

Article

A New Visualisation and Analysis Method for a Convolved Representation of Mass Computational Experiments with Biological Models

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Abstract: Modern computational biology makes widespread use of mathematical models of biological systems, in particular systems of ordinary differential equations, as well as models of dynamic systems described in other formalisms, such as agent-based models. Parameters are numerical values of quantities reflecting certain properties of a modeled system and affecting model solutions. At the same time, depending on parameter values, different dynamic regimes - stationary, oscillatory, established as a result of transient modes of various types - can be implemented in the system. Predicting changes in the solution dynamics type depending on changes of model parameters is an important scientific task. Nevertheless, this problem does not have an analytical solution for all formalisms in a general case. The routinely used method of performing a series of computational experiments, i.e. solving a series of direct problems with various sets of parameters followed by expert analysis of solution plots is labor-intensive with a large number of parameters and a decreasing step of the parametric grid. In this regard, the development of methods allowing to obtain and analyze information on a set of computational experiments in an aggregate form is relevant. This work is devoted to developing a method for visualization and classification of various dynamic regimes of a model using a composition of the dynamic time warping (DTW-algorithm) and principal coordinates analysis (PCoA) methods. This method allows to obtain a qualitative visualisation of the results of the set of solutions of a mathematical model and to carry out the correspondence between the values of the model parameters and the type of dynamic regimes of its solutions. This method has been tested on the Lotka-Volterra model and artificial sets of various dynamics.

Keywords: visualization; dynamic regime; mathematical model; dynamic time warping; computational experiment

1. Introduction

Modern computational biology is using mathematical models of biological systems, in particular systems of ordinary differential equations (ODE) [1–3] and partial differential equations (PDE) [3,4], as well as models of dynamic systems described in other formalisms, such as agent-based models [5–10], Boolean networks [11,12] and cellular automata [13,14]. Parameters are numerical values of quantities reflecting certain properties of a modeled system and affecting model solutions. At the same time, depending on the parameter values, different dynamic modes - nonstationary, oscillatory,

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The Mathematical-Function Computation Handbook Nelson H.F. Beebe, 2017-08-20 This highly comprehensive handbook provides a substantial advance in the computation of elementary and special functions of mathematics extending the function coverage of major programming languages well beyond their international standards including full support for decimal floating point arithmetic Written with clarity and focusing on the C language the work pays extensive attention to little understood aspects of floating point and integer arithmetic and to software portability as well as to important historical architectures It extends support to a future 256 bit floating point format offering 70 decimal digits of precision Select Topics and Features references an exceptionally useful author maintained MathCW website containing source code for the book s software compiled libraries for numerous systems pre built C compilers and other related materials offers a unique approach to covering mathematical function computation using decimal arithmetic provides extremely versatile appendices for interfaces to numerous other languages Ada C C Fortran Java and Pascal presupposes only basic familiarity with computer programming in a common language as well as early level algebra supplies a library that readily adapts for existing scripting languages with minimal effort supports both binary and decimal arithmetic in up to 10 different floating point formats covers a significant portion with highly accurate implementations of the U S National Institute of Standards and Technology s 10 year project to codify mathematical functions This highly practical text reference is an invaluable tool for advanced undergraduates recording many lessons of the intermingled history of computer hardware and software numerical algorithms and mathematics In addition professional numerical analysts and others will find the handbook of real interest and utility because it builds on research by the mathematical software community over the last four decades

