Course of "Industrial Automation"
2023/24

Research activities – Thesis work

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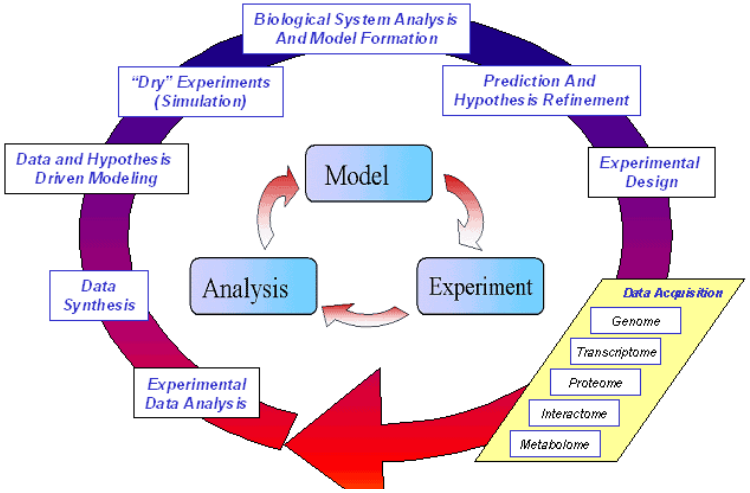
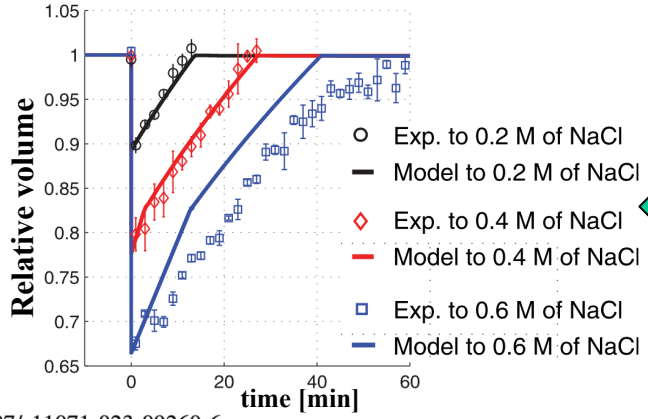
Team code: **vgxlryz**

Systems Biology





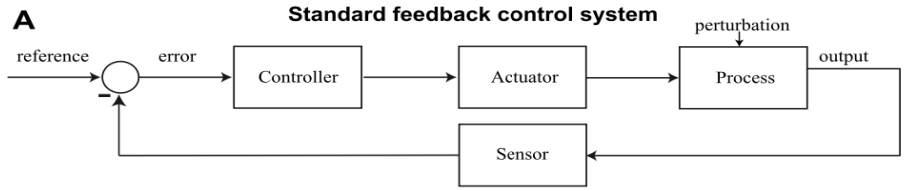
Nonlinear Dyn
https://doi.org/10.1007/s11071-023-09260-6

