Spatial organization of neuroepithelial cells during embryo development

J. Mazzeo[1,2], M. Rapacioli[2], V. Flores[2]

[1]Institute of Biomedical Engineering, School of Engineering, Buenos Aires University
[2]Interdisciplinary Group in Theoretical Biology, Favaloro University

Buenos Aires, Argentina

Pan American Advanced Studies Institute
Buzios, June 2014

Embryonic development

- A few **simple** cell behaviors

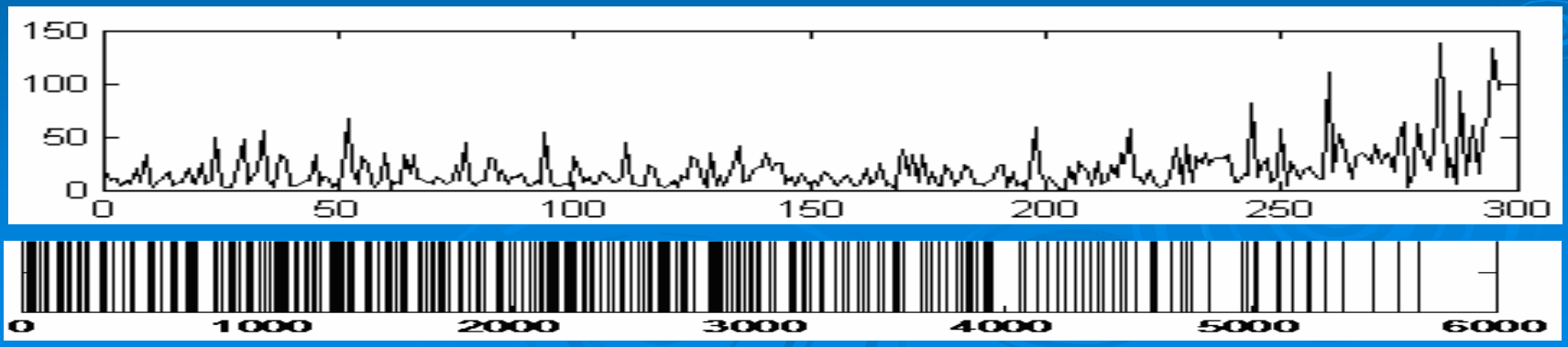
  … **organized** in **time** and organized in **space**

- One these behaviors is **proliferation**

- Proliferation not only increases volume but may also generate complex shapes

Biological model

- Chicken central nervous system (Optic Tectum)



What are we searching in these records?

- In general:

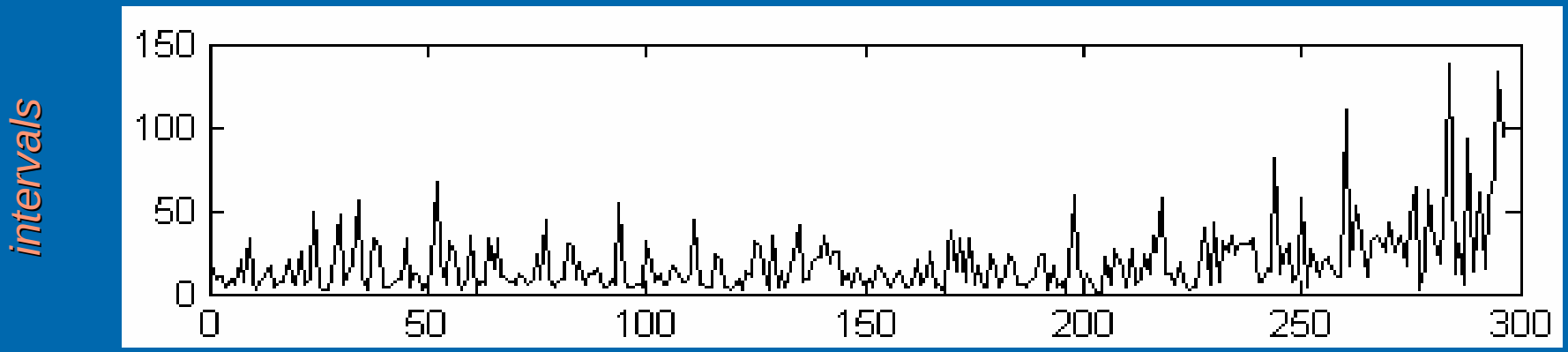
  assess organization in space

- In particular:

