

Comparing Time-Series Clustering Algorithms in R Using the dtwclust Package

Alexis Sardá-Espinosa

Abstract

Most clustering strategies have not changed considerably since their initial definition. The common improvements are either related to the distance measure used to assess dissimilarity, or the function used to calculate prototypes. Time-series clustering is no exception, with the Dynamic Time Warping distance being particularly popular in that context. This distance is computationally expensive, so many related optimizations have been developed over the years. Since no single clustering algorithm can be said to perform best on all datasets, different strategies must be tested and compared, so a common infrastructure can be advantageous. In this manuscript, a general overview of shape-based time-series clustering is given, including many specifics related to Dynamic Time Warping and other recently proposed techniques. At the same time, a description of the `dtwclust` package for the R statistical software is provided, showcasing how it can be used to evaluate many different time-series clustering procedures.

Keywords: time-series, clustering, R, dynamic time warping, lower bound, cluster validity.

1. Introduction

Cluster analysis is a task which concerns itself with the creation of groups of objects, where each group is called a cluster. Ideally, all members of the same cluster are similar to each other, but are as dissimilar as possible from objects in a different cluster. There is no single definition of a cluster, and the characteristics of the objects to be clustered vary. Thus, there are several algorithms to perform clustering. Each one defines specific ways of defining what a cluster is, how to measure similarities, how to find groups efficiently, etc. Additionally, each application might have different goals, so a certain clustering algorithm may be preferred depending on the type of clusters sought (Kaufman and Rousseeuw 1990).

Clustering algorithms can be organized differently depending on how they handle the data and how the groups are created. When it comes to static data, i.e., if the values do not change with time, clustering methods can be divided into five major categories: partitioning (or partitional), hierarchical, density-based, grid-based and model-based methods (Liao 2005; Rani and Sikka 2012). They may be used as the main algorithm, as an intermediate step, or as a preprocessing step (Aghabozorgi *et al.* 2015).

Time-series is a common type of dynamic data that naturally arises in many different scenarios, such as stock data, medical data, and machine monitoring, just to name a few (Aghabo-

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Siddappa N.Byrareddy



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Information Technologies and Intelligent Decision Making Systems Arthur Gibadullin, 2024-04-30 This book constitutes the refereed post proceedings of the Third International Scientific and Practical Conference on Information Technologies and Intelligent Decision Making Systems ITIDMS 2023 held in Moscow Russia during December 12 14 2023 The 18 full papers included in this book were carefully reviewed and selected from 54 submissions The papers presented in this volume focus on topics such as digital intellectual and information transformation the development of computer models and the improvement of automated and computing processes

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Sensing Technology Nagender Kumar Suryadevara, Bobby George, Krishanthi P. Jayasundera, Subhas Chandra Mukhopadhyay, 2023-04-08 This book gathers the latest advances innovations and applications in the field of sensing technology as presented by international researchers and engineers at the 15th International Conference on Sensing Technology ICST held in Sydney Australia on December 5 7 2022 Contributions include a wide range of topics such as vision sensing sensor signal processing sensors phenomena and modelling sensor characterization smart sensors and sensor fusion electromagnetic chemical and physical sensors electronic nose technology biosensors nano sensors wireless sensors and WSN Internet of Things optical sensors sensor arrays intelligent sensing Internet based and remote data acquisition The contributions which were selected by means of a rigorous international peer review process present a wealth of exciting ideas that will open novel research directions and foster multidisciplinary collaboration among different specialists

Protein Kinases, 2021-12-08 For the past two decades the protein kinase family has been an intense area of research for developing anticancer drugs Despite tremendous advancements in kinase drug expansion many kinases are still unexplored As such this book includes research and review articles from experts that focus on protein kinase signalling pathways as a molecular drug target Chapters include illustrations and cover such topics as the mechanism of action and anticancer activity of protein kinase inhibitors on various cancer types They also discuss new opportunities challenges and