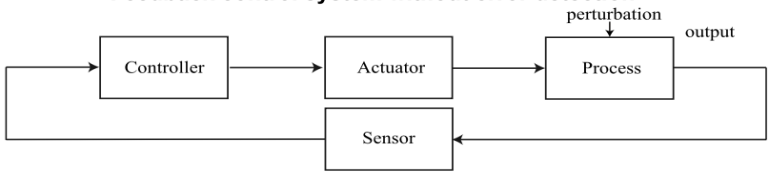
ORIGINAL PAPER

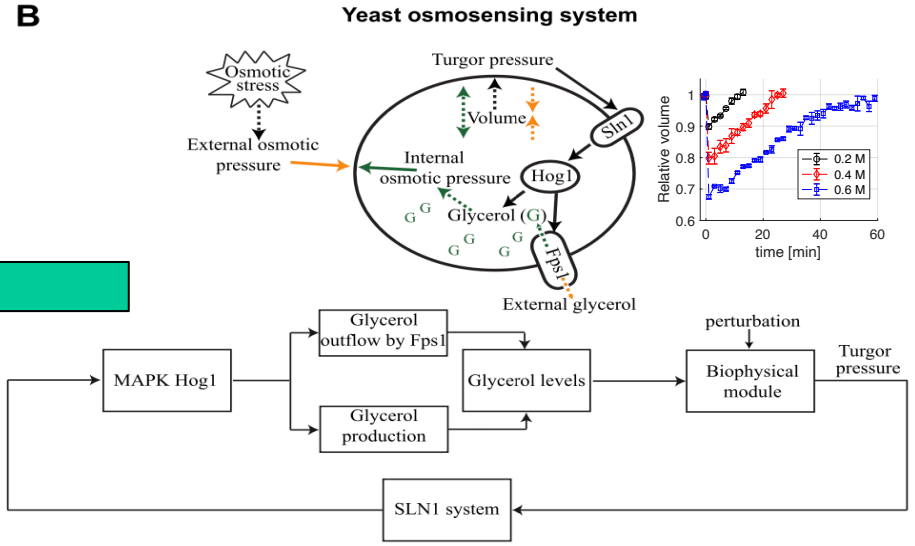
Role of ultrasensitivity in biomolecular circuitry for achieving homeostasis

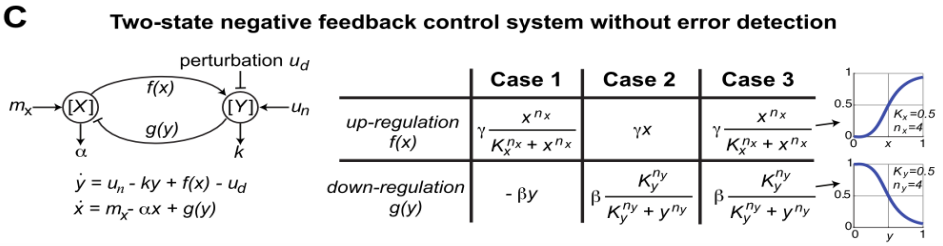
Francesco Montefusco · Anna Procopio · Iulia M. Bulai · Francesco Amato · Carlo Cosentino

