

PHYSICS INFORMED-NEURAL NETWORK FOR MODELLING THE GLUCOSE-INSULIN SYSTEM IN TYPE 1 DIABETES

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ABSTRACT

Diabetes impairs the body's ability to regulate blood sugar due to insufficient insulin production or ineffective insulin use. Insulin, produced by the pancreas, helps cells absorb glucose for energy. There are three main types of diabetes: type 1, type 2, and gestational. Type 1 diabetes, or insulin-dependent diabetes, occurs when the pancreas produces little or no insulin, leading to high blood sugar levels. It is managed through insulin injections, diet, and exercise. Overdosing on insulin can cause hypoglycemia (low blood sugar), while a lack of insulin results in hyperglycemia (high blood sugar), making regular blood sugar monitoring crucial.

In our study, we present a Physics Informed Neural Network (PINN) framework modeling the Bergman minimal model, a system of three coupled ordinary differential equations focusing on the relationship between glucose concentration in the bloodstream. PINNs seamlessly integrate the core principles and equations of physics into the training process of artificial neural networks (ANNs). We utilize PINNs to create a physics-based deep learning model for glucose and insulin concentration for a patient with type 1 diabetes while considering disturbances in glucose concentration due to meals and exercise. By comparing the performance of the PINN-based approach to conventional numerical methods for solving the Bergman model, we demonstrate that PINNs offer an efficient and reliable computational solution for this system of coupled ODEs. From a practical perspective, computationally simulating blood glucose dynamics in diabetic patients offers a valuable approach to optimizing insulin delivery to maintain healthy glucose levels. This method enhances understanding of glucose-insulin interactions, enabling personalized treatment plans and reducing the risks of glycemic fluctuations, ultimately improving patient outcomes and diabetes management.

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