

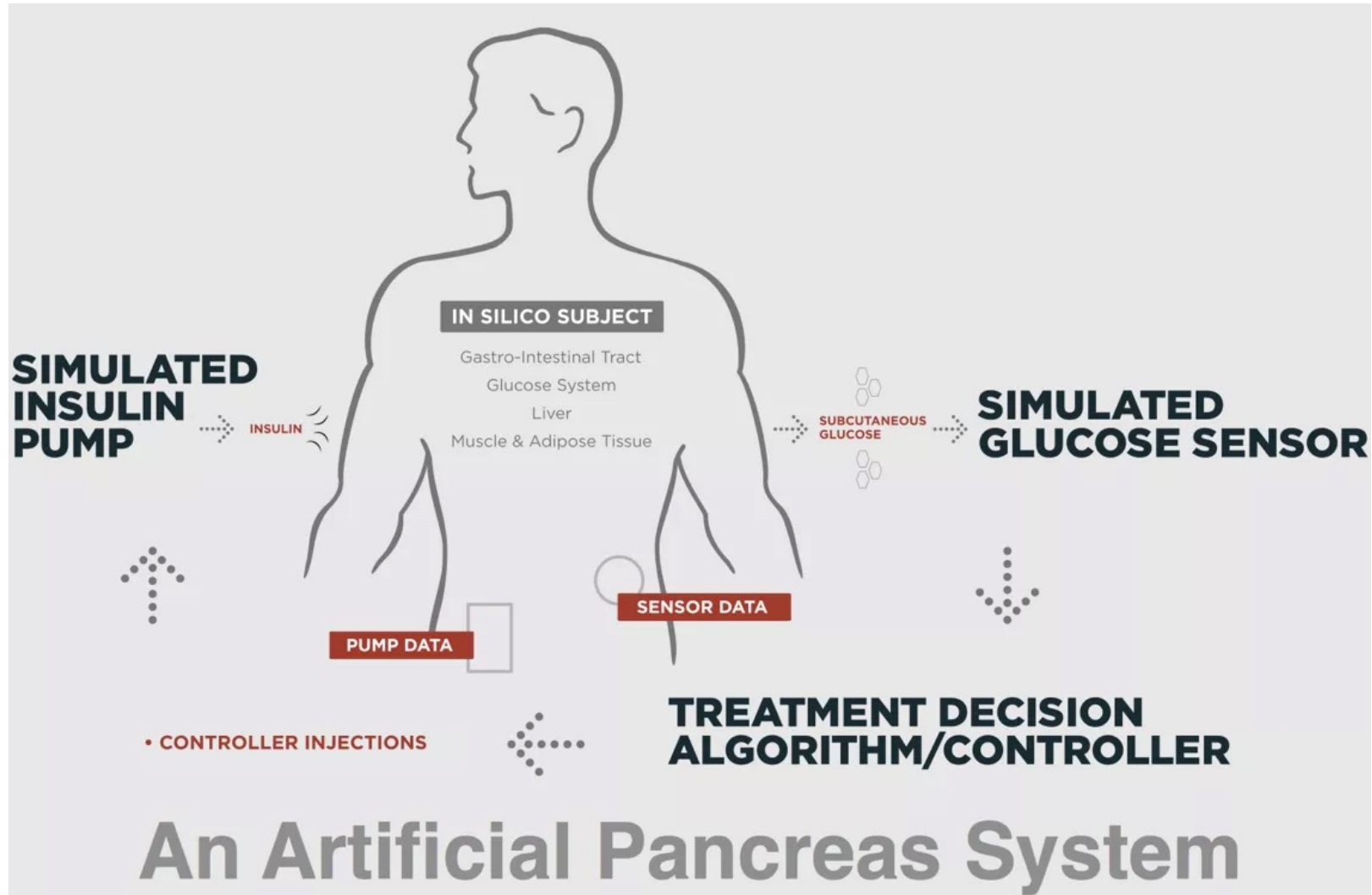
# Artificial Pancreas

Type 1 diabetes occurs when the pancreas produces little or none of the insulin needed to regulate blood glucose

They rely on external administration of insulin to manage their blood glucose levels.



