding the contents of urban informatics: Urban Sensing. Data visualization, Urban big data and CIM, could you choose one or two aspects to discuss the status, opportunity, challenge and relationship with urban planning?

4. In what areas of urban research are attempts at urban visualization and informatics most likely to succeed and be the most impactful?

5. How should urban visualization and informatics be incorporated into the urban planning and design? What institutional changes should be made to improve the research of urban visualization and informatics?

6. What forms of education and training are needed to make students aware of urban visualization and informatics issues?

Defining urban informatics

Xinyue Ye: It is necessary to give a definition of informatics first. Traditionally, informatics consists of information system and information technology in the field of computer science. It includes data, modeling, calculation, visualization, decision-making system, optimization, etc.. Informatics is a relatively comprehensive system that summarizes data collection, data simulation and visualization, and integration with hardware. Over the past ten years, urban informatics has gradually emerged due to a deeper understanding of people, and we can understand the interaction between people and the environment better, especially the built environment. With urban informatics, we can better understand how cities operate in the above-mentioned technological cluster, and better facilitate cities to achieve sustainable development.

In addition, the definition of urban informatics varies due to the different understandings of different disciplines. Scholars majoring in computer science pay more attention to the understanding of data, while urban planners pay more attention to the application of knowledge, such as scholars at Texas A&M University using new knowledge to guide communities in how to deal with disasters and improve their operational capabilities.

Xiaoru Yuan: In terms of intuition, urban informatics and bio informatics have some similarities. It has never been data-driven or data-centric, and now more data-driven forms are slowly appearing. Bio informatics can be extended to solve biological problems, bring related applications and corresponding technologies. By analogy, urban informatics may also have a similar definition. Not only urban planning domain but also many traditional majors are becoming more incorporated with informatics.

I strongly agree with the view that urban informatics pays great attention to the end user, and emphasizing users distinguishes urban informatics from other definitions of computer science or social science.

Wenwen Zhang: Many scholars in the field of computer science are also engaged in urban analysis and related studies. Then what are the advantages of urban planning scholars who want to conduct urban informatics research in their disciplines? I think we should pay attention to public end-users. As urban planners, we should utilize planning knowledge to promote policy making and public fairness. Taking a project as an example, the computer science scholars I worked with were willing to optimize the division of school districts by developing an optimization model. However, dividing school district in the United States is affected by social and political factors. These aspects are beyond the consideration of people who have never studied urban planning.

Therefore, in the field of urban informatics we should focus on the following aspects: policy making, powerful machine learning and advanced mathematical models, data security and the bias from the model results.

Chenghe Guan: Urban informatics should be explained more deeply under the existing definition. It includes three aspects of participants, place, and technology in urban informatics.

First of all, participants can be explained by stakeholders in urban informatics Participants include not only individual, but also different institutions or industries. In addition, a single participant or person can assume multiple roles. Therefore, this is a fundamental and new interpretation of people in the city, which considers the existence of multiple dimensions in a more understandable way.

Secondly, place emphasizes spatiality. In the context of urban informatics, the built environment and the natural environment are more accurate, and the two are connected to each other without clear boundaries.

The third is technology. The essential change is not the technology itself. Urban technology and the city as an organic structure follows multiple urban spatial laws. We should merge the technological change with the essence of urban systems. For example, many scholars engaged in computational analysis and urban science have been working on the new urban order induced by innovative technology. If we sort these out clearly, we will be able to understand urban informatics better.

Fan Zhang: Compared with the concepts of Urban Data Mining and Urban Computing, urban informatics covers a wider range and emphasizes the contents of urban information, urban data infrastructure, data acquisition, data platform construction, data-driven intelligent decision-making, implementation, and evaluation. Urban informatics can be defined relative to geo-informatics and traditional urban studies. So on the one hand, compared with geo-informatics, urban informatics focuses not only on static physical spaces, but also on dynamic spatial interactions, understanding of time processes, social relations in social spaces, and virtual cyberspace containing social media behavior, etc. It also includes a more important interactive mechanism between urban physical space and social media space, such as how epidemic information and even rumors affect people's travel behaviors. On the other hand, the definition of urban informatics is relative to urban study. Urban informatics not only pays attention to urban issues, but also pays more attention to intelligent policy making, and refined evaluation of policy effectiveness.