future perspectives in the field **German Medical Data Sciences: Visions and Bridges** Rainer Röhrig,Antje Timmer,Harald Binder,Ulrich Sax,2017-09-15 We live in an age characterized by computerized information but ubiquitous information technology has profoundly changed our healthcare systems and if not adequately trained to deal with it healthcare professionals can all too easily be overwhelmed by the complexity and magnitude of the data This demands new skills from physicians as well as novel ways to provide medical knowledge Selecting and assessing relevant information presents a challenge which can only be met by bridging the various disciplines in healthcare and the data sciences This book presents the proceedings of the 62nd annual meeting of the German Association of Medical Informatics Biometry and Epidemiology German Medical Data Sciences GMDS 2017 Visions and Bridges held in Oldenburg Germany in September 2017 The 242 submissions to the conference included 77 full papers of which 42 were accepted for publication here after rigorous review These are divided into 7 sections teaching and training epidemiological surveillance screening and registration research methods IT infrastructure for biomedical research data integration centers healthcare information systems interoperability standards terminologies classification and biomedical informatics innovative algorithms and signal processing The book provides a vision for healthcare in the information age and will be of interest to all those concerned with improving clinical decision making and the effectiveness and efficiency of health systems using data methods and technology

Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management. Human Body, Motion and Behavior Vincent G. Duffy,2021-07-03 This two volume set LNCS 12777 and 12778 constitutes the thoroughly refereed proceedings of the 12th International Conference on Digital Human Modeling and Applications in Health Safety Ergonomics and Risk Management DHM 2021 which was held virtually as part of the 23rd HCI International Conference HCII 2021 in July 2021 The total of 1276 papers and 241 posters included in the 39 HCII 2021 proceedings volumes was carefully reviewed and selected from 5222 submissions DHM 2021 includes a total of 56 papers they were organized in topical sections named Part I Human Body Motion and Behavior Ergonomics human factors and occupational health human body and motion modeling and language communication and behavior modeling Part II AI Product and Service Rethinking healthcare artificial intelligence applications and ethical issues and digital human modeling in product and service design

Machine Learning and Knowledge Discovery in Databases Massih-Reza Amini,Stéphane Canu,Asja Fischer,Tias Guns,Petra Kralj Novak,Grigorios Tsoumakas,2023-03-17 The multi volume set LNAI 13713 until 13718 constitutes the refereed proceedings of the European Conference on Machine Learning and Knowledge Discovery in Databases ECML PKDD 2022 which took place in Grenoble France in September 2022 The 236 full papers presented in these proceedings were carefully reviewed and selected from a total of 1060 submissions In addition the proceedings include 17 Demo Track contributions The volumes are organized in topical sections as follows Part I Clustering and dimensionality reduction anomaly detection interpretability and explainability ranking and recommender systems transfer and multitask learning Part

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Europe in the New World Economy: Opportunities and Challenges Luminita Chivu, Valeriu Ioan-Franc, George Georgescu, Ignacio De Los Ríos Carmenado, Jean Vasile Andrei, 2024-11-25 The transition from traditional economic patterns to a model marked by enhanced efficiency environmental responsibility and the adaptation to a new normal economic philosophy marks a pivotal moment in understanding Europe's economic ecosystem within the new world economy However the reliance on conventional economic philosophies has often overlooked the broader economic and social landscapes in which these paradigms operate This volume explores emerging research topics methodologies and techniques that are essential to understanding the global economy dynamics and growth patterns under crisis circumstances and persistent uncertainties Featuring contributions presented at the 2023 International Conference Economic Scientific Research Theoretical Empirical and Practical Approaches ESPERA held in Bucharest Romania in honor of the 50th Anniversary of the National Institute for Economic Research Costin C Kiritescu of the Romanian Academy this book offers theoretical and practical contributions as well as quantitative and qualitative analyses providing valuable inputs for the design of adequate strategies and policies aimed to address the future challenges and to capitalize on the emerged opportunities From sustainable development to digital innovation this book examines the dynamic landscape of European economics and underscores the significance of interdisciplinary approaches and technological advancements in fostering economic resilience and growth The contents of this book are of interest to scholars researchers students practitioners and policy makers in economics and business transformation

Mathematical Methods for Knowledge Discovery and Data Mining Giovanni Felici, Carlo Vercellis, 2008 Annotation The field of data mining has seen a demand in recent years for the development of ideas and results in an integrated structure Mathematical Methods for Knowledge Discovery Bayesian methods data visualization kernel methods neural networks text speech and image recognition and many others This Premier Reference Source is an invaluable resource for scholars and practitioners in the fields of biomedicine engineering finance and insurance manufacturing marketing performance measurement and telecommunications

Efficient Pattern Discovery in Massive Time Series Databases Li Wei, 2006

Data Warehousing and Mining John Wang, 2008 This collection offers tools designs and outcomes of the utilization of data mining and warehousing technologies such as algorithms concept lattices multidimensional data and online analytical processing With more than 300 chapters contributed by over 575 experts from around the globe this authoritative collection

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