Master 2 of Science in

Computational Biology and Biomedicine

Track of Master Biologie, Informatique, Mathématiques

Nice Sophia Antipolis University, France

Coordinators: E. De Maria, T. Papadopoulo

Teaching language: English
Public: International attendance, applied mathematicians

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 prothesis: pre-op simultations
- Computer monitored physiotherapy

Epilogue: Bill run the Boston Marathon

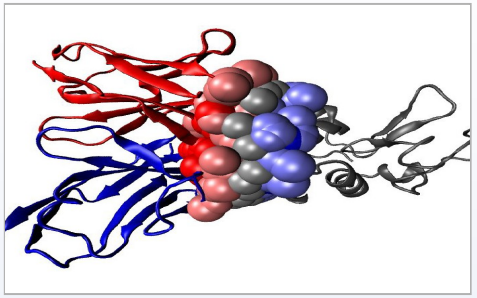
Our future

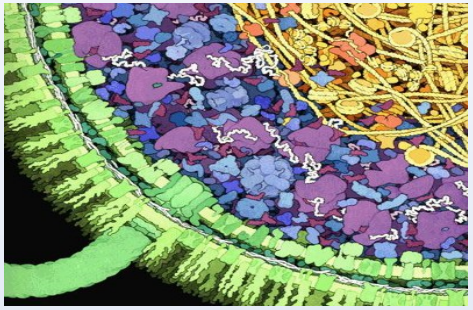
Computational biology and biomedicine

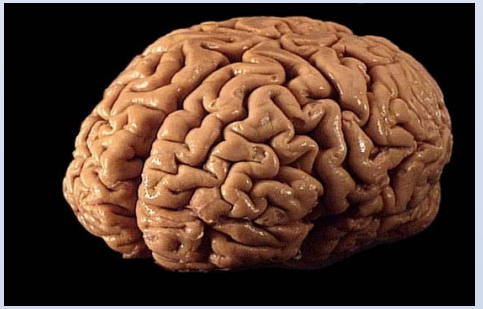
An emerging interdisciplinary field that applies the techniques of **computer science, applied mathematics and statistics** to address biological problems.

- Mathematical modeling
- Computational simulation techniques.

Focus on the human being







From different perspectives

- understanding and modeling functional aspects
- interpreting biomedical signals for various devices

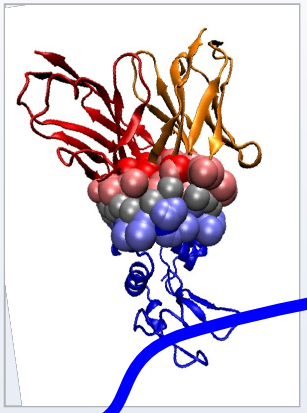
At different scales

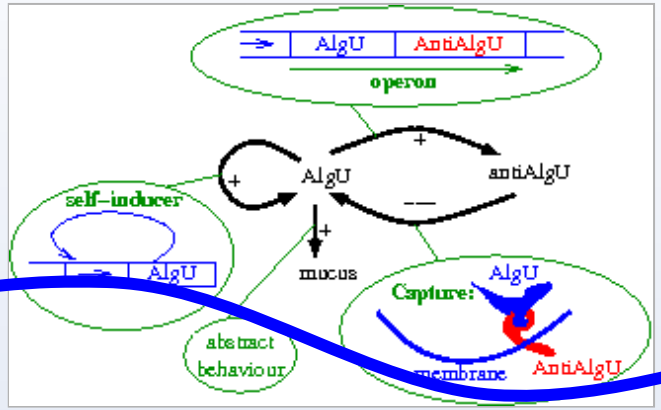
- from molecules to organs and the whole organism

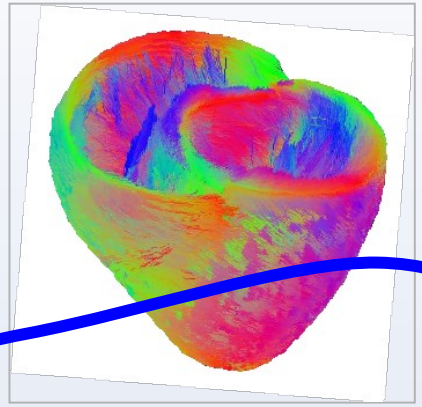
Three main topics

- Bioinformatics
- Biomedical signal and image analysis
- Modeling in neuroscience

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).

