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From Medical Images to Computational Medicine

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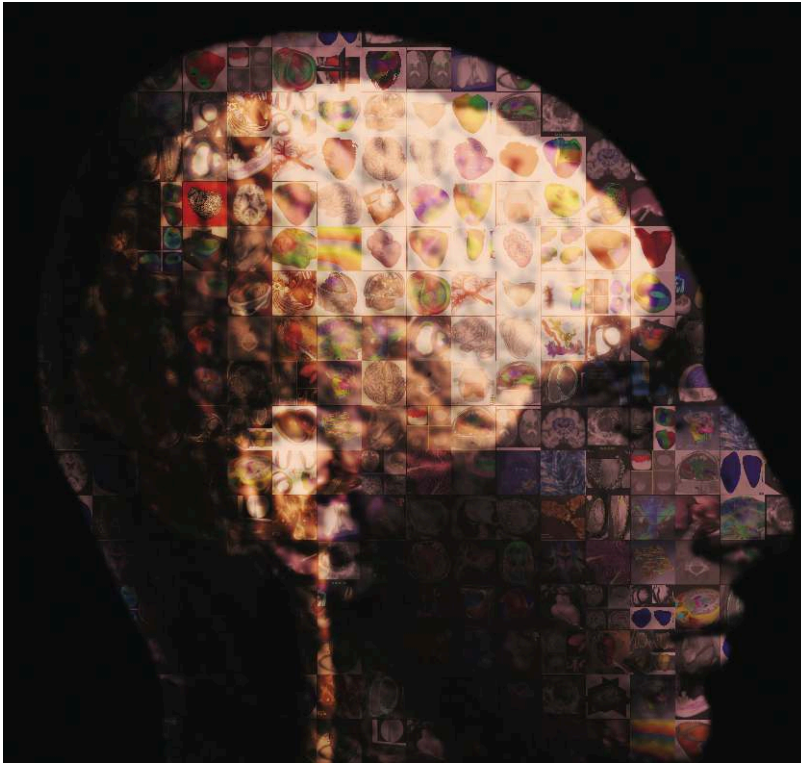
From Medical Images to Computational Medicine

Nicholas Ayache

EDITOR'S NOTE

Source: La lettre, no. 39, March 2015

- ¹ The international symposium *From Medical Images to Computational Medicine* was held in English on 24 June 2014 at the Collège de France.**



Set of medical images of the digital patient

- 2 It highlighted some of the most advanced research activities in computational medical imaging and the computational modelling of organs, to further understanding of human anatomy and physiology. Ten internationally renowned researchers participated in it, alongside its organizer and Annual Chair of Informatics and Computational Sciences, Nicholas Ayache.
- 3 Sir Michael Brady (Oxford) and Daniel Rueckert (Imperial College London) were the first to speak. The former presented biophysical models tailored to the computational analysis of anatomical and metabolic images of various forms of cancer (breast cancer, rectal cancer, skin cancer), and the latter presented sparse representations of the images and machine learning methods, designed to extract clinically useful information from cardiac and cerebral images, particularly MRIs of the foetus. Guido Gerig, from the University of Utah, discussed some spatiotemporal models for the analysis of image sequences to quantify changes, especially the development of brain structures in new-borns and young children. Antonio Criminisi (Cambridge) then focused on statistical learning algorithms, used to locate organs automatically in medical images of the whole body, in order to segment cancerous lesions, or to quantify the movement of Parkinson's patients placed in front of video cameras. The morning was concluded by Peter Hunter, from the University of Auckland (New Zealand), who presented the work of the international project *Physiome* and that of the European consortium *Virtual Physiological Human* on the multi-scale modelling of the physiology of the human body and its clinical applications. Five researchers then presented their advances in this domain. Olivier Faugeras (University of Nice Sophia Antipolis) discussed models of neuron populations at different spatiotemporal resolutions, and mathematical and algorithmic analysis and simulation tools, which draw on the theories of dynamic systems, stochastic calculus, mean field, and large deviations.

Looking at biomechanical models, James Duncan (University of Yale, USA) considered the sparse image representations used to analyse medical images, particularly in neuro-imaging and cardiac imaging.

- 4 David Hawkes (University College London) commented on the role of multi-scale computational medical imaging in the guiding of surgical operations, especially for prostate, breast and colon cancer. In a lecture titled “Augmented Reality in the Operating Room”, Nassir Navab (Technische Universität München, Germany) shed light on the use of augmented reality in surgery, and of innovative automated image acquisition systems. The last speaker was Dorin Comaniciu from Princeton (USA), who discussed a multi-scale computational model of the heart, which simulates its metabolism and its electric, mechanical and hemodynamic activity, and which has a range of potential applications in cardiology.
- 5 Nicholas Ayache, who opened the day by addressing the challenges surrounding the personalized digital patient, concluded the symposium by considering the future of computational medical imaging and of the digital patient. This symposium marked the end of a lecture and seminar series, *The Personalized Digital Patient: Images, medicine and informatics*, which presented the algorithmic, mathematical and biophysical foundations of computational medical imaging. It provided a good illustration of the international state of the art of computational medical imaging and the computational modelling of human organs.

Videos of the symposium are available at www.college-de-france.fr on the professor's page.

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