Visual Data Mining of Brain Cells

J. Symanzik*, G. Ascoli,

J. L. Krichmar, S. D. Washington

George Mason University, Fairfax, VA

***e-mail: symanzik@galaxy.gmu.edu**

WWW: http://www.galaxy.gmu.edu/~symanzik

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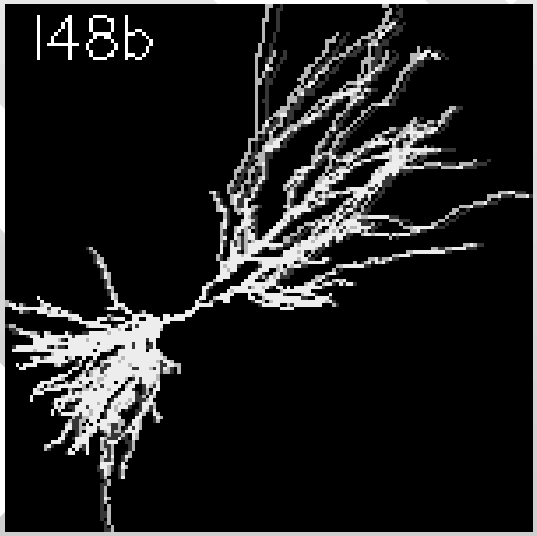
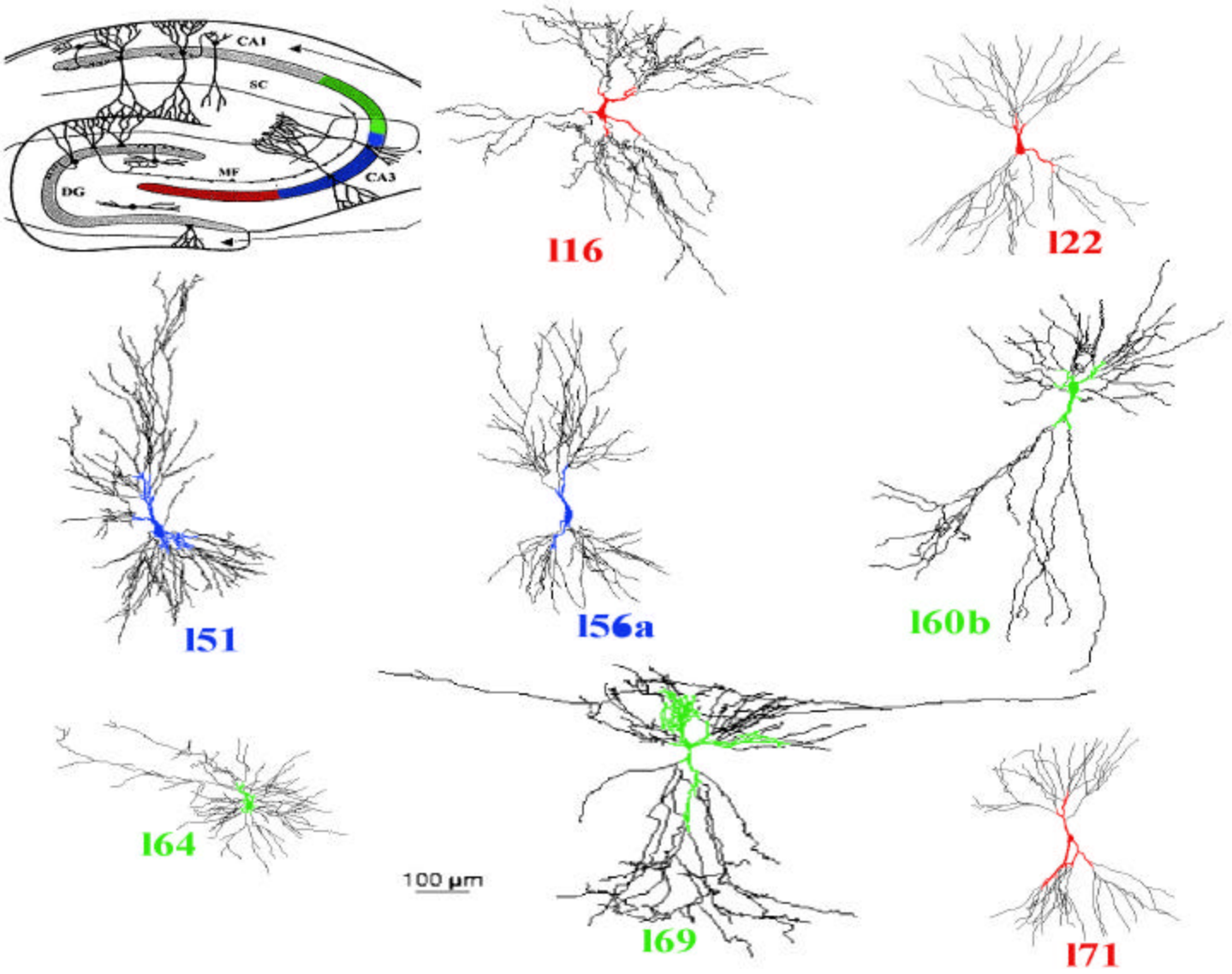
- Simulation
- Visual Data Mining Using XGobi

Data Archives

Public Morphological Archive:
http://www.neuro.soton.ac.uk
~200 hippocampal neurons
(pyramidal, chandelier, etc.)