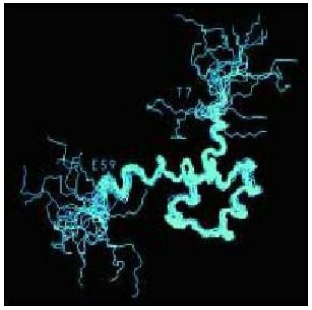
Bioinformatics: Methodology

Biochemistry

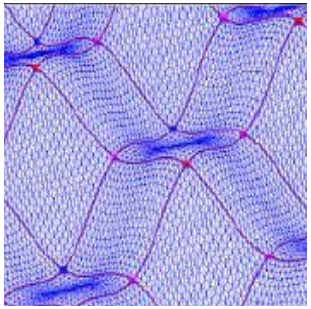
Biophysics

biophysical models
and experimental data

Geometry

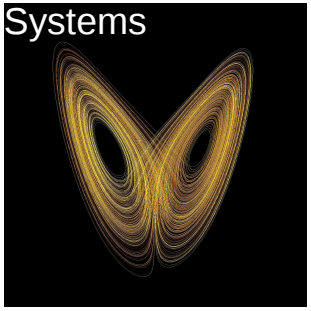


Topology

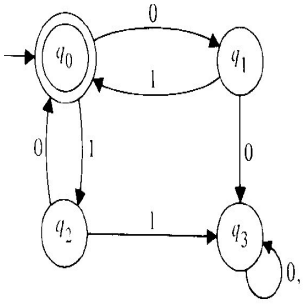


F. Cazals

Dynamical Systems

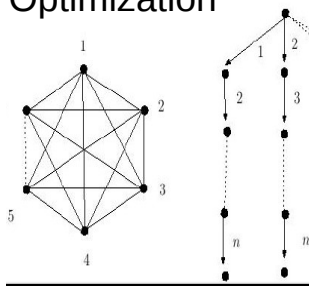


CS

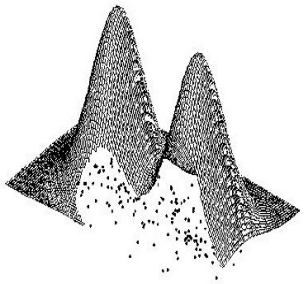


G. Bernot

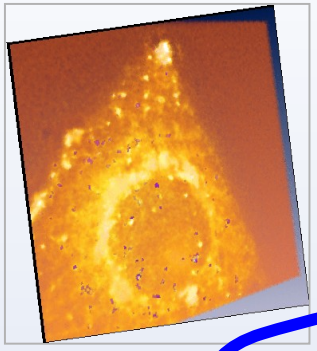
Combinatorics
Optimization

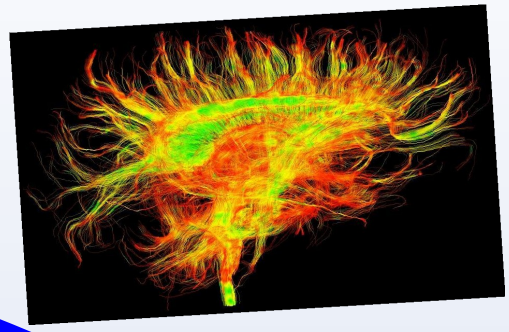
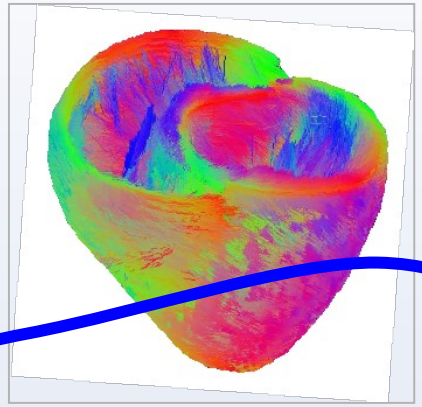


