Week 7 – part 6 : Modeling in vitro data

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Neuronal Dynamics:
Computational Neuroscience of Single Neurons

Week 7 – Optimizing Neuron Models For Coding and Decoding

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- √ **7.1 What is a good neuron model?**
  - Models and data
- √ **7.2 AdEx model**
  - Firing patterns and analysis
- √ **7.3 Spike Response Model (SRM)**
  - Integral formulation
- √ **7.4 Generalized Linear Model (GLM)**
  - Adding noise to the SRM
- √ **7.5 Parameter Estimation**
  - Quadratic and convex optimization
- **7.6. Modeling in vitro data**
  - how long does the effect of a spike last?
- **7.7. Helping Humans**

Week 7 – part 6 : Modeling in vitro data

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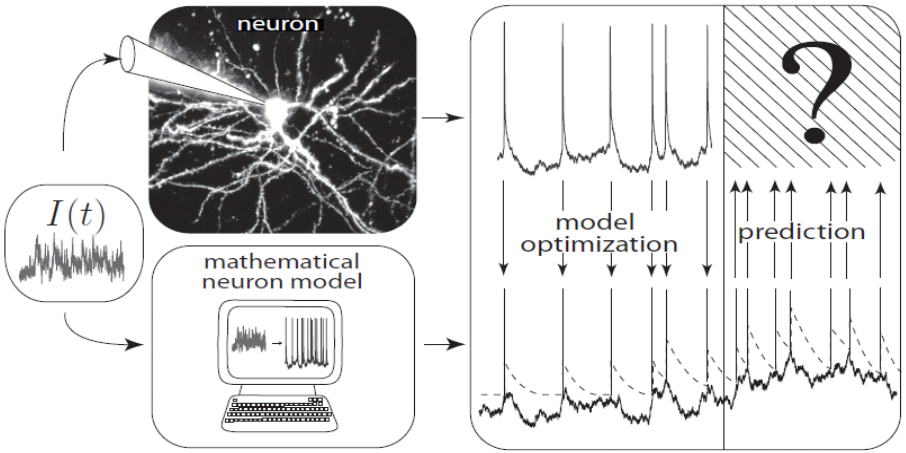
7.7. Helping Humans

