Notes on Density of Neurons and Synapses

N. Lygeros

- Connectivity matrix (mouse)
- Satisfactory solution of the problem of cortical connectivity
- Differences in synaptic density of hemispheres of rabbit.

$$N_v = \frac{N/A}{t+d} \text{ cell bodies}$$

$$N_v = \frac{N/A}{t+d\,\pi/4} \text{ synapses}$$

d:= diameter of a neuron or synapse
t:= section thickness

- Cell bodies

$$d = \frac{2}{\pi}\left(\bar{d} - t + \sqrt{\left(\bar{d} - t\right)^2 + \pi\bar{d}t}\right)$$

$$d = \frac{2}{\pi}\left(\bar{d} - t + \sqrt{\left(\bar{d} - t\right)^2 + \pi\bar{d}t - v\,\pi^2/4}\right)$$

- Synapses

$$d = \frac{1}{2}\left(\bar{d} - \frac{4}{\pi}t + \sqrt{\left(\bar{d} - \frac{4}{\pi}t\right)^2 + 4\bar{d}t}\right)$$

$$d = \frac{1}{2}\left(\bar{d} - \frac{4}{\pi}t + \sqrt{\left(\bar{d} - \frac{4}{\pi}t\right)^2 + 4\bar{d}t - v}\right)$$

$\bar{d}$:= average diameter v:- variance

- These formulae are derived from simple geometrical calculations.
- The average density of neurons is between 9.0 and 9.3 x 10^4/mm^3. With a neocortical volume of 112mm^2 this makes 1.0 x 10^7 neurons (in both hemispheres together). The average density of synapses is between 6.9 and 7.5 x 10^8/mm^3. The total number in the neocortex is thus between 7.7 and 8.4 x x10^{10} synapses.
- 8,200 synapses per neuron.
- neuron involved in 2-cycle
- $p=1-(1-k/n)^k$ with k=8,200 n=10^7 => p=0,999
- The vast majority of neurons are involved in short feedback cycles.