Final Report for project AKTION 58p5

Planned activities

When we consider fractal based cancer diagnostic, many times a statistical procedure to assess the fractal dimension is needed. We shall look for some analytical tools for discrimination between cancer and healthy ranges of fractal dimensions of tissues. Baish and Jain, 2000, discussed planar tissue preparations in mice which has a remarkably consistent scaling exponents (fractal dimensions) for tumor vasculature even among tumor lines that have quite different vascular densities and growth characteristics. Stehlik 2009-2010 with different coauthors have developed the cancer risk model based on Tsallis entropy.

Mrkvicka 2009 has developed a novel testing of general random closed hypothesis. The binary images of mammary cancer tissues and mastopathic tissues were tested on the Boolean model assumption. The Boolean model serve here as a hypothesis of independent layout of the cells in the tissue. It was proven that the mastopathic tissues deviates from the Boolean model significantly more than mammary cancer tissues. Unfortunatelly this difference is not satisfactory for distinguishing between masthopathic case and mammary cancer case.

The aim of this project is to find a characteristic of the binary image of the tissue which is able to distinguish between masthopathic case and mammary cancer case and constract statistical test based on such characteristic. Furthermore the comparison of new method and other method will be performed.

1) We may construct a continuously parameterized set of weakly (sometimes strongly) consistent estimators of Pareto tail (and consequently cancer risk). The one alternative to the Hill estimator was developed by [2]. Therefore we may get a relatively large scale of possible estimated risk levels, which constitutes an inverse problem. 2) Scaling of the data. This is apparently important for the power and p-value modelling (see [8]). Scaling may led to a scale of p-values and powers, which constitutes an inverse problem. Beside 1) and 2) non invasive techniques generally may produce inverse problems, e.g. estimating a Hausdorff fractal dimension from boundary of examined tissue. (see [3-8]). The binary images of mammary cancer tissues and mastopathic tissues were tested on the Boolean model assumption. The Monte Carlo method based on the approximation of the envelops by multi-normal distribution with the normalized intrinsic volumes densities of parallel sets as a summary statistics was chosen with respect to its biggest power. [Mrkvicka 2009] It was proven that the mastopathic tissues deviates from the Boolean model significantly more than mammary cancer tissues. Unfortunately this difference is not satisfactory for distinguishing between masthopathic case and mammary cancer case. The aim of this project is to find a characteristic of the binary image of the tissue which is able to distinguish between masthopathic case and mammary cancer case and construct statistical test based on such characteristic. Furthermore the comparison of new method and other method will be performed.The obtained results will be illustrated on the real and simulated datasets.

Obtained Results

Research in AKTION 58p5 focused both on the theoretical and practical aspects of cancer risk assessment.

In [1] characteristic of the binary image of the tissue which is able to distinguish between masthopathic case and mammary cancer case is derived and appropriate statistical test based on such characteristic is constructed. The distinguishing characteristics were standard deviation

of the Euler number density per tumor case and the mean area fraction of a parallel set per tumor case. The constructed test for cancer was based on the approximation of the founded characteristic by a normal distribution. The significance of founded test was estimated to 0.05 and the power was estimated around 0.9.

During this project we tested several models of carcinogenity (e.g. Boolean, Quermass interaction, stochastic and deterministic fractals. We observed partially interesting results, however, more work should be done to answer the problem of carcinogenity modelling thoroughly. Further work will continue in the possible prolongation of this project. In [2] we introduced a flexible model of cancer growth when two observations on the boundary are made. This model may be later extended in a way of n-observations from the boundary, which may have a specifical applications on Wilms tumors. In [3] a theoretical methodology for likelihood ratio testing of the Hausdorff dimension is developed and illustrated on several simulated and real data examples.

Synergies of the project

There is a synergy with WTZ project 1. 3. 2011 - 28. 2. 2013, with India 2011-12 Nr. IN 11/2011: Thermal Modeling of Cancer, with Maulana Azad National Institute of Technology: MANIT, Bhopal.

Publications of the project: There are 3 publications which have been made with the help of the project AKTION 58p5. They are listed in the following References section.

References

[1] M. Stehlík, T. Mrkvička, J. Filus, L. Filus (2011) Recent development on testing in cancer risk: a fractal and stochastic geometry, invited paper to *Journal of Reliability and Statistical Studies*, submitted

[2] J. Filus, L. Filus, M. Stehlík (2011) Pseudoexponential models in medical trials: design, estimation and testing, *Proceedings of the 4th Intern. Conf. on Risk Analysis*, ICRA4, Cyprus, May 2011, Edited by Alex Karagrigoriou, pages 75-83

[3] M. Stehlík, J. prostakova, S. Giebel, J. Schenk (2011). Statistical inference on fractals for cancer risk assessment, technical report.

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