

Preface

Recurrence phenomena are regularly experienced in our daily lives. Recurrences are ubiquitous in the real world and constitute fundamental properties of dynamical systems. Starting with the seminal work of Poincaré in the late nineteenth century (who proved the existence of recurring states in autonomous Hamiltonian systems), the study of recurrences has grown within and across various scientific disciplines. The relatively recent introduction of the recurrence plot (1987) has paved the way for interdisciplinary success stories whereby this simple tool is becoming a unifying force across numerous scientific fields. Indeed, the combined efforts of investigators representing different disciplines are finding common ground with recurrence plots as applied to their specific systems of interest.

On a biannual basis, international symposia on recurrence plots are providing a platform for lively and fruitful debate on both the theoretical and practical domains of recurrence strategies. Unexpected collaborations are being formed that cut across interdisciplinary boundaries. A common vocabulary is being forged which makes “foreign” systems understandable to “strangers” as it were. Starting almost a decade ago, four previous recurrence plot symposia were conducted in Potsdam, Germany (2005); Siena, Italy (2007); Montreal, Canada (2009); and Hong Kong, China (2011).

This volume features 13 selected papers from the Fifth International Symposium on Recurrence Plots in Chicago, Illinois, USA (August 2013). For this particular meeting, special emphases were placed on biological, behavioral, and cognitive systems as well as on the analysis of coupled systems using cross-recurrence methods. These methodological developments and applications highlight the current interest in bivariate and multivariate applications of recurrence analysis to real-world, complex systems.

This book showcases several important examples of the continuing success of recurrence plot strategies across disciplines. Spiegel et al. and Crowley et al. are using recurrence plots to construct novel measures of dissimilarity for multivariate cluster analysis of automotive operational profiles or bivariate detection of dissimilarity between macroeconomic data. Multivariate recurrence-based clustering can also be used to improve the efficiency of brain–computer interfaces as shown by

Uribe et al. and Dos Santos et al. are underscoring the potential of support vector machines based on recurrence quantification measures for the detection of pathological cardiovascular conditions. This strategy is contrasted by Gonz  les et al. who are using traditional recurrence quantifications to compare different variables of the cardiovascular system. Fusaroli et al. are exploring the utility of cross-recurrence analysis to investigate social interactions as well as to delineate crucial challenges and make recommendations for further developments of this approach. Coey et al. and Tolston et al. are studying the complexity of behavioral tasks and examining the coupling of interpersonal coordination by applying cross recurrences. Cross recurrences (besides recurrence networks) are also used by Guhathakurta et al. to study similarities in stock and commodity markets. Sipers et al. are introducing important methodological approaches using recurrence analysis for complex valued signals as well as providing the theoretical foundation for understanding redundancies in recurrence plots. A novel recurrence criterion that can be applied to a special kind of amplitude-varying signals (e.g., for studying transients) is suggested by Ioana et al. Rawald et al. are developing an efficient parallelization scheme for recurrence plot-based calculations, addressing the challenge of recurrence analysis of very long time series.

The papers within this volume represent just a portion of the many other contributions presented at the recurrence plot symposium in Chicago. All such contributions indicate that the applicability of this nonlinear methodology is increasing and that there remains huge potential for interdisciplinary applications, knowledge exchanges, and collaborations. We hope that this volume will encourage the development and application of recurrence plot-based methods in numerous and diverse fields of study.

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