Pyramidal Brain Cells



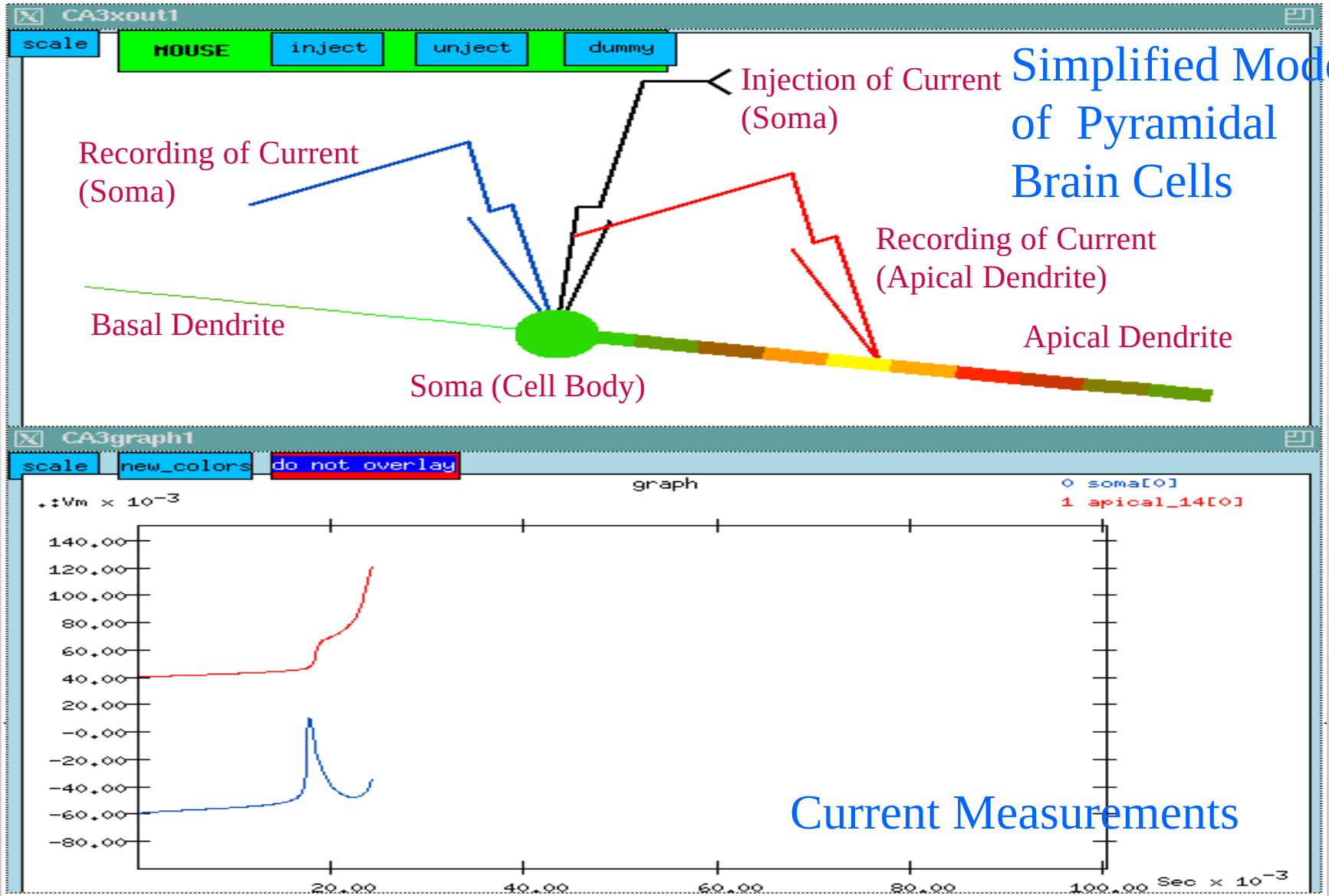
Morphological Parameters

- Apical Dendrite
- Basal Dendrite
- Distance from Soma
  - 50 um
  - 100 um
  - 150 um
  - 200 um
  - Entire Dendrite Tree
- Length
- Diameter
- Area
- Asymmetry
- Bifurcations
- Terminations

