EDITORIAL

This special issue gathers together papers presented during the workshop Shape and Size in Medicine, Biotechnology, Materials Science and Social Sciences, Milano, Italy, 16-17 February 2011 https://sites.google.com/site/shapemilan/home

Among all different aspects underlying visual information, the shape (and form) of the objects certainly plays a special role. Shape analysis deals with the geometrical information on objects that is left after location, scale and rotation effects are removed. If scale effects are not removed, then we are led to form (size and shape). In applications, a crucial role is played by computational methods that are aimed to preserve and enhance shape information as well as to effectively capture the structure of a shape by identifying relevant shape components and their mutual relationships. We point out that bodies rarely have exactly the same shape within measurement error; hence randomness of shapes need to be taken into account. Thanks to the development of information technologies, the last decade has seen a considerable growth of interest in the statistical theory of shape and its application to many and diverse scientific areas. Statistical Shape Analysis and Stochastic Geometry deal with the geometrical information of families of objects in presence of stochasticity.

Often the diagnosis of a pathology, or the description of a biological process mainly depend on the shapes present in images of cells, organs, biological systems, etc., and mathematical models which relate the main features of these shapes with the correct outcome of the diagnosis, or with the main kinetic parameters are often still not present. In material sciences, optimization for quality control requires mathematical models from Stochastic Geometry and the related statistical estimation procedures, and methods of Statistical Shape Analysis for comparison of different random geometrical patterns.

From the mathematical point of view, Shape Analysis and Stochastic Geometry use a variety of mathematical tools from differential geometry, geometric measure theory, stochastic processes, harmonic analysis, fractals, partial differential equations, etc. The aim of this workshop was to gather both mathematicians and scientists from diverse scientific areas, and emphasize topics which are relevant in Medicine, Material Sciences and Social Sciences, with attention both to direct and inverse problems. The main topics of the Workshop included, but were not limited to, Fractals and self-similarities, Neuroimaging, and Stochastic Geometry.

The papers included in this special issue cover self-similar multimeasure in image analysis, stochastic optimal decision making and self-similarity in economic growth, statistical properties of the birth and growth processes in material science, statistical methods for stationary fibre processes and 3*D* segmentation.

La Torre and Mendivil analyze a useful class of multimeasures for modelling of images and information derivable from images. Images are often modeled as functions or measures and implicitly these are most often positive. In the case of measures, restricting to positive measures greatly simplifies the technical details as spaces of positive measures have nicer properties than spaces of signed measures or multimeasures. La Torre and Mendivil examine two different classes of positive multimeasures, namely *positive multimeasures* and *cone-positive multimeasures*, discuss the main properties and show how to define a notion of self-similarity based on a generalized Markov operator. In fact, many images exhibit approximate self-similarity and several authors in literature have showed how this structure is very useful in applications to image compression, representation and analysis.

La Torre, Marsiglio and Privileggi consider an application of fractal-based techniques to the analysis of an economic growth model. They study a stochastic, discrete-time, two-sector optimal growth model in which the production of the homogeneous consumption good uses a Cobb-Douglas technology, combining physical capital and an endogenously determined share of human capital. Assuming that the exogenous shocks are i.i.d. and affect both physical and human capital, they build specific configurations for the primitives of the model so that the optimal dynamics for the state variables can be converted, through an appropriate log-transformation, into an Iterated Function System with probabilities converging to an invariant distribution supported on a generalized Sierpinski gasket.

The contribution by Villa and Rios deals with birth and growth processes in material science. In particular they concern with crystalline materials and with the nucleation process which almost always takes place in an internal crystalline defect. They introduce an expression for the case of nucleation on lower dimensional sets. Moreover, general expressions for nucleation on random planes and random lines are given. More specific expressions to be used in practical applications are also provided.

Rancoita, Giusti and Micheletti study the so called stationary fibre processes which are processes of curves in a higher dimensional space, whose distribution is translation invariant. Applications of this kind of processes involve models of several real objects, such as roots, vascular networks and fibres of materials. They develop a general computational-statistical approach for the estimation of the intensity of these processes from digital images of the same processes. Due to its generality, their approach is successfully applied to images of very dissimilar structures, in a variety of application scenarios, avoiding the requirement of an ad-hoc segmentation method for the identification of the fibres.

In Naldi et al. a 3*D* segmentation method is introduced as a basic step in a computational approach recently proposed by the same authors in order to represent quantitatively the geometrical features of organs at risk, summarized in characteristics of distance, shape and orientation of such organs in respect to the target (tumor). The data are sequences of CT 2*D* slices and with these data it was not possible to proceed with a direct 3*D* segmentation algorithm. Their algorithm is based on different steps, a preprocessing phase where a nonlinear diffusion filter is applied; a level set based method for extract 2*D* contours; a postprocessing reconstruction of 3*D* volume from 2*D* segmented slices. Some comparisons with manually traced segmentation by clinical experts are provided.

We thank all participants for the quality of contributions and for making this workshop a success. The papers included in this special issue represent a significant sample of the Workshop and they show the interest of the research activities of the form (shape+size) analysis with innovative methods and stimulating real world applications. Last but not least we would like to extend our thanks to ISS (International Society for Stereology), ADAMSS (ADvanced Applied Mathematical and Statistical Sciences), ECMI (European Consortium for Mathematics in Industry) and Università degli Studi di Milano for the financial and logistic support during all the phases of the Workshop.

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