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 sciience 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?

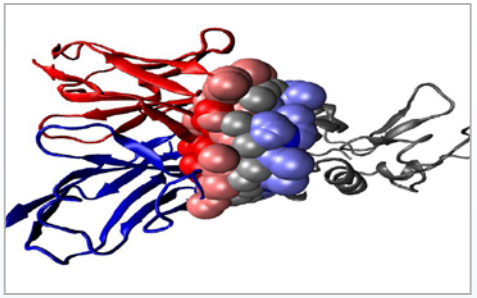
- Sequences Bill's genome and tracks deficient genes
- Seeks drugs fixing the protein which malfunctions

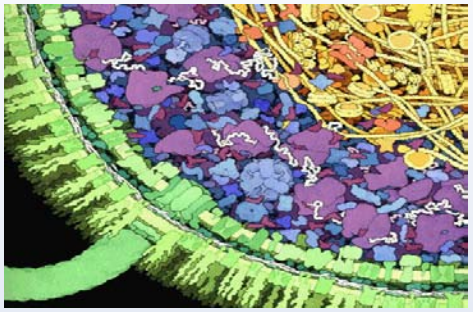
Dr House and Bill agree on surgery

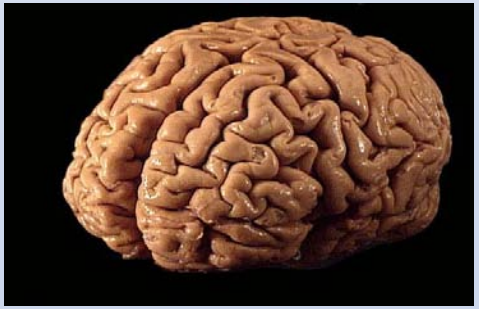
- Design of a patient specific prothesis: pre-op simultations
- Computer monitored physiotherapy

Epilogue: Bill run the Boston Marathon

Focus on the human being







From different perspectives:

- Understanding and modeling functional aspects.
- Interpreting biomedical signals for various devices.

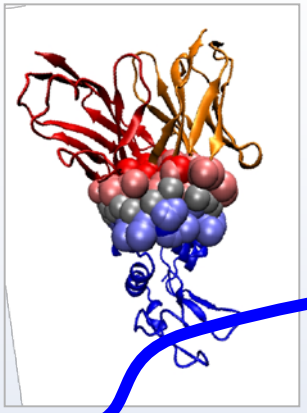
At different scales:

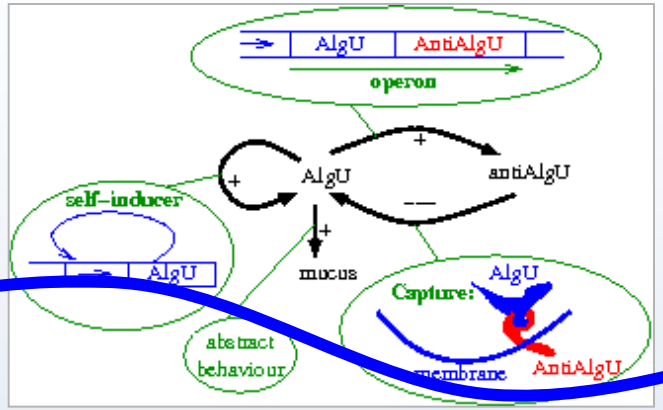
- From molecules to organs and the whole organism.

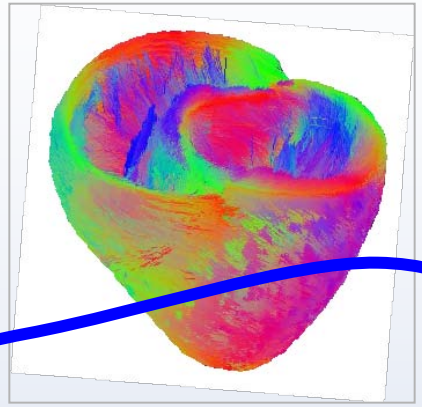
Three main topics

- 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).