Aim of the Study

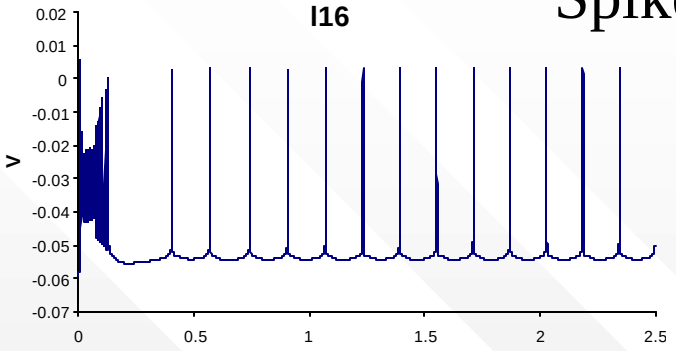
- Study the function of neurons by injecting current into a neuron and measure the neuron's response
- Here: Computational Simulator
- 16 sets of morphometric data used
- About 3 hours of computer time for 5 sec of neuron time on SGI Origin 200
- 10 injected currents per cell: 0.1 nA to 1.9 nA

Simulation

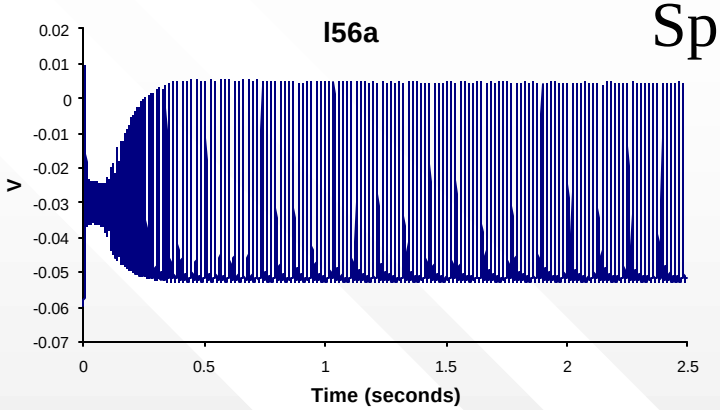

CA3xout1
scale
MOUSE
inject
unject
dummy
Injection of Current
(Soma)
Simplified Model
of Pyramidal
Brain Cells
Recording of Current
(Soma)
Recording of Current
(Apical Dendrite)
Basal Dendrite
Apical Dendrite
Soma (Cell Body)
CA3graph1
scale
new_colors
do not overlay
graph
0 soma[0]
1 apical_14[0]
.:Vm x 10^-3
140.00
120.00
100.00
80.00
60.00
40.00
20.00
-0.00
-20.00
-40.00
-60.00
-80.00
20.00
40.00
60.00
80.00
100.00
Sec x 10^-3
Current Measurements