Received: 17 November 2022 / Accepted: 17 December 2023

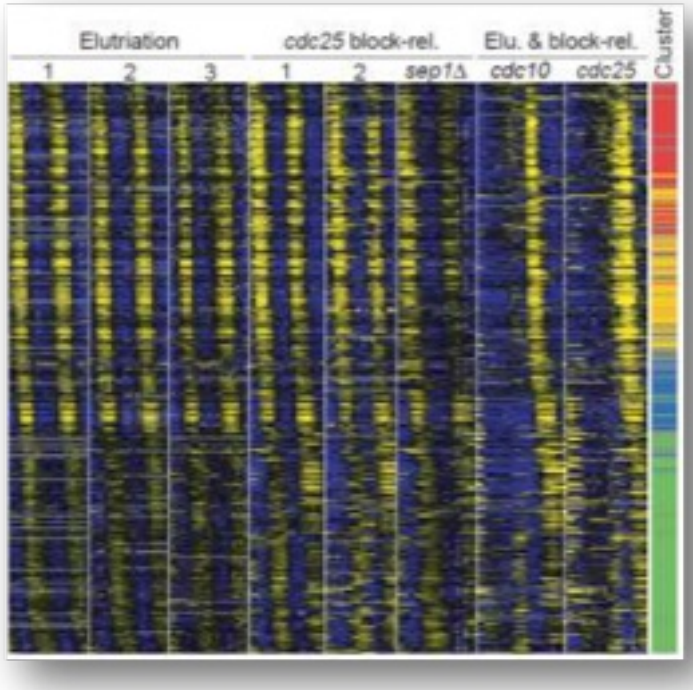


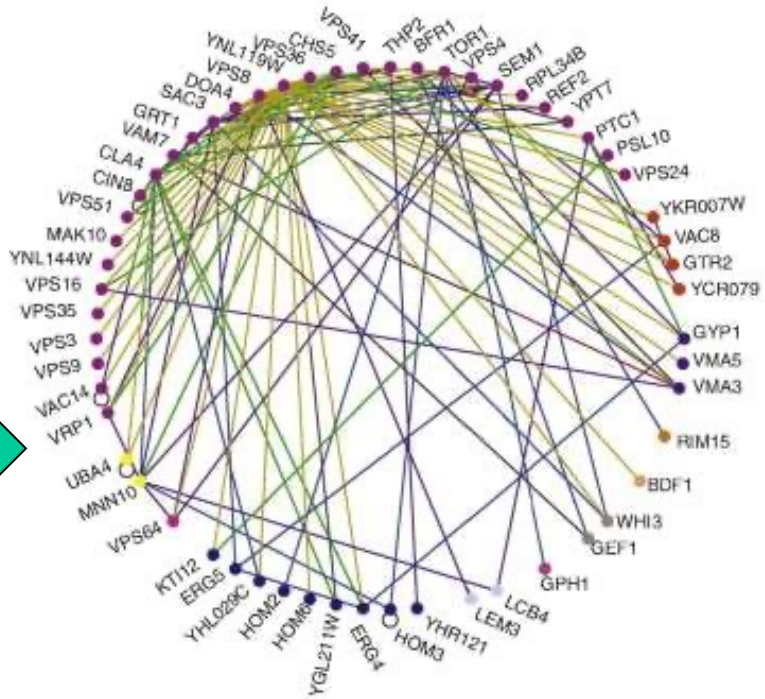






Reverse engineering of biological networks





Received: 15 June 2021 | Revised: 29 October 2021 | Accepted: 10 January 2022

DOI: 10.1002/rnc.6044

SPECIAL ISSUE ARTICLE

WILEY

Scalable reverse-engineering of gene regulatory networks from time-course measurements

Francesco Montefusco[1] | **Anna Procopio**[2] | **Declan G. Bates**[3] | **Francesco Amato**[4] | **Carlo Cosentino**[2]

