

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

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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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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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