Statistics



Biomedical signal and image analysis : Open problems



Signal processing and inverse problems

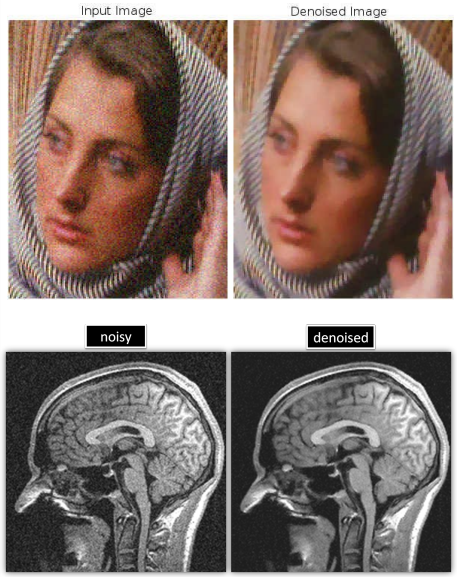
- Image/Signal denoising and enhancement.
- Inverse problems.
- Coupling to physical properties of sensors and tissues.

Virtual human and patient specific modeling

- Parameter identification.
- Statistical analysis (in shape spaces).
- Simulations.

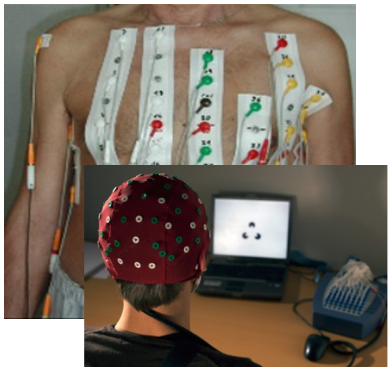
Biomedical signal and image analysis : Methodology

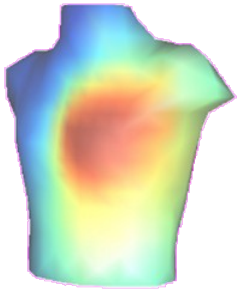
Variational or Markovian models. Wavelets and



