

Manual for the Blaunet 3 Graphic User Interface Package

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1. INSTALLATION

Blaunet 3 uses a Shiny-based graphical interface. The package currently imports rgl, network, sna, ergm, shiny, and bslib. Required R-package dependencies are installed through the usual R package installation process. Across the Microsoft Windows, Linux, and Mac OS X operation systems, open R (or RStudio) and install Blaunet from CRAN with:

```
install.packages("Blaunet", dependencies = TRUE).
```

2. START BLAUNET GRAPHIC USER INTERFACE PACKAGE

- In R, type:
library(Blaunet)
blaunetgui()
- Blaunet starts with no data loaded. The left sidebar contains the data-loading controls and the inputs for the selected analysis. The main workspace contains vertically arranged cards for the selected analysis, Calculation status, Browse current data, Network Statistics, Graph, and Help. The page can be scrolled vertically so that these sections are not compressed into one browser window.
- Main interface areas

Area	Purpose
Left sidebar	Open attribute/network files, clear the current session, choose an analysis, set variables/options, and click Run.
Analysis card	Displays the result for the currently selected analysis.
Calculation status	Reports the most recent completed calculation and its key settings.
Browse current data	Previews the currently loaded attributes, edge list, and adjacency matrix.
Network Statistics	Displays standard network summaries when a network is loaded.
Graph	Plots the loaded network and degree histograms.
Help	Shows "About" information and provides the two PDF manuals.

3. LOAD AND CLEAR DATA

3.1 Open an Attribute Data

Use "Open attribute file" in the left sidebar. Blaunet 3 currently supports attribute files in .rda, .RData, and .csv formats.

- The first row of a CSV file should contain variable names.
- A node-identification variable is required for the analyses. An ecology/time identifier is optional and is selected separately in the interface when needed.
- An R data file may contain attribute data alone or Blaunet-style data with embedded network information. If embedded network information is present, it becomes available to the network-aware functions.

3.2 Open a Network Data

Use "Open network file" in the left sidebar. Blaunet 3 currently supports network files in .rda, .RData, .csv, .dat, .DAT, .net, and .txt formats. Network data may be supplied as an edge list or an adjacency matrix in the formats recognized by the package loader.

- Attribute and network files can be opened independently and in either order.
- Opening a separate network file replaces the current edge list/adjacency matrix but does not replace the currently loaded attribute data

3.3 Clear All

Click "Clear all" to remove the current attribute and network data, reset the data-source display, and recreate the two file-selection controls. This is the appropriate way to begin a new project in the same Blaunet session.

Blaunet 3 does not require setting working directory for graphical-interface downloads. Results downloaded from the interface are handled by the browser or viewer used to display the Shiny application.

4. BROWSE CURRENT DATA

The Browse current data card provides three tabs: Attributes, Edge list, and Adjacency matrix.

- Attributes displays up to the first 100 rows of the current attribute data.
- Edge list displays up to the first 100 rows of the current edge list.

- Adjacency matrix displays up to the first 100 rows by 100 columns of the current adjacency matrix.

These limits apply only to the on-screen preview. The full loaded data are used for calculations.

5. NETWORK STATISTICS

When a network is loaded, the Network Statistics card provides the following tabs:

- Info – summary information for the current network.
- Density – network density.
- Centrality – out-degree, in-degree, betweenness, closeness, and eigenvector centrality for each node. CSV and RData downloads are available.
- Dyad Census – counts of mutual, asymmetric, and null dyads.
- Reciprocity Index – the proportion of mutual ties among present directed ties using the Blaunet reciprocity definition.
- Triad Census – counts for the 16 directed triad isomorphism classes.
- Global Clustering – the Blaunet global clustering coefficient.
- Local Clustering – the local clustering coefficient for each node. CSV and RData downloads are available.

If no network is loaded, the card displays a message asking the user to open a network file.

6. GRAPH

The Graph card is available when a network is loaded and contains three tabs: Network Graph, Histogram Out-degree, and Histogram In-degree.

