Personalized Short-Term Blood Glucose Prediction in T1DM

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2012

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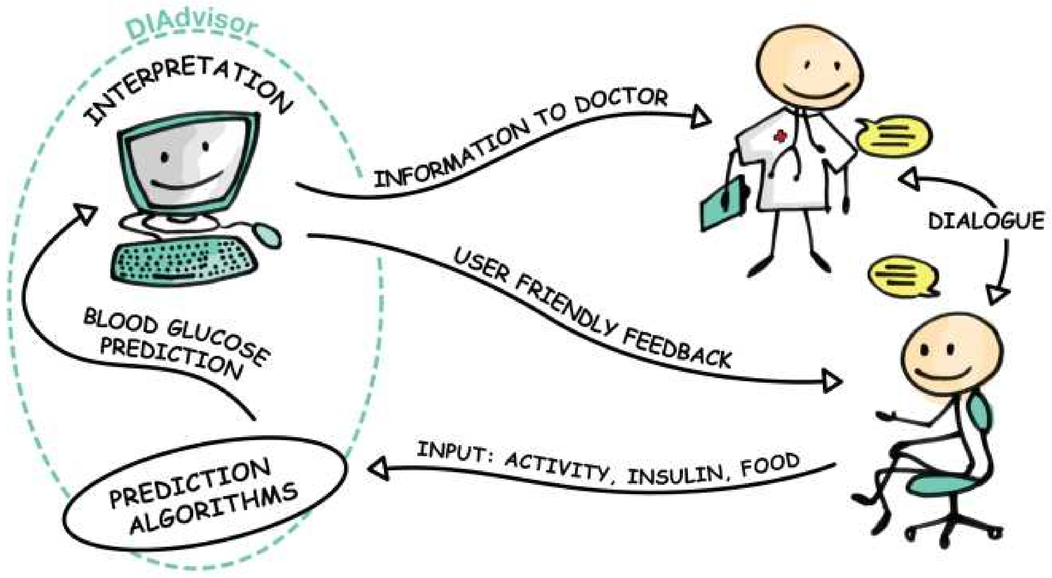
Background

The focus of the European project DIAdvisor ^{TM} [3] is the development of a personalized tool providing diabetic patients with reliable and accurate near future blood glucose predictions in order to support the users in the insulin therapy decision-making tasks while letting them maintaining control over their own treatments management.



Objective

Estimate data-driven individual-specific short-term BG predictors given:

- plasma glucose [mg/dL];
- plasma glucose rate of appearance [mg/kg/min] after CHO absorption;
- total plasma insulin I [mIU/L] after subcutaneous injection

Data

8 T1DM subjects (5 MDI/3 CSII, 5 males/3 females, age = 45.25±13.53 years, disease duration = 22.37±11.81 years, BMI = 23.88±3.25, HbA1c = 8.27±0.90%) underwent a 3-days visit at the CIC in Montpellier, France, within the European research project DIAdvisor^{TM} [4]. Patients were served standardized meals for breakfast, lunch and dinner (carbohydrate content: 42, 70, 70 [g], respectively) and decided insulin needs based on their personal HemoCue^{TM} Glucose Analyzer outcomes. Blood samples were collected by nurses to measure plasma glucose concentrations: every hour during day, every 2 hours during night, 30 min before breakfast, 10, 20, 30, 60, 90, 120, 150, 180, 240, 300 min after breakfast and every 15 minutes after lunch and dinner for 2 hours, for a total of 37 blood samples per day.

