Research on Collaborative Agent Learning Mechanism of Virtual Medical System Based on Agent

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Abstract: 【Objective】The purpose of this study is to explore the collaborative agent learning mechanism of virtual medical system based on Agent, in order to improve the efficiency and quality of medical system. 【Methods】Agent technology was used to split the virtual medical system into multiple intelligent agents to achieve the synergy of the system. In the research process, the virtual medical system is analyzed and designed firstly. Then, a collaborative subject learning mechanism is proposed to realize the autonomous learning and intelligent recommendation functions of the system. Finally, the system is evaluated and analyzed. 【Conclusion】It shows that the simulation system is efficient and easy to implement, which can improve the quality of the medical system and has a good application prospect and promotion value.

Keywords: virtual medical system; multi-cooperative agent model; learning mechanism

1. Introduction

The collaborative subject in the virtual medical system refers to the entities that play an important role in the system, including doctors, patients, medical equipment, medical institutions, etc. The system can realize virtual medical content learning, medical skills training and surgical preview, etc. This model has been highly expected by people [1]. In the virtual medical system, these collaborative subjects can realize intelligent diagnosis and treatment, health management and medical decision-making through intelligent algorithms and human-computer interaction technology[2]. The collaboration and communication of multiple collaborative interactive subjects can promote the sharing and circulation of medical information, improve the quality and efficiency of medical services, reduce medical costs, improve patient satisfaction and doctor 's work efficiency, and promote the optimization and upgrading of medical services. The biggest feature of the multi-collaborative agent model of virtual medical system[3] is that multiple collaborative agents learn from each other and make progress together in the process of interaction.

2. Characteristics and classification of collaborative agent learning

2.1 Characteristics of collaborative agent learning

In the virtual medical system, the frequent communication and cooperation between collaborative agents make the learning of multi-collaborative agent model present such

ICBBEM 2023, May 19-21, Hangzhou, People's Republic of China

DOI 10.4108/eai.19-5-2023.2334290

characteristics:

(1) Interaction

The interaction of collaborative agent learning refers to the interaction between collaborative agents. When they exchange information or their respective changes affect each other 's running situation, their learning process may change. The interaction between multiple collaborative agents may accelerate, change, and slow down the learning process of their members.

(2) Dynamic

The learning process of multiple collaborative subjects is carried out in the dynamic interaction between their internal members and the situation between members and medical institutions. Therefore, the learning process of multi-cooperative subjects is complex and changeable, which is difficult to predict.

(3) Concurrency

The learning process of multi-collaborative subjects is the process of their members learning separately and co-evolution. Therefore, the learning of multiple collaborative subjects is a process of concurrent learning of multiple collaborative subjects.

2.2 Classification of collaborative agent learning

According to different standards, collaborative learning can be divided into different types.

1.According to the classification of the learning purpose of the collaborative subject, it can be divided into the following categories :

(1) Learning of multi-cooperative subject organization

The learning of multi-cooperative subject organization is the process of learning how to make correct diagnosis and treatment according to the specific patient 's condition change problem and how to choose the members (that is, the medical system : such as clinics, pharmacies and other institutions and organizations providing medical services).

(2) Learning from a single collaborative subject

The learning of a single collaborative agent is a process in which the collaborative agent that constitutes a multi-collaborative agent model learns the ability, personality and other information of a member.

(3) Learning the coordination of multiple collaborative subjects

The learning of multi-cooperative subject coordination is the process of multi-cooperative subject model learning how to arrange multi-cooperative subject resources, how to reasonably divide labor to realize multi-cooperative subject model and cooperative subject goal.

(4) Learning of multi-agent communication

The learning of multi-agent communication is the process of learning how to choose appropriate communication and cooperation methods to improve the communication efficiency between collaborative agents.

3. According to the classification of collaborative learning approach, it can be divided into the following categories

① *Compound learning*

The compound learning of multi-cooperative subjects refers to the learning mode in which the cooperative subjects in the multi-cooperative subject model learn independently, and the cooperation and communication between them do not affect the individual learning process.

② *Distributive learning*

The distributed learning of multi-collaborative agents refers to the learning process in which the multi-collaborative agent model decomposes the learning process into different learning tasks and is performed by a collaborative agent.