Neuronal Dynamics – 7.6 Models and Data

comparison model-data



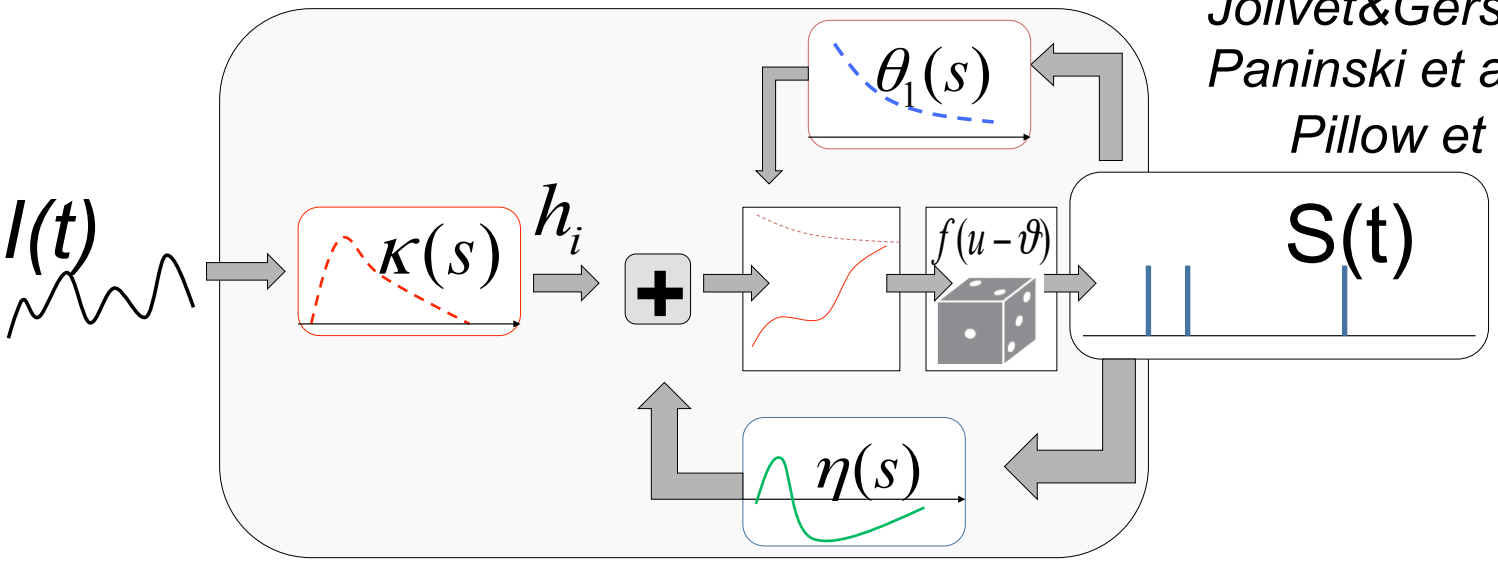
Predict

-Subthreshold voltage

-Spike times

Neuronal Dynamics – 7.6 GLM/SRM with escape noise

Jolivet&Gerstner, 2005
Paninski et al., 2004
Pillow et al. 2008



potential $u(t) = \int \eta(s) S(t-s) ds + \int_0^\infty \kappa(s) I(t-s) ds + u_{rest}$

threshold $\vartheta(t) = \theta_0 + \int \theta_1(s) S(t-s) ds$

firing intensity $\rho(t) = f(u(t) - \vartheta(t))$

Neuronal Dynamics – 7.6 GLM/SRM predict subthreshold voltage

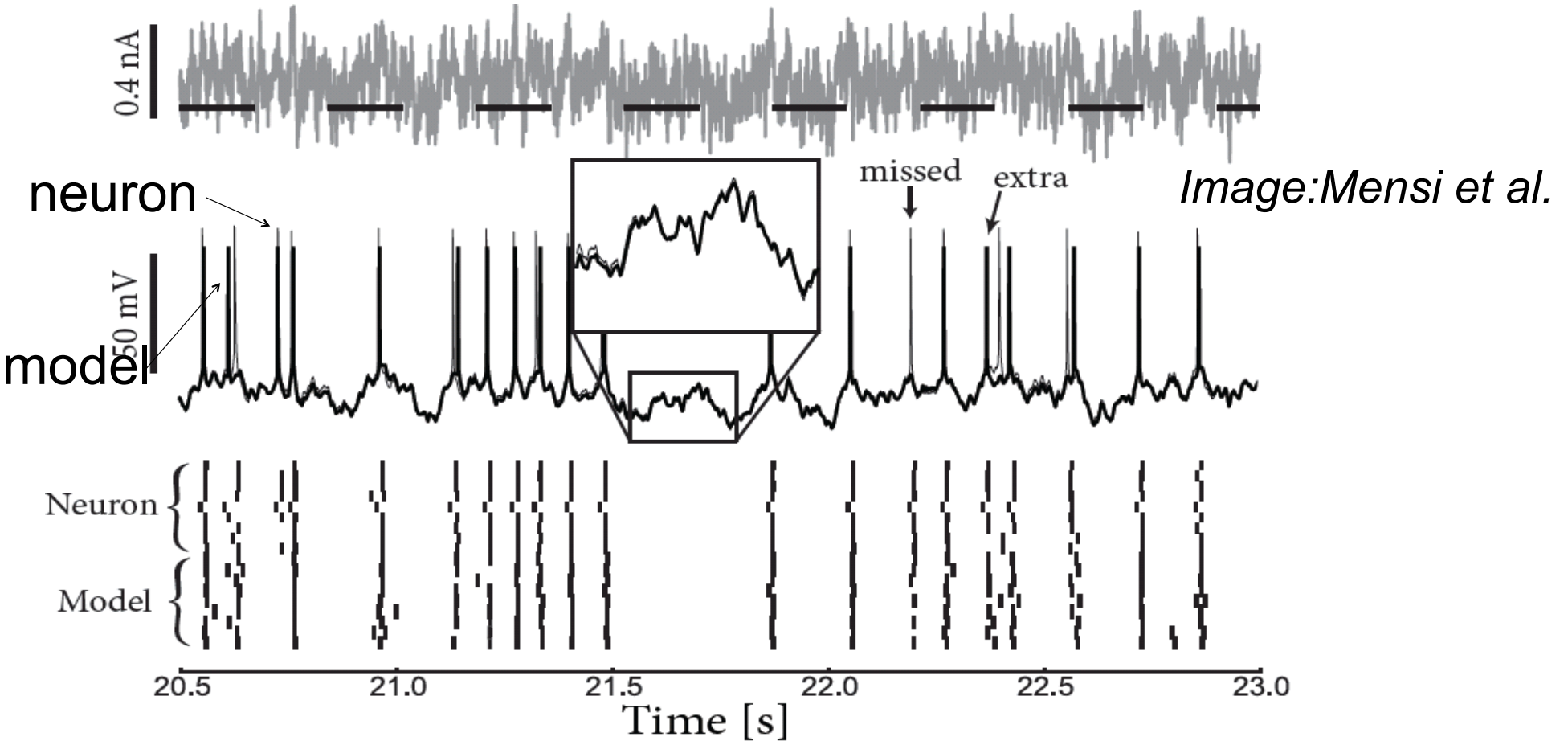
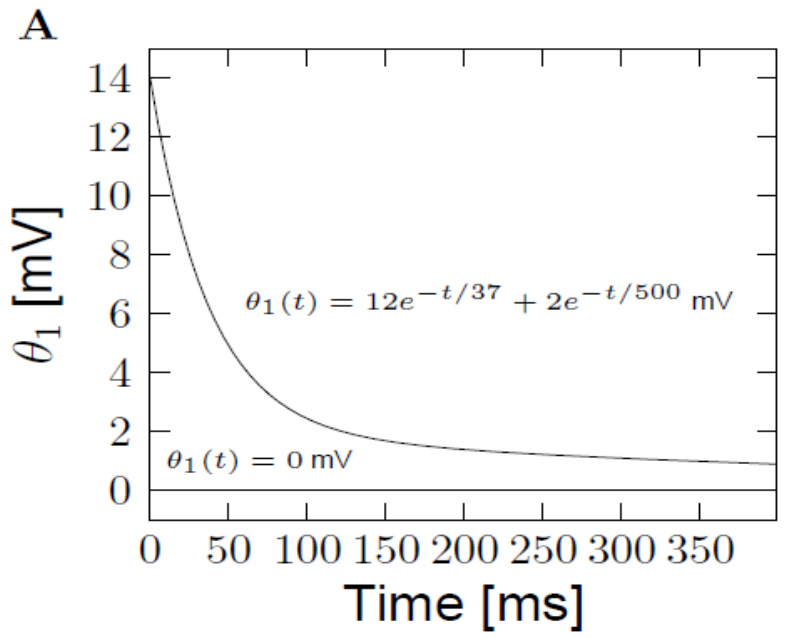