Simulated Physiological Response under 0.7 nA

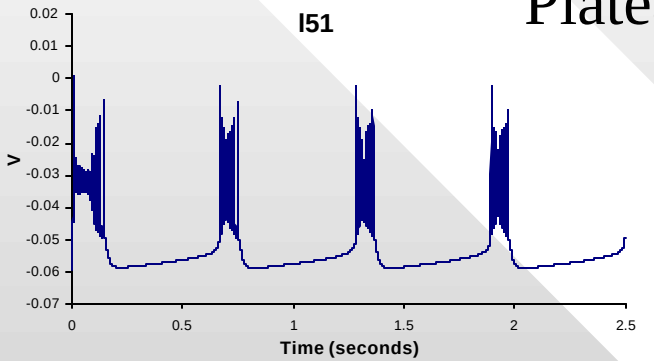
Spike



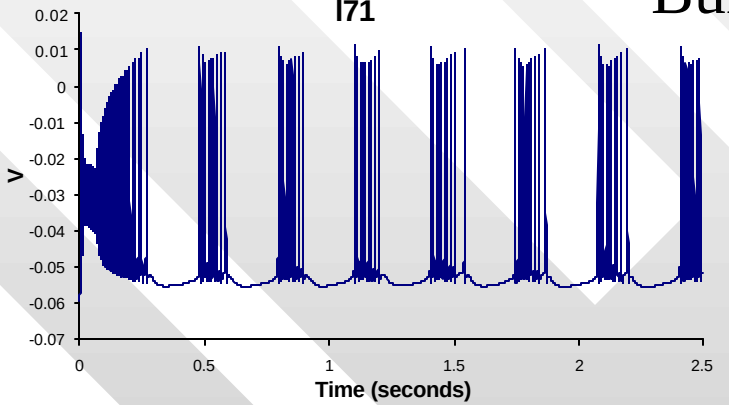
Spike



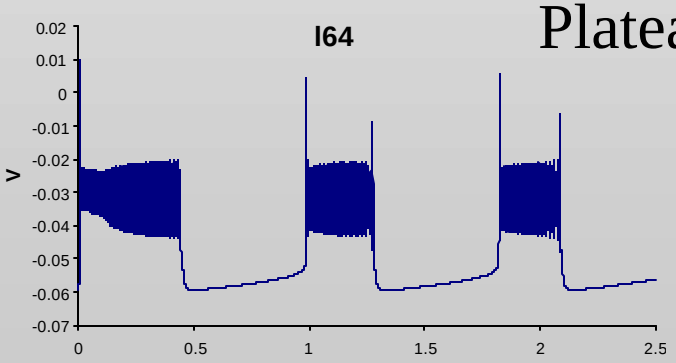
Plateau



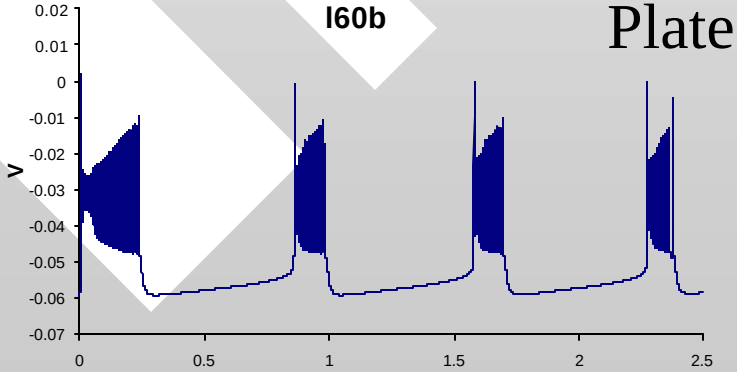
Burst



Plateau

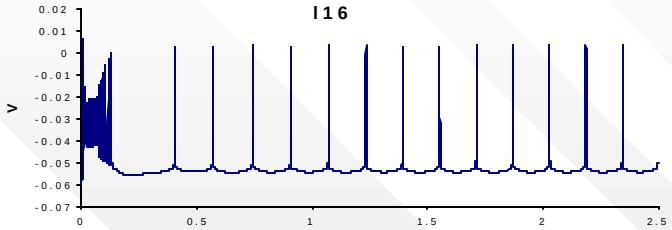


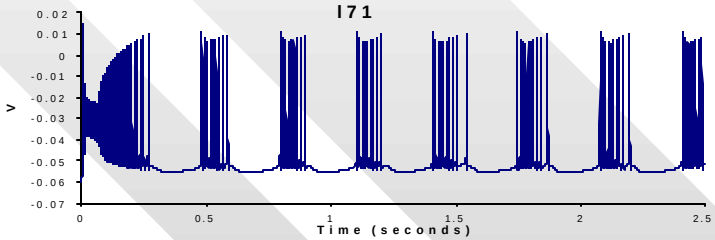
Plateau

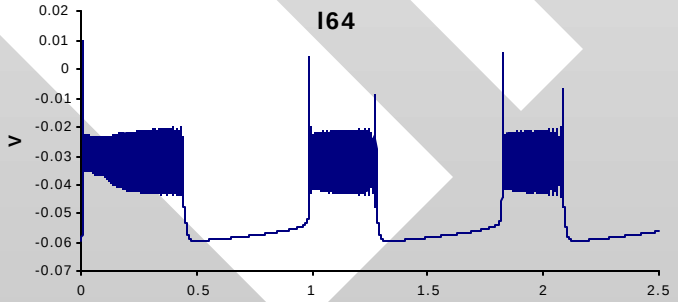


Response Parameters

- Spiking:
  - Spike Rate (Hz)
  - Spike Transition (nA)
- Bursting:
  - Burst Rate (Hz)
  - Interburst Interval (sec)
  - Spikes per Burst (Hz)
- Plateau:
  - Plateau Range (nA)
  - Plateau Rate (Hz)
  - Interplateau Interval (sec)
  - Spikes per Plateau (Hz)

