The Contribution of Physical Activity in Blood Glucose Concentration for People with Type 1 Diabetes

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This paper addresses the problem of mathematical deconvolution for the estimation of unknown inputs in linear discrete-time state-space models. We apply our deconvolution algorithm to the modeling of blood glucose (BG) concentration for people with type 1 diabetes (T1D). We present a method using an activity tracking watch, a continuous glucose monitor and an insulin pump to study the effect of physical activity on BG concentration for people with T1D. The physical activity signatures are represented by an unknown input, also referred to as a "net effect". In addition, the net effect captures the unmodelled BG variations, eg. mismatches in meal estimation, and circadian metabolic variations. We test our method using data from a clinical study. We show the glucose net effect traces associated to physical activity for a specific patient during 20 consecutive days, and the glucose net effect traces associated to physical activity for eight subjects under identical conditions. The net effect signatures can be used to (i) reproduce experiments with different insulin administration strategies, (ii) build a physiological model of glucose-insulin dynamics able to simulate a physical activity in people with T1D, and (iii) design a model-based control algorithm able to predict the effect of physical activity on the blood glucose concentration.

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