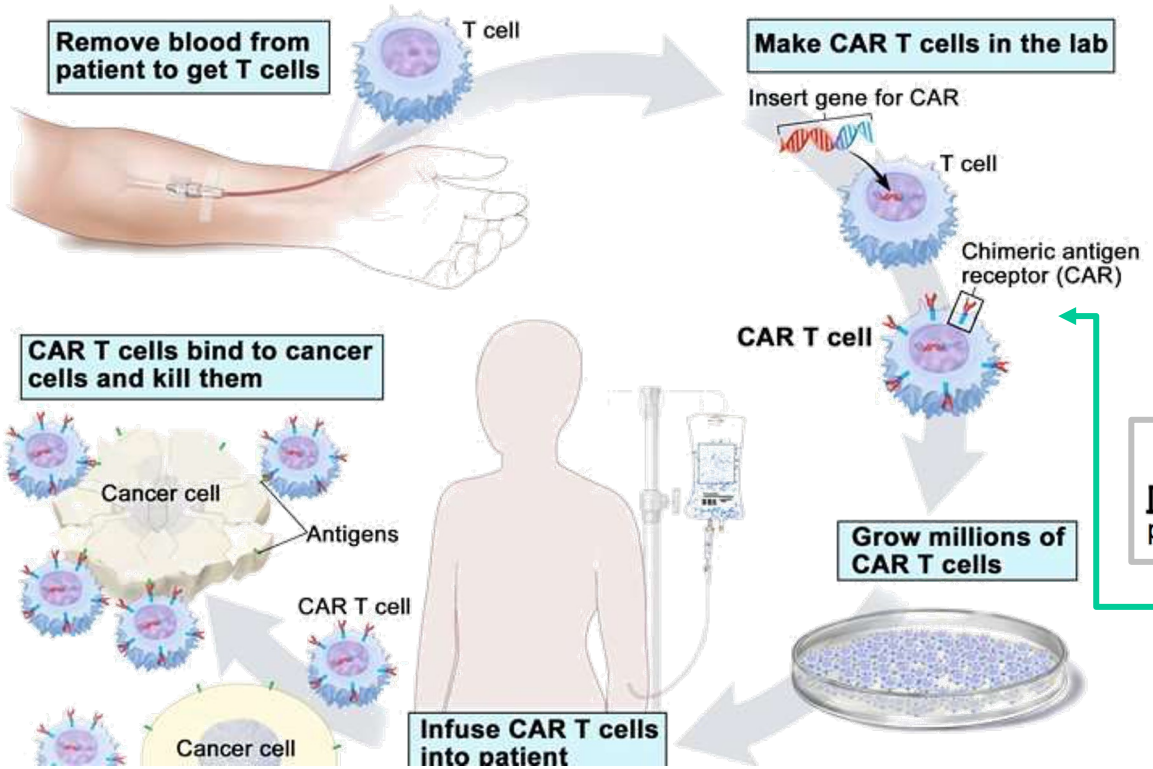
$$\dot{x}(t) = Ax(t) + Bu(t),$$

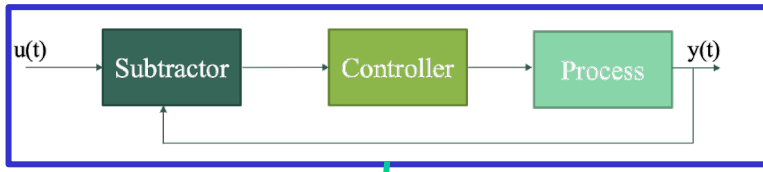
$$\Xi := \begin{pmatrix} x(h) & \dots & x(1) \end{pmatrix} = \Theta\Omega\,,$$

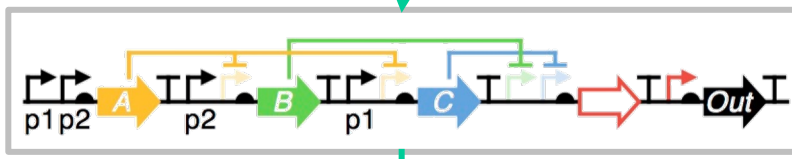
$$\text{where} \quad \Theta = \begin{bmatrix} \hat{A} & \hat{B} \end{bmatrix},$$

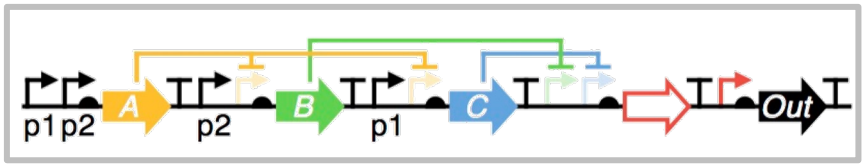
$$\Omega := \begin{pmatrix} x(h-1) & \dots & x(0) \\ u(h-1) & \dots & u(0) \end{pmatrix}.$$

Design of Complex Circuits and clinical application









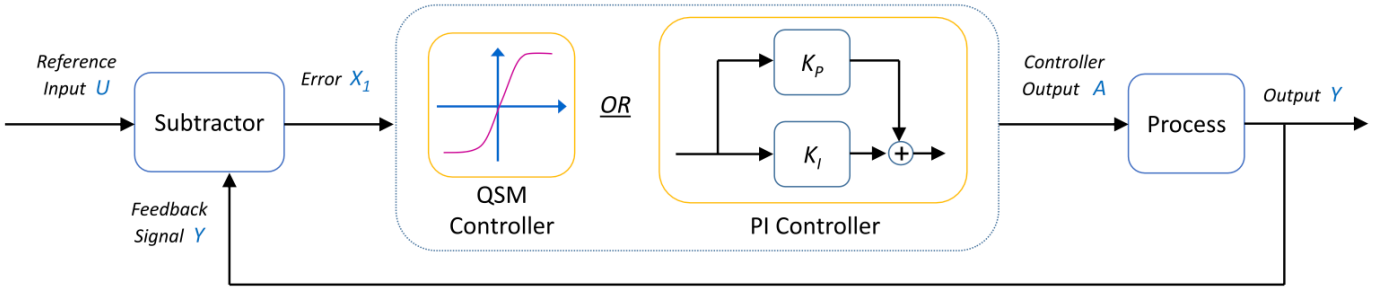


Fig. 1. A prototype embedded biomolecular closed loop feedback control system

$$X + P \underset{k_{ub}}{\overset{k_b}{\rightleftharpoons}} Y + Q, \Rightarrow \frac{dY}{dt} = k_b X(t)P(t) - k_{ub}Y(t)$$