Ying Long: Urban informatics has different meanings in different times. A lot of information and technology have profoundly changed individuals, society, space, and the operation of cities. Therefore, in the past years, in addition to urban study and planning and design supportive work, our laboratory also paid attention to the emergence of "new cities". I believe this is very important in terms of methodology, technology or engineering, and it will also have a profound impact on the entire society and the city, and even reshape or redefine it.

We can understand urban informatics from two aspects. One is to use information to understand traditional city, and the other is how to learn the changed city. Through investigation, we found that each industrial revolution has profoundly changed the city. In fact, data analysis and data visualization are just two aspects of this transmission, I urge everyone to attach importance to whether it is possible to study new cities.

Chao Liu: Many literature believe that urban informatics is a seamless transition between visible and invisible infrastructure in cities, or the extension of big data, or the application of information technology to urban areas. I think these kinds of understanding are too narrow. Urban informatics should not only include data technology, but also include responses from urban planning and management.

My preliminary conclusion is that it can be regarded as a discipline that uses a comprehensive method to perceive the city in information perspective, collect and process data information, and use the data information to conduct study and practice on planning issues. Urban informatics can be divided into 4 directions: urban sensing, urban big data, urban data model (CIM), and urban data visualization. In the future, more directions may be included along with the development of urban planning discipline and information technology.

Regarding the contents of urban informatics: Urban Sensing. Data visualization, Urban big data and CIM, choose one or two aspects to discuss the status, opportunity, challenge and relationship with urban planning

Fan Zhang: Regarding the role of urban informatics in the creation of urban knowledge, I think that the massive urban data and new data mining methods are opening up possibilities to deeply understand cities. For example, in the process of observing the expansion and growth of different cities, although the geographical and population conditions of the cities are not consistent, there are some universal laws, such as the sub-linear relationship between urban population growth and infrastructure, super-linear relationship between urban population growth with economy or technology, etc. As the data we obtain becomes increasingly richer in time and space, we have the opportunity to discover the consistent laws at different scales, and to verify some hypotheses about city understanding derived from physics, ecology and other complex sciences, and form new knowledge. It is the contribution of urban informatics to the creation of new knowledge in urban theory, helping us understand cities better.

In practice, also the level of contribution to urban planning, urban informatics put particular emphasis on the construction of data infrastructure, that is, to actively and customizedly collect the needs of the city and residents through the construction of data collection platform, and assist in planning and places-making. At MIT Senseable City Lab, we developed a project in cooperation with the Paris bus system in recent years, which is to observe how Paris residents use the curb, and the types of activities in this area by installing cameras on buses. We use computer vision to identify and classify, and conduct spatio-temporal analysis of streets with Paris's bus network. This is one aspect of it. It is through active data collection and customized data platform to assist planning and design.

Chenghe Guan: I'd like to talk about one of the three most basic domains just mentioned, which are participants or stakeholders. We should not treat 600 million people living in rural or non-urban areas in China as individuals, but as families or collectives and communities with inherent social structures. Correspondingly, due to the typology of the built environment, the idea of digital urban platform and pre-cast construction are easier to achieve in townships and villages, comparing that in the larger cities. We can learn how to use urban big data to know when people in villages need to change their living environment, or when their family structure changes. It is a comprehensive system to effectively solve their long-term lifestyle problems, for example, through a data platform, rather than simply providing them with what they need at the moment.

If we use this urban data platform in other countries, such as using collected data to observe park activities, stakeholders will become park users of the urban land system. It is difficult for everyone to tell whether they are park users or not, and we always face the challenge of incompleteness of data collection. Taking a step back, there will always be a bottleneck when we obtain data. These bottlenecks make the city operation not efficient even if urban information is available. The biggest barrier is that city information cannot be communicated and exchanged. When our research results are combined with the results of others, we may

find that we need to recalculate the model. Therefore, if it can be unified, big data can then be truly applied to cities.

Wenwen Zhang: At present, the most commonly used theory in transportation planning is the application of machine learning to improve the prediction accuracy of existing models, interpret able machine learning to identify the impact of nonlinear relationships on transportation demand, and agent-based simulations to predict the impact of traffic technologies that have not been widely used on future cities, and to solve the research barriers due to the lack of user preference data. I think another contribution of big data and urban informatics is to make some national-scale models which can be better developed. The previous data was more fragmented, but now comparable models between cities can be established, such as Google Street View.

