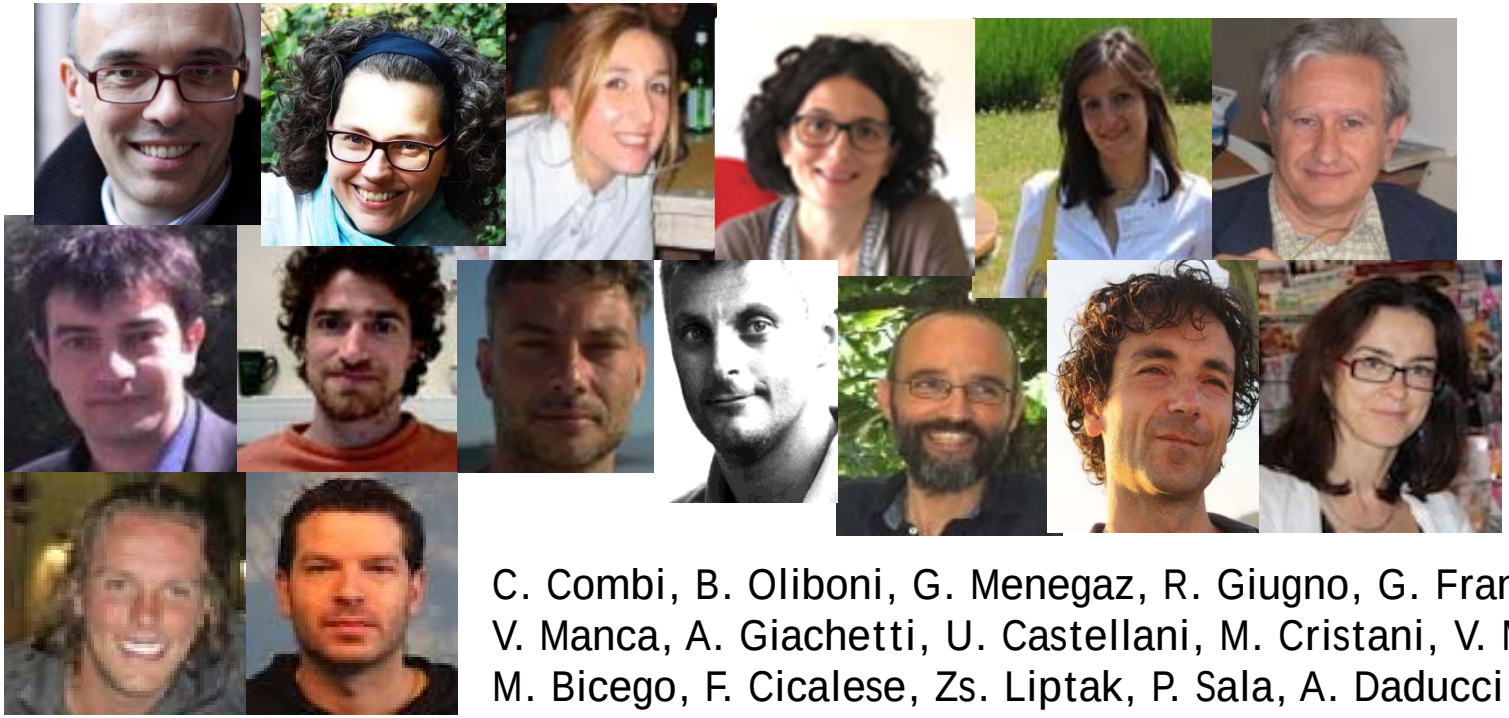
Bioinformatics and Medical Informatics

Dept. of Computer Science Research Day
11 April 2017

Research Interests and People

Medical Informatics

Bioinformatics



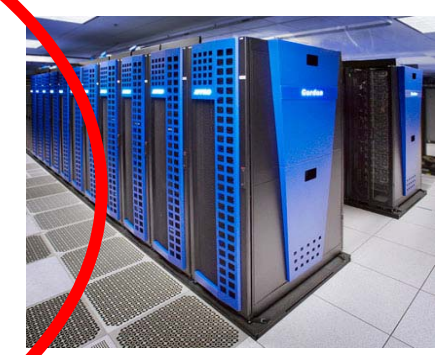
C. Combi, B. Oliboni, G. Menegaz, R. Giugno, G. Franco, V. Manca, A. Giachetti, U. Castellani, M. Cristani, V. Murino, M. Bicego, F. Cicalese, Zs. Liptak, P. Sala, A. Daducci

What is bioinformatics?

Bioinformatics uses mathematical and informational techniques to solve biological problems (mathematical models and computer programs).

