The scientific project of NeuroMat

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January 20, 2014

1st Workshop of FAPESP

Research, Innovation and Dissemination

Center for Neuromathematics

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- ▶ Long term goal:
- ▶ *to develop the new mathematics which is deemed necessary to account for a Theory of the Brain (...)*
- ▶ *The long-term objective is to understand and explain complex neuroscientific phenomena, with focus on plasticity mechanisms underlying learning and memory, (...)*

I am quoting the Research Project we submitted to FAPESP

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- *The construction of these models should occur together with the development of suitable statistical and computational methods, including model selection principles (...)*

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- ▶ The mathematics required to address the issues associated to brain plasticity does not exist yet
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- ▶ We are **NOT** signal processors,
- ▶ even if part of our activities involves signal processing tasks.

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in the Statistical Mechanics derivation of Thermodynamics.

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- ▶ Recall the text sent to FAPESP with our goals for the first two years

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The development of the long-term goal (. . .) requires the initial development of two foundational aspects:

- ▶ *Development of a new class of stochastic processes*
- ▶ *Development of the statistical tools required by this new class of stochastic processes*

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- ▶ with a large number of interacting components,
- ▶ whose evolution depends on the history of the system.

Basic features of these stochastic processes

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- ▶ The activity of each component depends on the past history of its interaction neighborhood.

- ▶ Both the size of the relevant past history and of the interaction neighborhood change as the process evolves.

Double time evolution

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► one describing the changes in neuronal activity,

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Therefore there is a double time evolution:

- ▶ one describing the changes in neuronal activity,
- ▶ and another one describing changes in the graph of interactions among components.

Development of statistical tools

for this new class of stochastic processes.

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- ▶ physical graphs defined by connections between brain regions
- ▶ and functional graphs relating regions recruited for each particular activity.

While the physical graphs can be directly observed, functional interactions can only be inferred from data.

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- ▶ Alternative to this naive descriptive statistical approach: statistical model selection.

- ▶ Statistical model selection means: to assign models to samples following some optimality criterion.

Inference and model selection within this framework requires the development of new statistical methods.

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Question: are these subprojects converging in a synergetic way
towards the achievement of the project main goals?

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- Question: what is the NeuroMat point of view?!
- *To be continued ....*