For data visualization, I think there are two main aspects of applications. On the one hand, it can effectively communicate with the public using the visualizing results during public participation, so that they can agree with your model and support your planning decisions. On the other hand, for researchers, data visualization can make the black-box model more effective.

Xiaoru Yuan: Visualization is not limited to conveying information, it will have many different functions. For example, it can help making decision, especially if the model is still iterating, optimizing, or there is no complete analytical expression in mathematics. In this case, visualization can extend our brains and hands, and can powerfully expand people's cognitive and analytical capabilities. In addition, from the perspective of public understanding and communication, the public needs to associate with the data or the information behind it directly, and establish a corresponding feedback mechanism so that the public can participate in. It requires us to have good methods and media, and to add some points that may be missed from a single perspective.

There is still a considerable gap between the backgrounds of urban planning and computer science researchers in study and practice. Replying on personal efforts is not sufficient, and there needs to construct a collaborative mechanisms. How to promote the in-depth interdisciplinary studies to output giant influences and practical guidance is a research question.

Xinyue Ye: We have conducted research and practice on urban visualization from three aspects. The first is to challenge the computing limits. We built a system to observe the mobility anywhere in the city without worrying too much about computers' calculating capability. Our second idea is how to provide data to the local community in an easily understandable way, including social media data, POI data, and demand data of the community. We put all these data in a visualizing system. The third idea is to collect data in places where there is limited data.

So the purpose of visualization has changed from dealing with massive amounts of data to considering who are still outside the massive data, and finally achieve the goal of community wellness and fairness.

Chao Liu: Big data and CIM in urban informatics is now a research focus in China and the world. Data visualization is also important to urban planners. Scholars in urban planning and urban study have the advantages of better aesthetics and understanding of three-dimensional space. Therefore, we have competitive edge compared to CS experts in visualization. However, the visualization technology is complicated, urban planners engage less in model building and more in model application.

I wish we can develop a platform easy to use such as CAD and break the technological barrier. Then urban planners will engage more actively in this field.

What's the role of urban informatics play in current urban planning? What institutional changes should be made to improve the research of urban visualization and informatics?

Xinyue Ye: In the first project I did in Texas A&M University, I set up an intelligent project of "preventing the city from being flooded" and gathered scholars from different major such as architecture, landscape, planning, and soft engineering. For example, we used a photo of a building as the starting point, allowing scholars to point out whether the building meets the flood control requirements from different perspectives. Therefore, we established a system and a huge knowledge graph on this basis, linking the visible content in the map with the remote sensing, socioeconomic factors, and urban policy factors behind it.

Since it is not possible to mark all pictures, we rely on the rich professional knowledge of teachers from multiple disciplines to build a cold-start. we kept collecting data to make the project more intelligent. Finally, if you input a picture into our system, the system will tell you whether the design meets the flood control standard. It will also mark the design problems on the picture. This makes it possible for teachers to show students whether a plan is reasonable or not without exhaustive design cases during class. More importantly, relying on such a project, the scattered knowledge can be linked to achieve interdisciplinary cooperation.

Xiaoru Yuan: This topic contains two possibilities. One is that the demand is strong and the resource allocation is sufficient, but the people who are doing it are not capable enough. It may also be that we have demands but there are not enough resources. Generally speaking, if we want to succeed and have a systematic development in a certain field, this requires sufficient talents and resources, and it goes beyond personal behavior.

For example, Chinese Academy of Sciences is building News Science, to combine new information technology with traditional humanities. This requires the design of corresponding institutions or mechanisms. The technology may not be the most important here, but the difficulty lies in the entire mechanism and whether there is enough power input. So the key point is there are enough resources and attractive enough to talents.

Wenwen Zhang: There are more barriers in practice, mainly in resources, laws and regulations. On the one hand, there is a barrier of institutional resources. For example, in the United States, the support of the planning department is relatively insufficient, and the existing infrastructure is relatively old. Many things that can be made theoretically have little space for practical applications. In the absence of data sharing mechanism, the combination of databases is difficult, and especially in urban data. Therefore, we still need to invest continually to support data-driven development. China has done better than the United States in this aspect, such as supporting the development of data cities and government big data platforms.