biological data

bioinformatician

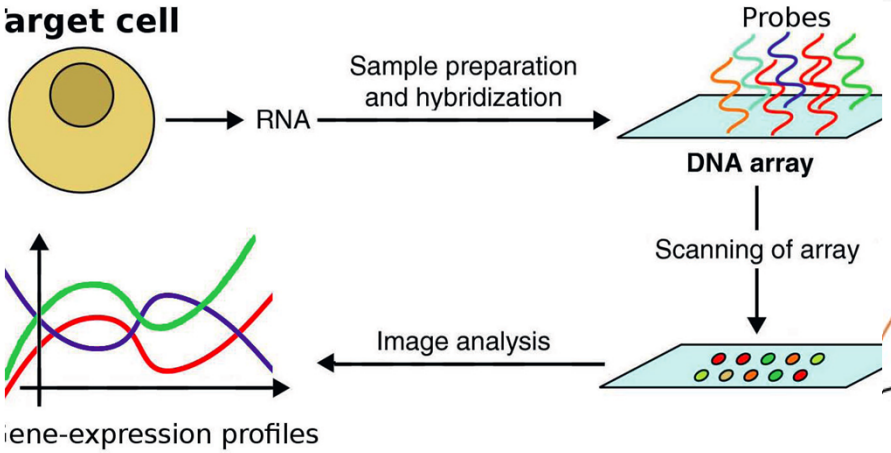


computers

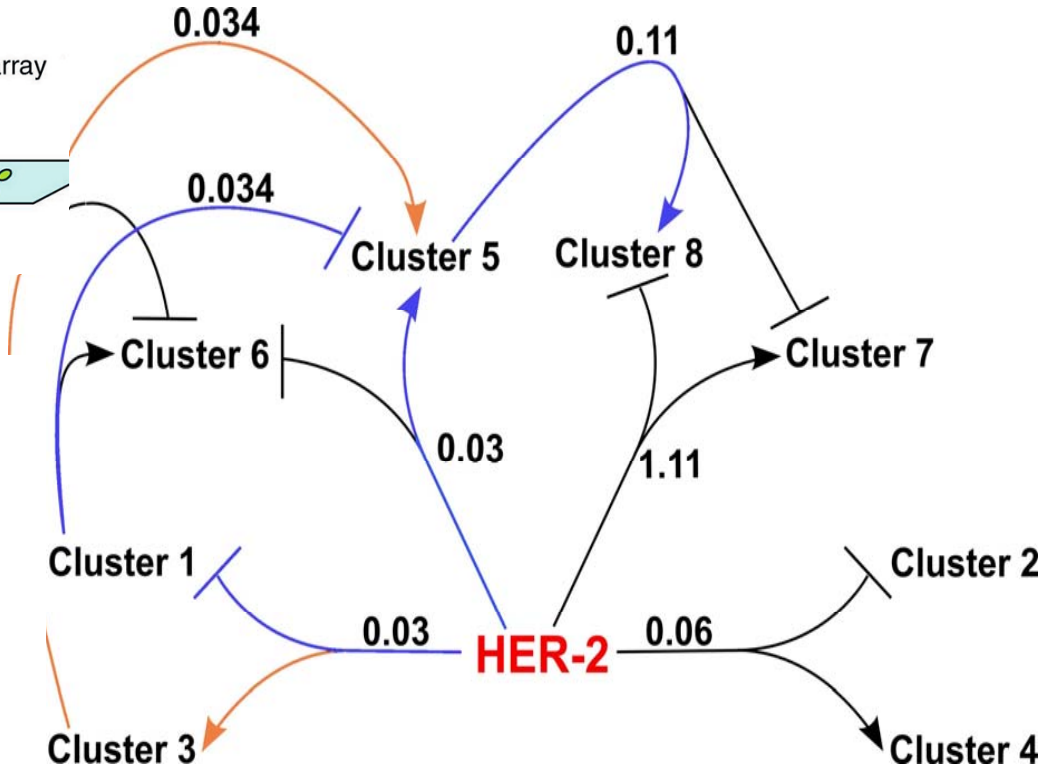
Main research topics

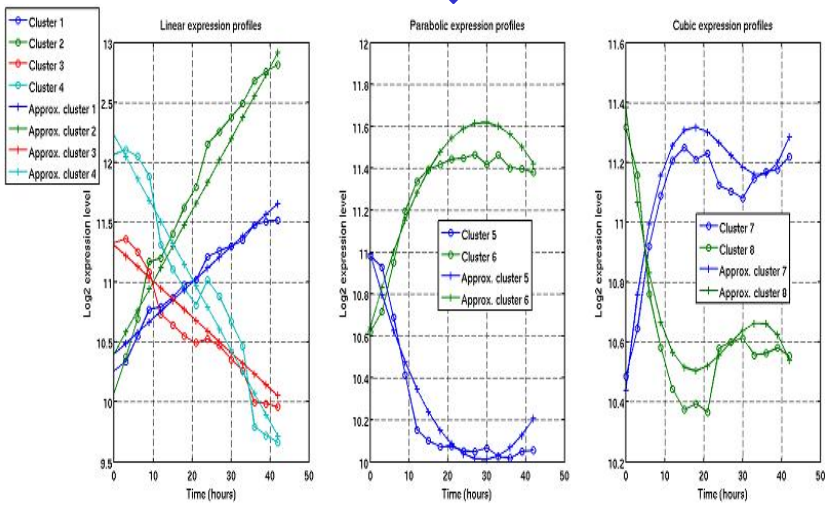
- Biological Networks
- Computational models for biological dynamics
- Infogenomics
- Algorithmic bioinformatics
- Design and analysis of DNA algorithms
- Pattern recognition for Bioinformatics

Biological Networks: Dynamics and Interactions



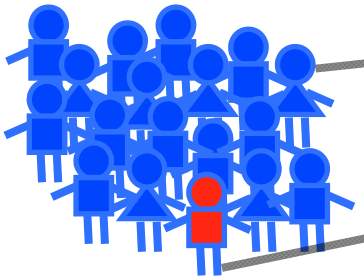
Ordinary Differential Equations
Recurrence Equations + Regression





Genome structure and evolution: identification of pathology variants

Linking disorders to genetic variants (< 0.01%)



healthy: ... A C G T C A C G T A C C G T ...

unhealthy: ... A C G T C A C C T A C C G T ...