# Artificial Pancreas



# Stochastic Hybrid Systems Of Glucose

$$\frac{d}{dt} \mathbf{x}(t) = F(\mathbf{x}(t); u(t); \Theta);$$

$$y(t) = x_1(t)$$

glucose concentration

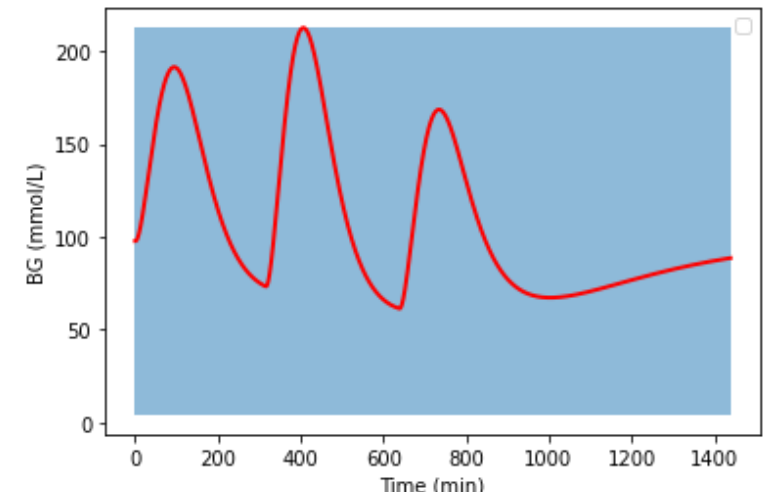
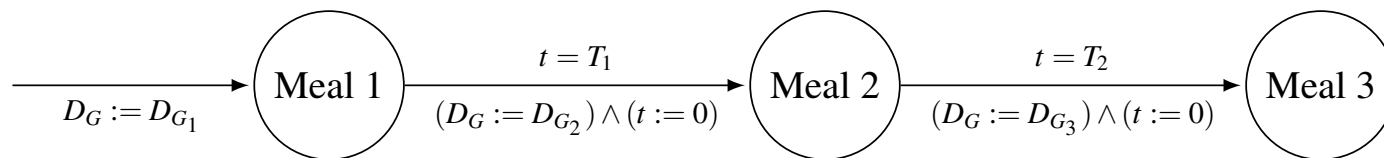
the control parameters

Infusion rate of bolus insulin

$\Theta = (D_{G_1}; D_{G_2}; D_{G_3}; T_1; T_2)$  are the control parameter

$(D_{G_1}; D_{G_2}; D_{G_3}) \in (N(40; 10); N(90; 10); N(60; 10))$  are the three daily meals

$(T_1; T_2) \in \sim N(300, 10)$  and  $T_2 \sim N(300, 10)$  are the inter-times between each of them



# Stochastic Hybrid Systems Of Glucose

$$\frac{d}{dt} Q_1(t) = -F_{01} - x_1 Q_1 + k_{12} Q_2 - F_R + EGP_0(1 - x_3) + \frac{D_G A_G}{t_{maxG}^2} t e^{-\frac{t}{t_{maxG}}}$$