  - Are cells distributed just at random?
  - Do correlation exist between the intervals?
  - What kind of correlations?
  - Characterize non-stationarity

✓ **Correlations tells us about communications between cells**

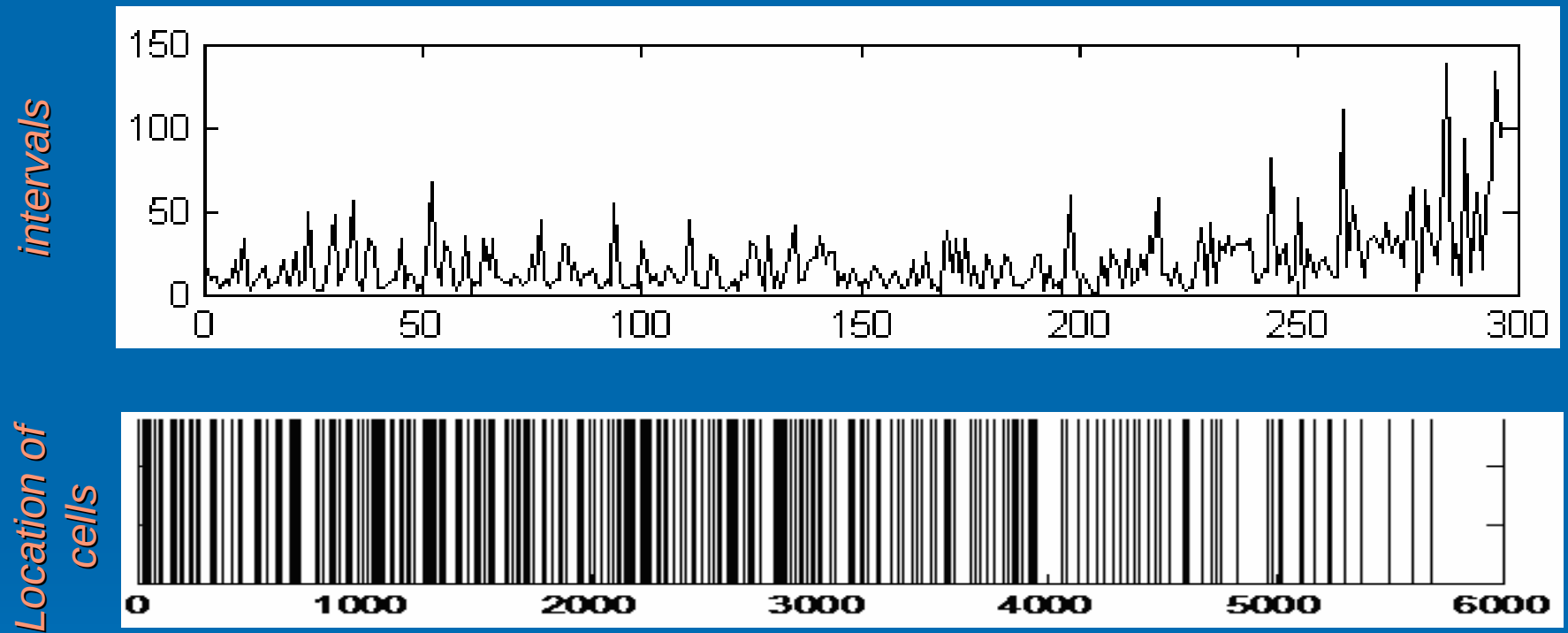
Data


intervals
150
100
50
0
0
50
100
150
200
250
300


Location of cells
0
1000
2000
3000
4000
5000
6000


0
500
1000
1500

Data



Some of the characteristics are:

- around 300 samples long
- non-stationary
- PDF of intervals is far from being Gaussian

Methodology

- Stochastic point process

- **Fractal** characteristics assessed by estimating Hurst index, scaling index

Methodology

- Stochastic point process

- **Fractal** characteristics assessed by estimating Hurst index, scaling index

"Size"

Methodology

- Stochastic point process

- **Fractal** characteristics assessed by estimating Hurst index, scaling index

"Size"

Methodology

- Stochastic point process

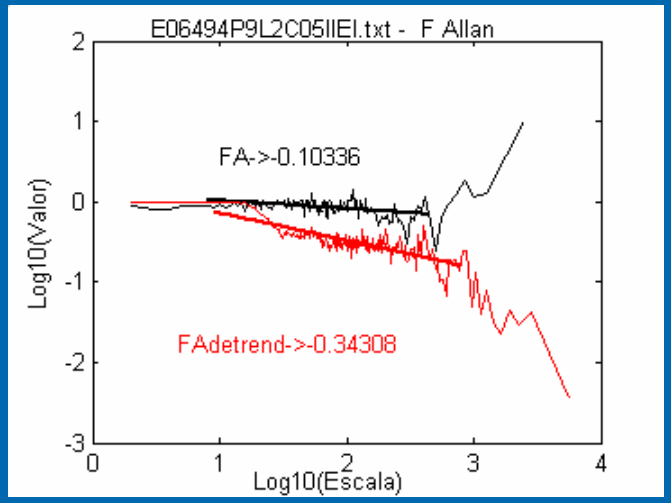
- **Fractal** characteristics assessed by estimating Hurst index, scaling index

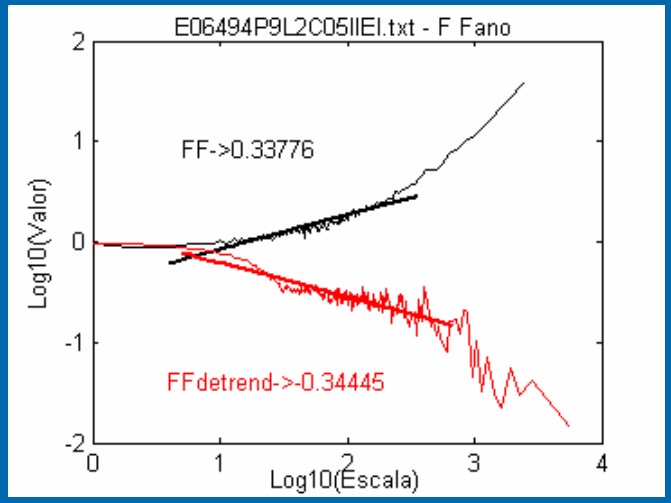
"Size"

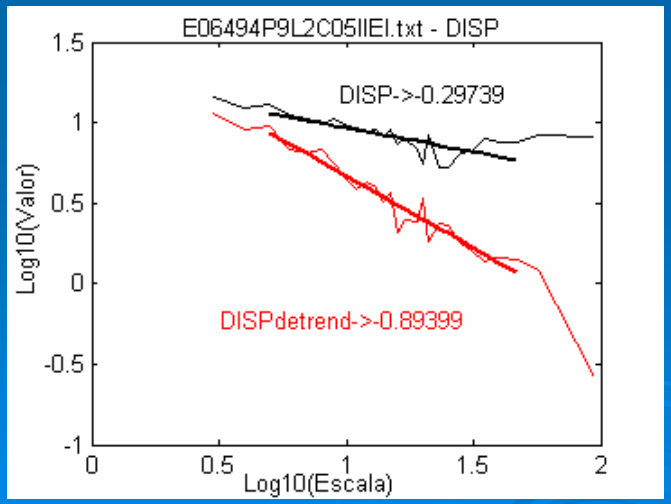
✓If f(size) follows ≈ a^{H} ⇨ *H is the* fractal exponent

