Editorial

In 1987, Eckman, Kamphorst and Ruelle published a short, but significant article describing a "recurrence plot" as diagnostic tool for the analysis of dynamical systems [1]. They pointed out that the information obtained from such plots was surprising and not easily available by other methods. Most importantly, they showed that the coordinates exhibited subtle time correlation, and went on to provide examples how specific features were related to dynamical information, including Lyapunov exponents.

Perhaps the authors were too modest in the significance of this report. At a time when extravagant claims for chaos were being made for various systems, the authors provided a method to check for some basic prerequisites for such systems. A drawback to the method, mentioned by the authors, was that the "human eye/brain not very good at seeing small variations". Thus they included an analysis by histograms to provide some objectivity. Later, during the following two decades, the idea of providing objectivity to the analysis was continued by Zbilut, Webber, Marwan, Romano, Thiel [4–6], and others.

It is remarkable that the methods of analysis based on the recurrence plot have expanded and have become a tool for the analysis of subtle features of both time and spatial series. In this respect it complements the Fourier transform. Whereas the Fourier transform often obscures fine detail, recurrence analysis can frequently unveil it.

What is even more remarkable is its application in a wide variety of disciplines. From a bibliographical review [2,3], more than 350 articles are known with applications ranging from mathematics to engineering, to molecular biology. Also remarkable has been the progressive increase in the number of articles published each year dealing with recurrence analysis. From some three articles in 1991, the number has increased to approximately 70 in 2007 [3].

Recurrence plots and their quantification analysis are obviously good examples of how real interdisciplinary research can be done by sharing the same technique that is at an intermediate level of insight, between simple view (e.g. mean) and high detail (e.g. wavelet analysis). Recurrence plot based techniques require that the user understands the idea behind it and is able to adapt the method to his own problem. The sharing of this kind of thinking enables the scientists from different disciplines to talk together and with the same language. Only few data analysis techniques have the same potential of unifying scientists (e.g. PCA, cluster analysis).

To recognize the importance of this contribution, on the occasion of the 20th anniversary of the publication of the article, a "Second International Workshop on Recurrence Plots" was convened at the University of Siena in Italy under the aegis of Centro per lo Studio dei Sistemi Complessi in September of 2007. Contributions were presented from a wide variety of disciplines; moreover, the dissemination of the concept was attested by wide global origins of the attendees. The contributions were not only from Europe and North America, but also Asia and South America.

This issue of European Physical Journal-Special Topics collects a number of recent efforts and work on the further understanding, development and application of recurrence plots. The Editors chose these not only on the basis of quality but also on the variety of applications.

Certainly, Eckmann, Kamphorst and Ruelle might well be surprised by the influence and directions their original contribution has spawned. It is hoped that these examples can provide inspiration for further development.

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Greetings from J.-P. Eckmann, S.O. Kamphorst, D. Ruelle

The editors of this volume have asked us to add a few words on the 20th anniversary of our paper. It is of course rewarding to discover that a small paper has, after a dormant period, led to an active field, with many ramifications we certainly had not anticipated. One can wonder what exactly is responsible for this development. We think that it is the interface with the human visual system, which allows for a quick analysis of phenomena which are hard to quantify with purely algorithmic methods, in particular in situations where the result is not clear or is not being anticipated. Its strength is also that it is not tied to any particular application, as can be seen from the many papers in this volume, whether they concern transients, hidden regularities, covering finance, biology, and many other fields. In problems of turbulence, chaos, and the like, where numbers are easily produced, one has often the feeling that it is their intrinsic nature and not numbers which are of interest, and that one understands complex behavior only once one "sees" it. In this sense, scatter diagrams are a typical example of these more general aspects. We hope and expect that the researchers will find many more applications and indicators in the future.