International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 4 ǁ 2022 ǁ PP. 01-05

Modern Health Care with Reinforcement Learning

Veena Vinod, Meghana Raj
Department of computer applications
Saintgits College of Applied Sciences,Pathamuttom
P.O,Kottayam,686532,India

A B S T R A C T
Optimizing healthcare efficiency is a major concern in modern society. One drawback in the existing predictive models is that they do not fully model the natural response, and thus cannot apply methodologies that take into account the human internal mechanism for healthcare maintenance. In this paper, we suggest to incorporate to the natural healthcare needs, a medical expert system by using reinforcement learning model with natural and medical agents. This new model has a potential to improve healthcare, with better control of the desired level of medical intervention with the desired effect.
Keywords*: Reinforcement learning, machine learning, dynamic treatment regime, RL modeling, constrained RL, Natural-Medical RL and Automated medical diagnosis.*

Date of Submission: 15-04-2022 Date of acceptance: 30-04-2022

I. Introduction

Modern clinical research tried to discover many new treatments and personalizing existing ones. Reinforcement learning provides a major contribution to the healthcare domain.

There are a huge number of diseases and these diseases may affect the human population as many people die every year due to these diseases. Chronic diseases generally last for 3 months or more. If these diseases are not treated at the correct time, the patient may get weak. Reinforcement learning can be used to predict diseases and also many techniques for their prevention.

Normally a patient visits a doctor when he or she has any health issues and to take proper treatments for the disease. The doctor checks the patient and decides the treatment to be followed in order to maintain the good health of the patient. A regular check-up of a patient by the same doctor helps the doctor to decide the next set of treatments as per the health issues of the patient. Also, the present state of the patient is based on the earlier treatment suggested by the doctor. This is called a sequential nature of the medical treatment. But artificial intelligence is based on the present state of the patient.

Artificial intelligence techniques are now widely used in the fields of healthcare. It is used for the prediction, analysis, etc. of the diseases uses different reinforcement learning techniques in order to avoid these diseases.

Reinforcement is widely used in many different areas of healthcare. It is used for Sepsis treatment for treating patients with chemo and other dynamic treatments. Reinforcement learning is also used for checking physical activity in diabetic patients.

Although reinforcement learning is applied in the field of healthcare, there are many challenges in its application to healthcare. Evaluating the algorithms seen to be one of the hardest tasks in healthcare scenarios. Also, a large amount of data are needed for evaluation. The non-stationary nature of the data is the other challenge forced by reinforcement learning in healthcare.

Reinforcement learning is encouraged in health care as it finds optimal policies based only on previous experience without any knowledge about the mathematical model of biological systems.

As previously mentioned, reinforcement learning is used in implementing dynamic treatment regime (DTRs). DTRs are a set of rules governing many important health care decisions like the treatment type, dosage of the prescribed medicine, appointment timing, and many more. Here the input data is the clinical observations and the most suitable treatment options for the patient are produced output. RL has helped in design DTRs for cancer and HIV.

Another important application of RL is in the discovery of medicines, their development, and design. A traditional discovery of medicine is quite time consuming, RL can be applied in this field. For analyzing the behavior of molecules and atoms, we can use computer models and simulations properly known as M & S. Since the success of traditional discovery of medicines is relatively low, RL is used to improve the drug design and other compound selection

II. RL Modeling

Medical diagnostics can be inaccurate due to inefficient number of measurements inaccurate analyses and sometimes because it is human biased or limited computational resources. This leads to unnecessary operations that can cause damage and cost a lot of money. It can lead to wrong type of medication and it also need sometimes to a negative of under dose of drugs or this decrease medical treatment efficiency and we need to find a way to enhance medical treatment. The goal is to predictive model for personal medicine to maximize the medical treatment efficiency. We can implement it by reinforcement learning with two agents: the natural that imitate the natural respond of the body and the medical agent.

