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Continuous Glucose Monitoring Prediction

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Abstract

Diabetes is one of the deadliest diseases in the world and affects nearly 10 percent of the global adult population. Fortunately, powerful new technologies allow for a consistent and reliable treatment plan for people with diabetes. One major development is a system called continuous blood glucose monitoring (CGM). In this review we look at three different continuous meal detection methods that were developed given CGM data from patients with diabetes. From this analysis an initial meal prediction algorithm was also developed utilizing these methods.

Keywords

Continuous glucose monitoring; Auto regression; kalman filter; Recurrent neural networks.

Introduction

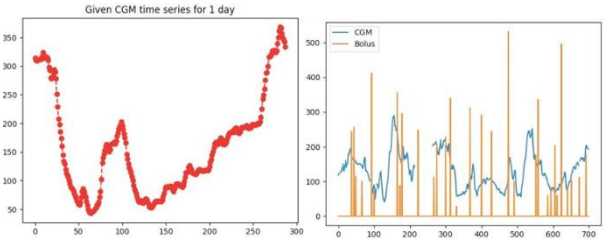
It is important to detect meal-intake in type-1 diabetic patients. Meal intake can affect glucose level of the body and it can even lead to harmful scenarios such as hyperglycemia.

Fortunately, with the advancement of technology, there are different sensors and devices that let you monitor glucose levels. However, many of these devices come with their own limitations and inaccuracies. Thus, algorithmic detection can be a useful tool. This project focuses on 3 such algorithms for online meal detection and includes a suggestion for an initial algorithm as well. We focus on using an Auto-regression based model, Kalman-Filter based approach, and an LSTM-RNN based approach. We start off by first syncing the given CGM time series (corresponding to a patient) with the bolus ground truth. We then move to the development, instantiation, and implementation of the 3 algorithms. We then report the train and test accuracies. After which we go on to provide execution time analysis and on to the development of an initial algorithm for prediction of meal from CGM.

Project setup:

Input CGM series and Bolus Data file which has a recording of glucose level of a person in 5 minute increments over 6 months. It had approximately 55000 records total with some empty values. The empty values were dropped and the rest of the values were considered.

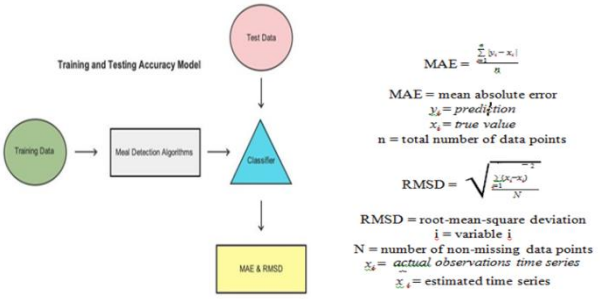
Figure 1 illustrates the given CGM series for 1 day. Since the given records are in intervals of 5 minutes, this would mean 288 such records correspond to 1 day. Task 1 of the project was to synchronize a given CGM series with ground truth. It illustrates the CGM series synced with ground truth data.



Implementation.

We implemented three algorithms for meal detection: auto regression based model, kalman filter based model, and a Recurrent Neural Networks based approach. Each algorithm needed to be developed, instantiated, implemented, and then accuracy evaluated. This was done using training and testing data.

We used Mean Absolute Error and Root Mean Squared Error for error/loss calculation. The formulas are written in Figure 2.



Auto Regression SARIMA Seasonal Autoregressive Integrated Moving Average (SARIMA) is a very common and useful technique for time series modeling and forecasting. The fact that SARIMA accounts for the seasonal variation in time series is what makes it so powerful. Our CGM data has seasonal components in it which explains the use of SARIMA for this project. SARIMA comes with trend and seasonality parameters that must be configured before you use it

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