$$\frac{d}{dt} Q_2(t) = x_1 Q_1 - (k_{12} + x_2) Q_2;$$

$$\frac{d}{dt} S_1(t) = u(t) + u_b - \frac{S_1}{t_{maxI}};$$

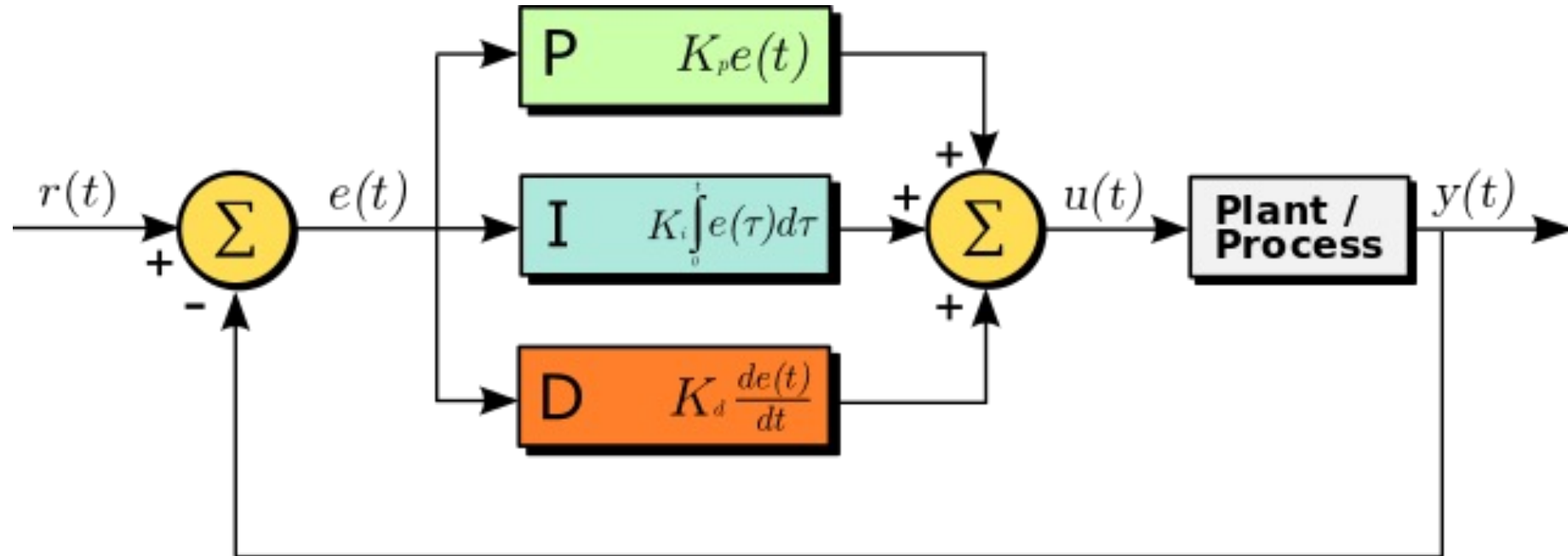
$$\frac{d}{dt} S_2(t) = S_1 - \frac{S_2}{t_{maxI}};$$

$$\frac{d}{dt} I(t) = \frac{S_2}{t_{maxI} V_I} - k_e I;$$

$$\frac{d}{dt} x_i(t) = -k_{a_i} x_i + k_{b_i} I; \quad (i = 1, 2, 3)$$

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{d}{dt} e(t), \quad e(t) = r(t) - y(t)$$