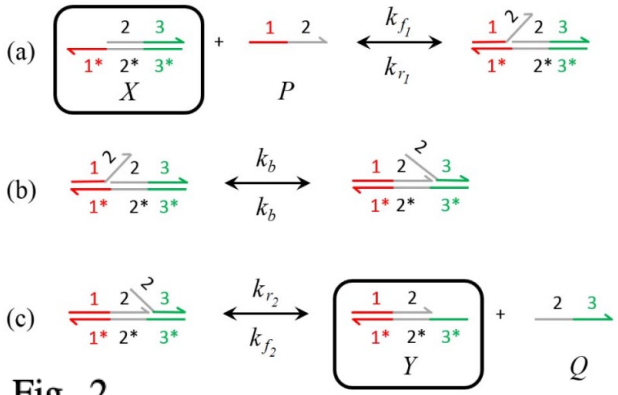
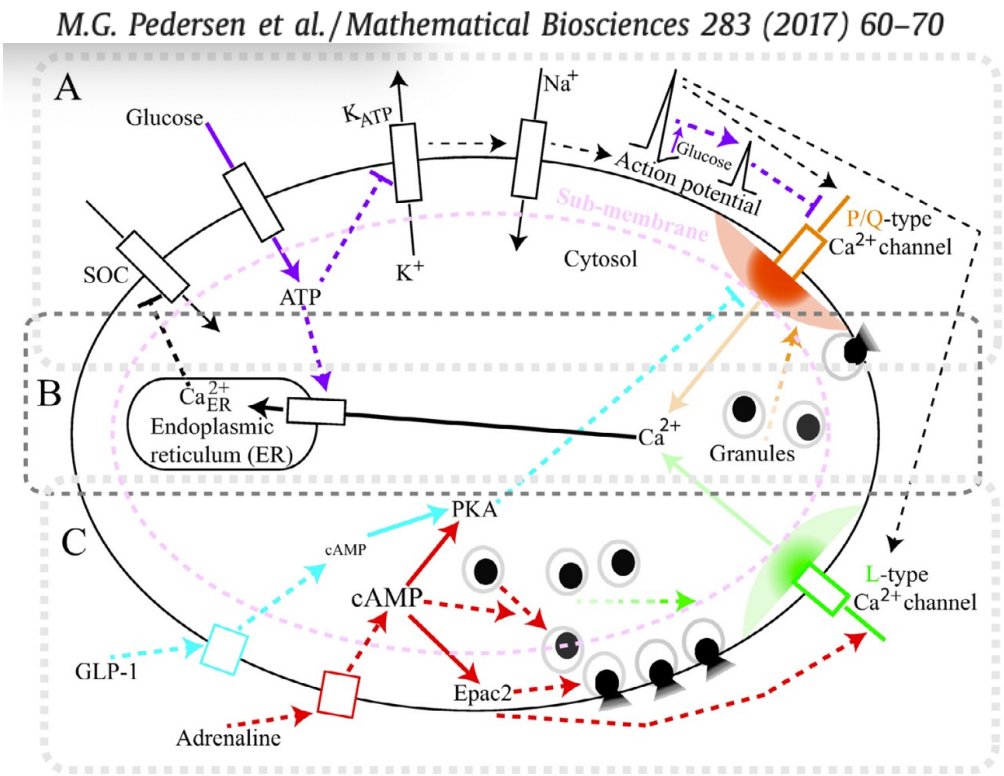


Fig. 2. Examples of DNA strand displacement reactions illustrated using the software package Visual DSD [25]: the DNA strands are bonded by Watson-Crick base pairing, denoted by * and the basic steps involved are (a) binding of toehold **1** to **1***, (b) branch migration wherein the strand **1–2** partially displaces strand **2–3**, and (c) complete separation of strand **2–3** [26].

Implementing Nonlinear Feedback Controllers Using DNA Strand Displacement Reactions

Rucha Sawlekar, Francesco Montefusco, Vishwesh V. Kulkarni, and Declan G. Bates*

Mathematical modelling for excitable cells



$$\frac{dV}{dt} = -(I_{CaL} + I_{CaP/Q} + I_{CaT} + I_{Na} + I_K + I_{KATP} + I_{KA} + I_L + I_{SOC})/C_m,$$

