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Editorial

Scaling, Self-Similarity, and Systems of Fractional Order

Carlo Cattani,[1] Martin Ehler,[2] Ming Li,[3] Zhiwu Liao,[4] and Mohammadreza Hooshmandasl[5]

[1] *Department of Mathematics, University of Salerno, Via Giovanni Paolo II, 84084 Fisciano, Italy*
[2] *Faculty of Mathematics, University of Vienna, Oskar-Morgenstern-Platz 1, 1090 Vienna, Austria*
[3] *Institute of Systems Science, East China Normal University, Shanghai 200241, China*
[4] *Visual Computing and Virtual Reality Key Laboratory of Sichuan Province, Sichuan Normal University, Chengdu 610101, China*
[5] *Faculty of Mathematics, Yazd University, Yazd, Iran*

Correspondence should be addressed to Carlo Cattani; ccattani@unisa.it

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Scaling (power-type) laws and self-similarity reveal some featuring properties of physical-chemical objects and can be easily noticed in nature. Moreover, also some mathematical abstract objects, such as nondifferentiable functions and fractals, enjoy scaling and self-similarity. Experimental data often show some characteristic power law and self-similarity. A self-similar (scaling) object repeats itself at different scales in space or time. The property of self-similarity gives us a better opportunity to study phenomena from all analytical and computational aspects.

Scale dependence and multiscale analysis are peculiar properties of some families of special functions and can be observed in nature. A continuous scale transformation from one scale to another implies a generalization and suitable extension of differential operator, as it happens with fractional derivatives.

Dynamical processes and systems of fractional order attract researchers from many areas of sciences and technologies, ranging from mathematics and physics to computer science. From analytical point of view, these kinds of problems often lead us to deal with the concepts of scales, fractals, and fractional operators. For instance, medical images nowadays play an essential role in detection and diagnosis of numerous diseases and a suitable scale-depending interpretation of the images is a fundamental aspect of the clinical investigation. Nonlinear analysis of data, collected by modern devices, offers still unsolved analytical problems related to not only complex physics and abstract mathematical theories but also nonlinear science.

The focus of this special issue is on both the abstract mathematical models on scaling and self-similarity and the applied computations on those dynamical processes and systems of fractional order towards the applications in all aspects of theoretical and practical study in analysis.

Scaling and self-similarity characterize several mathematical topics:

(1) self-similar analytical problems: scale-depending theoretical and applied analytical problems;

(2) fractals, nondifferentiable functions: theoretical and applied analytical problems of fractal type;

(3) $1/f$ process, fractional Brownian motion, fractional Gaussian noise, self-similar processes, long memory processes, heavy-tailed random processes, and power law systems;

(4) fractional differential/integral equations, fractional operators: systems of fractional order;

(5) complex systems, nonlinear processing;

(6) wavelets;

(7) scaling and self-similarity in applications by focusing on theoretical and analytical aspects arising, for example, in nonlinear analysis of data, image analysis, data science, and system science.

This special issue contains 17 papers.

In the category of scale-depending problems, fractals and, self-similarity there are many papers devoted to interesting problem.