Research and Analysis on the Evaluation of the Application Level of Intelligent Medical Technology Based on the Background of Big Data Meta-Universe

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Abstract. Digital smart medical care combining metadata and smart medical care is an important means to improve medical services, but the evaluation system of the level of smart medical construction in the context of metadata has not yet been established, and there is a certain blindness in the development. This study proposes an evaluation model for the level of smart medical technology application by investigating the level of smart medical technology application in a sample of 1,546 Class A tertiary hospitals in China. Using the model, it was found that the majority of Class A tertiary hospitals in China have a low level of smart healthcare and are still in the construction stage. This paper combines current developments in the healthcare industry with applied research based on the big data foundation of the meta-universe, laying a new foundation for new research.

Keywords: metaverse · smart medical technology · grade A tertiary hospital · index model · assessment system

1 Introduction

In 2017, China began to propose the "Healthy China" strategy, and the long-term coexistence of COVID-19 and human society has led to a continuous increase in the demand for medical resources. However, China has a vast land area, huge development differences between different regions, and highly unbalanced medical resources. It is impossible to rapidly reduce the level of medical care in the physical world in the short term, so redistribution of medical resources in the metaverse is one of the possible paths to improve the level of medical infrastructure in China.

Currently, the metaverse is in the development stage of the digital twin [1], which is considered as a new platform and means to achieve personal health management and provide health care services in the medical field [2], which makes the metaverse and smart medical have a close connection. In addition, with the development of virtual reality, augmented reality, mixed reality, AI, cloud computing, brain neuroscience, and other technologies, The ability of the metaverse to symbiosis with the reality of the real world will continue to improve [3], which will provide more possibilities for the development

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of smart medicine. in February 2022, the International Association and Alliance of Metaverse in Medicine was established, which to a certain extent also confirms that smart medicine in the metaverse has a broad development prospect.

2 Fundamentals of the Multiverse Algorithm

Population-based metaheuristic algorithms are usually divided into two phases, namely the exploration phase and the development phase. In multiverse algorithms, models of black holes white holes are used to explore space, while wormholes are helpful to explore space [4].

The solution vector of each algorithm is assumed to be analogous to each universe of the multiverse, and each element of the solution vector is a star of each universe [5]. In addition, each multiverse is assigned a cosmic expansion rate proportional to the value of the fitness function of the solution.

The basic multiverse algorithm uses a roulette wheel algorithm to build the individual stars in the universe population. During each iteration of the algorithm, the universes are reordered according to the size of the expansion rate of the universe and one of them is rotated to have a white hole according to the roulette algorithm [6].

The multiverse population in the algorithm, which is composed of:

$$U = \begin{bmatrix} x_1^1 & x_1^2 & \dots & x_1^d \\ x_2^1 & x_2^2 & \dots & x_2^d \\ \dots & \dots & \dots & \dots \\ x_n^1 & x_n^2 & \dots & x_n^d \end{bmatrix} \tag{1}$$

where: d is the dimensionality of the variable and n is the number of universe groups.

Firstly, the universe population is standardized and pre-processed, while the pre-processed multiverse population with random selection probabilities is selected using Russian roulette with the following results:

$$x_i^j = \begin{cases} x_k^j, r_1 < NI(U_i) \\ x_i^j, r_1 \geq NI(U_i) \end{cases} \tag{2}$$

where: x_i^j is the jth star in the ith universe; $NI(U_i)$ is the normalized cosmic expansion rate of the ith universe; r_1 is a random number between [0,1]; x_k^j is the value of the jth star in the kth universe calculated by the roulette algorithm.

In this paper, we consider that there are wormholes in each universe that randomly transfer stars to other universes. The algorithmic model of multiverse arithmetic is shown in Fig. 1:

In Fig. 1, the white circles indicate stars transferred through wormholes, and the black and white hole tunnels are located between two universes with different cosmic expansion rates. In the algorithm, the universe with high expansion rate is considered to have black holes, while the universe with low cosmic expansion rate is considered to have white holes, and the stars in the universe can travel in time and space through black and white hole tunnels.