J Physiol 593.20 (2015) pp 4519–4530

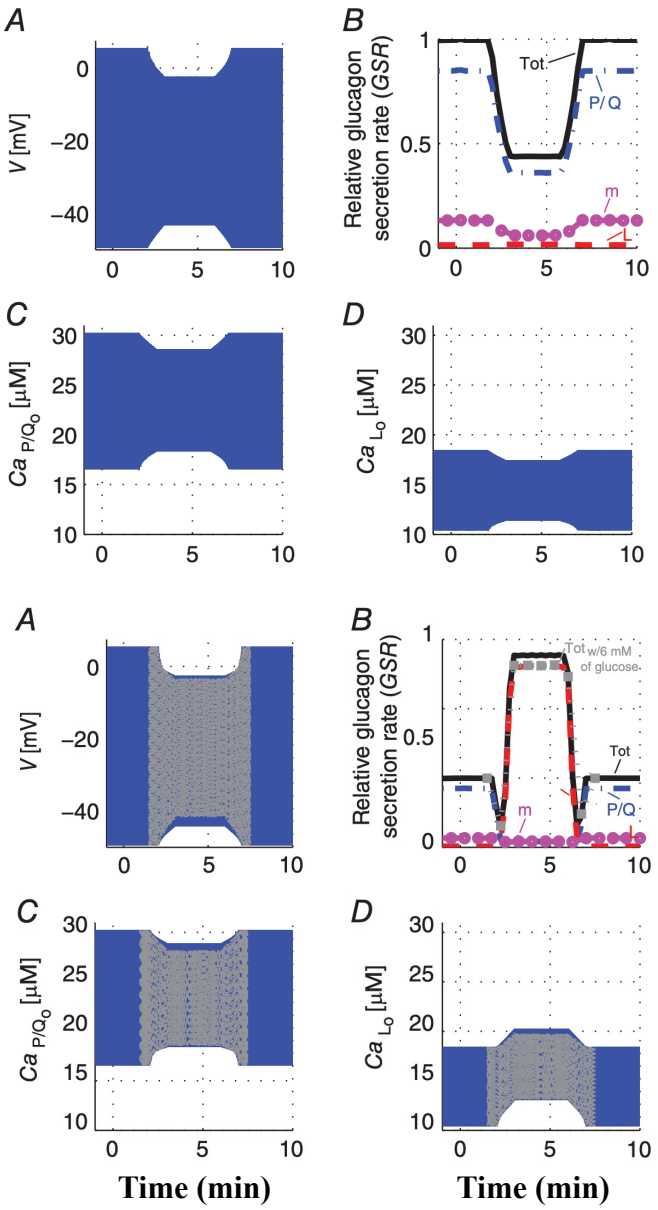
Mathematical modelling of local calcium and regulated exocytosis during inhibition and stimulation of glucagon secretion from pancreatic alpha-cells

Francesco Montefusco and Morten Gram Pedersen

The Journal of Physiology

Control glucose of glucagon secretion

Effects of adrenaline on glucagon secretion



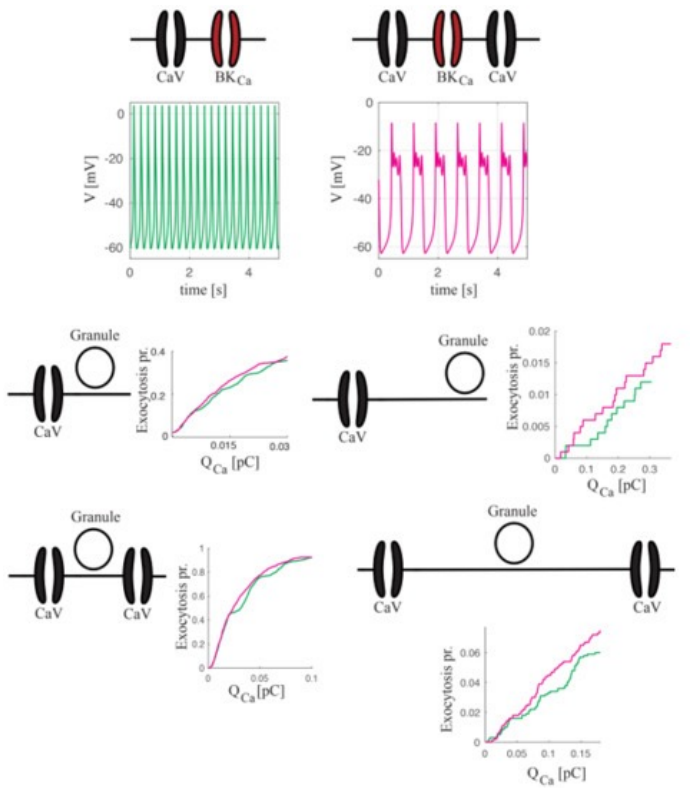
Mathematical modelling for excitable cells