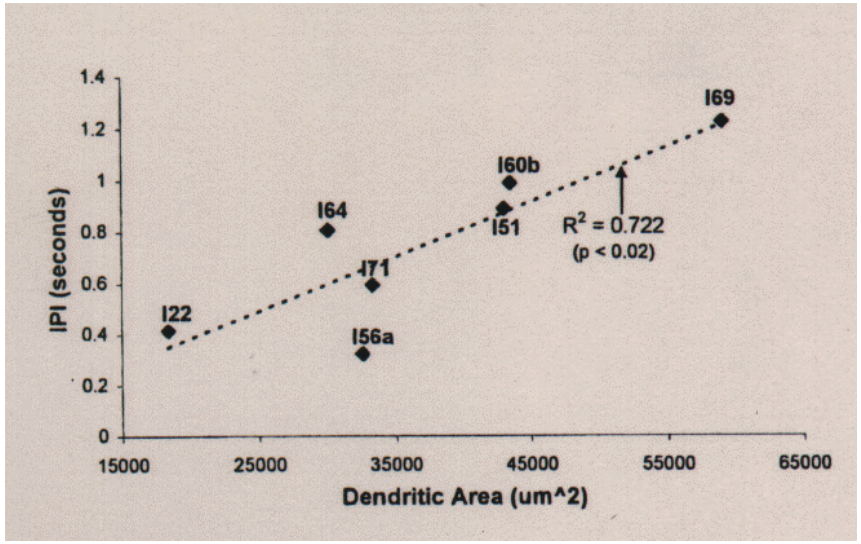






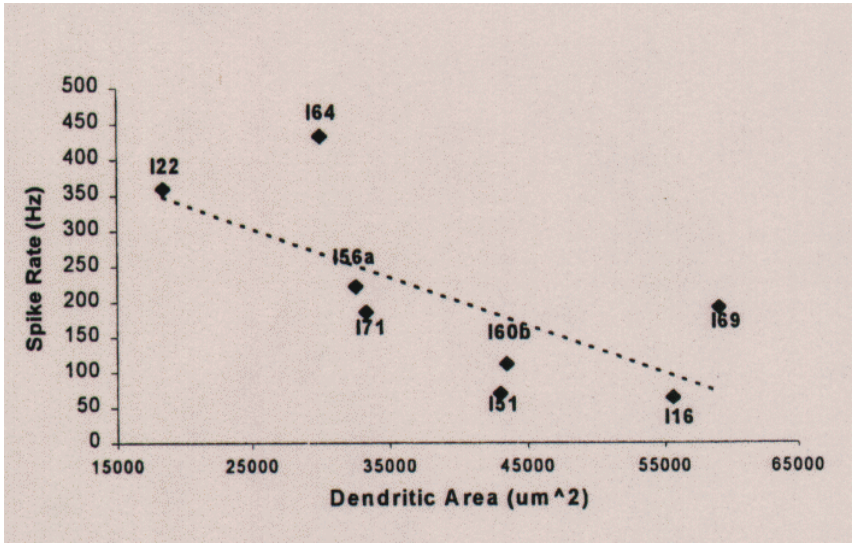
Influence of Dendritic Area on Firing Rate