INFOGENOMICS

Genomic Indexes

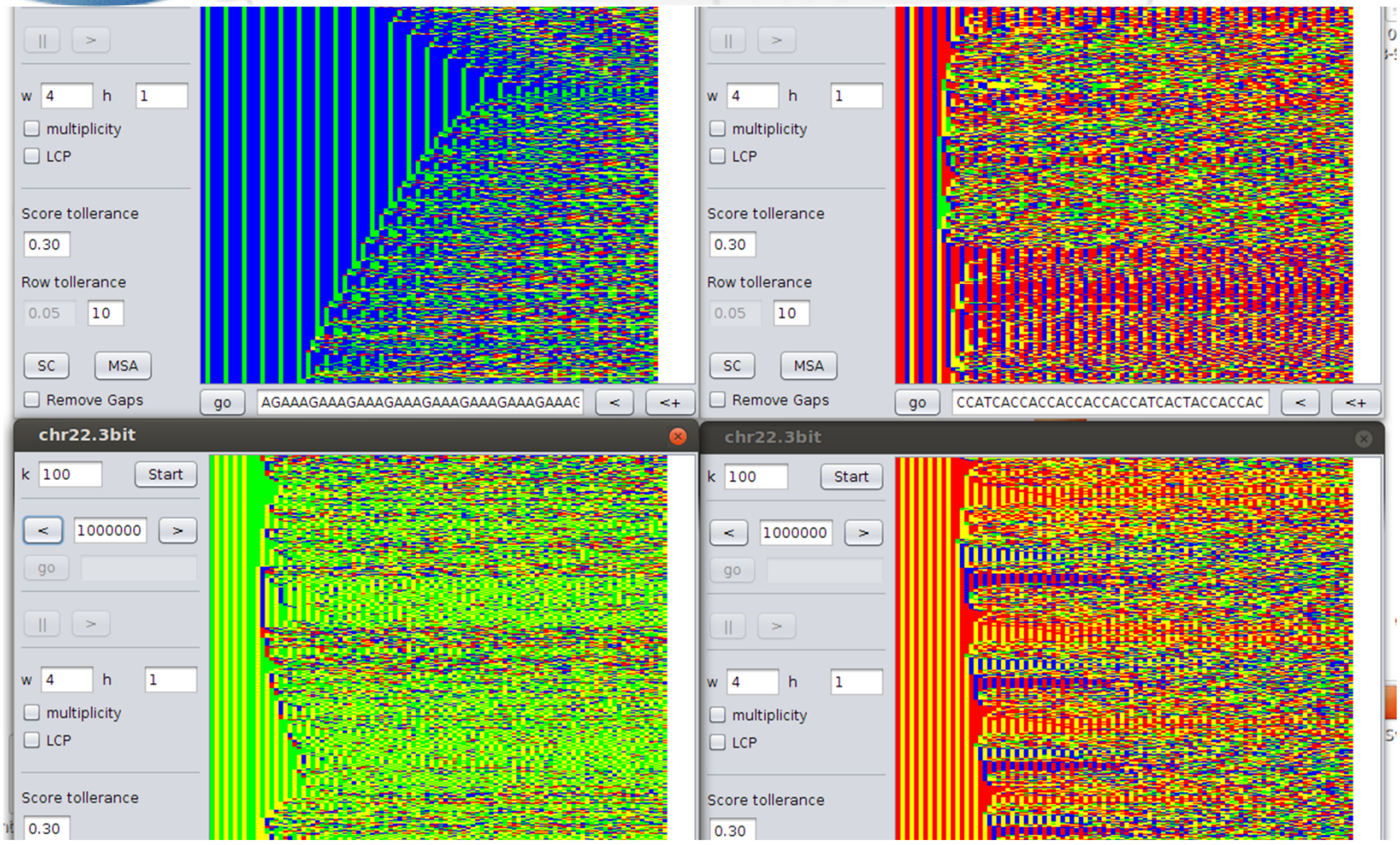
Dictionaries

Distributions

Information Theory
Probability Theory
String algorithms

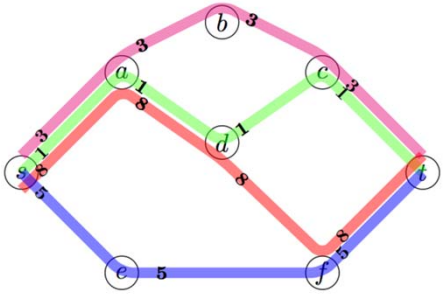
Decoding Genomes by finding and interpreting Their mathematical regularities:
Informational Laws of Genome Structures, Nature SR, 2016 (online)

