DyaDA: An R Package for Dyadic Data Analysis

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ABSTRACT

The current research presents a new statistical software to conduct a wide range of statistical analyses for dyadic interaction data. Specifically, an R package, called DyaDA, is being developed to measure and test different characteristics concerning dyadic interaction. The main aim of the DyaDA package is to provide a free statistical software that includes a wide set of statistical methods developed in fields as ethology, social psychology, communications, family studies, and sociology. These statistical methods cover the study of social phenomena as dominance, social reciprocity, mutual influence and dyadic nonindependence. The common feature of all statistical methods included in the package is that dyads are taken the units of analysis. The statistical software here presented can be useful for those social researchers interested in studying groups from a dyadic perspective.

Author Keywords

Dyadic data analysis, statistical tests, R statistical software, R packages

INTRODUCTION

Social interaction can be defined as any sort of behavior that manifests itself in a group context involving at least two individuals that have an influence on each other (i.e., a dyad). Two different approaches have been proposed to study data emanating from such social interactions: the dynamic and static analyses of social interaction [8]. The dynamic approach is concerned with sequences of behavior over time and seeks to identify patterns and relations between different kinds of events. On the other hand, the static approach assumes stability of behavior over time (i.e., established relationships). The present study is primarily concerned with the static approach because all the statistical procedures here presented assume that patterns of behavior remain unchanged over time.

In the above definition of social interaction the concept of the dyad was mentioned. Dyad is the most basic structure in a group. It represents the unit of analysis adopted in most social interaction studies to explain phenomena as social dominance, social reciprocity and interpersonal perception. In this regard, social scientists often use sociomatrices when analyzing dyadic data.

In the field of ethological research, statistical methods have been proposed to study social dominance, rank order in (near-)linear hierarchies, correlation between sociomatrices, and social reciprocity. Regarding dominance hierarchy, several indices and statistical tests have been developed to measure and test this attribute in groups [3,5]. Other statistical methods have been proposed to rank individuals as a function of the outcomes of dyadic dominance encounters [4,5]. As for reciprocity, interchange, and other social interaction patterns, rowwise matrix correlation indices between two matrices, have been recommended to analyze interaction data. Procedures based on permutation tests have been developed to make statistical decisions [2,6].

In the context of social psychology, interdependence is, beyond all doubt, the main feature of dyadic data analyses. Several statistical methods have been proposed to evaluate nonindependence for different dyadic data structures, including the standard dyadic designs [1] in which each person has one interaction partner and the Social Relations Model [SRM; 10]. Focusing on the SRM, social interaction data can be decomposed into its variance components and, subsequently, actor, partner, and relationship effects can be

estimated by means of a two-way ANOVA. This statistical model also enables social researchers to estimate dyadic and generalized reciprocity as correlation coefficient values [15]. More recently, other measures of social reciprocity based on dyadic discrepancies have been developed to measure and test this social aspect at group, dyadic and individual levels [14].

The main aim of the present study is to develop statistical software that includes some of the statistical methods mentioned above. The performance of the DyaDA package is shown by means of some examples from applied research. This software can be useful for social scientists interested in dyadic data analysis.

THE DYADA PACKAGE

The primary aim in designing the DyaDA package is to provide free statistical software for measuring and testing several types of social structure in dyadic interaction data. An excellent way to achieve this is by writing an R package for these measures and tests. R [12] is a free, open-source statistical computing language and a statistical platform that can be run on Linux, MacOS and Windows. It can be downloaded from the Comprehensive R Archive Network (CRAN) at http://CRAN.R-project.org/. The DyaDA package can be obtained from the authors on request. This package will be also available at the CRAN web page. Once the DyaDA package has been installed, users can load it into the current R work session and use it very easily. One of the main reasons of creating DyaDA as an R package is that social researchers can benefit from the wide variety of powerful tools for statistical computation and graphics integrated in R.

The DyaDA package was firstly thought to consist of statistical methods to study the following social phenomena:

1. Social dominance hierarchies.
2. Rank order in linear hierarchies.
3. Correlation between sociomatrices.
4. Social reciprocity.
5. Dyadic nonindependence.

As regards social dominance hierarchies, the DyaDA package includes functions to measure and test social dominance at different levels of analysis. Specifically, it integrates several procedures to quantify dominance at dyadic (e. g., number of one and two-way dyads), group (e. g., h and h' indices [3]), and individual levels (e. g., David's Scores [5]).

To find a rank order consistent with a linear dominance hierarchy, several functions are implemented in the R package (e.g., I&SI method [4]).

