Peter Ly

Task 2

Reinforcement learning has been applied to try and solve a wide variety of healthcare problems ranging from giving the correct diagnosis to a patient based on general information to applying individual treatments to a specific patient at the right time for optimal recovery. One such application is the use of reinforcement learning to try and determine the optimal set of treatments to be used on people with mental disorders such as schizophrenia and depression. Chao et al. describe the treatment process of conditions like terminal diseases as “Dynamic Treatment Regimes” where the current treatment and medication applied may be needed to be adjusted based on factors such as time since the treatment started and values derived from the patient’s biometrics [1]. As mental health disorders may be lifelong conditions that may be difficult to evaluate from a human perspective a reinforcement learning algorithm offers the potential to learn efficient treatments with reduced risk of bias from external factors or difficulty or correlating it to more numerical factors such as presence of drugs in the body.

In the case of treating epilepsy, Chao et al. observe that patients that are resistant to drug treatments may instead be treated via deep-brain stimulation devices to try and counteract abnormal neural activity in the brain [1]. The sheer complexity of a person’s brain combined with the difficulty of treating the disorder means that every person is effectively a new case that would have a different optimal treatment. This works well with the idea of reinforcement learning as we can think of the problem as a need to find the optimal Q Table for a device to stimulate each individual person with the correct timing and frequency. By measuring the current features of the state of a brain and the possible frequency waves the device can emit, a reinforcement learning model can have a device successfully reduce seizure occurrences present in animal brains by 25%. With sufficient data augmented by synthetic data, these models could be used on a wide away of simulated brains to further test the efficacy of any frequency-based devices and determine optimal settings before they are even tested on an animal subject.

While I was not able to find an open source reinforcement learning model that is focused on solving this problem, there do exist available machine learning model implementations on Github such as Elliot’s “Automatic Generalised Seizure Detection in Clinical Electroencephalography Records” that demonstrate the general idea of how these models can be used. Elliot first preprocesses the data by extracting relevant features such as time, frequency, power, phase, and space from EEG data, and then applies appropriate techniques to it such as Wavelet transformation to remove artifacts and channel reduction to ensure all data follows the same uniform format [2]. Elliot then proceeds to use multiple machine learning methods such as Multilayer Perceptron to try and determine the effectiveness of those methods on the classification problem of “Is the patient having a seizure?”. If we were to take the result of Elliot’s work and expand it into a reinforcement learning problem, we could take the classification data generated by this implementation and pass it to a reinforcement learning model whose goal is to maximize the amount of time a person is spent not having a seizure. The model would take a combination of the aforementioned features such as frequency as a state and would have to learn to use the device it's simulating to try and bring it to a state representing a combination of features where the patient is at minimal risk of transitioning into a seizure state.

[1] Yu, Chao, et al. "Reinforcement learning in healthcare: A survey." *ACM Computing Surveys (CSUR)* 55.1 (2021): 1-36.

[2] Elliott, D 2021, 'Automatic Generalised Seizure Detection in Clinical Electroencephalography Records', PhD, Mathematics and Statistics. https://doi.org/10.17635/lancaster/thesis/1347