MyTreat

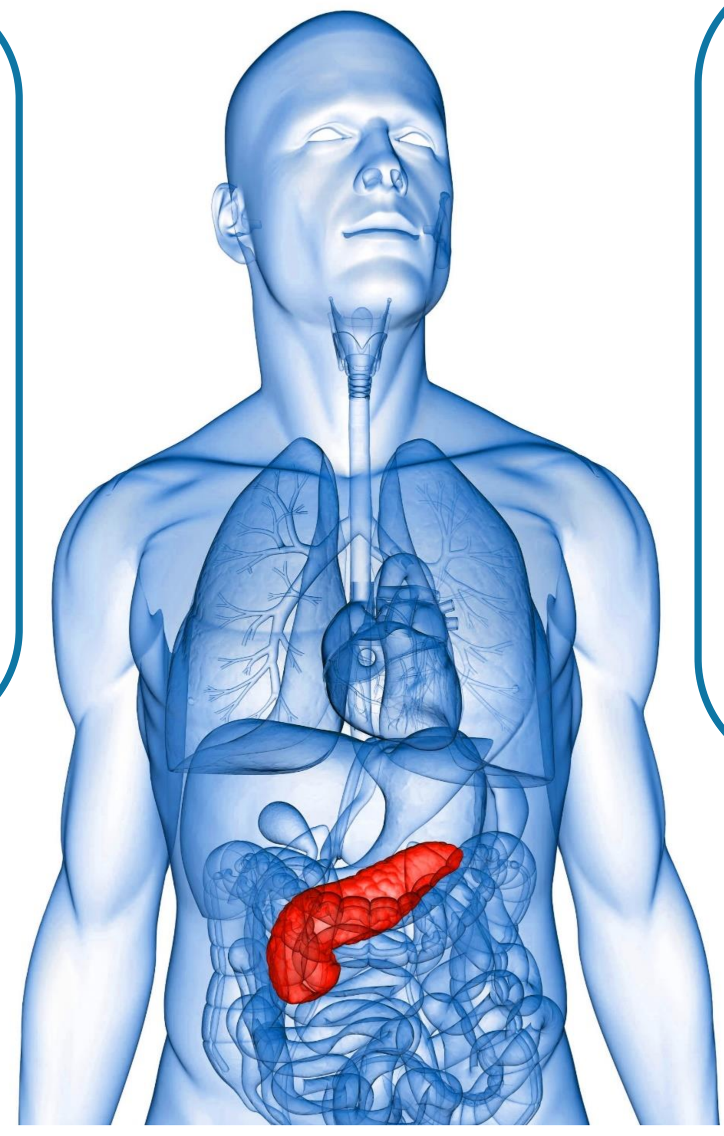
Intelligence in the Artificial Pancreas

A Mobile Platform for Personalization of Insulin Delivery based on a Patch Pump and Reinforcement Learning

Closed-loop to personalize insulin treatment in T1D, emulating the healthy function of the physiological pancreas

Current challenges for the AP

- Complex, non-linear system = Rapid changes in dynamics
- Inter- & intra-subject variability
- Delays in the sc-sc route: glucose measurement, insulin action
- Uncertainty = Limited information about patient's status
- CGM sensor issues and noise, pump inaccuracies
- Major disturbances: e.g. meal intakes, physical activity
- Control constraints 'one-sided'
- Patient's safety requirements



MyTreat innovations

Control algorithm = Reinforcement Learning

- Model-free (no physiological model required)
- Real-time adaptive, with personalization capabilities
- Low computational cost
- Fast compensation times in case of disturbances

CGM and pumps: Highly accurate patch pump, along with a CGM and blood glucose meters

Portable platform: Highly secured portable solution

Control system integrated into the JewelCOM™, a portable platform with dual SIM cards

Information about the status of the individual with T1D

Glucose

Values and trends

Continuous glucose monitor

Blood glucose meter

Insulin infusion history

Controller: Reinforcement Learning

Actor-Critic Agent

Critic
Q-value function
Policy evaluation

Actor
Control policy improvement

status → action

Safety mechanisms

Glucose prediction: Early Warning System

Alarms against hypo-/hyperglycemia events

Inputs: CGM, Meal CHO, Phys activ, Insulin

Prediction layer
- Corrected ARX (autoregressive) model
- Recurrent Neural Network (trained by Unscented Kalman Filter)

Correction layer
- Extreme Learning Machine

Insulin constraints

(Insulin-on-board, max. daily amount allowed)

JewelPUMP™ patch insulin pump

- High infusion accuracy
- Early automatic occlusion detection

Daskalaki E, et al. Model-free machine learning in biomedicine, Feasibility study in type 1 diabetes. PLoS One. 2016 (In press; IF: 3.234: Ranking: 0.9).

Daskalaki E, et al. Personalized tuning of a reinforcement learning control algorithm for glucose regulation. 35th IEEE EMBC, 2013.

Daskalaki E, et al. An actor–critic based controller for glucose regulation in type 1 diabetes. Comput Meth Programs Biomed. 2013;109(2):116-25 (IF: 1.093, Ranking: 0.7)

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