On the other hand, the standardization of data sharing, data privacy and other related laws are not yet complete, which is also one of the barriers. For example, the urban sensing topics that we have studied a lot are not operational in many cities in the United States. But when these are gradually established and improved,

the application prospects are still very bright.

Chenghe Guan: We need to know who the decision makers are. Under universal conditions, this may be difficult to make clear. We went to Accra, the capital of Ghana in Africa, to explore how to provide them with information when they are start with. The former mayor said that there were many problems to be solved in the local area, but planners were unable to provide data, and even if they had data, It cannot be easily understood by decision-makers and cannot be integrated into local planning and design. Another example is the evolution of population migration in China. I think that if we analyze it with big data, we can see neighbor relations, cultural relations, and immigration relations. These are what we can show to local decision-makers as planners. This requires a lot of effort beyond platform building, but if we combine informatics and planning together from a non-standard perspective, perhaps we can do better.

Regardless of the differences in the definition of urban informatics within different disciplines, the panel believes that the most important thing is the consideration of end users and the care for the community. Panelists consistently suggested that without sufficient resources, talents, institutional guarantees, and platform construction, it is difficult for urban informatics to achieve substantial development. Although urban planning scholars have advantages in this regard, they cannot succeed by relying solely on individuals. In addition, the panel believes that based on the understanding of the connotation and significance of urban informatics, related practice and education should promote each other. Cooperation between disciplines is one of the ways to develop urban informatics, and the data thinking of participants should be cultivated.

Fan Zhang: Data mining or visualization can be roughly divided into two stages in urban study from facts to insights. First of all, discovering the facts is the early approach we use big data. For example, simply using the location and time information of vehicles to understand the peak travel periods of different streets can help us understand the formulation of urban traffic policies. But now we hope to use shallow information to build in-depth understanding and insight such as job-housing balance, pollution emissions, health issues, group segregation, or even the problem of unequal distribution of resources. This is a process from the use of big data and facts to insights.

Our requirements for big data are far from being satisfied with the facts, and the bias of big data may lead us to reveal a kind of bias. Therefore, if we want to better integrate data into planning and design, we need to add better insights to data mining. In practice, we need to strengthen the understanding of the business, in research, we need to combine real research questions and theory with data.

Ying Long: We believe the good studies should be problem or question oriented. The integration of urban informatics territorial spatial planning is relatively easier, what urban informatics can do has been done ten years ago, but the engineering integration is still going on. Yet the integration of urban design and urban informatics is more difficult. Therefore, at the research level, our laboratory is more inclined to design the human-based scale, or the superhuman-based scale.

For urban informatics, being planners and designers are not the only way for us to have a social impact and improve the quality of life. Therefore, we not only focus on planning support or design support. We are also exploring other ways to improve the quality of life.

Chao Liu: A fundamental change has quietly occurred in China. It is very important that some academic leaders who have seen the feasibility in a optimistic perspective. For example, when Prof.Long came back from the UK, he quickly made this subject very influential. In addition, Academician Wu Zhiqiang of Tongji University, as the helm of the entire discipline, is leading intelligent planning research and education.

Therefore, in the case of late development in China, if some people at the helm ca n push this direction, it will make changes faster. This is one of the reasons why China's urban informatics is relatively prosperous at this stage. In the future, in-depth discipline cooperation will be even more important.

What forms of education and training are needed to make students aware of urban visualization and informatics issues?

Chao Liu: I taught a course of Urban Data Informatics and Visualization this semester. Before the course started, I did a questionnaire. The feedback from the students was that nearly 100% of them needed this kind of knowledge, but they were hesitant to learn it because they didn't have a programming background. So I conducted heuristic teaching, including inviting scholars to present at class and simple programming teaching. These are some of my explorations this semester.

Although this course has only one credit, it is effective and receive positive feedback from students. The final course project was to use the COVID-19 data to do visualization and data analytic. Most students could fulfill the requirement of the course.

Fan Zhang: We will employ many interdisciplinary methods in our research and education, for example, AI is increasingly used to solve problems. However, we need to use these tools in a standard way. From my perspective, three aspects might be importance in student training. The first aspect is urban econometrics. During the paper review process, I found that many statistical methods were not used correctly, such as ignoring various endogenous issues, and discussing causal effects from a regular correlation analysis. The second aspect is machine learning. We often use one set of data to predict another. However, how to construct a training set, how to verify whether it is over-fitting, and whether the model has really learned knowledge from empirical research. These issues haven't received enough attention. Good visualization can tell the story more clearly and thoroughly, and good visualization can even save a relatively ordinary research. In terms of student training, these can be solved through training.

