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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Michal Rosen-Zvi

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