Meal detection

In this project, you will test and improve algorithms for detecting whether a person has a consumed a meal recently and if they forgot to take an appropriate amount of insulin with the meal. Detecting meals is important for 1) making controllers able to mitigate forgotten meal insulin boluses and 2) assisting doctors in their (very brief) consultations with their patients. You will first test the algorithms on simulated data in order to verify the correctness of the implementation. Thereafter, you will test the algorithms using real clinical data provided by doctors and researchers from Steno Diabetes Center Copenhagen (it cannot be shared with others).

1. Simulate a single patient over 1 month with 3 meals each day (choose many different meal sizes, e.g., from 10 to 150 g CHO in increments of 10 g CHO).
2. Implement the GRID algorithm described by Harvey et al. (2014).
3. Test the GRID algorithm on the simulated data.
4. Compare with the code provided by Rayhan A. Lal (cannot be shared with others).
5. Simulate a single patient over 1 month with 3 meals and 2 snacks each day (meals between 50 and 150 g CHO and snacks of 20 g CHO).
6. Test the GRID algorithm on the simulated data.
7. Simulate 100 patients over 1 month with the same protocol (i.e., meals) as in step 4.
8. Test the GRID algorithm on the simulated data for 100 patients (use Matlab's parfor to parallelize the simulations).
9. Update the MVP measurement model with a stochastic measurement noise model (add a zero-mean normal distributed measurement noise variable to each measurement).
10. Simulate the 100 patients with the stochastic model.
11. Repeat the test of the GRID algorithm.
12. Augment the MVP model with a stochastic diffusion term which will give rise to random variations in the dynamics of the virtual person. Assume that there are random variations in the blood glucose concentration, G(t).
13. Implement the Euler-Maruyama method (see the paper by Higham (2001)).
14. Simulate the 100 patients with the stochastic model with the stochastic measurements and the stochastic diffusion term using the Euler-Maruyama method.
15. Repeat the test of the GRID algorithm.
16. Compare with the code provided by Rayhan A. Lal (cannot be shared with others).

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R. A. Harvey, E. Dassau, H. Zisser, D. E. Seborg, F. J. Doyle III, 2014. Design of the glucose rate increase detector: A meal detection module for the health monitoring system. Journal of Diabetes Science and Technology 8(2), pp. 307-320.

Higham, D.J., 2001. An algorithmic introduction to numerical simulation of stochastic differential equations. SIAM Review 43(3), pp. 525-546.