Toward a Personalized Decision Support System for Blood Glucose Management During and After Physical Activities in Patients with Type 1 Diabetes

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Introduction

- Physical activities have a significant impact on blood glucose homeostasis of patients with type 1 diabetes.
- The risk of hypoglycemia (low blood glucose) is much higher during and after physical activities.
- Our research aims to reduce the risk of hypoglycemia and empower type 1 diabetes patients in making decisions in connection with physical activities.

Model-Based Recommendation for Short Physical Activities Using Feedforward Neural Networks

Inputs:
- Amount of CHO in food
- the average heart rate expected during the physical activity.

Output: the BG score (Table 1)

BG level	Score/reward
BG < 3.9 mmol/L	-10
3.9 mmol/L ≤ BG < 4.2 mmol/L	-3
4.2 mg/dl ≤ BG < 5.6 mmol/L	10
5.6 mmol/L ≤ BG < 7.2 mmol/L	5
7.2 mmol/L ≤ BG < 10.0 mmol/L	-1
10.0 mmol/L ≤ BG < 15.6 mmol/L	-5
BG ≥ 15.6 mmol/L	-8

Table 1: Score/reward for different BG levels.

Recommended amount of CHO in food is obtained by maximizing the output of the feedforward neural networks.

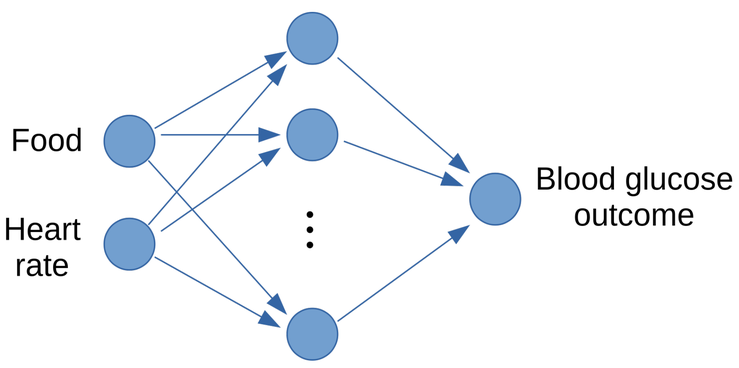

Figure 1: Diagram of the FFNN

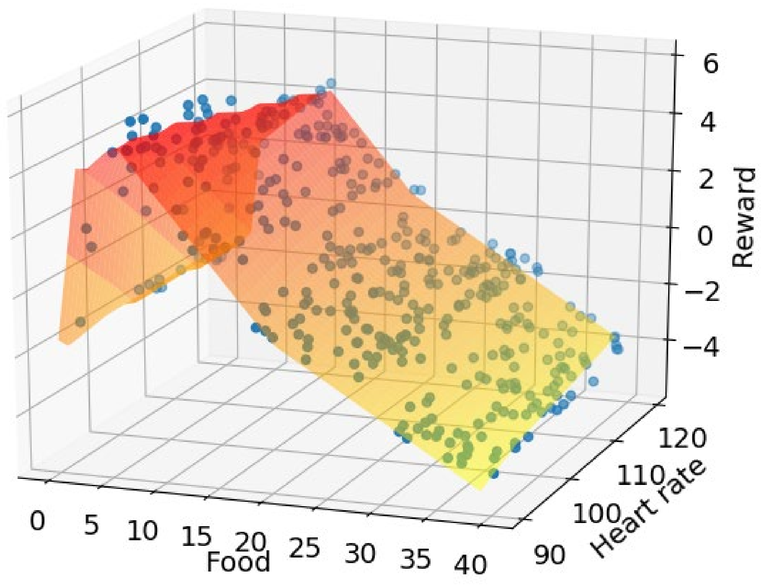

Figure 2: Estimation of the blood glucose score using feedforward neural networks.

Food Recommendation for Long Physical Activities Using Reinforcement Learning

The RL framework consists of:
- States (blood glucose levels and physical activity intensity) define the condition of the patient at a certain time.
- Action (the quantity of food) is used to control the blood glucose.
- Score/reward is the result (or consequence) of selecting an action at certain states.

The objective of the algorithm is to search for an optimal policy that will maximize the accumulation of score/reward throughout the exercise.