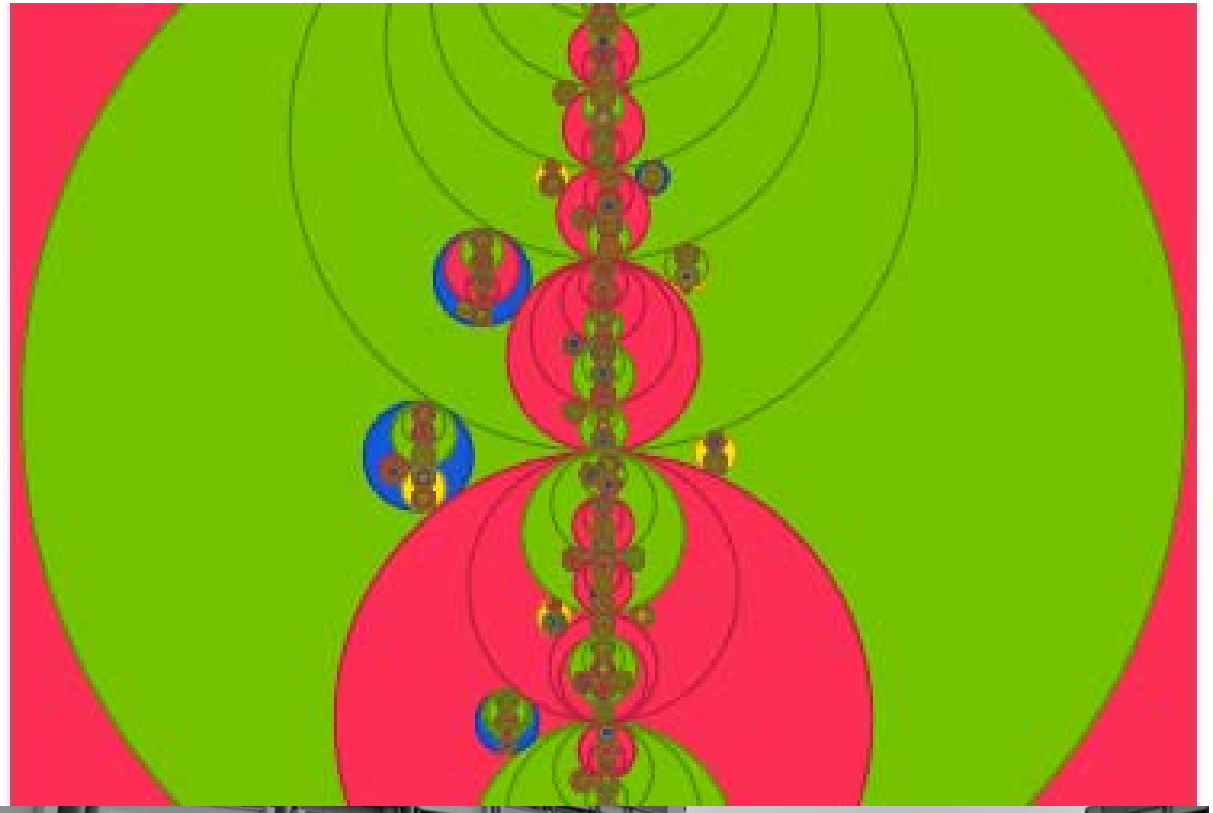
Genome dictionaries and genome visualizations

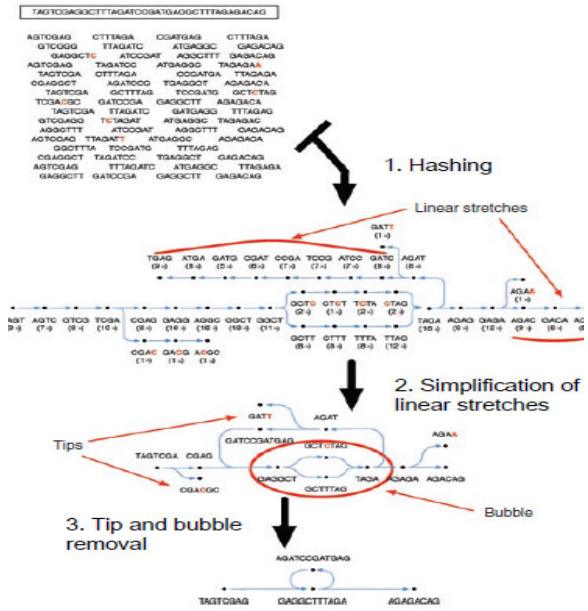


Graph theoretic methods in Bioinformatics

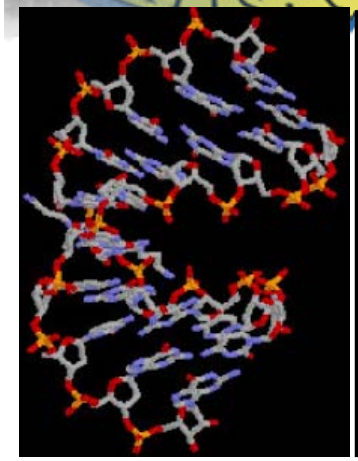
The assembly of DNA/RNA reads can be formulated as the problem of constructing a weighted DAG (directed acyclic graph) with weighted paths.

