Fractional Calculus, Probability and Non-local Operators: Applications and Recent Developments

November 6th - 8th 2013

BCAM - Alameda Mazarredo, 14 48009 Bilbao (Bizkaia), Basque Country, Spain

A workshop on the occasion of the retirement of Professor Francesco Mainardi

Invited Speakers

Francesco Mainardi (Bologna University, IT)
Luisa Beghin (La Sapienza Rome University, IT)
Michele Caputo (La Sapienza Rome University, IT, and Texas A&M University, US)
Diego del Castillo Negrete (Oak Ridge National Laboratory, US)
Rudolf Gorenflo (Berlin Free University, DE)
George Karniadakis (Brown University, US)
József Lörinczi (Loughborough University, UK)
Yuri Luchko (Berlin Beuth University, DE)
Mark M. Meerschaert (Michigan State University, US)
Ralf Metzler (Potsdam University, DE)

Scientific Committee

Michele Caputo (La Sapienza Rome University, IT, and Texas A&M University, US)
Rudolf Gorenflo (Berlin Free University, DE)
József Lörinczi (Loughborough University, UK)
Yuri Luchko (Berlin Beuth University, DE)
Francesco Mainardi (Bologna University, IT)
Mark M. Meerschaert (Michigan State University, US)
Gianni Pagnini (BCAM, ES)
Enrico Scalas (East Piedmont University, IT BCAM, ES)

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Enrico Scalas (East Piedmont University, and BCAM)

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Fractional Dynamics in Forest Fires

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Oral presentation

Every year forest fires consume large areas, being a major concern in many countries like Australia, United States and Mediterranean Basin European Countries (e.g., Portugal, Spain, Italy and Greece). Understanding patterns of such events, in terms of size and spatiotemporal distributions, may help to take measures beforehand in view of possible hazards and decide strategies of fire prevention, detection and suppression. Traditional statistical tools have been used to study forest fires. Nevertheless, those tools might not be able to capture the main features of fires complex dynamics and to model fire behaviour [1]. Forest fires size-frequency distributions unveil long range correlations and long memory characteristics, which are typical of fractional order systems [2]. Those complex correlations are characterized by self-similarity and absence of characteristic length-scale, meaning that forest fires exhibit power-law (PL) behaviour. Forest fires have also been proved to exhibit time-clustering phenomena, with timescales of the order of few days [3]. In this paper, we study forest fires in the perspective of dynamical systems and fractional calculus (FC). Public domain forest fires catalogues, containing data of events occurred in Portugal, in the period 1980 up to 2011, are considered. The data is analysed in an annual basis, modelling the occurrences as sequences of Dirac impulses. The frequency spectra of such signals are determined using Fourier transforms, and approximated through PL trendlines. The PL parameters are then used to unveil the fractional-order dynamics characteristics of the data. To complement the analysis, correlation indices are used to compare and find possible relationships among the data. It is shown that the used approach can be useful to expose hidden patterns not captured by traditional tools.

References

[1] Alvarado, E., Sandberg, D. and Pickford, S. 1988 *Modeling Large Forest Fires as Extreme Events*. Northwest Science 72, 66-75.

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[3] Telesca, L., Amatulli, G., Lasaponara, R., Lovallo, M. and Santulli, A. 2005 *Time-scaling properties in forest-fire sequences observed in Gargano area (southern Italy)*. Ecological Modelling 185, 531-544.