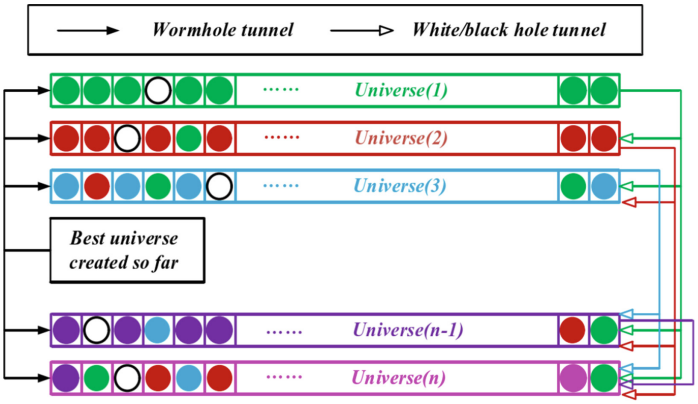

Fig. 1. Multiverse algorithm schematic

In order to provide local variations in each universe, in a high probability of using wormholes to provide higher expansion rates, in the hypothesis of this paper, the tunneling of wormholes is established, being generated between the best universes in the universe.

3 Application and Evaluation of Smart Medicine in the Background of the Metaverse

3.1 Analysis of the Possibility of Smart Medical Development in the Background of the Metaverse

Smart medical care involves medical, artificial intelligence, computer, and communication technologies, covering electronic medical records, medical and health big data analysis and mining, medical natural language processing, smart medical image analysis, smart question, and answer system, smart assisted diagnosis, telemedicine, remote consultation, smart hospital, patient privacy protection and so on [4]. Meta-universe further combines the ideas of digital twin and virtual-real integration with smart medical services, which not only effectively improves patients' remote medical experience and remote diagnosis and treatment effects, but also forms effective interaction between online and offline smart diagnosis and treatment systems, reduces unnecessary repeated diagnosis and treatment, lowers the cost of follow-up consultation, and saves limited medical resources.

In the current metaverse, smart medical has made some attempts in the fields of medical training, surgery, medical care, virtual doctor diagnosis, and smart health management, and has potential applications in diagnosis and treatment, telemedicine, remote patient care, and monitoring [5]. In the treatment of mental illnesses, smart medicine in the metaverse can be combined with pre-trained language models such as Chatgpt to play a unique role in emotional companionship, emotional de-escalation, and assisted treatment. Taken together, the ideal level of development of smart medicine in the context of metaverse should achieve the reshaping of hospital treatment processes and tools.

3.2 Evaluation System Design for the Level of Smart Medical Applications in the Metaverse

Hospitals are the main body of current medical services in China [6], and this study also takes Chinese Grade A tertiary hospitals as the research object to assess the level of smart medical technology application in China, so the main reference in the evaluation system design process is the current treatment process of Chinese Grade A tertiary hospitals.

At present, the treatment process in Chinese Grade A tertiary hospitals can be roughly divided into three stages: pre-hospital diagnosis, in-hospital treatment, and post-discharge, and in-hospital treatment can be divided into three stages: initial consultation, examination, and treatment [7]. In addition, there are a large number of online consultation and registration platforms in China, and many patients will consider consulting on online consultation platforms before seeking medical treatment offline, and a large number of doctors in Grade A tertiary hospitals will also provide consultation services on online consultation platforms in their spare time.

Based on the principles of comprehensiveness, completeness, and objectivity [8], the evaluation system of smart medical application level in the metaverse is initially set up with six dimensions and 20 secondary indicators (Table 1), combining the diagnosis and treatment process of Chinese Grade A tertiary hospitals and the development status of smart medical in China. In the later iteration process, some indicators can be eliminated and the optimization of indicator items can be completed based on the descriptive statistics and analysis of each indicator test data.

4 Wormhole Travel Distance Based on Trigonometric Functions

The wormhole selection probability in MVO, which increases linearly with the number of iterations, and the WEP in MVO denotes the probability of wormhole existence in multiverse space. WEP serves as an important role parameter, which can change the search result of the algorithm during iteration. In response to the limited update of the universe individuals due to the sluggish rise of WEP value, the linear growth form of WEP is modified to the trigonometric growth form (Sine Wormhole Existence Probability, SWEP), which is given by:

$$SWEP = WEP_{min} + (WEP_{max} - WEP_{max}) \times \sin(\frac{\pi l}{2L}) \tag{3}$$

Figure 2 shows the changes of WEP and SWEP in the iterative process. From the figure, it can be seen that SWEP, compared with WEP, has a relatively faster rising speed at the initial point, which facilitates finding the region where the optimal universe is located in the earlier stage, and a relatively slower rising speed in the middle and later stages, and its convergence accuracy is more accurate when finding the optimal universe location in the later stage.