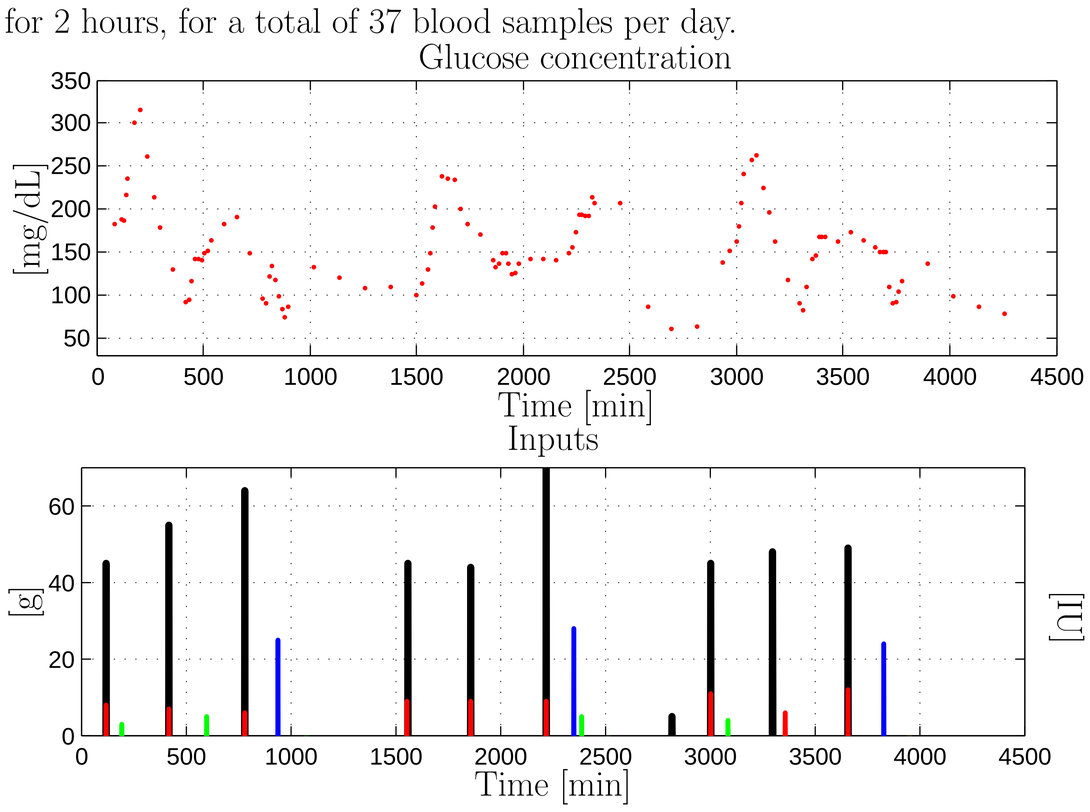
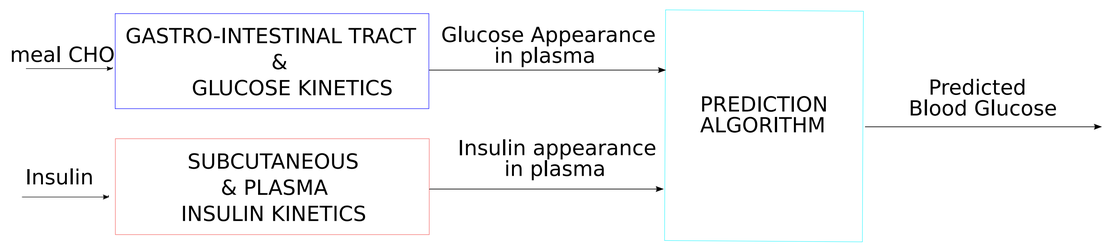


FIGURE 1: Representative patient data vs. Time [min]. *Top* Plasma glucose concentration [mg/dL]; *Bottom* Meal carbohydrates [g] (black) and corresponding Insulin doses [IU]: basal (blue), bolus (red), correction (green)

Methods



Results

Cross validation showed prediction error standard deviation 14.19±8.45 [mg/dL], 26.22±15.04 [mg/dL], 33.59±19.41 [mg/dL] and 37.70±22.14 [mg/dL] on 30-, 60-, 90- and 120- minutes-ahead prediction, respectively.