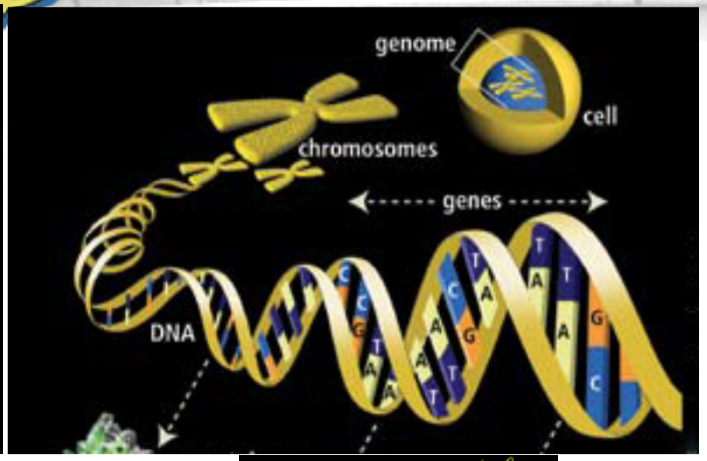


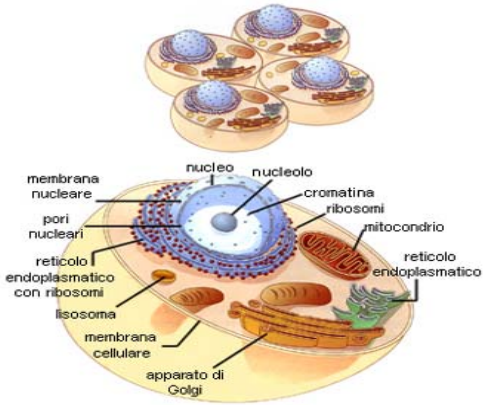


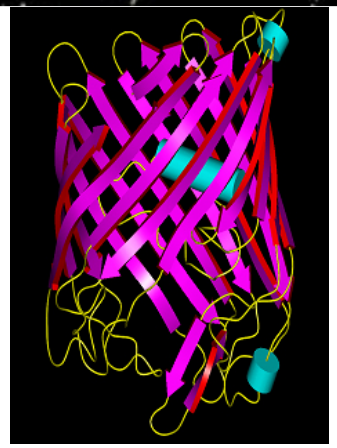


Pattern Recognition for Bioinformatics









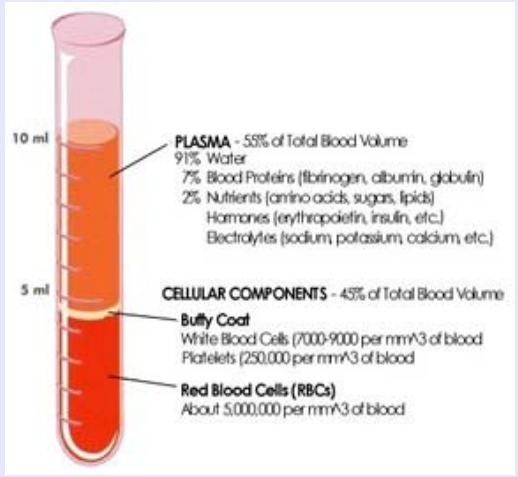
Biological data

Information

Pattern Recognition Techniques are used to extract information from biological data

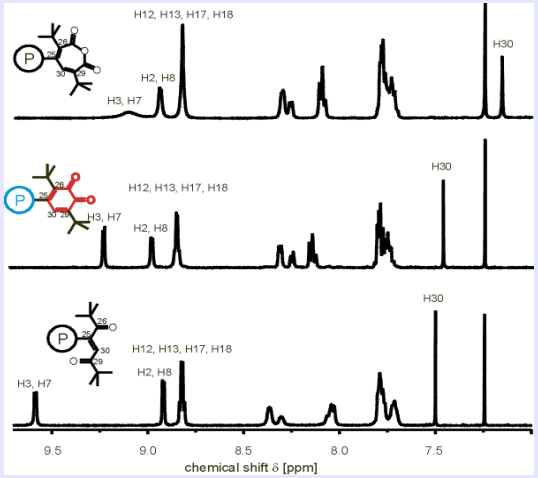
Example: classification of diseases

Individual

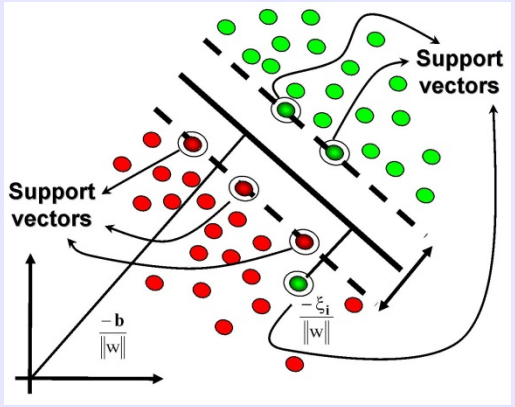


Blood

NMR



Spectra



Pattern Recognition technique

Healthy or diseased?

What is Medical Informatics?

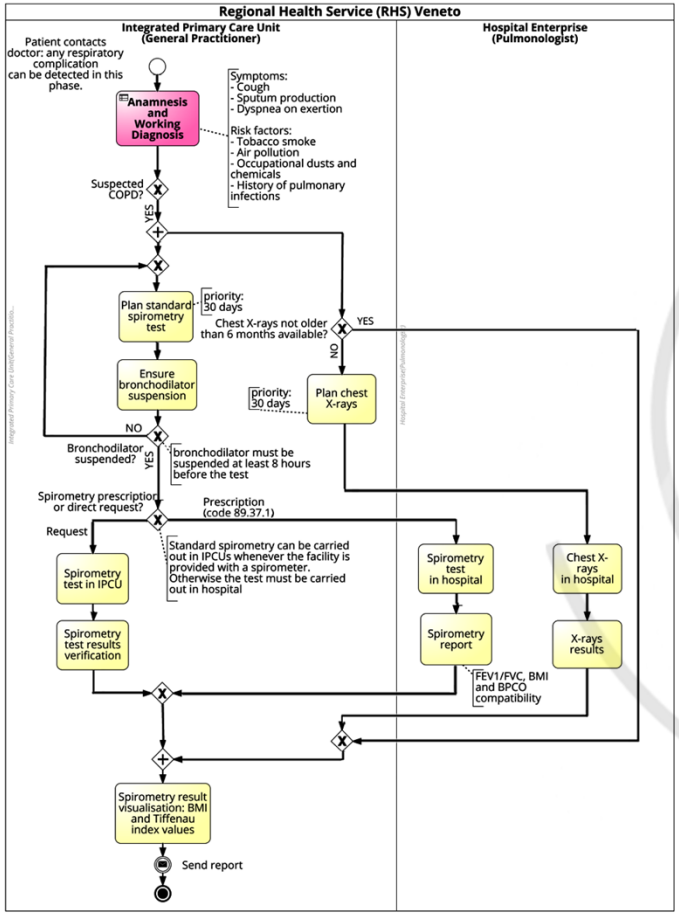
Medical informatics is [...] informatics in health care. It deals with the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