Image:Mensi et al.

Role of moving threshold



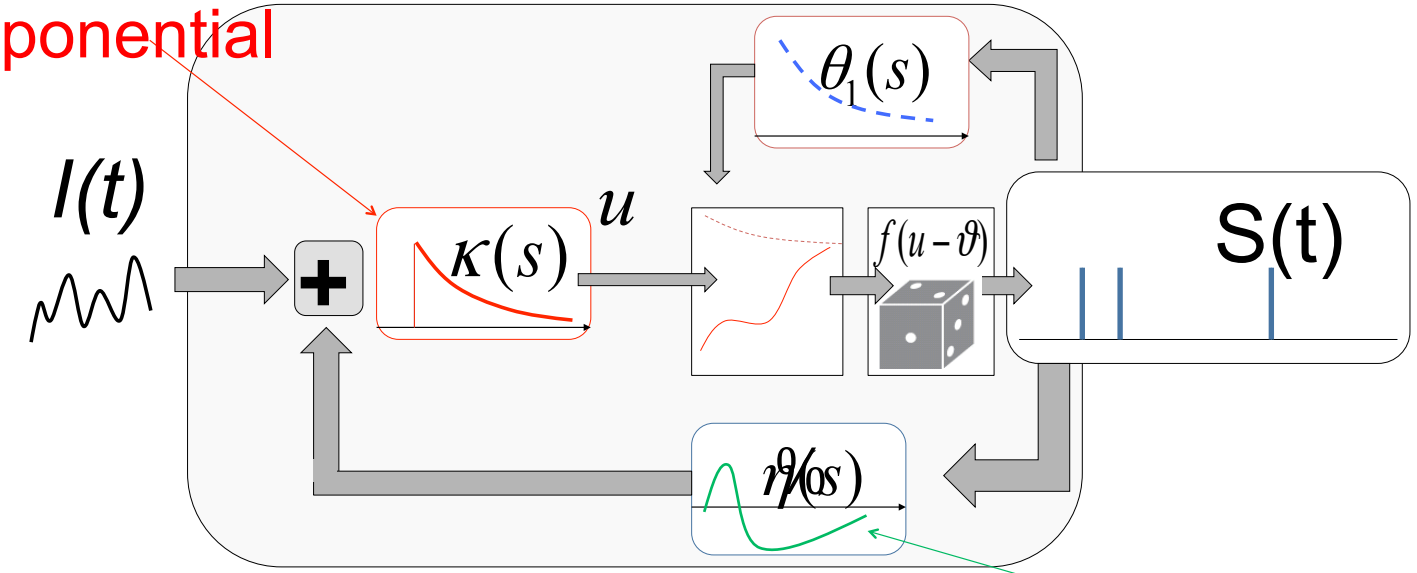
Mensi et al., 2012

Change in model formulation:

What are the units of …. ?