Reinforcement learning is part of machine learning. It is inspired by the brain and close agent and interpreter. The agent seeks to perform an action point

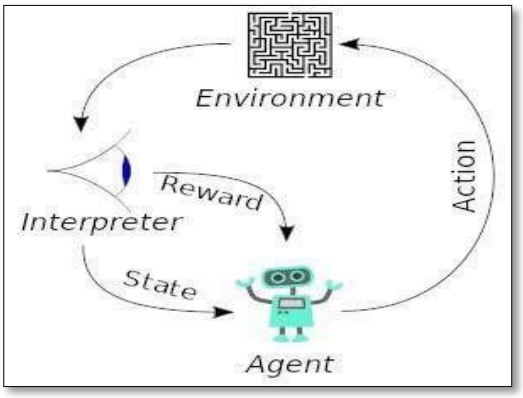

Fig. 1 – Framing of Reinforcement Learning

Agent: Choose an action that maximize future reward

□□+□= □□□□□□□□+□ **P (Q|**□□+□**+**□□+□**)**

Q-cumulative future reward

rt+1-estimated instantaneous reward

St+1 – Estimated state

Interpreter: Calculate internal reward and state

□□+□= □□□□□□□□+□ **P (**□□+□**|**□□**,** □□**)**

□□+□=□**(**□□ → □□+□**,** □□**)**

The interpreter calculates from the environment. Based on the environment the instantaneous reward and in the state the input to the agent to design by certain policies the optimal action.

III. Natural-Medical RL

3.1 Natural- Medical Dual Agent: RL (DaRL)

It includes both the agent: the natural agent – it is the reward related to the internal subject criterion and is not fully known and is homeostatic. Based on the biogiological principle of home studies the medical agents is related to medical system. It is related to the health's reward in reference to a medical baseline. Medical agent interpretation is based on external software utility and action tools and also by external sensors. Natural agent interpretation is the sensor is the real body sensors and computation and decision is performed by the brain.

The natural and medical agents can collaborate. We define fully collaborative when the reward is similar to origin and partial collaboration when it just overlaps between the rewards. Since we do not estimate fully the internal body reward we need our model to design by partial collaborative RL modeling. Medical agent did not try to estimate the natural state. The medical agent estimate the natural reward and perfect the energy

policy in action so observation so medical data fires and data reading if it is a variable of the brain of reinforcement learning model.

3.2 Constrained RL

The constraints can be to maximize the self-healing and minimize the medical action. The optimal medical action can incorporate other medical considerations. It is implemented a s medical agent RL's constraint

$$\pi_{t+1} = \max_{a_{t+1}} \mathbf{P}(a_{t+1} | s_{t+1}, \pi_{t+1}, \ldots, a_{t+1})$$

s.t. min (c_1), min (c_2), Max (c_3)

- c_1 – medical intervention (maximal self-healing)
- c_2 – medical economical cost
- c_3 – medical treatment comfort

