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Patterns of Dynamics

In Honour of Bernold Fiedler's 60th Birthday

Berlin, July 2016

Springer

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Preface

Dynamical systems as a field have had tremendous impact across mathematics and the sciences that goes far beyond the in-depth study and classification of the qualitative behavior of flows and iterations. The dynamical-systems viewpoint has infused areas as diverse as partial differential equations, number theory, cosmology, pattern formation, and, more recently, data assimilation and machine learning. A common theme is the goal of describing phenomena based on laws of evolution, be they fundamental laws of physics or simply ad-hoc rules, using algebraic or analytic language for qualitative and quantitative descriptions.

Bernold Fiedler, whose 60th birthday was celebrated at the conference "Patterns of Dynamics," held during July 25–29, 2016 at the Free University of Berlin, has been a leader in this field. The "dynamical-systems viewpoint" forms a thread that runs through his many research contributions on a vast range of problems; this thread also connects the many current and past members of his active research group. The conference held on the occasion of his 60th birthday featured many of the areas to which Bernold Fiedler has made seminal contributions; in addition, it also offered an outlook toward the future of dynamical systems.

The theme of the conference was *Patterns of Dynamics*. The articles in this volume discuss these structures in areas such as pattern formation, elliptic and parabolic PDEs, numerical algorithms, biology, and data science. They also demonstrate the diverse range of ideas that were communicated at this meeting, connected in many ways to Bernold Fiedler's work.

Dynamics of patterns are at the center of the contributions by Schneider and Zimmermann on Turing patterns in the presence of conservation laws, by Zakharova, Semenova, Anishchenko, and Schöll on noise-induced chimeras in neural networks, and by Herrmann and Matthies on solitary waves in FPU lattices. Scheurle explores patterns in Fourier space with an eye toward imaging. Scheel and Tikhomirov explore disorder in spatial dynamics and its impact on depinning transitions, while Ekström and Schmeling give a timely survey on Fourier dimensions and their role in complex dynamics.

Elliptic equations are of interest from analytic and topological view points in contributions by Recke, Väth, Kucera, and Navrátil on bifurcation in non-differentiable systems, in Butuzov, Nefedov, Omel'chenko, Recke, and Schneider's contribution to the study of singular boundary layers, and in Du and Efendiev's work on multiplicity of solutions in quasi-linear elliptic equations. In time-dependent, parabolic equations, contributions of this volume study convergence to equilibrium using entropic methods (Mielke), weaker convergence concepts in parabolic equations on the real line (Polacik), combinatorial descriptions of attractors through meander permutations (Wolfrum), and singular, non-unique solutions to semilinear heat equations (Fila, Matano, and Yanagida).

Numerical techniques and control of dynamical systems are the main theme of several other contributions. Schneider describes new, noninvasive methods for control of spatially extended dynamical systems. Beyn and Rottmann–Matthes describe main ideas and refinements of a method for the computation of relative equilibria in PDEs, and Böhmer presents results for center manifolds in spatiotemporally discretized parabolic equations.

The dynamical-systems viewpoint in the sciences is illustrated in two contributions: Young's contribution describes a program that explores information processing in the brain, in particular the visual cortex, as a dynamical system, while Rendall presents a study of the Calvin cycle as a dynamical system.

The last three contributions are concerned with data analysis in the sciences and engineering. Turnhoff, Kusch, and Schuppert discuss the role of data in personalized medicine. Verduyn–Lunel summarizes work on analysis of time series using Takens embedding and Wasserstein metrics for finite data sets. Finally, Rajendran, Kattis, Holiday, Kondor, and Kevrekidis propose novel ways of analyzing networks, using appropriately constructed distances between graphs in order to identify low-dimensional structures in data sets of graphs.

The editors of these volumes express their gratitude to everyone who contributed to this volume, including the contributors and referees, and to the sponsors of the conference (including the Deutsche Forschungsgemeinschaft, the Sonderforschungsbereiche 647 and 910, the Freie Universität Berlin, the Technisched Universität Berlin, the Humboldt Universität and the Weierstrass Institute for Analysis and Stochastics).

We are deeply indebted to Bernold Fiedler, as a colleague, mentor, collaborator, and friend.

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