Urban Planning Reform Trend Based on Artificial Intelligence

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Abstract. Artificial intelligence (AI) will offer opportunities for comprehensive reform in the urban planning field, including thoughts, technologies, methods, and management. It is inevitable that the urban planning reform throughout the urban planning management process will be optimized by the development and application of AI. Firstly, the development and evolution of AI and its stage features are consolidated, and several technological breakthrough directions of AI are expounded. Subsequently, the interactions between AI and urban planning are analyzed. Meanwhile, based on the clarification of four basic features (uncertain, scientific, democratic and dynamic) of urban planning reform, the problems of China’s urban planning reform in four aspects of information, technology, subject, and feedback are reviewed. Finally, from the four technical breakthrough directions, that is, big data intelligence, human-computer hybrid enhanced intelligence, Internet group intelligence, and cross-media intelligence, in the AI technology closely related to the above urban planning reform problems, optimization strategies are prosed for the urban planning reform in China.

Keywords: Artificial Intelligence, Urban Planning, Planning Reform

1. Introduction
The application of artificial intelligence (AI) in urban planning can symbolize a game changer in this field. In July 2017[1-2], the State Council issued the development plan of AI, emphasizing “promoting the full life cycle intelligence of urban planning, construction, management, and operation”. In the visible future, while urban planning continues to provide research and development platforms for AI applications, AI also brings possibilities for comprehensive reform in the field of urban planning, including ideas[3-4], technologies, methods, and management. As an essential part of the whole urban planning management process, it is inevitable that urban planning reform will be optimized by the development and application of AI. Hence, based on clarifying the development context of AI and
looking forward to the development direction of AI, analyzing the essential features of urban planning reform [5-6], and investigating the existing problems in the current urban planning reform in China, and then putting forward the corresponding optimization strategies, has a strong pertinence and practical significance.

2. Evolution of ai and its interaction with urban planning

With the rapid development of information technology in the 21st century and the expansion of social demand for AI, the goal of AI has changed, that is, from the past pursuit of “simulating human intelligence with computer” to “synthesizing hybrid, group and more complex intelligent system with machine, human, network and object”. Currently, it includes big data intelligence, Internet group intelligence, cross-media intelligence. Many new technological changes such as man-machine hybrid enhanced intelligence and autonomous intelligent systems spring up, which will become the main development direction of AI in the future (Table 1).

| Table 1. Development directions of AI in the future |
|---------------------------------------------------|
| **Existing basis** | **Directions** | **Future development directions and specific contents** |
| Big data intelligence | Knowledge expression technology and big data driven knowledge learning | From data to knowledge, from knowledge to intelligent behavior | Establish a knowledge center connecting multiple fields to support cross-border integration and innovation services of new technologies and new formats |
| Cross-media intelligence | Data processing technology of vision, hearing and text | Cross-media perception, learning, reasoning and creation | Establish the theory and model of multimedia perceptual analysis and semantic communication compatibility, establish and develop new theory, new method, new software and new hardware of intelligent perception, cross-media autonomous learning and reasoning |
| Human computer hybrid to enhance intelligence | Intelligent machine | High level collaborative integration of human intelligence and machine intelligence system | The new computing form of hybrid enhanced intelligence realizes the situation understanding, problem solving, scheduling and transformation of human-computer and brain computer cooperation |
| Internet group intelligence | Network intelligence | Technology and platform of group intelligence based on Internet Technology, architecture, platform and design standard of autonomous intelligent system | Group intelligence and its mechanism and platform of coordination, order, security, evolution, learning and evolution on the Internet, as well as related industrial formats |
| Autonomous Intelligent System | Robot | | Lead all kinds of machinery, equipment and products to become intelligent, and form independent intelligent transportation platform, self-service production and processing system, intelligent dispatching and monitoring system, etc |

Currently, the application of AI in the field of urban planning has begun to take shape, involving in urban research, planning and design, planning and management, etc. Artificial intelligence plays a vital role in urban planning because of its strong analytical ability, strict logical reasoning, quick selection and change, and sensitive information feedback. In the aspect of urban research, it mainly relies on the machine learning technology of AI to recognize and summarize the law of urban growth and spatial law and strives to change the thinking of urban planning from “Ideal orientation” in the
middle ages and “problem orientation” in the 20th century to “Urban law orientation” in the future. In the aspect of planning and design, AI is mainly used to explore the relevant elements and their weights that affect the urban development, and then through model construction to associate, coordinate and integrate these elements, and then draw the planning and design scheme. In the aspect of planning management, 3D support system, machine learning, the cityscope platform are used to assist urban planning management, and the PSS system is used to support urban planning change management.

3. Analysis of urban planning reform characteristics

The definitions of “Urban planning reform” has not been unified among scholars as it involves the relationship with “Urban planning”, “Planning management” and “Planning implementation”. In a narrow sense, planning management consists of two parts: “planning change” and “planning implementation”, the former is the preparation stage of the latter; in a broad sense, planning change is a vital link and component throughout the whole process of urban planning management, that is, “urban planning change is the changing subject to sort out information and select problems that have occurred, are occurring and will occur in the process of urban planning The activity process of focusing, selecting programs, formulating and implementing policies”. 