J. Zerubia

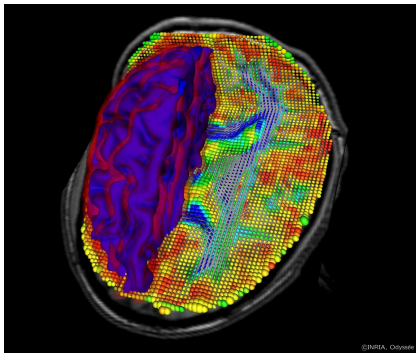
Inverse problems

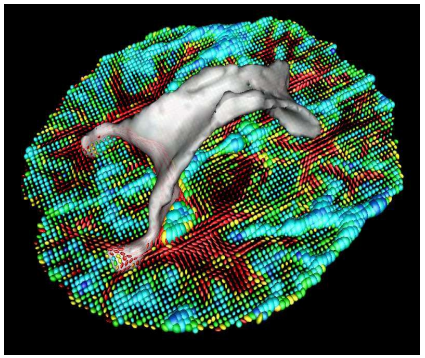




O. Meste, M. Clerc

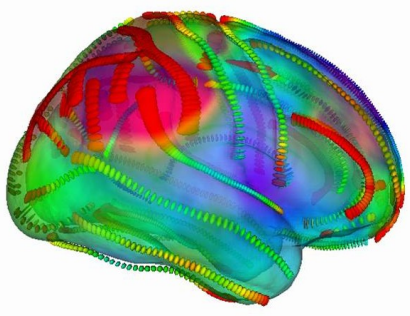
Tensor calculus

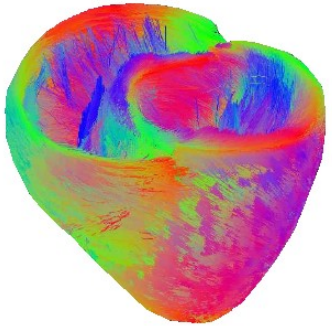




R. Deriche

Statistics

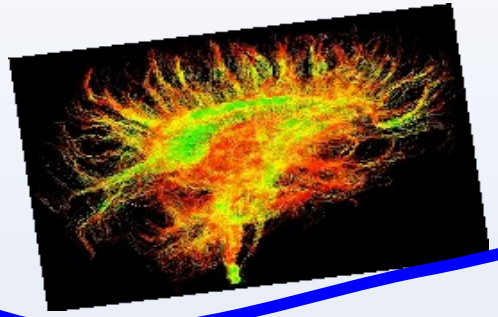
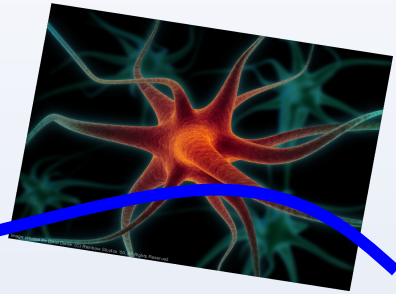




X. Pennec

Modeling in neuroscience : Open problems



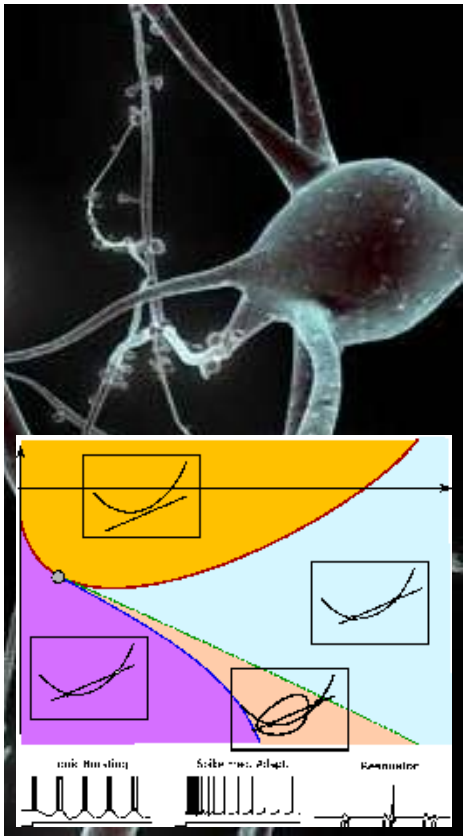



A multiscale multidisciplinary problem

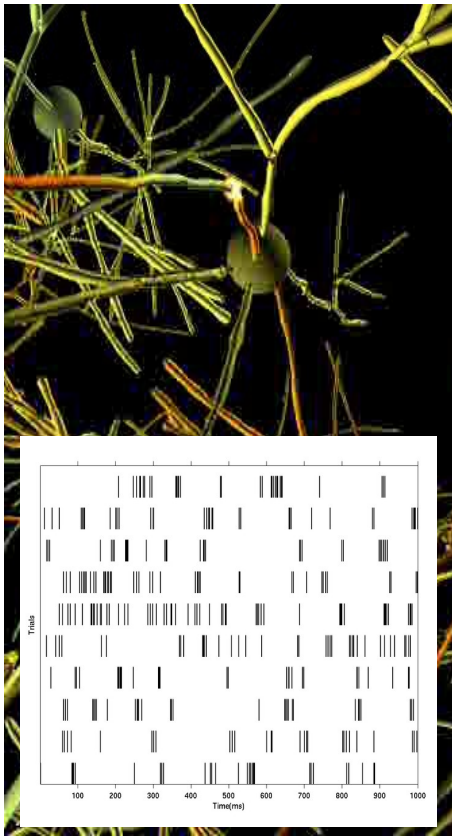
- Neurons and synapses: analysis of neuron dynamics
- Neuronal networks: Dynamical evolution. What about the statistics of spike trains?
- Neural masses: At a mesoscopic scale the neuronal substrate can represented by a continuum where points represent neuronal populations.

