

Bachelor(BA) Thesis Proposal

Thesis Title: Fractal and multifractal analyses of PET, CT and MRI images of metastatic cancer [Collaboration between the Univ. of Athens, the NCSR “Demokritos” & the German Cancer Research Center.]

Aim: The study of images PET and CT images from patients with cancers which present metastases, such as melanomas. The scope is to use the methods of fractal and multifractal analyses to develop indices related to the stage of the disease as well as parameters to evaluate the therapeutic effect after novel medical treatments (Immunotherapy). Relevant quantities are the fractal dimensions of the image, the mass dimension, the autocorrelation function, the information dimension and the multifractal spectrum. The proposed BA thesis is a continuation of an earlier work by the same collaboration group (see ref. [1]).

Methodology:

For each case the following steps will be followed:

- A number of high resolution 2D Dicom images are given for each subject covering all human body (see typical 2D picture).
- As a first step the superposition of the 2D images into a 3D structure is required.
- A 3D digital representation of the human body is performed.
- Fractal dimensions, Correlations, Multifractal Spectra etc are computed.

*** DICOM ***
CT 22-June-2012 11:00:20



Typical 2D image

The method will be applied to 25 patients, at different stages of the melanoma disease, before and after medical treatments and will be compared with those of a group of healthy subjects (control group).

Literature:

- [1] Breki CM, Dimitrakopoulou-Strauss A, Hassel J, Theoxaris T, Sachpekidis C, Pan L, Provata A, “Fractal and multifractal analysis of PET/CT images of metastatic melanoma before and after treatment with ipilimumab”, EJNMMI Research 6(1):61, 2016.
- [2] Medical PET Group - Biological Imaging, “Quantitative approaches of dynamic FDG-PET and PET/CT studies (dPET/CT) for the evaluation of oncological patients”, Cancer Imaging, 10/2012; 12(1):283-289.
- [3] Dimitrakopoulou-Strauss A, Strauss LG, Burger C, Mikolajczyk K, Lehnert T, Bernd L, Ewerbeck V, “On the fractal nature of dynamic positron emission tomography (PET) studies”. W J Nucl Med, 2:306-313, 2003.
- [4] Sachpekidis C, Roumia S, Schwarzbach M, Dimitrakopoulou-Strauss A., “Dynamic (18)F-fluorodeoxyglucose positron emission tomography/CT in hibernoma: Enhanced tracer uptake

- mimicking liposarcoma". World J Radiol. 5(12):498-502, 2013. doi: 10.4329/wjr.v5.i12.498.
- [5] Katsaloulis P, Hizanidis J, Verganelakis DA, et al., "Complexity Measures And Noise Effects On Diffusion Magnetic Resonance Imaging of the Neuron Axons Network in the Human Brain", Fluctuation and Noise Letters 11 (4):1250032, 2012.
- [6] Katsaloulis P, Ghosh A, Philippe AC, Provata A, "Fractality in the neuron axonal topography of the human brain based on 3-D diffusion MRI", EUROPEAN PHYSICAL JOURNAL B 85 (5): 150, 2012.
- [7] Sfikas K, Theoharis T, Pratikakis I, "3D object retrieval via range image queries in a bag-of-visual-words context", VISUAL COMPUTER 29(12):1351-1361, 2013.
- [8] Danelakis A, Verganelakis DA, Theoharis T, "A new user-friendly visual environment for breast MRI data analysis", COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE 110 (3): 411-423, 2013.

Collaboration:

This BA Thesis is performed in the framework of a collaboration between:

- the Department of Informatics of the University of Athens (Prof. T. Theoharis),
- the Institute of Nanoscience and Nanotechnology of the National Center for Scientific Research "Demokritos" (Dr. A. Provata) and
- the German Cancer Research Center, Heidelberg, Germany (Prof. A. Dimitrakopoulou-Strauss).

Requirements:

We are looking for an BA student with a good knowledge of:

- a) image analysis techniques
- b) programming language C/C++ (or other)
- d) English

Additional Skills (not required) could be useful:

- a) Knowledge of Linux operating system
- b) Knowledge of Fractal and Multifractal Analysis

Interested students, please contact:

Dr. A. Provata
Statistical Mechanics and Complex Dynamical Systems Laboratory
Institute of Nanoscience and Nanotechnology
National Center for Scientific Research "Demokritos"
15310 Athens, Greece

tel: +30 210 6503964

fax: +30 210 6511766

E-mail: a.provata@inn.demokritos.gr

and

T. Theoharis theotheo@di.uoa.gr