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management e using numerical and graphical methods for describing monitoring data descriptive statistics f understanding and reporting removal efficiencies g recognizing symmetry and asymmetry in monitoring data normal and log normal distributions h evaluating compliance with targets and regulatory standards for effluents and water bodies i making comparisons with the monitoring data tests of hypothesis j understanding the relationship between monitoring variables correlation and regression analysis k making water and mass balances l understanding the different loading rates applied to treatment units m learning the principles of reaction kinetics and reactor hydraulics and n performing calibration and verification of models The major concepts are illustrated by 92 fully worked out examples which are supported by 75 freely downloadable Excel spreadsheets Each chapter concludes with a checklist for your report If you are a student researcher or practitioner planning to use or already using treatment plant and water quality monitoring data then this book is for you 75 Excel spreadsheets are available to download *Life-Cycle Performance of Structures and Infrastructure Systems in Diverse Environments* Chun-Qing Li,Dan M. Frangopol,2025-07-14 Life Cycle Performance of Structures and Infrastructure Systems in Diverse Environments contains the lectures and papers presented at the Ninth International Symposium on Life Cycle Civil Engineering IALCCE 2025 Melbourne Australia 15 19 July 2025 This book includes the full papers of 228 contributions presented at IALCCE 2025 including the Fazlur R Khan Lecture seven Keynote Lectures and 220 technical papers The papers cover recent advances and cutting edge research in the field of life cycle civil engineering including emerging concepts new theories and innovative applications related to life cycle design assessment inspection monitoring repair maintenance rehabilitation and management of structures and infrastructure systems under uncertainty Major topics covered include life cycle carbon assessment of civil infrastructure systems life cycle design and assessment for structures and infrastructure systems life cycle management of civil infrastructure whole life costing life cycle risk analysis and optimization of civil infrastructure and life cycle digital tools for civil engineering among others This open access book provides both an up to date overview of the field of life cycle civil engineering and significant contributions to the process of making more rational decisions to mitigate the life cycle risk and improve the life cycle safety reliability resilience and sustainability of structures and infrastructure systems exposed to diverse environments in a changing climate for the purpose of enhancing the welfare of society It will serve as a valuable reference to all concerned with life cycle of civil engineering systems including students researchers practitioners consultants contractors decision makers and representatives of managing bodies and public authorities from all branches of civil engineering **Federal Register** ,2003-11 *Large-scale and High Performance Computations of Complex Turbulent Reacting Flows* Asghar Afshari,2006 **Energy and Water Development Appropriations for 2016** United States. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development,2015 **Mathematical Reviews** ,2005 **11th International Symposium on High Performance Distributed Computing** ,2002 Forty two full papers from the July 2002 conference in Edinburgh discuss data servers and

grid storage adapting to grid behavior grid resource management applications frameworks parallel application analysis optimizing grid performance grid practice and experience communication and RPC protocols grid job submission and scheduling and adapti **Proceedings of the ... IEEE International Symposium on High Performance Distributed Computing** ,2003 **X-Ray Absorption Fine Structure -- XAFS13** Britt Hedman,Piero Pianetta,2007-03-09 Stanford California USA 9 14 July 2006 **Advances in Human Factors and Ergonomics 2012- 14 Volume Set** Gavriel Salvendy,Waldemar Karwowski,2012-08-06 With contributions from an international group of authors with diverse backgrounds this set comprises all fourteen volumes of the proceedings of the 4th AHFE Conference 21 25 July 2012 The set presents the latest research on current issues in Human Factors and Ergonomics It draws from an international panel that examines cross cultural differences design issues usability road and rail transportation aviation modeling and simulation and healthcare **Cornell University Courses of Study** Cornell University,1994 **AMSTAT News** ,2005 *Proceedings of the 2003 ACM SIGCOMM Internet Measurment Conference* ,2003 Internet Service Providers ISPs can exploit path diversity to balance load and improve robustness Unfortunately it is difficult to evaluate the potential impact of these approaches without routing and topological data which are confidential In this paper we characterize path diversity in the real Sprint network We then characterize path diversity in ISP topologies inferred using the Rocketfuel tool Comparing the real Sprint topology to the one inferred by Rocketfuel we find that the Rocketfuel topology has significantly higher apparent path diversity As a metric path diversity is particularly sensitive to the presence of false or missing links both of which are artifacts of active measurement techniques We evaluate heuristics that improve the accuracy of the inferred Rocketfuel topologies Finally we discuss limitations of active measurements techniques to capture topological properties such as path diversity *International Aerospace Abstracts* ,1999

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