Master 2 of Science in Computational Biology and Biomedicine

Parcours du Master d’Informatique, spécialité Fondements et Ingénierie (Now), BIM (2012)

Nice Sophia Antipolis University, France

Coordinators: E. De Maria, T. Papadopoulo

Teaching language: English
Public: International attendance, applied mathematicians, Computer science students, Biologists (with good mathematical background)
Computational biology and biomedicine (CBB)

An emerging interdisciplinary field that applies the techniques of computer science, applied mathematics and statistics to address biological/medicine problems.

- Mathematical modeling,
- Computational simulation techniques.

- Research Master 2 program CBB (3 years old).
- Hosted by the **Computer Science Department** of Nice Sophia Antipolis University (P. Lahire, J. Farré, C. Peyrat).
- Part of the BIM (Biology-CS-Maths) master program, starting in 2012 (F. Diener).

**Fellowships** available for foreign students (7) (800€/month).
Organisation

1 year (september, 15th – end of august), applications up to june.

4 periods:
- Basics in Mathematics and Biology (September).
- 2 periods of lectures: october-november, january-february.
- Training period: march-august (30 ECTS) + project (6 ECTS).

Lectures:
- 2 ECTS per lecture.
- Half-day lectures (once per week).
- Mandatory courses (9).
- Elective courses (3).
- Total: 60 ECTS (10/20 on every course).

http://cbb.unice.fr
cbb@unice.fr
November 12, 2030

Dr House meets his patient Bill

Bill Krivitz suffers from knee arthritis…
Severe pain and reduced flexion

Dr House first looks for a medication?
– Sequences Bill’s genome and tracks deficient genes
– Seeks drugs fixing the protein which malfunctions

Dr House and Bill agree on surgery
– Design of a patient specific prosthesis: pre-op simulations
– Computer monitored physiotherapy

Epilogue: Bill run the Boston Marathon
Explore the functional organization of humans

Focus on the human being

From different perspectives:
- Understanding and modeling functional aspects.
- Interpreting biomedical signals for various devices.

At different scales:
- From molecules to organs and the whole organism.

Three main topics
- Bioinformatics
- Biomedical signal and image analysis
- Modeling in neuroscience

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Bioinformatics: Open problems

**Structure**: Protein complexes are ubiquitous:
- Stability and specificity of macro-molecular complexes.
- Prediction ? (with little/no structural information).

**Networks**, systems biology:
- Structure of interaction networks (topology).
- Associated dynamics (feedbacks and control loops).
Bioinformatics: Methodology

Biophysical models and experimental data

- Biochemistry
- Biophysics
- Geometry
- Topology
- Dynamical Systems
- CS
- Combinatorics Optimization
- Statistics

F. Cazals
G. Bernot

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Biomedical signal and image analysis: Open problems

Signal processing and inverse problems:
- Image denoising and enhancement.
- Inverse problems.
- Coupling to physical properties of sensors and tissues.

Virtual human and patient specific modeling:
- Parameter identification.
- Statistical analysis (in shape spaces).
- Simulations.
Explore the functional organization of humans

Biomedical signal and image analysis: Methodology

Variational or Markovian models, Wavelets and Inverse problems

Tensor calculus

Statistics

J. Zerubia
O. Meste, M. Clerc
R. Deriche
X. Pennec

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Modeling in neuroscience: Open problems

A multiscale multidisciplinary problem
- Neurons and synapses: analysis of neuron dynamics
- Neuronal networks: Dynamical evolution. What about the statistics of spike trains?
- Neural masses: At a mesoscopic scale the neuronal substrate can be represented by a continuum where points represent neuronal populations.

Explore the functional organization of humans

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Explore the functional organization of humans

Modeling in neuroscience: Methodology

Dynamical systems
(stability, bifurcations, asymptotic dynamics).

statistics
Integrodifferential equations

B. Cessac

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