Interplateau Interval vs Dendritic Area



Current: 0.5 nA

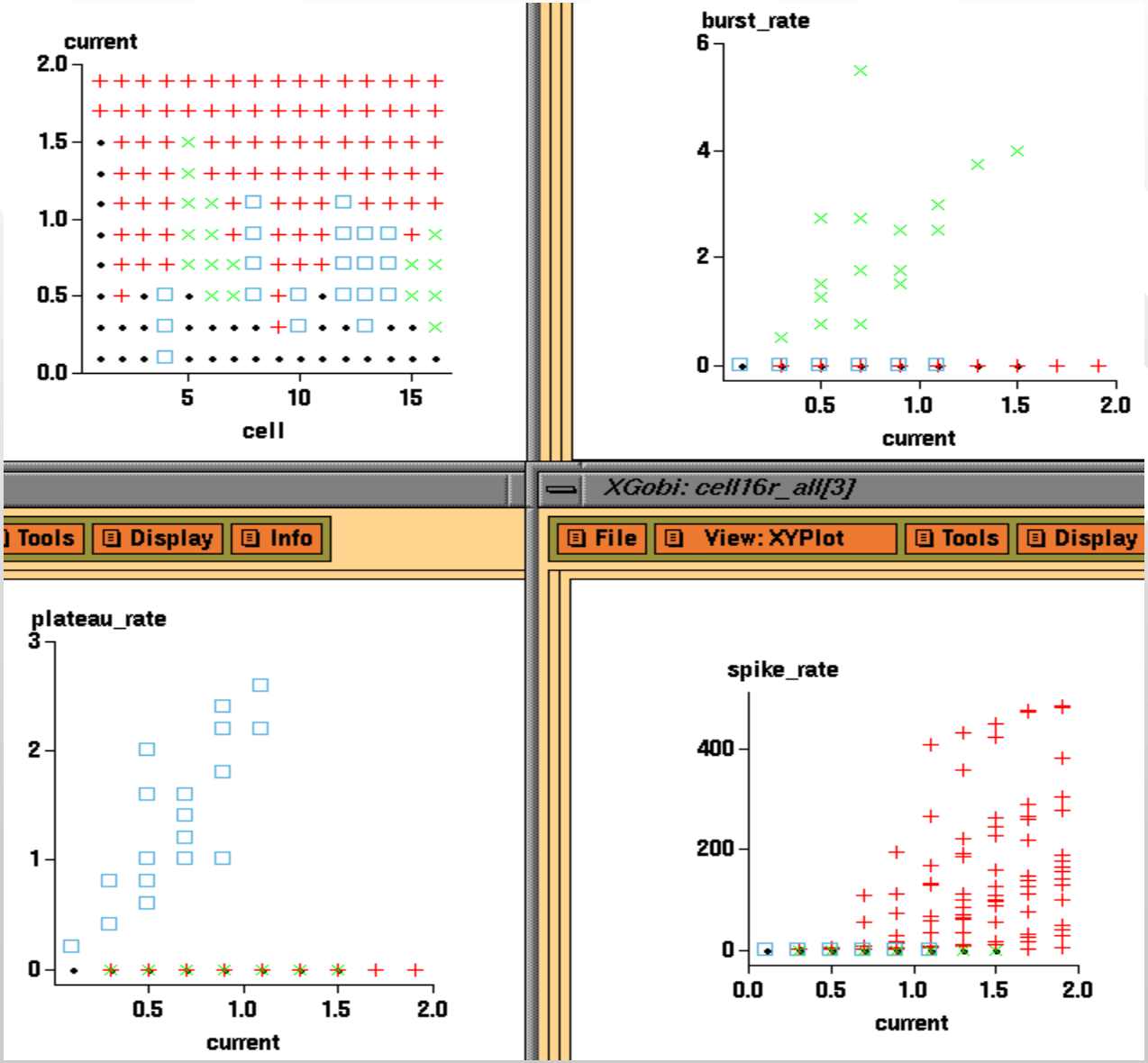
Spike Rate vs Dendritic Area