③ *Interactive Learning*

The interactive learning of multi-cooperative subjects refers to the learning process in which the cooperative subjects in the multi-cooperative subject model learn together, influence each other, and create conditions for each other 's learning.

4. Reinforcement learning system

The learning methods of multi-cooperative agents include example-based learning, reinforcement learning, contract network-based learning, failure-driven learning and so on. This paper focuses on the reinforcement learning of multi-combat agents.

4.1 Reinforcement learning principle

Reinforcement learning [4] is a learning process in which collaborative subjects continuously explore the behaviors that should be taken in the case of medical events and implement actions, and adjust their future behaviors according to the feedback information of medical events (often in the form of incurable diseases). This is a learning from state to behavior. The goal is to maximize the improvement of patients ' health and reduce the occurrence of adverse consequences such as deterioration and complications. In the process of learning, the collaborative subject is not told what the correct action method is, but to adjust his behavior through his continuous trial and error and exploration activities.

The reinforcement learning of collaborative agents can be represented by Figure 1.

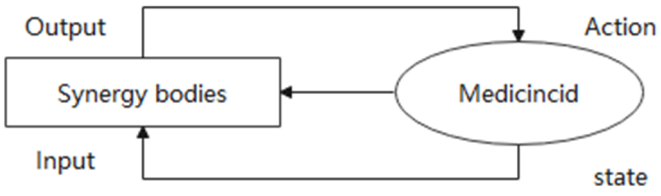

Figure 1 Reinforcement learning of collaborative agents

In Figure 1, collaborative agent reinforcement learning is mainly composed of two parts : collaborative agent and its medical scene situation. The situation of the medical scene is a dynamic system, and the collaborative subject produces actions to change its physical state ; the medical scene situation generates a feedback information on the action of the collaborative subject-the patient 's condition and health status, thereby helping the collaborative subject to adjust its behavior.

4.2 The structure of collaborative reinforcement learning

By further refining Figure 1, we can get the structure of collaborative agent reinforcement learning, as shown in Figure 2.

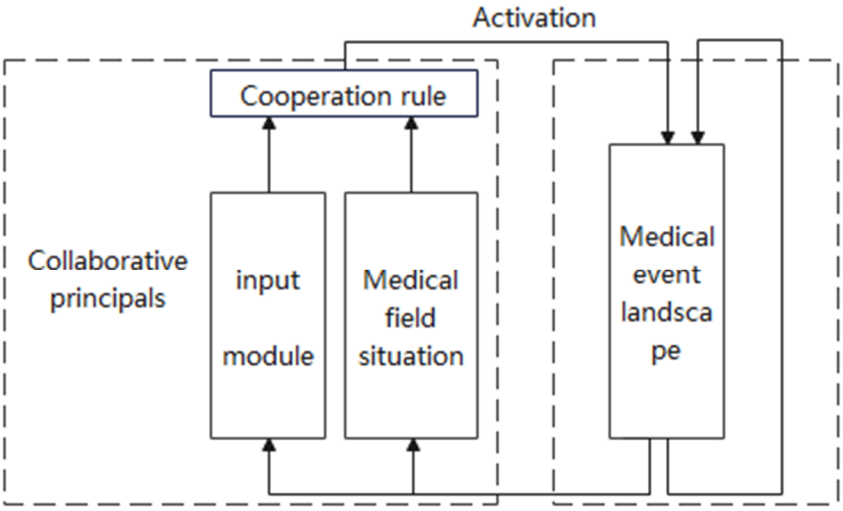

Fig.2 The structure of collaborative agent reinforcement learning

The input module converts the medical scene situation information into the input information of the collaborative subject and passes it to the collaborative rule module. The reinforcement module converts the state of the medical field situation into a reinforcement signal input to the collaborative rule module ; the collaborative rule module updates the knowledge of the collaborative subject, and at the same time makes the collaborative subject select an action according to a certain combat rule and act on the medical scene situation.

In the collaborative reinforcement learning structure, the most important is the collaborative rule module. The collaborative rule module has the function of learning and updating knowledge and selecting action plans. Its structure is shown in Figure 3.