6.1 Network Graph

The Network Graph tab allows the user to control the following display options before clicking "Plot Graph":

- Show vertex name.
- Vertex color by an attribute variable or None.
- Vertex size by an attribute variable or None.
- Vertex size by an attribute variable or None.

- Layout: fruchtermanreingold, kamadakawai, spring, circle, eigen, hall, mds, princoord, target, or random.

The graph is drawn only when "Plot Graph" is clicked, so changing an option does not automatically redraw the network.

6.2 Degree Histograms

- "Histogram Out-degree" plots the out-degree distribution.
- "Histogram In-degree" plots the in-degree distribution.

7. ANALYSIS

Blaunet is based on McPherson's Blau space and affiliation ecology framework, in which individuals occupy positions in a multidimensional social space and social entities occupy and compete within niches in that space (McPherson, 1983, 2004; Genkin et al., 2018).

Choose an analysis from the "Analysis" drop-down in the left sidebar. Blaunet 3 provides "Salient Dimensions", "Niche Plot", "Niche Analysis", "Blau Bubble", and "Niche Dynamics". The sidebar changes dynamically so that only options relevant to the selected analysis are shown. After setting the required inputs, click "Run".

7.1 Salient Dimensions

"Salient Dimension Identification" provides a list of candidate variables that are empirically associated with group membership and/or network structure and may be considered as dimensions for subsequent Blau-space analyses (Genkin et al., 2018).

Required/available controls include Node ID, optional Ecology ID and ecology selection, candidate Dimensions, Group affiliations, Categorical variable(s), and Alpha. Alpha defaults to 0.05.

- If a network is loaded, it is included automatically in the salient-dimension procedure.
- If no network is loaded, at least one group-affiliation variable must be selected.
- The output is a table containing the final set of identified salient dimensions. If none are identified at the selected alpha level, Blaunet reports that result explicitly.

7.2 Niche Plot

"Niche Plot" visualizes organizational niches in Blau space, where individuals are located according to their positions on salient sociodemographic dimensions and organizations occupy localized regions from which they recruit members (McPherson, 1983, 2004).

The sidebar provides Node ID, optional Ecology ID and ecology selection, Dimensions, Group affiliations, Dev.range for each selected dimension, optional Weights, Complete cases, Show nodes, and Show network ties. Dev.range defaults to 1.5 standard deviations for each dimension.

- With two dimensions, Blaunet displays a 2D niche plot.
- With three dimensions, Blaunet displays an interactive 3D rgl widget embedded in the Shiny page. The plot can be rotated interactively.
- When network data are loaded, they are available to the niche-plot calculation automatically. Show network ties controls whether ties are displayed; it is a display option rather than a switch that removes the network from the calculation.
- When an Ecology ID is selected, the user can choose all or selected ecology values for the plot.

7.3 Niche Analysis

"Niche Analysis" calculates nodal, dyadic, and niche-level Blau-status measures, with additional network-enhanced measures when network data are included (Genkin et al., 2018). Select Node ID, one or more Dimensions, at least one Group affiliation, Dev.range values, optional Weights, and Complete cases. Ecology ID is optional.

- If a network is loaded, a Network included checkbox appears. It is off by default so that the user explicitly decides whether to include network-based outputs in Niche Analysis.

Results are organized into tabs:

- Object – text representation of the Blau object, with an RData download.
- Nodal Result – nodal Blau-status measures.
- Niche Breadth Summary – lower and upper niche bounds by group/dimension.
- Focal Niche Summary – focal-niche membership and overlap measures.
- Niche by Niche Summary – niche overlap/competition information.
- Dyadic Result – shown only when Network included is selected.

- Correlation Matrix – correlation output for the selected analysis variables and, when included, network measures.

Tabular results can be downloaded as CSV and RData files.

7.4 Niche Dynamics

Niche dynamics analysis builds on the affiliation ecology view that competition for members creates pressures for organizational niches and group composition to change over time (McPherson, 1983, 2004; McPherson and Ranger-Moore, 1991; McPherson and Rotolo, 1996).