5 Application of Each Treatment Session

The six secondary indicators in the evaluation index system of the level of wisdom medical technology application in the context of metaverse point to different diagnosis and treatment aspects of wisdom medical, and there are certain differences in the difficulty

Table 1. Evaluation index system of smart medical technology application level in the context of metaverse

Tier 1 Indicators	Indicator Code	Secondary indicators
Online consultation	A11	Provide AI smart diagnosis or advice
	A12	The number of types of inspection reports that support smart identification
	A13	Accurate matching of doctors to departments through chat interaction
	A14	Scientific planning of waiting time, consultation is convenient and fast
Appointment Registration	A21	Provide symptom-based registration guidance or advice
	A22	Automatic matching of departments and doctors based on online consultation results
	A23	Provide interactive medical guidance
Initial diagnosis and treatment	A31	Automatic matching of medical information
	A32	Provide AI-assisted diagnosis
	A33	Using AI technology to help patients complete exams quickly
	A34	Using AI technology to assist physicians in obtaining more accurate test results
Check	A41	Number of species that support smart film reading with AI technology
	A42	Using AI technology to assist doctors in accurately diagnosing a disease, scoring the AI-assisted diagnosis based on the number of diseases diagnosed
	A43	Automatic generation of diagnostic reports using AI technology
Treatment	A51	Use of AI technology to assist in developing treatment plans
	A52	automatic filling of medical orders and consultation processes
	A53	Automated medical device distribution, Number of logistics robots
	A54	Using AI to monitor patients' physical condition

(*continued*)

Table 1. (*continued*)

Tier 1 Indicators	Indicator Code	Secondary indicators
	A55	Use of AI technology to assist in surgical decision making
Discharge after healing	A61	There is a smart medical app that can be used to track treatment results

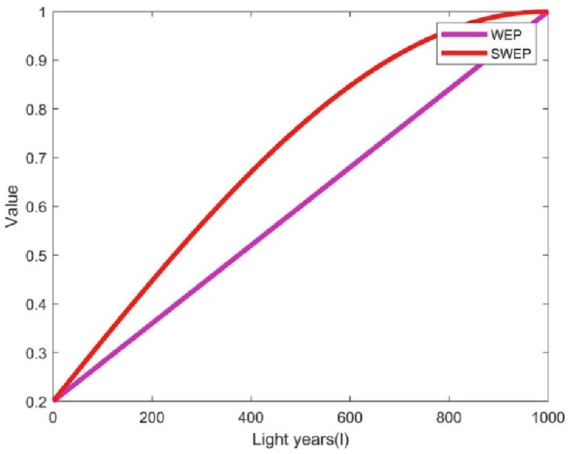

Fig. 2. Comparison of SWEP and WEP

of technology application in each diagnosis and treatment aspect, so the level of technology application in each diagnosis and treatment aspect also differs greatly [7]. The overall scores of 494 hospitals for each level 2 index can be found out the strengths and weaknesses of the current smart medical technology application in China. Specific scores can be found in Table 2.

As can be seen from the table, A14 (consultation is convenient and fast) and A32 (Provide AI-assisted diagnosis) are the two best-performing indicators of AI technology application in Chinese hospitals at present, while A52 (automatic filling of medical orders and consultation processes), A42 (Using AI technology to assist doctors in accurately diagnosing a disease) and A31 (Automatic matching of medical information), are the three worst-performing indicators [8].

Table 2. The overall score for each indicator

Level 1 indicators	Indicator code	score	Average score
Online consultation	A11	80	546.65
	A12	73.6	
	A13	430	
	A14	1603	
Appointment Registration	A21	442	224.67
	A22	136	
	A23	96	
Initial diagnosis and treatment	A31	48	487
	A32	1028	
	A33	564	
	A34	308	
Check	A41	60.4	87.6
	A42	34.4	
	A43	168	
Treatment	A51	140	74.67
	A52	16	
	A54	68	
Discharge after healing	A61	206	206

6 Conclusion

In this paper, we analyze the principle of multi-objective multiverse algorithm and propose an improved multivariate multi-objective universe algorithm according to the problems of MOMVO algorithm. The standard test functions ZDT1, ZDT2 and ZDT3 are selected, and the algorithm detection indexes GD and IGD verify the algorithm proposed in this paper, and IMOMVO outperforms MOMVO in each test function, which verifies the effectiveness of the algorithm proposed in this chapter. The application of smart medical technology has just started in China, and some hospitals are not clear about the definition and application of smart medical, and there is a certain problem of blindness in the development [9].

The evaluation method has the following two main shortcomings: First, it takes the Grade A tertiary hospitals that have applied smart medical technology in China as the research sample, and lacks the examination of urban medical groups, county hospitals and county medical communities that need to apply smart medical technology more to narrow the gap in medical level, and does not take into account the special characteristics of the above hospitals in applying smart medical technology when formulating the indexes, and further revision of the evaluation indexes and methods is needed in the future. Second, smart medical technology is an evolving concept, and as new smart

medical technologies emerge in the future, evaluation methods will be further adapted accordingly.

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