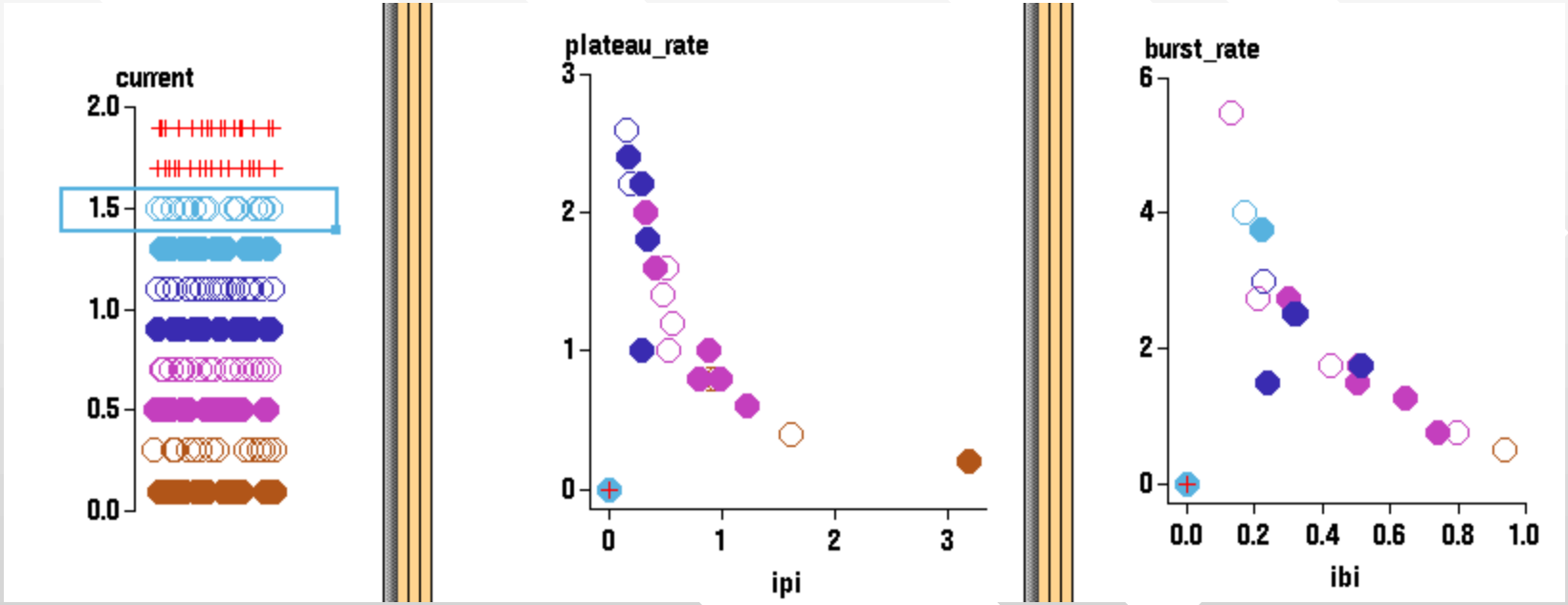
Current: 1.3 nA

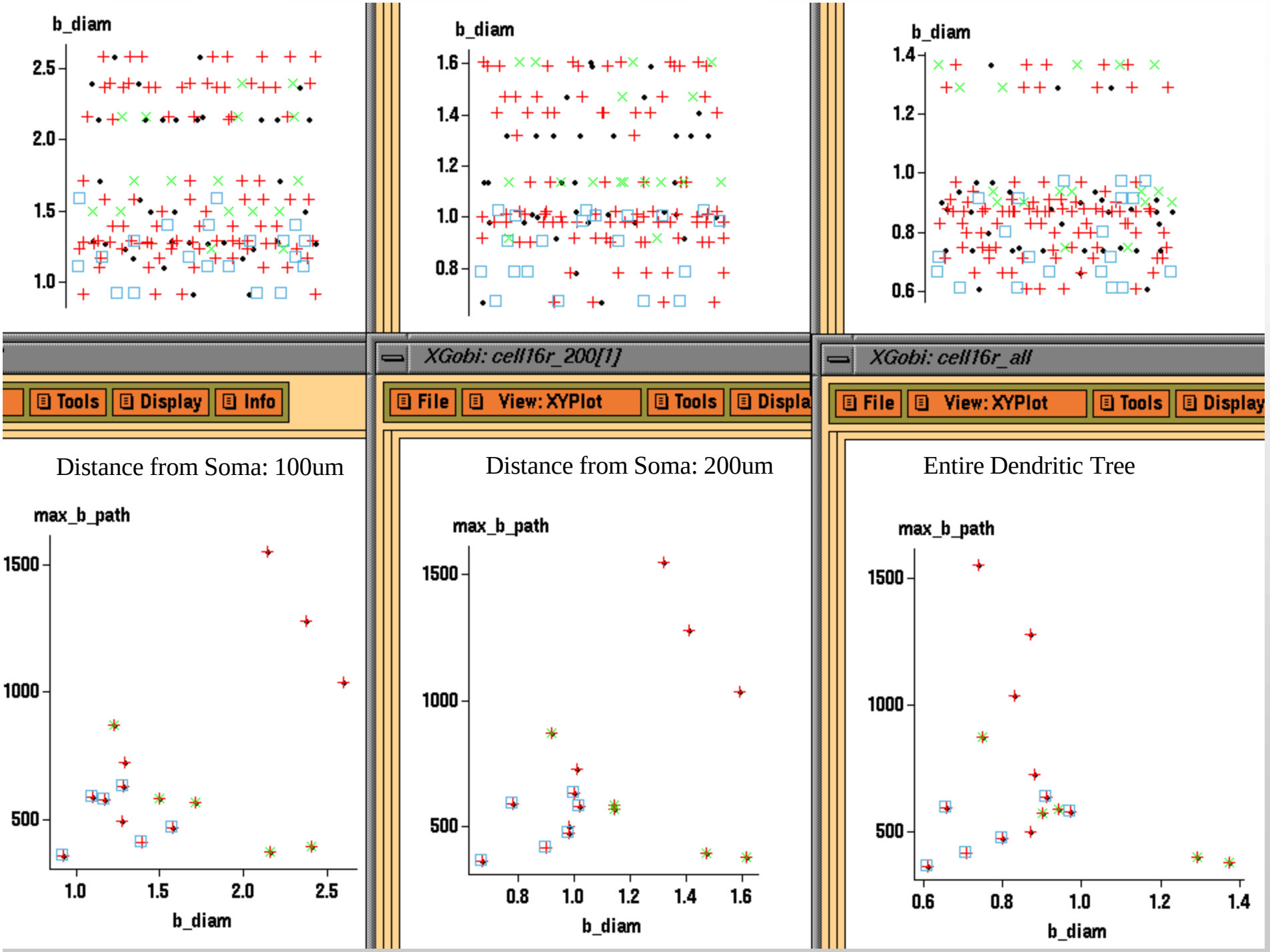
- Smaller cells tend to be more excitable and have higher firing rates.