Article

From Local to Global Modeling for Characterizing Calcium Dynamics and Their Effects on Electrical Activity and Exocytosis in Excitable Cells

International Journal of *Molecular Sciences*

Francesco Montefusco [1,*] and Morten G. Pedersen [1,2,3]

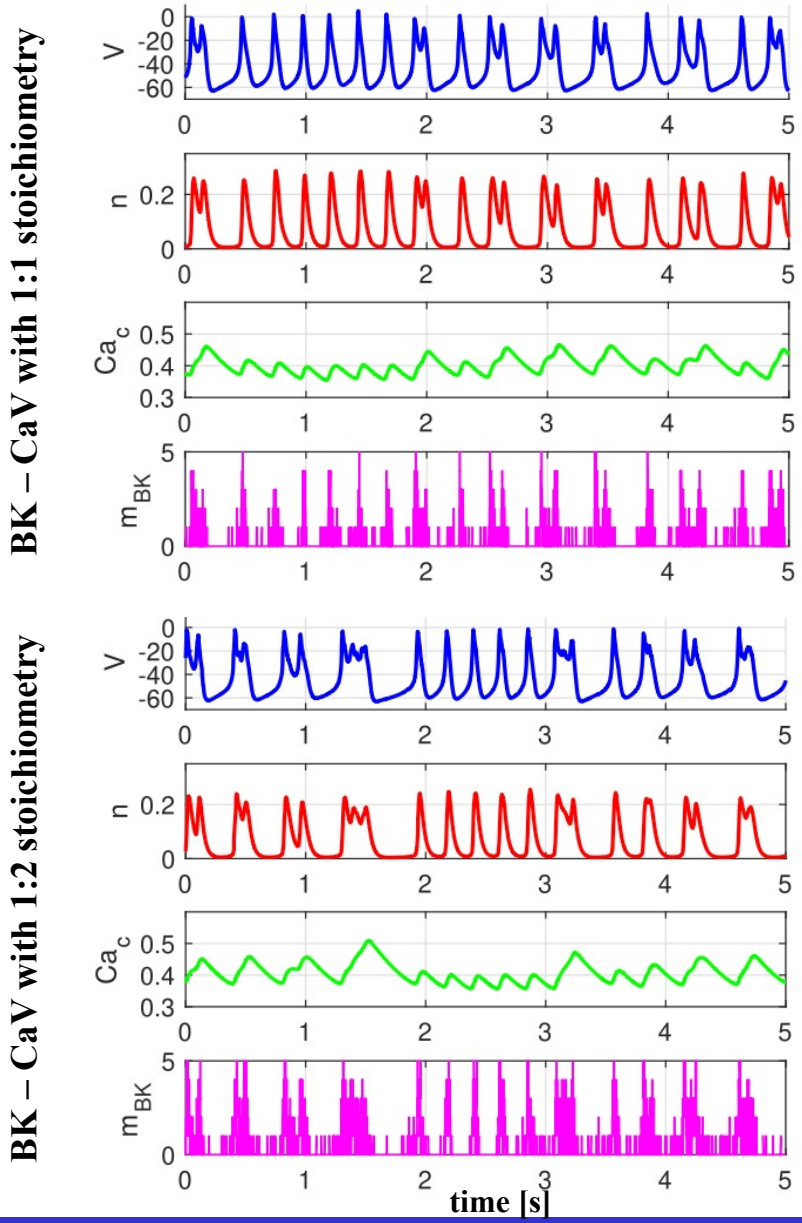


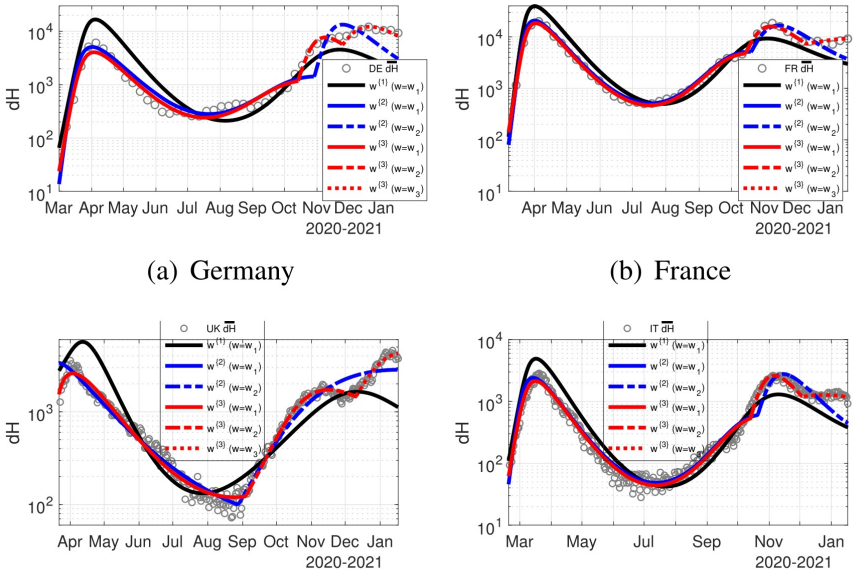
Nonlinear Dyn (2024) 112:1415–1430
https://doi.org/10.1007/s11071-023-09091-5

ORIGINAL PAPER

Geometric slow–fast analysis of a hybrid pituitary cell model with stochastic ion channel dynamics

Francesco Montefusco · Morten Gram Pedersen





(a) Germany (b) France

(c) UK (d) Italy

A. SIHM Model

We consider a SIHM model for characterizing COVID-19 dynamics, where S represents the susceptible individuals, I the infectious, H the cumulative hospital admissions and M the time-weighted average number of