Modeling in neuroscience : Methodology

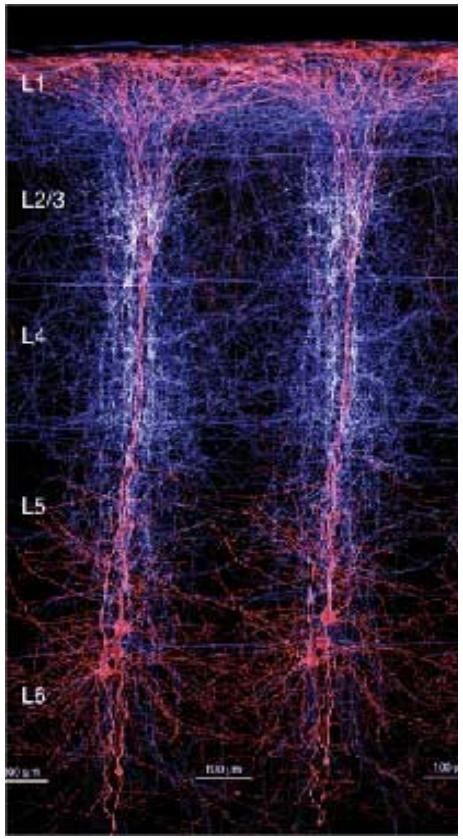
Dynamical systems
(stability, bifurcations, asymptotic dynamics).



statistics



Integro-differential equations



B. Cessac

Summary: CBB Scientific program

M2 Semester 1, Mid-September-February - 30 ECTS (European Credits Transfer System)

- 2 (out of 3) « Basics » modules (Mathematics, Biology, Computer Science)
- 11 courses (24 ECTS)
- A computer project (6 ECTS)

M2 Semester 2, March-August - 30 ECTS

6-month paid full time internship in one research team .

Teaching language: English

A french course is organized for foreign students during the first semester.

Courses (1st semester)

First part (first 15 days): 2 out of 3 courses (2 ECTS):

- Basics in Biology
- Basics in Mathematics
- Basics in Computer Science

- Period 1 (10-12 ETCS):
  - PDEs for Brain Imaging
  - Computational Anatomy & Physiology
  - Computational Structural Biology
  - Confocal Microscopy
  - Neuron Dynamics
  - .Automata in Biosciences
- Period 2 (9-11 ETCS):
  - Gene Regulatory Networks
  - Inverse Problems in Brain Imaging
  - DSP for electrophysiological records
  - Computer project.
  - Large Scale Distributed Systems
  - Introduction to Inverse Problems
  - ....

Alumni

In 2009/2010, out of 26 applications, 8 students accepted from: Argentina, France, India, Indonesia, Italy (2), Lebanon, Pakistan.

In 2010/2011, out of 30 applications, 8 students accepted from: Chile, India (2), Poland, Romania, Rwanda, Sri Lanka, Urugay.

In 2011/2012, out of 30 applications, 5 students accepted from: India (2), Nepal, Romania, Russia.

In 2012/2013, out of 19 applications, 6 students accepted from: Algeria, Bangladesh, France, Greece (2), Kazakhstan.

Out of these 27 students, **12 started a PhD**, 3 are working in companies (Amadeus, Philips), 1 is lecturer, 1 did another master 2.

So… why joining us?

- You will have a truly inter-disciplinary learning experience in the challenging field of computational biology and biomedicine given by experts, outstanding Professors and Researchers.
- You will have access to a wide network of contacts helping you to find the best opportunities for your internship, PhD or industrial position.

May
Results for first round of applications

End of June
Notification of acceptance for the second round

http://cbb.unice.fr

A few scolarships are available....