Visual Data Mining Using XGobi

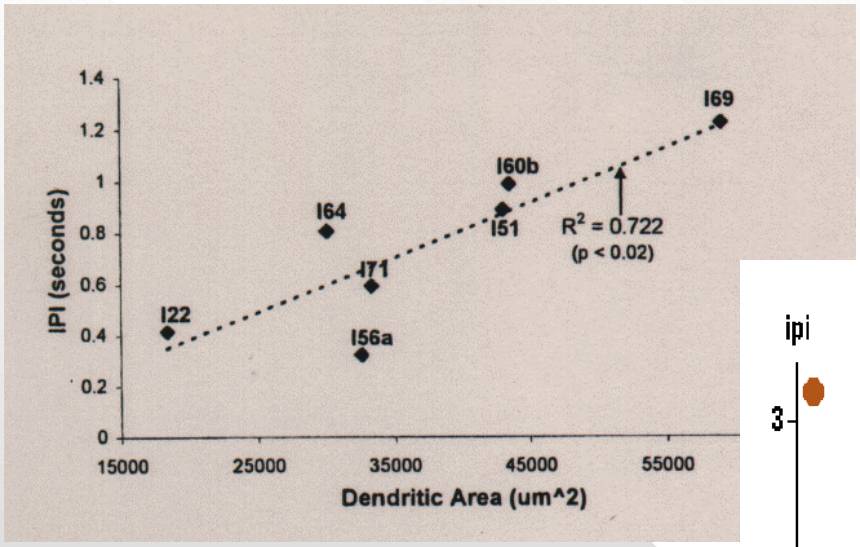


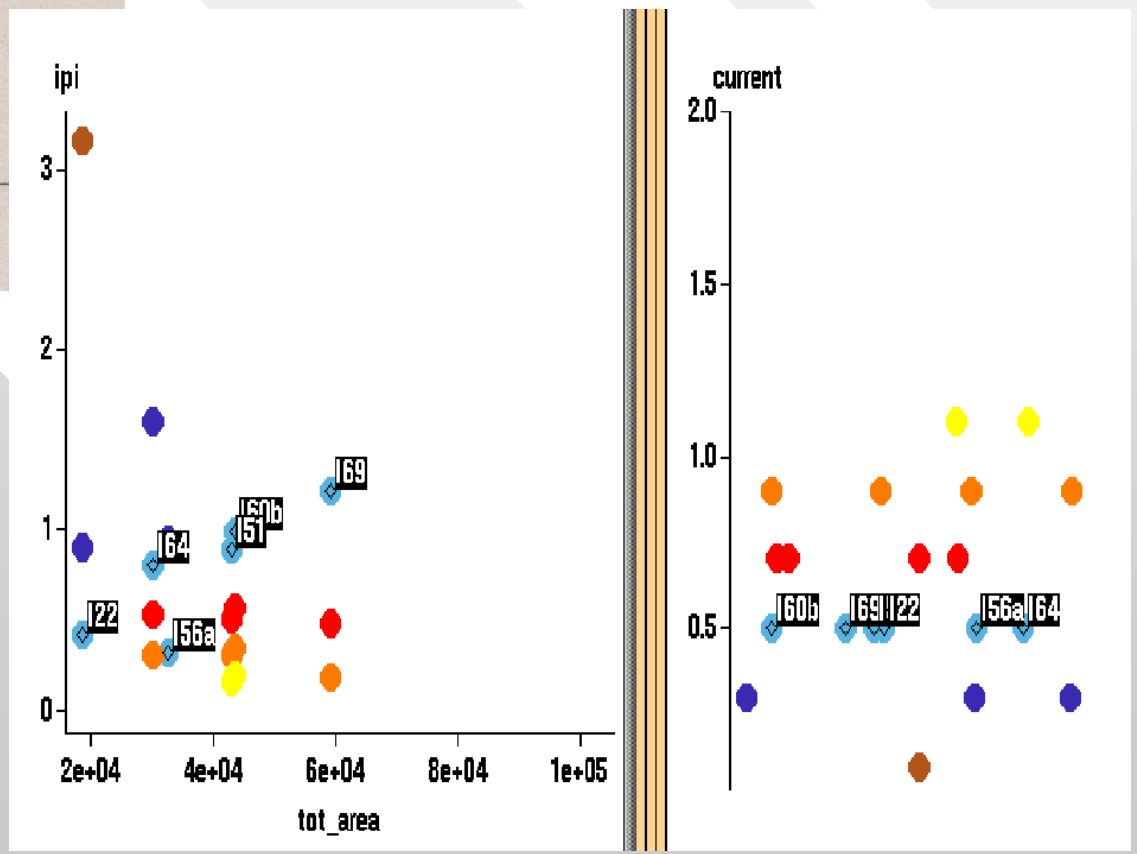
Visible Patterns




b_diam
2.5
2.0
1.5
1.0
b_diam
1.6
1.4
1.2
1.0
0.8
b_diam
1.4
1.2
1.0
0.8
0.6
XGobi: cell16r_200[1]
XGobi: cell16r_all
Tools
Display
Info
File
View: XYPlot
Tools
Displa
File
View: XYPlot
Tools
Display
Distance from Soma: 100um
Distance from Soma: 200um
Entire Dendritic Tree
max_b_path
1500
1000
500
1.0
1.5
2.0
2.5
b_diam
max_b_path
1500
1000
500
0.8
1.0
1.2
1.4
1.6
b_diam
max_b_path
1500
1000
500
0.6
0.8
1.0
1.2
1.4
b_diam

Interplateau Interval vs Dendritic Area ???





Future Research

- Morphometric Parameter Search
- Test Neuromorphology vs Neurophysiology
- Develop Predictive Model
- Test Predictive Model

QUESTIONS ?