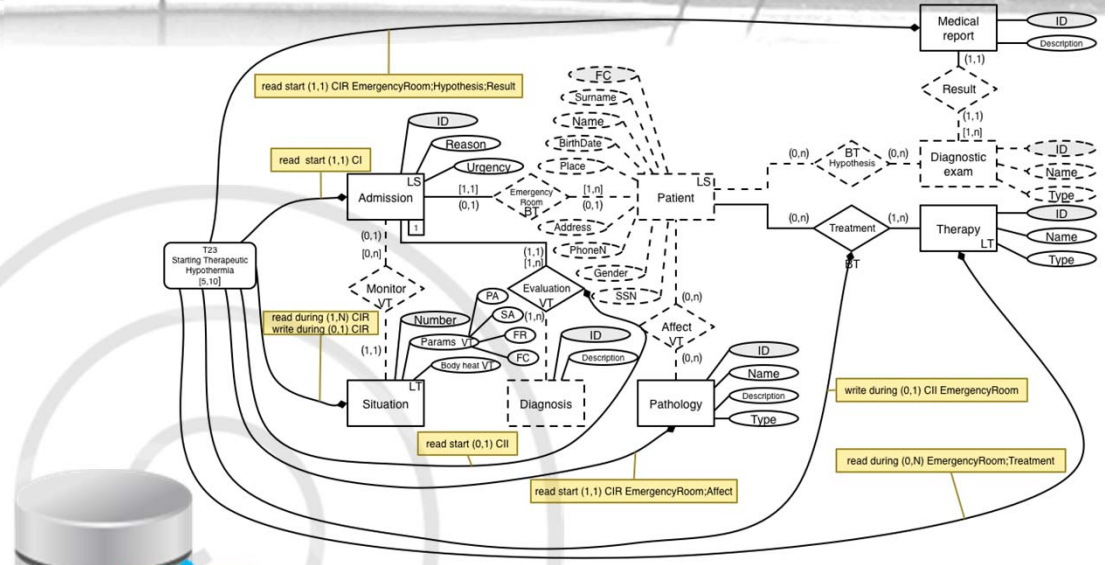
(Wikipedia)

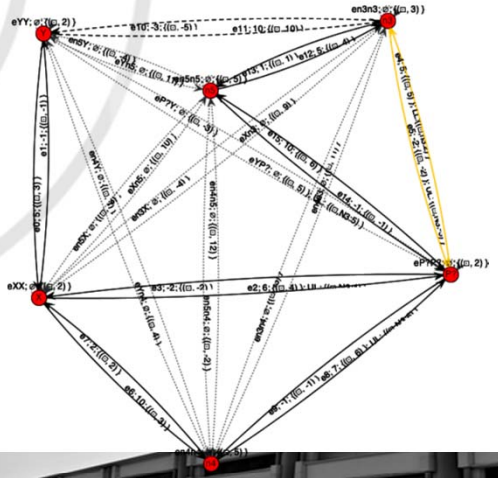
Main research topics

- **Healthcare process and data modeling**
- **Medical data modeling, analysis and mining**
- **Neuroimaging**
- **Medical image processing**
- **3D medical data processing**