hospital admissions (i.e., a memory variable), which feeds back onto the transmission rate of the disease, β_f. The model is described by the equations

$$\dot{S} = -\beta_f SI/N, \tag{1}$$
$$\dot{I} = \beta_f SI/N - (\eta + \alpha)I \tag{2}$$
$$\dot{H} = \eta I \tag{3}$$
$$\dot{M} = (\eta I - M)/\tau \tag{4}$$

with

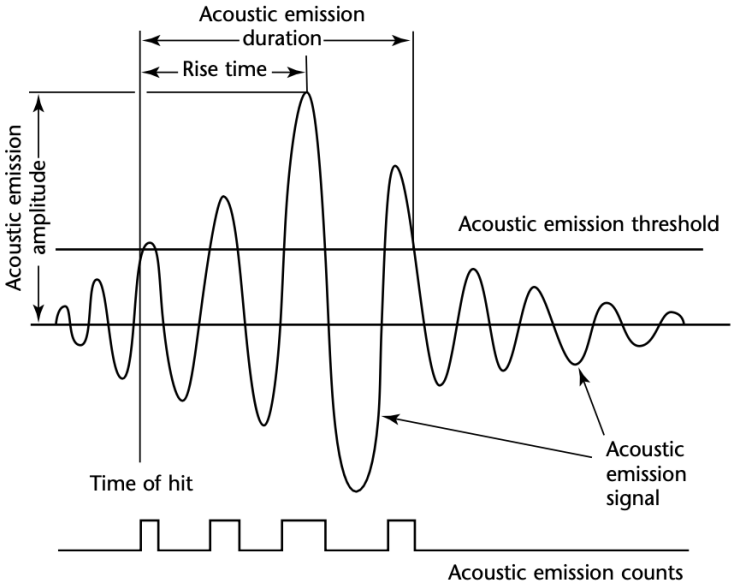
$$\beta_f = u(1+w)(1-\Delta u), \text{ with } u = \frac{\beta}{1+\left(\frac{M}{K_p}\right)^{n_h}}. \tag{5}$$

IEEE CSS IEEE CONTROL SYSTEMS LETTERS, VOL. 7, 2023 583

Interacting With COVID-19: How Population Behavior, Feedback and Memory Shaped Recurrent Waves of the Epidemic

Francesco Montefusco, Anna Procopio, Iulia M. Bulai, Francesco Amato, Morten G. Pedersen, and Carlo Cosentino

Data-driven predictive models from acoustic emission tests



Pattern recognition and signal classification