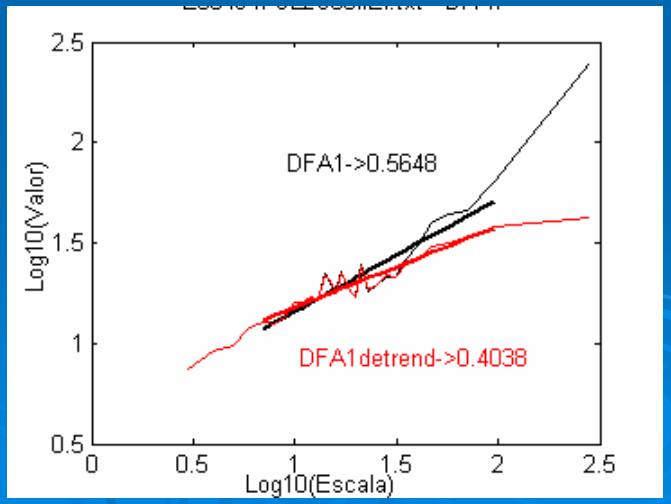
✓*Trend estimation and removal before processing*

Results


E06494P9L2C05IIEI.txt - F Allan
FA->-0.10336
FAdetrend->-0.34308
Log10(Valor)
Log10(Escala)


E06494P9L2C05IIEI.txt - F Fano
FF->0.33776
FFdetrend->-0.34445
Log10(Valor)
Log10(Escala)


E06494P9L2C05IIEI.txt - DISP
DISP->-0.29739
DISPdetrend->-0.89399
Log10(Valor)
Log10(Escala)


DFA1->0.5648
DFA1detrend->0.4038
Log10(Valor)
Log10(Escala)

Interpretation of results

- Negative correlations in a wide range of scales
- Global trend

✓ *proliferating cells communicate with each other*

✓ *their interaction is inhibitory*

✓ *Effect of "external control" generates non-stationarity*

This is cell by cell approach is much more descriptive approach than the averaged data generally used in Developmental Biology

Future work

- Alternative methods for studying this data set
- Include organization in time

Future work

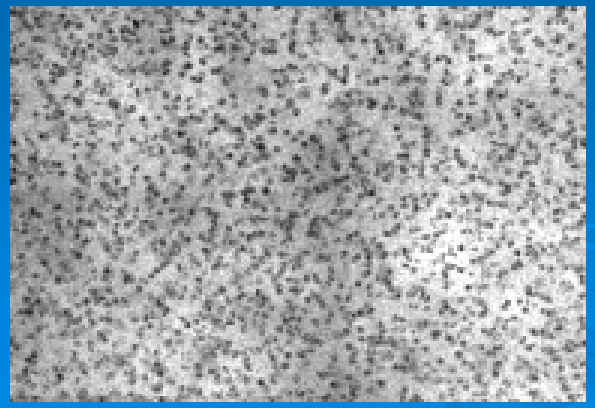
- Alternative methods for studying this data set
- Include organization in time

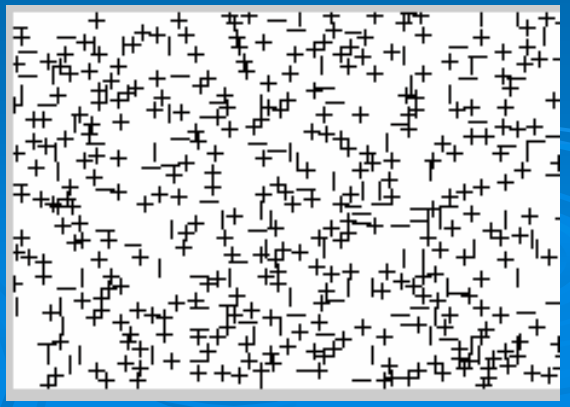
Future work

- Alternative methods for studying this data set
- Include organization in time
- Two dimensional data sets

Future work

- Alternative methods for studying this data set
- Include organization in time
- Two dimensional data sets





Future work

- Alternative methods for studying this data set
- Include organization in time
- Two dimensional data sets

Thank you!