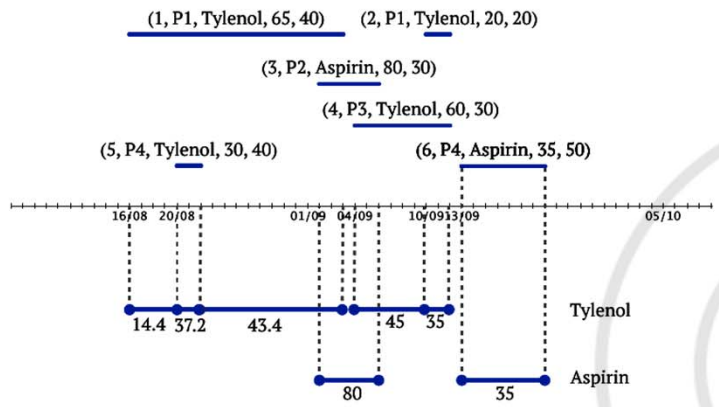
Healthcare process and data modeling

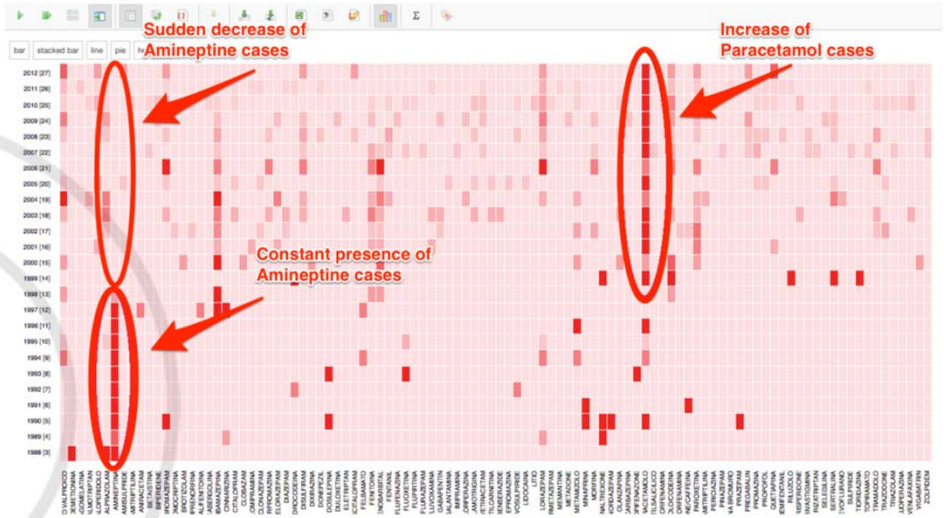


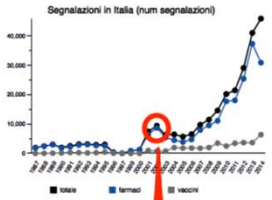


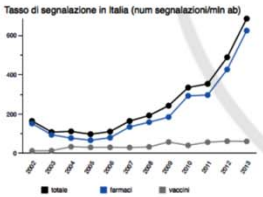


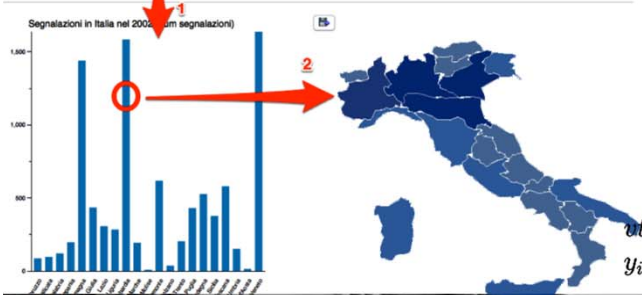
Medical data modeling, analysis and mining

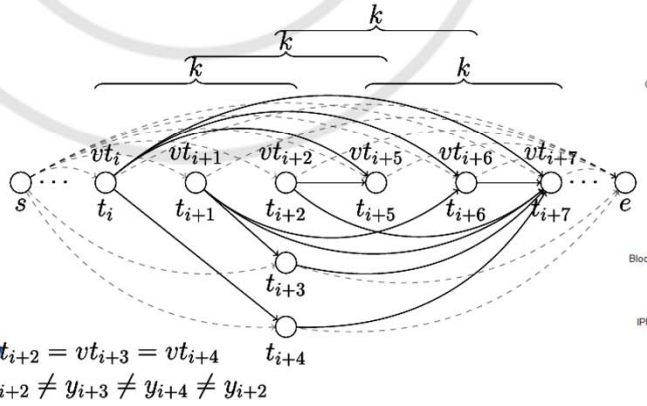


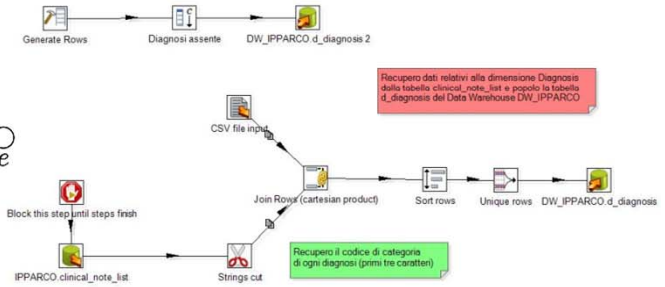






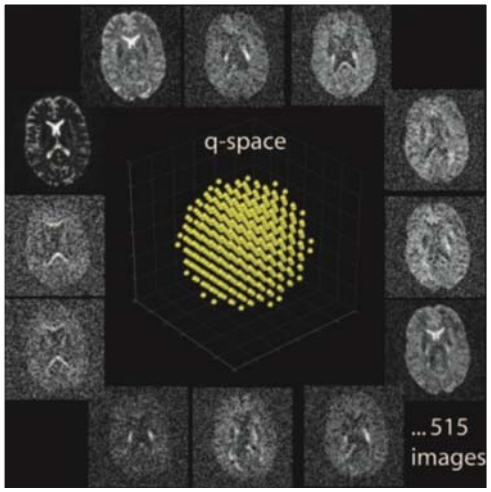




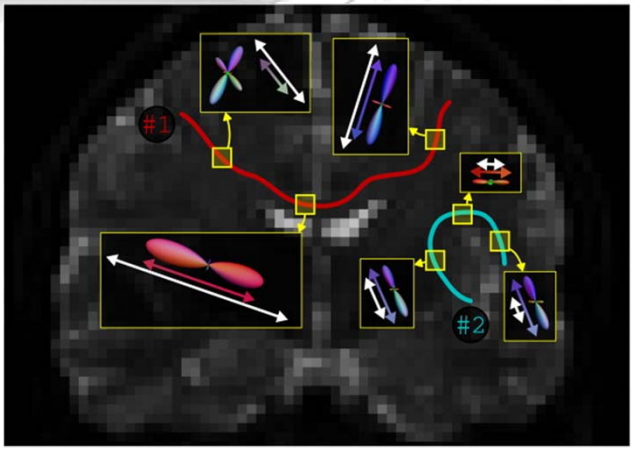


Neuroimaging

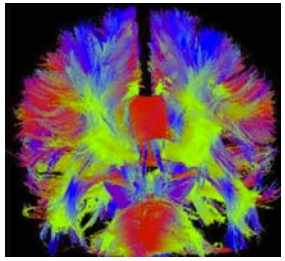
Wiring the brain



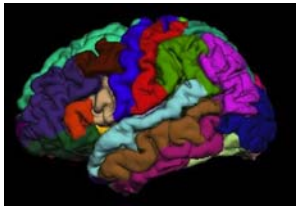
Wavelets
Multiresolution
Sparsity
Compressed sensing
Fourier



