INSTITUT NATIONAL
DE RECHERCHE
EN INFORMATIQUE
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INRIA

Ph.D. position at INRIA Sophia-Antipolis, France

Multi-scale computational models of brain tumors for medical image analysis.

Computational models of brain tumors have recently gained major attention. The Asclepios project-team of INRIA introduced one of the first couplings between these models and time series of medical images [1]. More recently, we designed advanced tools to (a) estimate tumor growth parameters for patient-specific diagnosis [2] and (b) extrapolate the tumor cell density beyond the visible tumor boundary of a medical image, with the objective to better plan radiotherapy [3].

The objective of this Ph.D. thesis is to improve the existing models and to develop new ones to include 1) the uncertainty on the growth of the tumor, 2) the effect of various therapies and 3) a multi-scale modeling approach from microscopic to macroscopic scales.

In a first stage, the research will be dedicated to the introduction of the notion of uncertainty into the existing tools, and of its representation and visualization in the medical images of a patient. The white matter parameters, so far considered as spatially constant, will be evaluated on specific fiber bundles. This will require identifying fiber clusters within the white matter.

In a second stage the Ph.D. candidate will explore how to model various therapies and how to identify their parameters from time series of medical images: existing microscopic models for radiotherapy and chemotherapy will be reviewed and adapted to the current models. Finally, a link between microscopic and macroscopic models will be sought.

This research will involve a number of advanced mathematical and algorithmic tools including Partial Differential Equations (PDEs), Stochastic differential equations (SDEs) Asymptotic approximation, Cellular automata, Homogenization methods, etc.

This research will be done within the Asclepios project-team at INRIA Sophia-Antipolis

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France in collaboration with Harvard Medical School (an associated team of Asclepios through the CompuTumor[1] program), and a number of research groups in France and Europe.

Requirements:

- Master of Science in Computer Science / Applied Mathematics / Theoretical Physics.
- Experience in medical image analysis.
- Good mathematical skills
- Good experience with C/C++ programming
- Fluent in English (knowledgeable in French is a plus)

Application:

Please email your resume, letter of motivation and references to:

- Nicholas Ayache: nicholas.ayache@sophia.inria.fr
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- Hervé Delingette: herve.delingette@sophia.inria.fr

[1] Olivier Clatz, Maxime Sermesant, Pierre-Yves Bondiau, Hervé Delingette, Simon K. Warfield, Grégoire Malandain, and Nicholas Ayache. Realistic Simulation of the 3D Growth of Brain Tumors in MR Images Coupling Diffusion with Mass Effect. IEEE Transactions on Medical Imaging, 24(10):1334-1346, October 2005.

[2] Ender Konukoglu, Olivier Clatz, Pierre-Yves Bondiau, Maxime Sermesant, Hervé Delingette, and Nicholas Ayache. Towards an Identification of Tumor Growth Parameters from Time Series of Images. In Nicholas Ayache, Sébastien Ourselin, and Anthony Maeder, editors, Proc. Medical Image Computing and Computer Assisted Intervention (MICCAI), volume 4791 of LNCS, Brisbane, Australia, pages 549-556, October 2007. Springer

[3] Ender Konukoglu, Olivier Clatz, Pierre-Yves Bondiau, Hervé Delingette, and Nicholas Ayache. Extrapolating Tumor Invasion Margins for Physiologically Determined Radiotherapy Regions. In Proc. of the 9th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI'06), Part I, number 4190 of LNCS, pages 338-346, 2-4 October 2006.

[1] *www-sop.inria.fr/asclepios/projects/boston/*