Sparse representation models of continuous glucose monitoring time-series

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Abstract—Continuous glucose monitoring (CGM) is essential towards effectively managing type 1 diabetes. Developing CGM time-series models may help identify clinically-meaningful signal components and rule-out noise providing new insights into treatment. As a step towards this goal, we propose to use sparse representation techniques with appropriately designed dictionaries to express CGM signals as a linear combination of a small set of knowledge-driven atoms. Results on a dataset of 25 patients diagnosed with type 1 diabetes indicate that the proposed framework is a viable solution for modeling CGM time-series reaching relative reconstruction error of 0.08 and suggest that this approach can be used to interpret the underlying CGM time-series in relation to clinical assessments.

I. INTRODUCTION

Type 1 diabetes is a chronic condition related to the body’s ability to produce insulin, an essential hormone to energy production. Patients suffering from this disease have to become actively involved in its management. Continuous glucose monitoring (CGM) systems can effectively provide real-time blood-glucose measures and warn individuals regarding dangerously high or low glucose levels [1]. While such systems have a great potential towards improving diabetes-related outcomes, the corresponding time-series might contain multiple sources of noise related to sensor limitations, needle drifts, and calibration issues. Thus, signal processing steps are needed to identify the meaningful signal components and appropriately interpret the underlying information. CGM time-series depict a characteristic structure over time, since the corresponding signal increases abruptly after food intake and slowly recovers. Taking this into account, we propose to use sparse representation methods with appropriately-designed signal-dependent dictionaries.

II. METHODS AND RESULTS

Our data come from the publicly available DirecNet repository. The dataset contains 25 participants (8-19 years old) with type 1 diabetes wearing a continuous glucose monitor for 6-7 days [2]. Glucose values were sampled every 5 minutes resulting in 67,388 measurements.

Sparse decomposition models represent a signal using a small set of exemplar sub-signals, called “atoms”, that

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