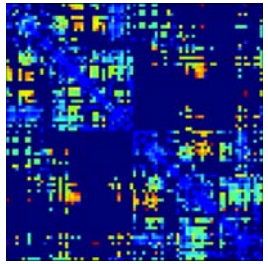
Analysis of *structural* and fuctional connectivity



fiber-tracking

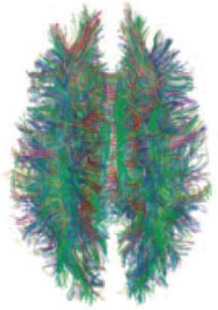


cortical segmentation

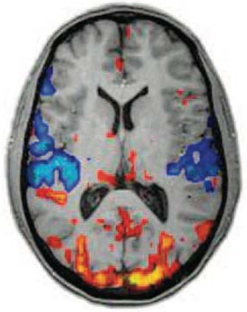


adjacency matrix

Structural map
of anatomical pathways

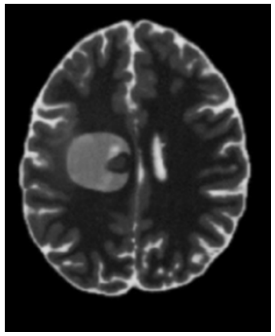


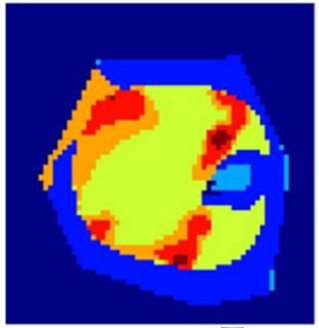
Functional map
of changes in activity



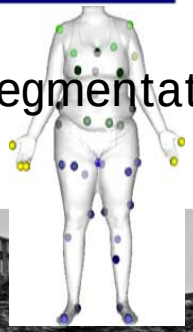
Recovery after injury

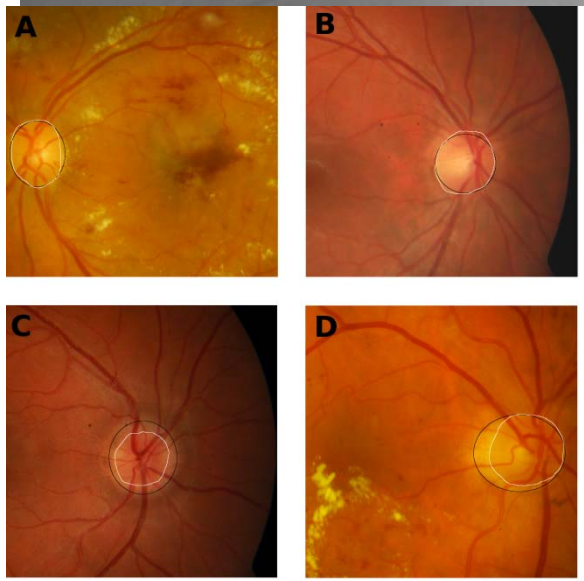
Medical Image Processing





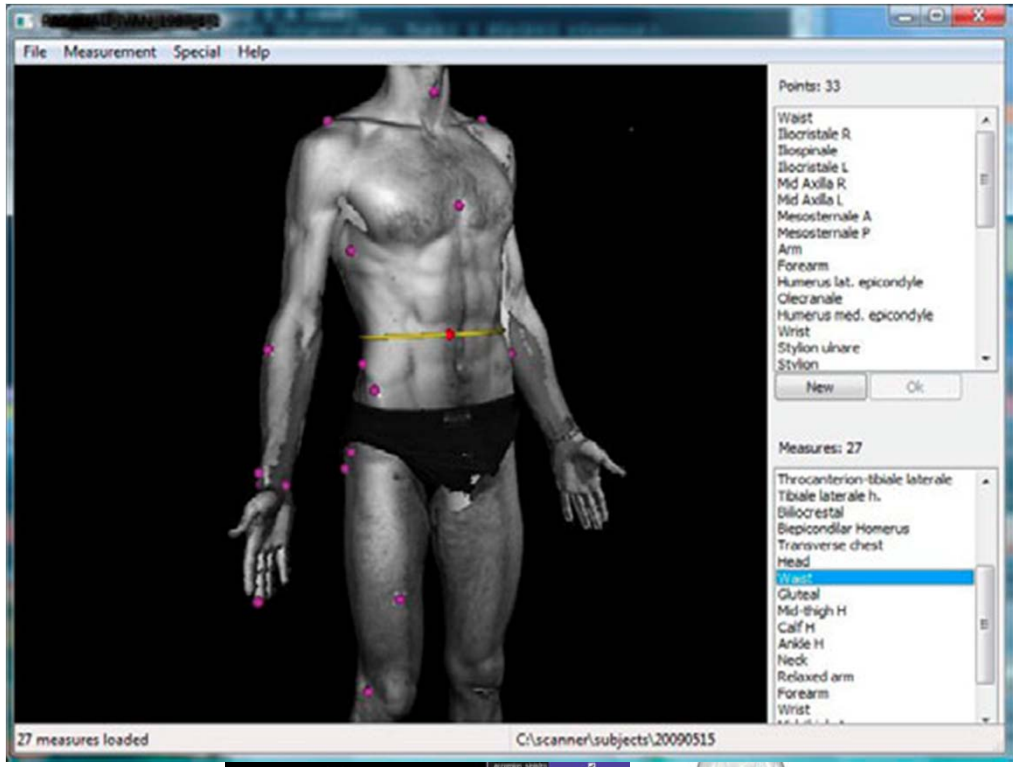
(Brain) Image Segmentation

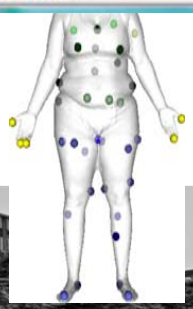




Retinal Image processing

3D medical data processing





Semi-automatic evaluation
of anthropometric parameters
from whole body scanner data.

- More info on our webpages!
- Master theses: We have many interesting topics, come and see us!