Computational Neuroscience
The mathematical theory of our brain

Lecture 8
Programming (I)

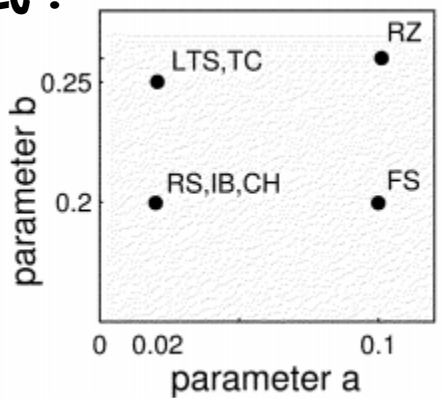
Daqing Guo / 郭大庆

dqguo@uestc.edu.cn
Department of Biomedical Engineering,
School of Life Science and Technology,
University of Electronic Science and Technology of China

8.1 Izhikveich模型

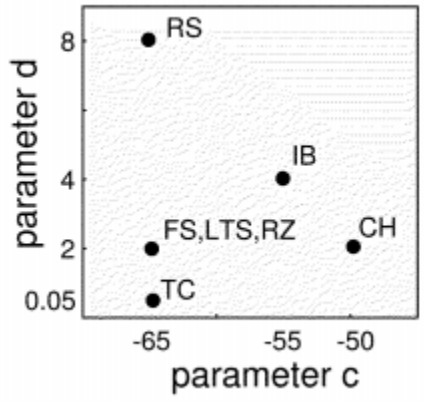
考虑Izhikveich 神经元模型，该模型的膜电位动力学具有如下形式：

$$\begin{cases} \dfrac{dv}{dt} = 0.04v^2 + 5v + 140 - u + I \\ \dfrac{du}{dt} = a\left(bv - u\right) \end{cases}$$



当$v \geq 30$ mV时，则按照如下形式重置膜电压v和回复变量u

$$\begin{cases} v \leftarrow c \\ u \leftarrow u + d \end{cases}$$



其中I为输入，a，b，c，d为模型参数，不同参数下该模型具有不同的放电性质。

问题 1：试采用欧拉法，积分步长为h=1 ms，利用matlab实现Izhikveich模型

要求：实现对规则放电(RS)和快速放电(FS)两类放电进行模拟，画出膜电位及两类神经元的f-I曲线

8.1 Izhikveich模型

问题 2：考虑采用高斯随机噪声刺激神经元，采用EM 算法(h=1 ms)，实现Izhikveich模型

要求：仅考虑规则放电(RS)，画出不同噪声强度下神经元的膜电位，比较放电序列的规则性

$$I=\sqrt{2D}\xi(t)$$

问题 3：实现计算神经元放电序列(SPT)的变异系数(CV)方法，画出CV随噪声强度变化的曲线

要求：每个SPT序列计算100秒。

问题4：考虑500个神经元，它们的放电均服从Poisson分布，其中放电率为λ_0=5 Hz，试写出一个程序生成这些神经元的放电序列，进一步以光栅图的形式给出放电情况，并以5ms的时间窗画出群体放电密度曲线。

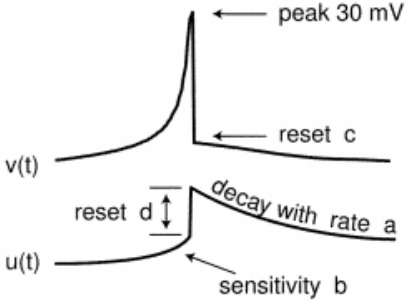
要求：步长为0.1ms，仿真时间为2000ms

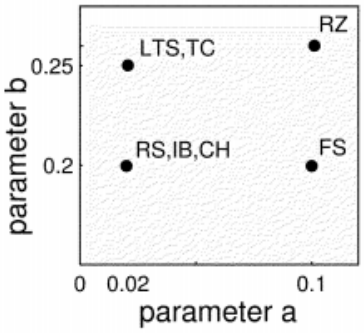
课后：考虑采用1000条Poisson 放电序列刺激Izhikveich神经元，实现下列文献中的结果。