IV. Application of Reinforcement Learning

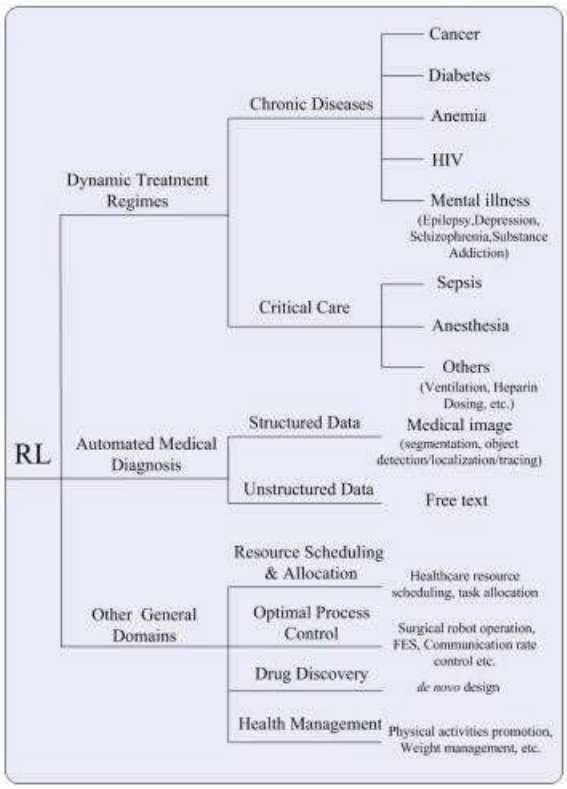

Fig. 2 – Application of Reinforcement Learning

4.1 Dynamic Treatment Regimes

In medical research, a dynamic treatment regime (DTR), adaptive intervention, or adaptive treatment strategy is a set of rules for choosing effective treatments for individual patients. Historically, medical research and the practice of medicine tended to rely on an acute care model for the treatment of all medical problems, including chronic illness. A set of sequential decision rules, each corresponding to a key decision point. Each rule dictates the treatment to be given from among the available options based on the accrued information on the patient to that point. Taken together, the rules define an algorithm for making treatment decisions. Treatment choices made for a particular patient under a dynamic regime are based on that individual's characteristics and history, with the goal of optimizing his or her long-term clinical outcome. Dynamic because the treatment action can vary depending on the accrued information. Ideally, provides an "evidence-based" approach to personalized treatment. A dynamic treatment regime is analogous to a policy in the field of reinforcement learning, and analogous to a controller in control theory. While most work on dynamic treatment regimes has been done in the context of medicine, the same ideas apply to time-varying policies in other fields,

such as education, marketing, and economics. Often, treatment regime is used to refer generally to any approach to deciding on treatment. And dynamic treatment regime is reserved for the case where patient information is used. We will use these terms interchangeably.

4.1.1 Chronic Diseases

Chronic diseases is defined as the diseases that last for more than one year and requires ongoing medical treatment and limit the activities in our daily life. It is caused mainly due to excess use of tobacco and alcohol use. Lack of nutrition, means less diet in fruit and vegetables and high in sodium and saturated fats. The major chronic diseases are heart diseases, cancer and diabetes which also lead human life to death or some kind of disabilities. Long-term treatment of these illnesses is often made up of a sequence of medical intervention that must take into account the changing health status of a patient and adverse effects occurring from previous treatment. Using reinforcement learning we can predict the future chances of increasing chronic diseases. RL has been utilized to automate the discovery and generation of optimal DTRs in a variety of chronic diseases including cancer, diabetes, anemia, HIV and several common mental illnesses.

4.1.2 Critical Care

Critical care is a part of medical industry that monitors and treats patients who are facing emergency medical conditions. When the patients suffer from high-risk and emergency conditions like a heart attack, accidents, severe stomach pain, brain stroke that require immediate medical attention, the critical care comes to the rescue. critical care if you have a life-threatening illness or injury, such as, Severe burns, COVID-19, Heart attack, Heart failure, Kidney failure, People recovering from certain major surgeries, Respiratory failure, Sepsis, Severe bleeding, Serious infections, Serious injuries such as from car crashes, falls, and shootings, Shock, Stroke. There are many different equipment's that is used in critical care such as catheters, dialysis machines, feeding tubes, intravenous (IV) tubes, oxygen therapy, machines that check our vital signs and display them on monitors, tracheostomy tubes, ventilators etc. RL has great potential for enhancing decision making in critical care. Challenges regarding RL system design, evaluation metrics, and model choice exist. More importantly, further work is required to validate RL in authentic clinical environments.