‘soft-threshold adaptive IF model’

exponential



potential $$C\frac{d}{dt}u(t) = \int \eta(s)S(t-s)ds \quad + I(t)$$

adaptation current

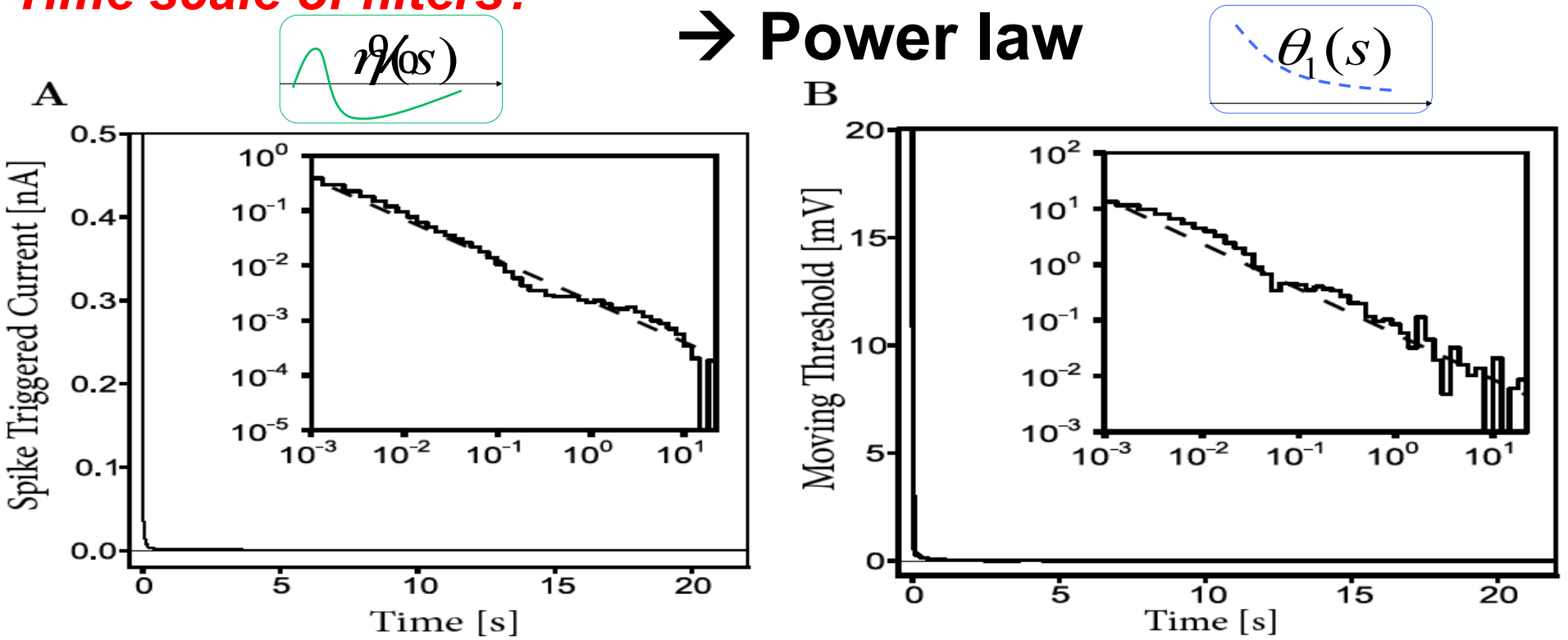
threshold $$\vartheta(t) = \theta_0 + \int \theta_1(s)S(t-s)ds$$

firing intensity $$\rho(t) = f(u(t) - \vartheta(t))$$

Neuronal Dynamics – 7.6 How long does the effect of a spike last?

Time scale of filters?

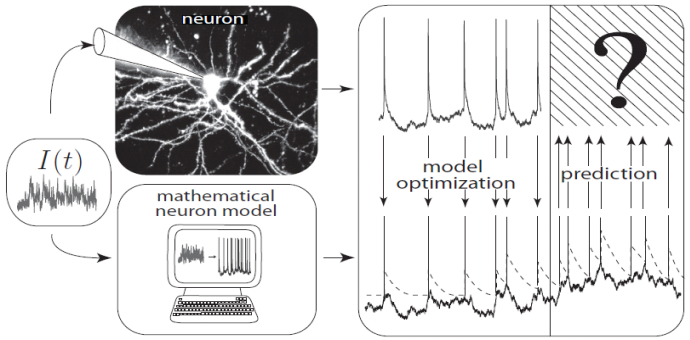
→ Power law



Pozzorini et al. 2013

A single spike has a measurable effect more than 10 seconds later!

Neuronal Dynamics – 7.6 Models and Data



-Predict spike times
-Predict subthreshold voltage
-Easy to interpret (not a ‘black box’)
-Variety of phenomena
-Systematic: ‘optimize’ parameters

BUT so far limited to in vitro