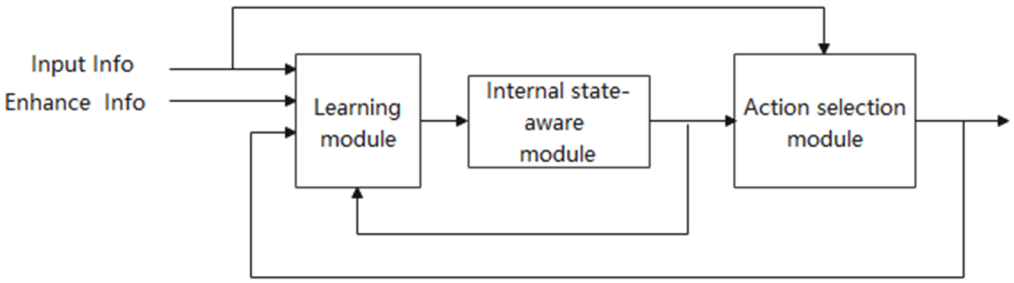

Figure 3 Reinforcement learning collaborative rule module structure

The internal state awareness module shows the knowledge level of the collaborative subject on responding to medical emergencies ; in each cycle, the action selection module determines the response of the collaborative subject to the input of the medical scene situation based on the internal state and the enhanced signal. The selected action makes the medical scene situation produce a new state and an enhanced signal ; at this time, the internal state awareness module of the collaborative subject is updated by the learning module, which makes the collaborative subject have a further understanding of the medical field situation knowledge.

4.3 Collaborative agent reinforcement learning algorithm

The algorithms of collaborative agent reinforcement learning include instantaneous difference algorithm, Q _ learning algorithm, adaptive heuristic evaluation algorithm and so on.

1. Q _ learning algorithm [5]

① The basic formula of collaborative agent Q _ learning algorithm

The medical scene situation is a finite state discrete Markov process. Each step of the collaborative agent can select an action in a limited set of actions. After the medical scene situation accepts the action, the state changes, and the evaluation r is given. The situation state of the medical scene changes with the following probability :

$$prob[s = s_{t+1} / s_t, a_t] = P[s_t, a_t, s_{t+1}] \tag{1}$$

The task faced by the collaborative subject is to determine an optimal collaborative rule, so that the total discount reward signal expectation is the largest. Under the action of collaborative rules, the value of state st is :

$$V^p(S_t) = r(p(S_t)) + g \sum_{s_{t+1} \in S} P[s_t, a_t, s_{t+1}] V^p(s_{t+1}) \tag{2}$$

The idea of Q _ learning is not to estimate the medical scene situation model, but to directly optimize a Q function that can be iteratively calculated. Watkin defines this Q function as the discounted cumulative reinforcement value when the action at is executed at the state st and then executed according to the optimal action sequence, namely :

$$Q(s_t, a_t) = r_t + g \max_{a_t} \{Q(s_{t+1}, a_t) \mid a_t \hat{1} A\} \quad (3)$$

② *Learning steps of collaborative agent Q _ learning*

In Q _ learning, the collaborative subject has to go through the following learning steps :

A. Observe the current state st ;

b. select and execute an action at ;

c. observe the next state st + 1 ;

d. Adjust the Q value.

$$Q_t(s_t, a_t) = \begin{cases} (1 - a_t) Q_{t-1}(s_t, a_t) + a_t [r_t + gV(s_{t-1})] & s = s_t; a = a_t \\ Q_{t-1}(s_t, a_t) & \text{otherwise} \end{cases} \quad (4)$$

$$\text{Quorum: } V(s_{t-1}) = \max_{a \hat{1} A} \{Q_{t-1}(s_{t-1}, a_{t-1}\} \quad (5)$$

5. Conclusion

The research on agent-based collaborative agent learning mechanism of virtual medical system provides new ideas and directions for the development of medical informatization and intelligence. The Q learning algorithm changes the mode of paper recording experience, achieves intelligent and informational storage of medical information, and helps the management of medical system. The learning mechanism of collaborative subjects helps to improve the professional level and technical level of medical subjects, enhance the efficiency of medical services, and solve the problem of inefficiency caused by medical information barriers.

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