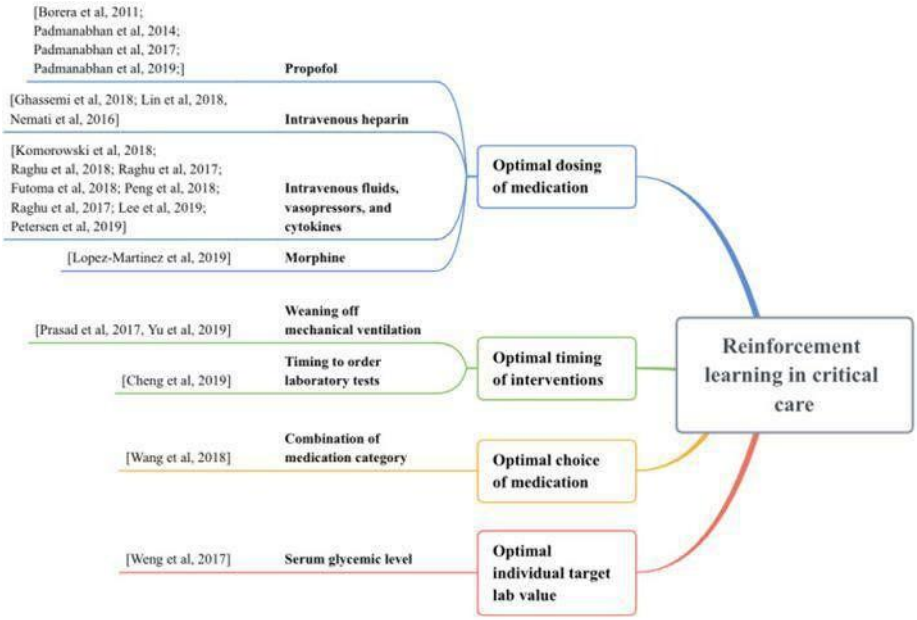

Fig. 3. Mappingof reinforcement learning studies in critical care by application type

4.2 Automated Medical Diagnosis

A medical diagnosis deals with disease or medical condition. Diagnosis or finding made by the doctor is based on the physiologic state of the patient or his medical condition. The diagnosis of a doctor focus on the illness itself. A medical diagnosis is specific in the pathology. It comes up with such diagnosis that would treat the medical problem. It is etiology i.e., cause focused. It is the process of determining which disease or condition explains a person's symptoms and signs.

Technology has been increasing nowadays. Technology in the field of medicine is evolving and they are introducing many manufacturing techniques. The advanced data analysis and machine learning techniques are used for the error-prone process in diagnosis and the necessity to assisting the clinicians for a better and

more efficient decision making of the diagnostic process. Researches are increasing fascinated in formulating the diagnostic problem as a sequential decision making process and using RL to support a data with appropriate evidence by giving graphs and charts. Based on the type of clinical data input into the learning process the research can be classified into two: structured data and unstructured data.

4.3 Other General Domain

Besides the above applications of RL in DTR design and automated medical diagnosis, there are many other case applications in broader healthcare domains that focus on problems specifically in health resource scheduling and allocation, optimal process control, drug discovery and development, as well as health management.

V. Challenges

As RL is growing the mainly focus is on board or video games their policies are untested in the real world environment the healthcare like healthcare. It is somewhat difficult to implement RL in healthcare. RL is not able to observe everything going in a person's body. There are also many unknown activities taking place inside the patient's body. Finding a good reward function is another main challenge faced by RL. It is also often hard to find which action result in reward or penalty. We know that healthcare data is not stationary by nature it can vary from time to time. Also viruses and infections are likely to change themselves after a period of time. For example new type of coronavirus is identified in Britain .it is normal that viruses can be produce different variance overtime and these changes are not observing the training used in RL.

VI. Conclusion

RL plays a main role in health care. Many applications of RL are applied here. It is used to find the nature of medicines and the way of treatment which is more effective to the patient's health. But at the same time it faces many challenges as well. It is nearly difficult to evaluate RL algorithms. Also the patient's data is non stationary and dynamic. Hence only a partial amount of data is considered in training time.

REFERENCES

[1]. IEEE Sensors Journal (https://ieee-sensors.org/sensors-journal/), https://analyticsindiamag.com/what-is-constrained-reinforcement-learning-and-how-can-one-build-systems-around-it/,https://arxiv.org/pdf/1908.08796.pdf,
[2]. https://www4.stat.ncsu.edu/~davidian/dtrwebinar.pdf,https://en.wikipedia.org/wiki/Dynamic_treatment_regime,
[3]. https://www.cdc.gov/chronicdisease/about/index.htm#:~:text=Chronic%20diseases%20are%20defined%20broadly,disability%20in%20the%20United%20States,https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7400046/,
[4]. https://roboticsandautomationnews.com/2017/06/17/the-advantages-of-automation-in-medical diagnostics/12963/