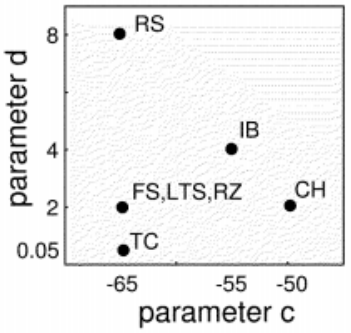
8.1 Izhikveich模型

$$v' = 0.04v^2 + 5v + 140 - u + I$$
$$u' = a(bv - u)$$

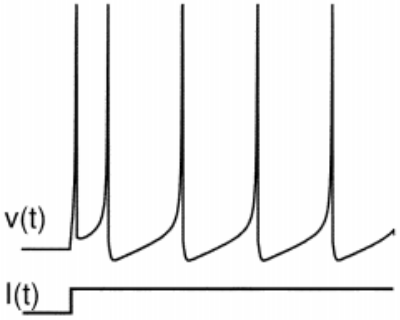
if v = 30 mV,
then v ← c, u ← u + d



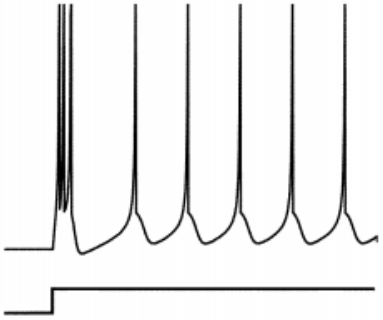




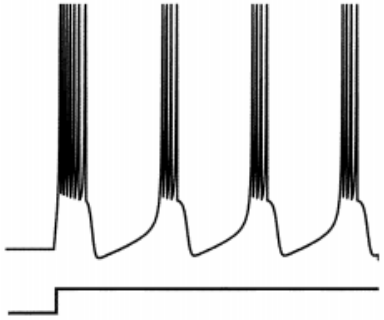
regular spiking (RS)



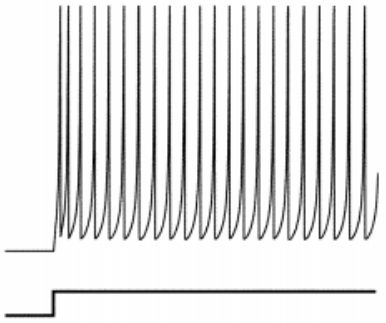
intrinsically bursting (IB)



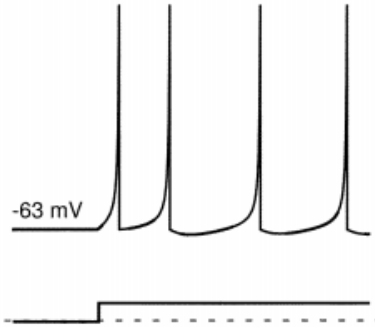
chattering (CH)



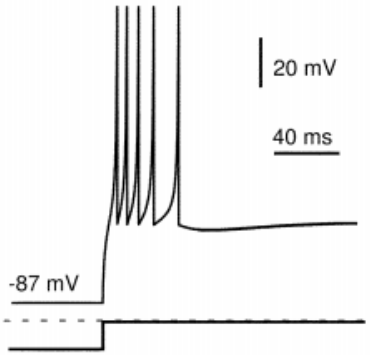
fast spiking (FS)



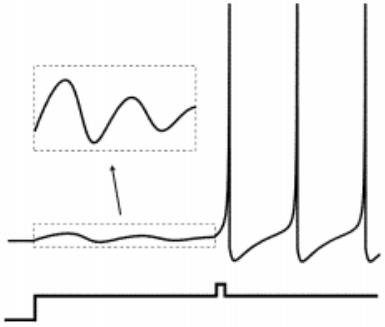
thalamo-cortical (TC)



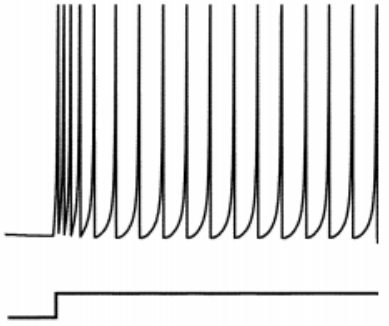
thalamo-cortical (TC)



resonator (RZ)



low-threshold spiking (LTS)



End

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