

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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**Guojun Gan, Bohan Li, Xue Li, Shuliang
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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 *Advanced Data Mining and Applications* Guojun Gan, Bohan Li, Xue Li, Shuliang Wang, 2018-12-28 This book constitutes the refereed proceedings of the 14th International Conference on Advanced Data Mining and Applications ADMA 2018 held in Nanjing China in November 2018 The 23 full and 22 short papers presented in this volume were carefully reviewed and selected from 104 submissions The papers were organized in topical sections named Data Mining Foundations Big Data Text and Multimedia Mining Miscellaneous Topics

Multi-disciplinary Trends in Artificial Intelligence Somnuk Phon-Amnuaisuk, Swee-Peng Ang, Soo-Young Lee, 2017-10-25 This book constitutes the refereed conference proceedings of the 11th International Conference on Multi-disciplinary Trends in Artificial Intelligence MIWAI 2017 held in Gadong Brunei in November 2017 The 40 revised full papers presented were carefully reviewed and selected from 82 submissions They are organized in the following topical sections knowledge representation and reasoning data mining and machine learning deep learning and its applications document analysis intelligent information systems swarm intelligence *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

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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 II Networks and graphs knowledge graphs social network analysis graph neural networks natural language processing and text mining conversational systems Part III Deep learning robust and adversarial machine learning generative models computer vision meta learning neural architecture search Part IV Reinforcement learning multi agent reinforcement learning bandits and online learning active and semi supervised learning private and federated learning Part V Supervised learning probabilistic inference optimal transport optimization quantum hardware sustainability Part VI Time series financial machine learning applications applications transportation demo track **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

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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

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Table of Contents Comparing Time Series Clustering Algorithms In R Using The

1. Understanding the eBook Comparing Time Series Clustering Algorithms In R Using The
 - The Rise of Digital Reading Comparing Time Series Clustering Algorithms In R Using The
 - Advantages of eBooks Over Traditional Books
2. Identifying Comparing Time Series Clustering Algorithms In R Using The
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Comparing Time Series Clustering Algorithms In R Using The
 - User-Friendly Interface
4. Exploring eBook Recommendations from Comparing Time Series Clustering Algorithms In R Using The
 - Personalized Recommendations

- Comparing Time Series Clustering Algorithms In R Using The User Reviews and Ratings
- Comparing Time Series Clustering Algorithms In R Using The and Bestseller Lists
- 5. Accessing Comparing Time Series Clustering Algorithms In R Using The Free and Paid eBooks
 - Comparing Time Series Clustering Algorithms In R Using The Public Domain eBooks
 - Comparing Time Series Clustering Algorithms In R Using The eBook Subscription Services
 - Comparing Time Series Clustering Algorithms In R Using The Budget-Friendly Options
- 6. Navigating Comparing Time Series Clustering Algorithms In R Using The eBook Formats
 - ePub, PDF, MOBI, and More
 - Comparing Time Series Clustering Algorithms In R Using The Compatibility with Devices
 - Comparing Time Series Clustering Algorithms In R Using The Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Comparing Time Series Clustering Algorithms In R Using The
 - Highlighting and Note-Taking Comparing Time Series Clustering Algorithms In R Using The
 - Interactive Elements Comparing Time Series Clustering Algorithms In R Using The
- 8. Staying Engaged with Comparing Time Series Clustering Algorithms In R Using The
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Comparing Time Series Clustering Algorithms In R Using The
- 9. Balancing eBooks and Physical Books Comparing Time Series Clustering Algorithms In R Using The
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Comparing Time Series Clustering Algorithms In R Using The
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Comparing Time Series Clustering Algorithms In R Using The
 - Setting Reading Goals Comparing Time Series Clustering Algorithms In R Using The
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Comparing Time Series Clustering Algorithms In R Using The
 - Fact-Checking eBook Content of Comparing Time Series Clustering Algorithms In R Using The

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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