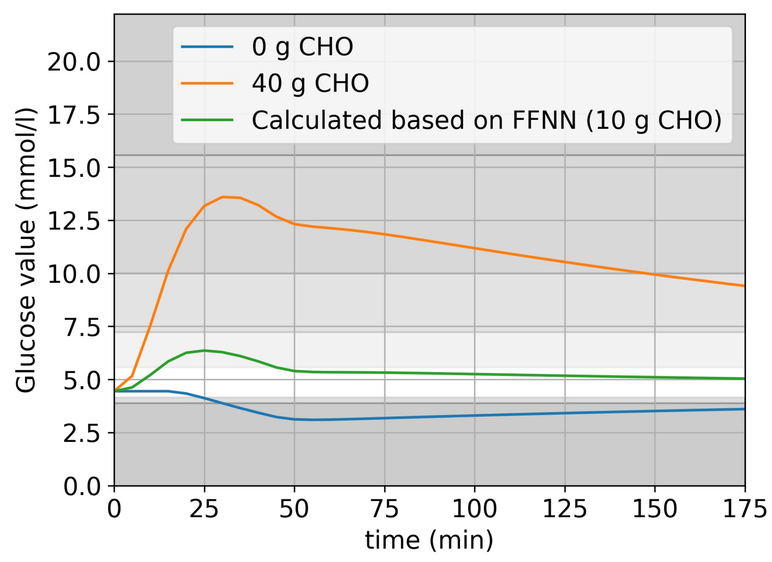

Figure 3: Blood glucose responses with different amount of CHO during a short physical activity.

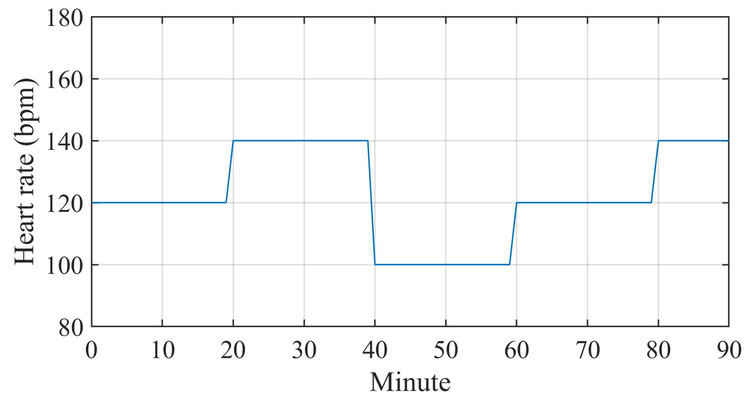

Figure 4: Heart rate during the exercise in the long physical activity scenario

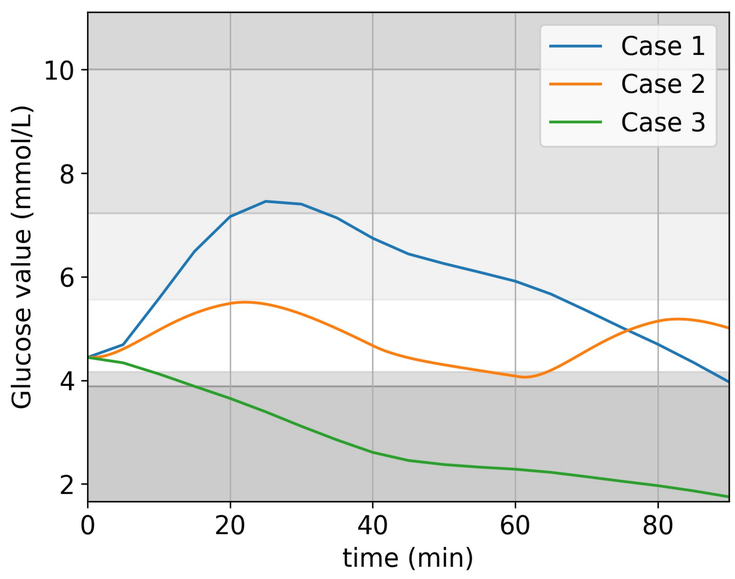

Figure 5: BG responses during the interval exercise in our simulations (Case 1: Food consumed at the beginning of physical activity using FFNN, Case 2: Food consumed throughout physical activity using RL, Case 3: No food consumption).

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