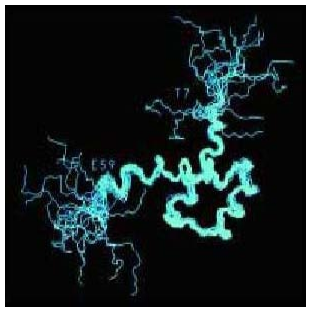
Bioinformatics: Methodology

Biochemistry

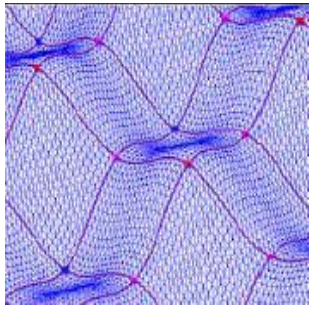
Biophysics

Biophysical models and experimental data

Geometry

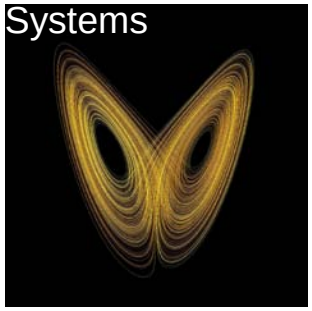


Topology

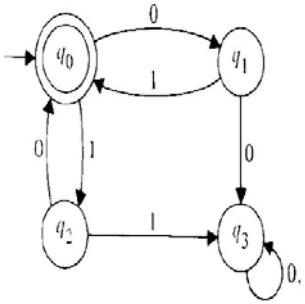


F. Cazals

Dynamical Systems

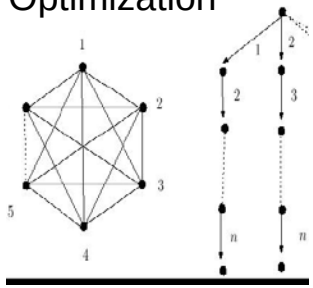


CS

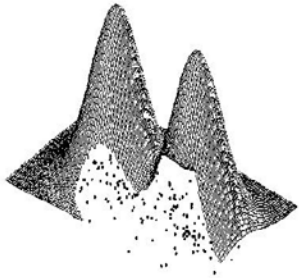


G. Bernot

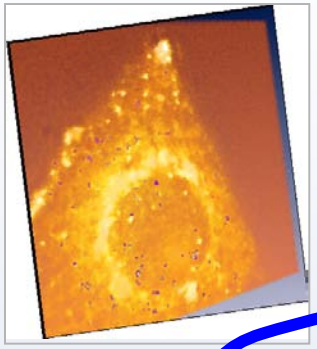
Combinatorics Optimization

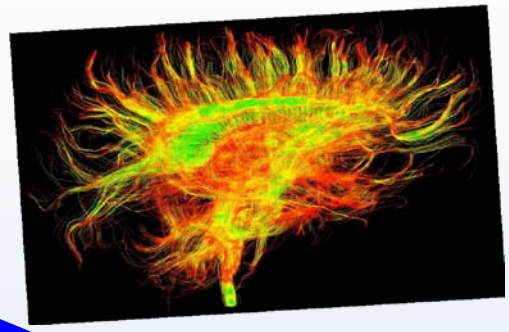
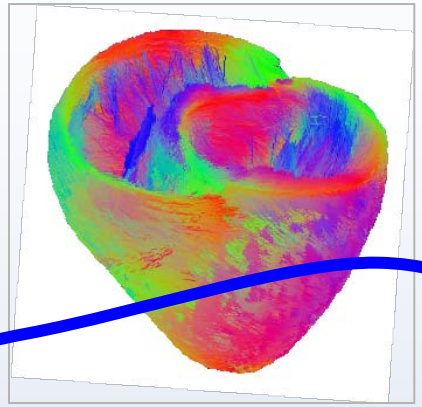


Statistics



Biomedical signal and image analysis : Open problems



Signal processing and inverse problems:

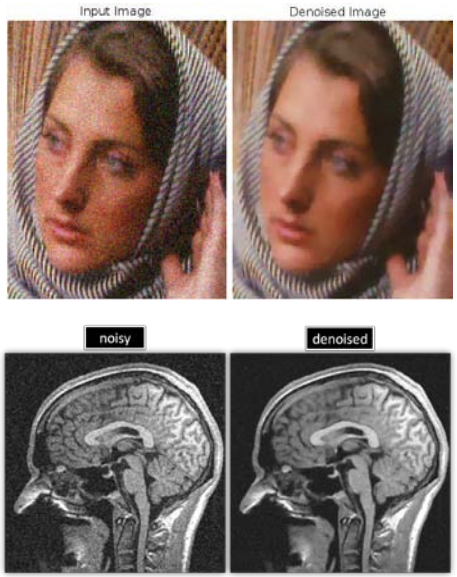
- Image denoising and enhancement.
- Inverse problems.
- Coupling to physical properties of sensors and tissues.