Wenwen Zhang: The uncertainty of the majors faced by students in the department of urban planning is particularly obvious. Many students hesitate to switch to computer science. Therefore, it is important to understand the demand for student skills in the market. It is not realistic to convince students to study urban informatics if we do not know the needs. In addition, the hardware must be improved. It is difficult for students to run on their own computers when teaching big data. These two are relatively big challenges. Others such as how to motivate students are also very important.

Ying Long: My course covers big data and city planning, city models, new city science, and smart cities. I have always called for understanding of the city to be more important, and then the

analyzing method. In addition, I am willing to let my students develop critical thinking. For example, Jacobs is also criticized by many people. And I hope students will not be too conservative. Urban informatics is unstoppable, so embracing it is the only choice. Finally, our discipline is too tolerant of the requirements for publishing papers. We must do a good job of exploring knowledge in research in order to better convey the content and experience to the students.

Xiaoru Yuan: Learning visualization is not about learning related technologies and applying them, which will make results similar. If above concept is taught to students, it will greatly damage students' thinking and analyzing ability. For example, some textbooks talk about technology in different categories at the beginning, which will make students think that only the application of technology is enough, but they do not understand where the technology comes from, and eventually students will find that they cannot treat visualization in a rigid manner. So in the teaching, we should first understand the essence is the training of thinking ability and analytical ability.

Good visualization is not complicated or cool visualization. The key is to have a systematic understanding of data, content of tasks, and comprehensive user analysis, and method matching follows by. The urban planning background may help in visualization. There is a possibility to share some relevant and good teaching cases to improve the construction of students' overall thinking ability. After the students have this ability, what work they will do in the future becomes less important. And teaching should be targeted, focusing on the construction of thinking ability for undergraduate teaching, professional training for graduate teaching, and critical thinking for doctoral teaching.

Xinyue Ye: First of all, I think the best thing teachers teach students is to cultivate students' curiosity and initiative, so that they will be willing to explore the boundaries of subjects. Secondly, we need to think from the perspective of students and appreciate their strengths. The happiest thing to be a teacher is to grow up with students simultaneously and find how you change students. At the same time, students can change you too. In addition, every week I will organize some of my collaborators in different majors to discuss together, including students and teachers, which is a way for students to learn better.

Finally, we should have great confidence. In 2001, Michael Frank Goodchild, an Academician of the American Academy of Sciences and the father of geographic information science, established Space Social Science Center. He hopes to use this platform to cultivate non-geographical students to learn spatial analysis, which is an ambitious investment. We should train more people in other disciplines, courageously cooperate with other disciplines, and let them grow up. The prosperity of the urban informatics does not depend on one discipline, but requires multiple disciplines to recognize the importance of this matter.

ChengHe Guan: The problem we encountered was to attract students' interest in city information and city data visualization. Unlike other schools, NYU Shanghai has just established a major in urban studies. In terms of size, it is not comparable to other already mature schools and majors. But at the same time, we also have the advantages of "small" and "new", and we can adapt to market demand and the needs of future students for employment and further education more quickly. My requirement for students is to learn more about the trends and basic courses of other related majors on the basis of traditional theories and professional courses. I suggest that they choose a major and a minor. Such as data science and computer science, urban economics, or more specific directions, such as urban simulation and prediction, urban social relationship networks, etc. In addition, I encourage students to have a broader thinking and a more top-down perspective on urban issues. In terms of practice, I suggest that you can apply what you have learned to different fields related to different cities, rather than just learning in one direction.

Conclusion and future directions

Regardless of the differences in the definition of urban informatics within different disciplines, the panel believes that the most important thing is the consideration of end users and the care for the community. Panelists consistently suggested that without sufficient resources, talents, institutional guarantees, and platform construction, it is difficult for urban informatics to achieve substantial development. Although urban planning scholars have advantages in this regard, they cannot succeed by relying solely on individuals. In addition, the panel believes that based on the understanding of the connotation and significance of urban informatics, related practice and education should promote each other. Cooperation between disciplines is one of the ways to develop urban informatics, and the data thinking of participants should be cultivated.

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