The detailed form of AI big data depth analysis is as follows:

In study samples, \((x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)\) are entered, where \(x\) represent instance space, \(y\) indicates the sample identification, \(y_i = 0, 1\), which are expressed as positive/negative samples, respectively. Among them, the number of positive samples is \(m\), and the number of negative samples is \(l\), \(M + L = N\).

The sample weights of the positive and negative sets are initialized respectively and expressed as follows:

\[
\frac{1}{M} = \frac{1}{L}
\]

The weight is normalized as follows:

\[
q_{i,j} = \frac{w_{i,j}}{\sum_{j=1}^{n} w_{i,j}}
\]

(1)

The error probability of each weak classifier for data classification in the operation is calculated as follows.

\[
\varepsilon = \sum_{i=1}^{n} \frac{1}{2} \| h_i(x) - y_i \|
\]

(2)

After classification, the weak classifier with the lowest error probability will be the optimal weak classifier in this operation;

\[
\varepsilon_i = \min_j \sum q_j \| h(x, h) - y_i \| = \sum q_j \| h(x, f_i) - y_i \|
\]

(3)

In general, the urban planning process can be divided into four stages as follows: problem
identification and objective definition, data investigation and analysis prediction, planning and design scheme evaluation, implementation management, and result feedback. Each stage requires changes, which shall be implemented based on different change tasks (Table 2). As the basis for guiding urban development and construction in a certain period, the urban planning changes in each stage are formulated based on the macro policy background and social and economic development at that time. The implementation results of the changes will also be fed back to the planning changes in the next stage, which will become the conditions for the formulation of new reform. Therefore, urban planning change can be regarded as a dynamic process of “Reform implementation”, and the timely feedback of the implementation results of changes in each stage of the urban planning process is vital.

| Urban planning process                                      | Reform initiatives                                                                 |
|-------------------------------------------------------------|------------------------------------------------------------------------------------|
| Problem identification and goal definition                  | Summarize and translate the views of the participants in planning into comprehensive, |
| Data investigation, analysis, and prediction                | systematic and reliable planning objective systems                                  |
| Evaluation of planning and design scheme                    | Analyze the planning elements related to the prediction results, establish the      |
| Implementation management and result feedback               | relationship model, and deduce the reasonable results                              |
|                                                             | Select the right plan from multiple planning plans                                 |
|                                                             | Analyze obstacles in implementation and give feedback to make adjustment decisions |

**Table 2.** Urban planning process and transformation tasks

4. Optimization strategy for urban planning reform based on AI

Based on big data intelligent technology, the “Information support system for urban planning reform” featuring data integration, key information extraction, rule mining and so on is established. Firstly, the system can integrate, store and share massive data from different departments, including structured and unstructured data. They are required by urban planning reform through the unification of data conversion interface, to eliminate the widespread phenomenon of “data island” and “data separation”. Secondly, the system is equipped with the technology of big data deep learning, which can automatically extract and learn the massive information data and extract the critical information according to the law of self accumulation. Finally, through the analysis and refinement of the internal logical connection of massive information data, the system further excavates the relationship between the natural, social, economic, cultural and political planning elements in the highly complex system of the city and the urban development, better summarizes the law of urban development in China and predicts the possibility of future development, as a valid basis and support tool for planning reform, to reduce planning The uncertainty of change.

Based on the human-computer hybrid technology-enhanced intelligence, the “Urban planning transformation technology auxiliary system” featuring model prediction, simulation, human-computer interaction and so on is established to integrate the technology perception of urban planning, the machine learning technology of rational learning, and the machine AI with the change of human beings, to achieve the optimal combination of change will and machine rationality. Firstly, based on the “Information support system” mentioned above, combined with the knowledge of system science, management change science, computer science, urban planning and related fields, the system clarifies the structure, composition, features, elements, operation mechanism of the complex giant system of city, and constructs the prediction model database of the same state with the objective entity.
Secondly, a virtual urban environment is established based on multi-dimensional, multi-element and 3D simulation and spatiotemporal deduction of the urban development picture under the constraints of multi-objective, establish the causal relationship between the future planning scene and the current situation, provide the dynamic, continuous and multi-scenario conclusions of the co-assimilation of digital planning results for the innovators, thereby providing reliable consultation for the judgment of the change activities. Finally, a friendly human-computer interaction platform is established for the change participants to integrate quantitative technology into the process of planning change. It can also be applied to scheme adjustment and scenario display according to the ideas, visions of different participants, and scheme review by administrative change personnel.

5. Conclusions
Currently, the application of AI is still at its infancy. However, it has started to take shape in urban research, planning design, planning management and other aspects. It can be predicted that AI technology will lead to comprehensive reform in the urban planning field. With the continuous policy promotion of AI development in China, its application in urban planning reform has broad prospects in the future, especially new technologies such as big data intelligence, human-computer hybrid enhanced intelligence, Internet group intelligence, and cross-media intelligence will play an essential role in expanding the reform information, improving reform technology, enriching reform subjects, and strengthening reform feedback, etc. This paper is expected to provide directional suggestions for the future practice of AI in the field of urban planning reform.

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