Virtual human and patient specific modeling:

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

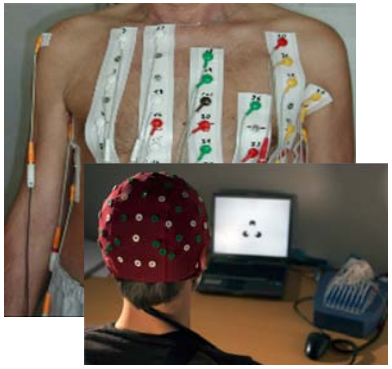
Biomedical signal and image analysis : Methodology

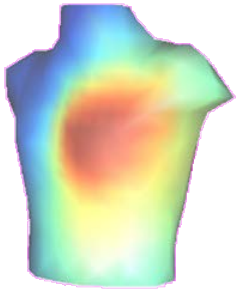
Variational or Markovian models. Wavelets and



J. Zerubia

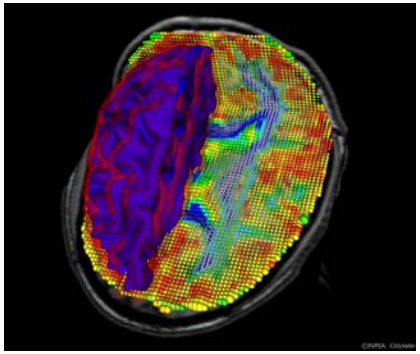
Inverse problems

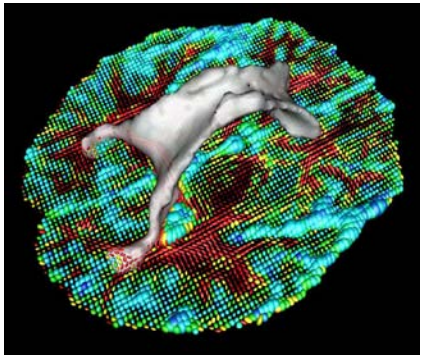




O. Meste, M. Clerc

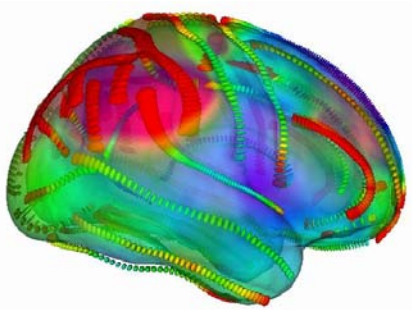
Tensor calculus

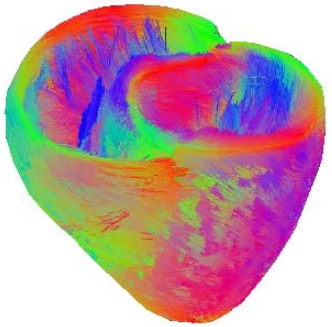




R. Deriche

Statistics

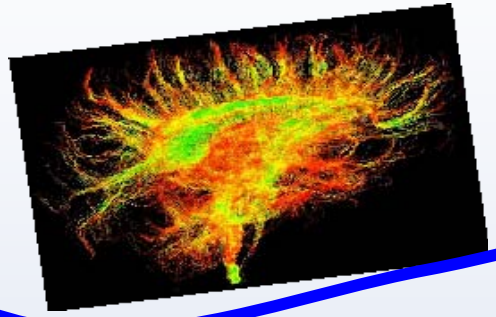
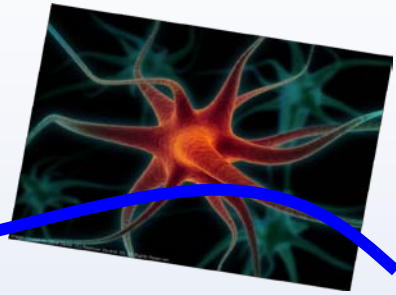