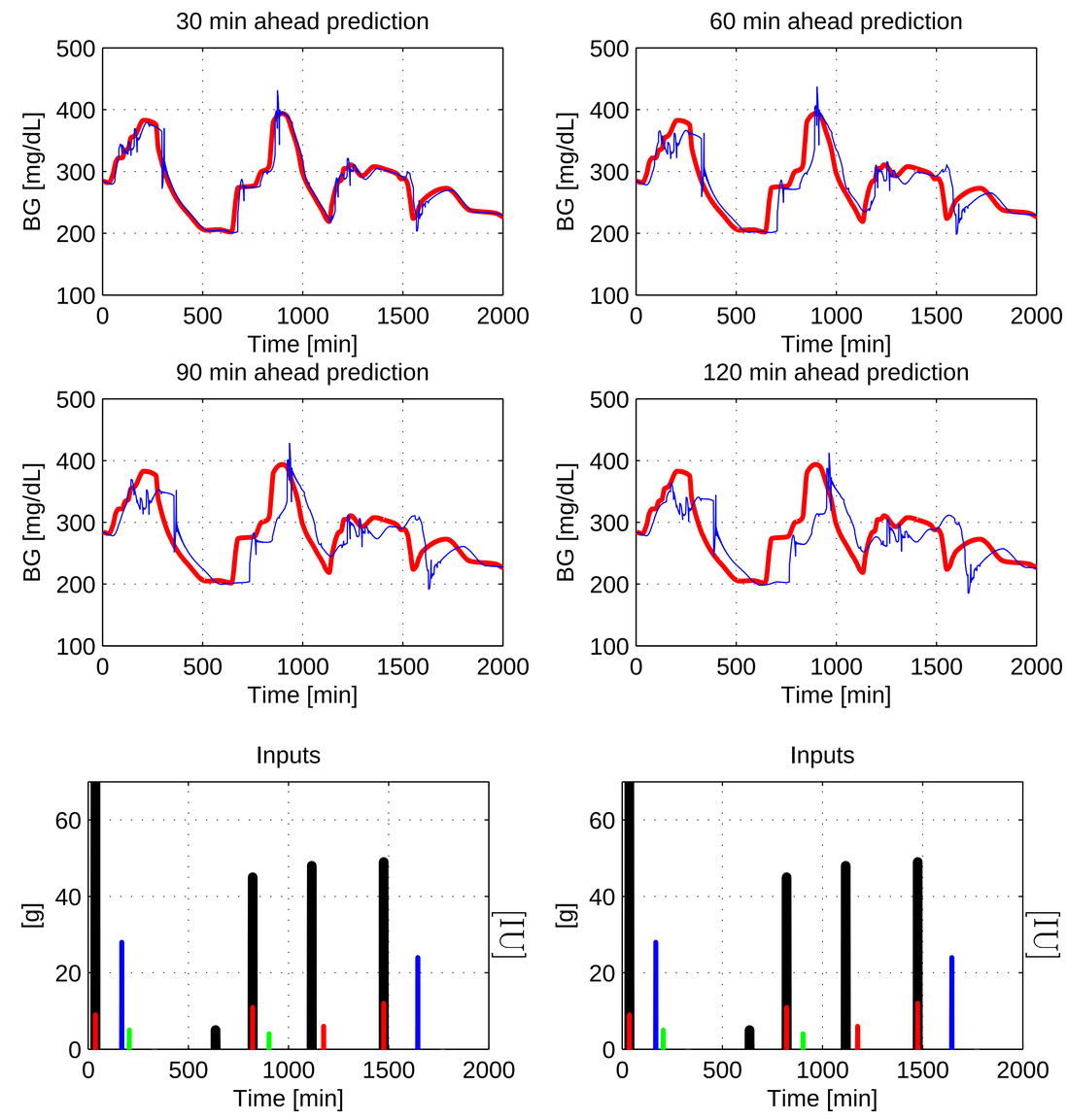


FIGURE 2: Representative patient. Evaluation on validation data: *Top panel:* 3rd-order ARMAX-based predictor (blue) and actual interpolated plasma glucose (red) [mg/dL] vs. time [min]; *Bottom panel:* Input signals: Meal carbohydrates (black) [g] and corresponding Insulin doses [IU]: basal (blue), bolus (red), correction (green).

Discussion

The glucose flux in the bloodstream after intestinal absorption and the total insulin flux in the bloodstream were considered as input variables. The inter-personal variability was disregarded when using population mean values reported in the literature [1] for the parameters appearing in the meal model and in the insulin kinetics model. The control variable, i.e., blood glucose, was interpolated and uniformly resampled from the numerous blood samples taken during the trial making it possible to have a reliable continuous time signal representing glycemia in plasma. However, this is not common practice where BG samples are available a couple of times a day at best, or is assessed indirectly from CGMS measurements.

Conclusions

The study provided reliable short-term glycemia predictions.

Acknowledgments

This research was supported by the European project DIAdvisor ^{TM} [4].

References

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[3] www.diadvisor.eu, FP7 IST-216592.