The package also incorporates a number of different functions to assess the association between two sociomatrices by means of the Pearson, Kendall or Spearman rowwise matrix correlation coefficients [2,6]. It also includes statistical methods to test the correlation between two sociomatrices when the effect of a third variable is partialled out [2,7]. Some of the previous correlation indices have been proposed as social reciprocity measures [6], but in the package are also implemented social reciprocity measures based on dyadic discrepancies (e.g. asymmetry indices at group, dyadic and individual levels [14]).Finally, as regards quantifying dyadic interdependence, DyaDA incorporates a set of functions to describe and make statistical decisions for the most used dyadic data structures. For instance, methods to be used in standard dyadic designs [1] and statistical procedures for other structures as round robin and one-with-many designs [9,10].

AN EXAMPLE

In this section an illustrative example is provided in order to demonstrate how the DyaDA package functions. In so doing, data drawn from psychological research are analyzed using this package. Specifically, a sociomatrix containing the interpersonal perceptions of six undergraduate students regarding their partners' contributions to the group performance [13] is used to quantify and test SRM variances and covariances. Then, users can use several DyaDA functions to obtain actor, partners and relationship effects and variances (e.g., *SRM.effects* and *SRM.variances* functions), as well as, estimating statistical significance for the several variances and covariances (e.g., *SRM.within.groups.tTest* function). The following table contains the interpersonal perceptions of the six students as well as the actor and partner effects estimated by means of *SRM.effects* function included in DyaDA:

		Partner						**Actor Effects**
		A	**B**	**C**	**D**	**E**	**F**	
Actor	**A**	-	6	3	2	6	4	1.125
	B	5	-	2	4	6	5	1.583
	C	6	6	-	6	5	1	-1.667
	D	4	6	2	-	4	3	-1.042
	E	6	6	2	3	-	4	.917
	F	6	5	4	2	5	-	-.917
Partner Effects		.125	.417	.167	-.708	.083	-.083	

Table 1. Interpersonal perceptions in the group of six individuals.

These effects show the tendencies of the students to elicit interpersonal perceptions regarding the importance of their partners' contribution to group performance, as well as their

tendencies to receive this assessment regarding their own contribution to the group performance.

The relationship effects can also be obtained by applying the *SRM.effects* function of the DyaDA package. The following table shows the dyadic adjustment for the interpersonal perceptions of contributions to group performance:

		Partner					
		A	**B**	**C**	**D**	**E**	**F**
	A	-	-.842	.408	-.717	.492	.658
	B	-.008	-	-.050	.825	.033	-.800
Actor	**C**	.242	-1.050	-	.075	-.717	1.450
	D	-1.383	.325	2.575	-	-.342	-1.175
	E	.658	.367	-.383	-.508	-	-.133
	F	.492	1.200	-2.550	.325	.533	-

Table 2. Matrix of estimated relationship effects for the dyads in the group of six undergraduate students.

Once the various SRM effects have been estimated, the researcher might well wish to estimate variances and covariances for the interpersonal perception data in the group of six students. It can be done by means of the *SRM.variances* function. DyaDA package also includes *SRM.within.groups.tTest* function that allows researchers to estimate statistical significance for the different variances and covariances obtained by means of the SRM (table 3).

	Estimated	**Standard Error**	**t statistic**	**Two-tailed p value**
Actor variance	-.139	.115	-1.203	.283
Partner variance	1.578	.999	1.579	.175
Relationship variance	1.406	.416	3.380	.020
Actor-partner covariance	.261	.254	1.028	.351
Dyadic covariance	-.178	.416	-.427	.687

Table 3. Matrix of variances and covariances for the round robin data of six undergraduate students. Statistical significances for the variances and covariances are estimated by means of a within-groups t test [11].

Note that the differences in the interpersonal perceptions of the partners' contributions to the group performance can only be explained by the relationship variance, i.e., by the differences in the individuals' adjustments within dyads regarding the evaluation of their partners' contributions.

Generalized and dyadic correlations can also be obtained using the nonindependence package. However, for this illustrative example they are expected to be non-significant, since actor-partner and dyadic covariances are non-significant at the 5% level.

CONCLUSIONS

DyaDA is a free, open-source statistical package for dyadic data analysis. It includes several statistical methods developed in the last years by psychologists, ethologists and other social scientists. Some of these statistical methods are not available in any statistical software. The package is open to incorporate more new statistical procedures than those originally included.

Social researchers can benefit from the powerful of DyaDA package when carrying out their dyadic data analyses and, additionally, they can also use the wide variety of packages and functions that already exists for statistical computation and graphics under the R environment.

Although using the DyaDA package by means of the R command prompt (i.e., Command Line Interface) is fast and highly flexible, it may be difficult to handle for novice users. For this reason we should also develop a friendly interface for using the DyaDA package (i.e., Graphical User Interface). The ultimate goal of this research is, therefore, to make this package more generally available to a wide audience of social scientists interested in dyadic analysis.

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