X. Pennec

Modeling in neuroscience : Open problems



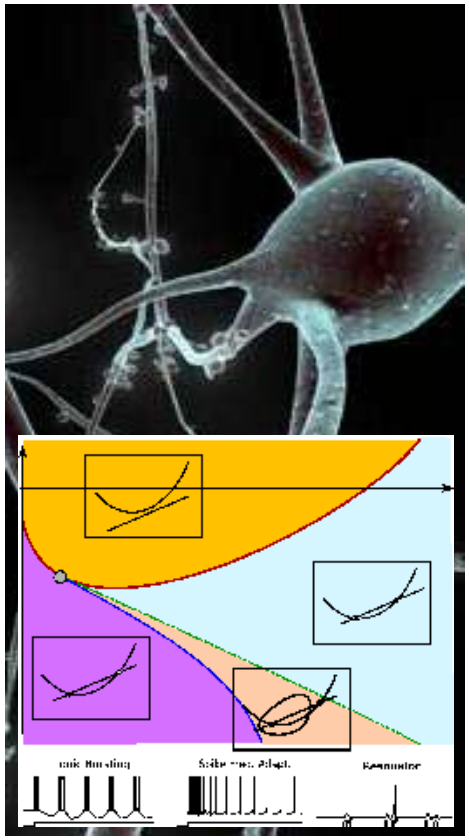



A multiscale multidisciplinary problem

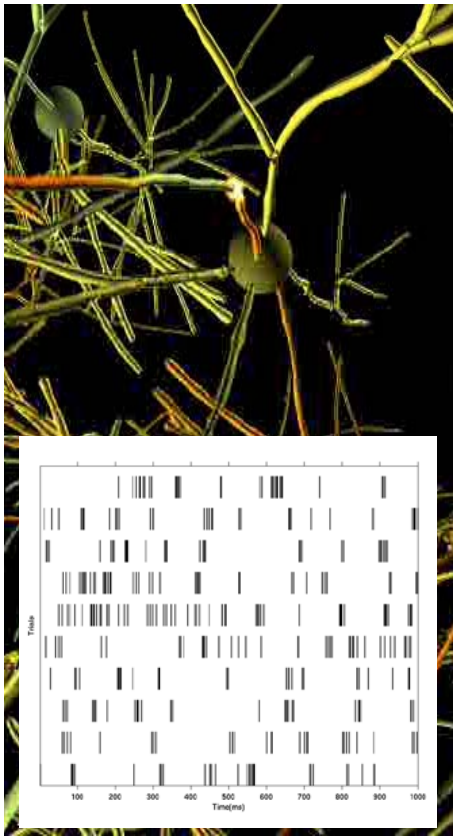
- Neurons and synapses: analysis of neuron dynamics
- Neuronal networks: Dynamical evolution. What about the statistics of spike trains?
- Neural masses: At a mesoscopic scale the neuronal substrate can represented by a continuum where points represent neuronal populations.

Modeling in neuroscience : Methodology

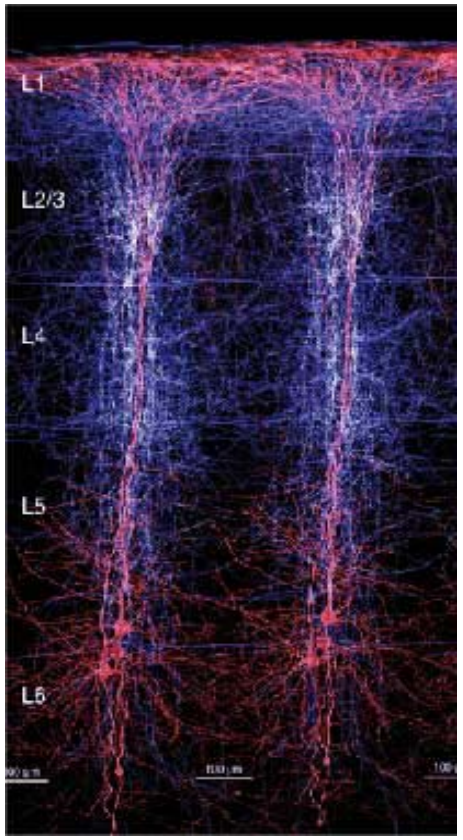
Dynamical systems
(stability, bifurcations, asymptotic dynamics).



statistics



Integrodifferential equations



B. Cessac