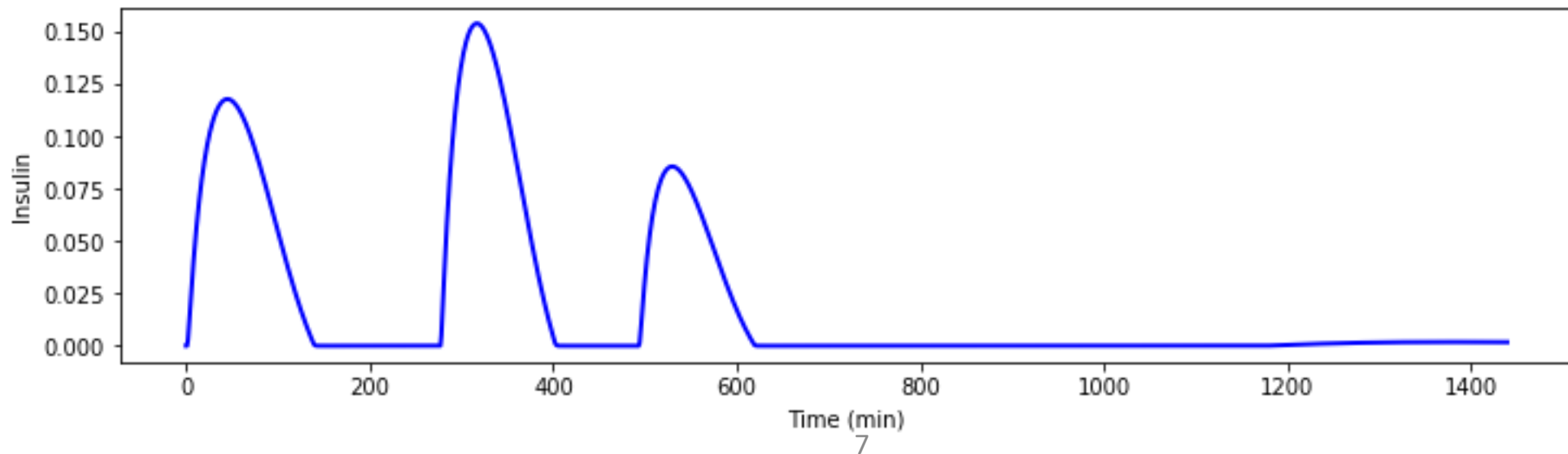
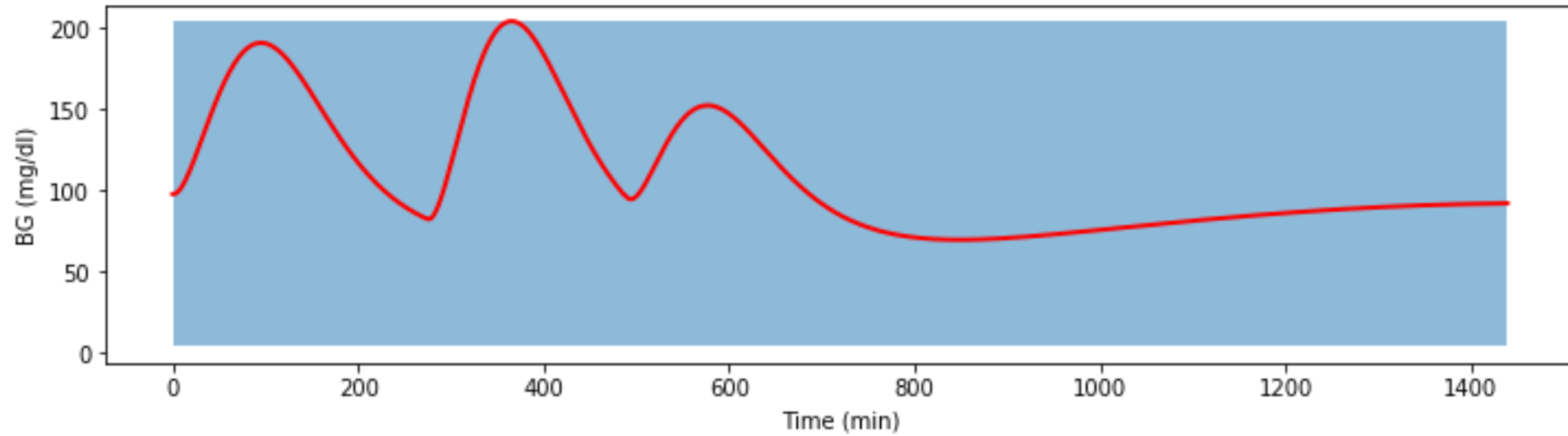
# PID Control



$$u(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{d}{dt} e(t),$$

$$e(t) = r(t) - y(t)$$

# Artificial Pancreas Simulation



# Bibliography

## Artificial Pancreas:

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