



Título: "EVALUATION OF BLOOD GLUCOSE LEVEL CONTROL IN TYPE 1 DIABETIC PATIENTS USING ONLINE AND OFFLINE REINFORCEMENT LEARNING"

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Resumen: Resumen de la tesis:

Patients with Type 1 diabetes are required to closely monitor their blood glucose levels and administer insulin to manage them. Automated glucose control methods that eliminate the need for human intervention have been proposed, and recently, reinforcement learning, a type of machine learning algorithm, has been used as an effective control method in simulated environments.

Currently, the methods used for diabetes patients, such as the basal-bolus regime and continuous glucose



monitors, have limitations and still require manual intervention. The PID controllers are widely used for their simplicity and robustness, but they are sensitive to external factors affecting their effectiveness. The existing works in the research literature have mainly focused on improving the accuracy of these control algorithms. However, there is still room for improvement regarding adaptability to individual patients. The next phase of research aims to further optimize the current methods and adapt the algorithms to better control blood glucose levels. Machine learning proposals have paved the way partially, but they can generate generic models with limited adaptability. One potential solution is to use reinforcement learning (RL) to train the algorithms based on individual patient data.

In this thesis, we propose a closed-loop control for blood glucose levels based on deep reinforcement learning. We describe the initial evaluation of several alternatives conducted on a realistic simulator of the glucoregulatory system and propose a particular implementation strategy based on reducing the frequency of the observations and rewards passed to the agent, and using a simple reward function. We train agents with that strategy for three groups of patient classes, evaluate and compare it with alternative control baselines. Our results show that our method with Proximal Policy Optimization is able to outperform baselines as well as similar recent proposals, by achieving longer periods of safe glycemic state and low risk.

As an extension of the previous contribution, we have noticed that, practical application of blood glucose control algorithms would necessitate trial-and-error interaction with patients, which could be a limitation for effectively training the system. As an alternative, offline reinforcement learning does not require interaction with subjects and preliminary research suggests that promising results can be achieved with datasets obtained offline, similar to classical machine learning algorithms. However, application of offline reinforcement learning to glucose control has to be evaluated yet. Thus, in this thesis, we comprehensively evaluate two offline reinforcement learning algorithms for blood glucose control and examine their potential and limitations. We assess the impact of the method used to generate training datasets, the type of trajectories employed (sequences of states, actions, and rewards experienced by an agent in an environment over time), the quality of the trajectories, and the size of the datasets on training and performance, and compare them to commonly used baselines such as PID and Proximal Policy Optimization. Our results demonstrate that one of the offline reinforcement learning algorithms evaluated, Trajectory Transformer, is able to perform at the same level as the baselines, but without the need for interaction with real patients during training.

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