The sidebar includes Dynamics type, Dev.range, optional Weights, Complete cases, and category-count controls for the two selected dimensions.

Category counts default to 10 when the data range supports 10 categories; the interface constrains the maximum to a value supported by the selected dimension.

7.4.1 Cross-sectional Niche Dynamics

Cross-sectional mode estimates carrying capacity, membership rate, and intensity of exploitation for one selected ecology (or for all data when no Ecology ID is supplied). Results are displayed in the following tabs:

- Carrying Capacity – interactive 3D surface.
- Membership Rate – interactive 3D surface.
- Intensity of Exploitation – interactive 3D surface based on the fitted polynomial model.
- Table – combined carrying-capacity, membership-rate, and intensity results, with CSV/RData downloads.
- Intensity Equation – coefficients from the fitted intensity model.
- Dimension Frequencies – frequency tables for the two categorized dimensions.

7.4.2 Longitudinal Niche Dynamics

Longitudinal mode requires an Ecology ID representing the ordered ecology/time values and uses all of those values. Blaunet estimates niche movement between consecutive periods for each selected group and provides additional summaries of niche trajectories, niche breadth, group growth and membership turnover, and model fit.

The longitudinal results are organized into the following tabs: Predicted Niche Movement, Equation for the first dimension, Equation for the second dimension, Niche Trajectory, Niche Breadth Dynamics, Group Growth & Turnover, Observed vs Predicted, and Dimension Frequencies. The Predicted Niche Movement table can be downloaded as CSV or RData. The longitudinal calculation retains the Blaunet niche-opportunity approach used in the original package (McPherson and Ranger-Moore, 1991; Genkin et al., 2018): the two selected dimensions are categorized within periods, niche opportunity is evaluated around the group location, and observed movement is regressed on predicted opportunity.

- Blaunet 3 adds four longitudinal summaries and diagnostics without replacing the original niche-movement equations: Niche Trajectory – select a Group to display its niche center across the ordered ecology/time values in the two selected dimensions. The plot connects consecutive niche centers and labels them by ecology/time; the accompanying table reports group size, membership rate, and the niche center on both dimensions. This provides a direct view of organizational movement through Blau space (McPherson and Ranger-Moore, 1991).
- Niche Breadth Dynamics – select a Group and Dimension to plot niche breadth over time. The first table reports group size, dimension-specific standard deviation, lower and upper niche bounds, breadth on each dimension, and two-dimensional niche area. A second table reports changes in breadth and niche area between consecutive periods. These outputs make it possible to examine changes in group heterogeneity and niche specialization or generalization (McPherson and Rotolo, 1996).
- Group Growth & Turnover – select a Group to plot its observed membership rate over time. The displayed tables report group size and membership rate by period, changes between consecutive periods, and, when Node ID identifies the same individuals across adjacent periods, matched-ID counts of retained members, exits, entrants, stable nonmembers, retention rate, recruitment rate, turnover rate, and net membership change. These summaries support analysis of recruitment, retention, and organizational composition (McPherson, Popielarz, and Drobnic, 1992; McPherson and Rotolo, 1996).
- Observed vs Predicted – select either dimension to compare observed niche movement with movement predicted by the existing longitudinal equation. The plot places observed values against predicted values with a 45-degree reference line. The diagnostics table

reports N, RMSE, MAE, correlation, and R-squared, and the detailed table reports observed, predicted, and residual movement for each group-period transition.

Important: membership-turnover results should be interpreted only when Node ID is a stable longitudinal identifier for the same individual across ecology/time values. For repeated cross-sectional data, apparent matches in numeric IDs do not by themselves establish individual retention, exit, or entry.

7.5 Blau Bubble (Proximity) Analysis

Blau Bubble analysis measures proximity between individuals in a mixed continuous/categorical Blau space without requiring organizational niche membership (Genkin et al., 2018). Select Node ID, optional Ecology ID, one or more Dimensions, identify the Categorical dimension(s), and set the Radius. The default radius is 0.33.

- Categorical dimensions contribute a 0/1 mismatch distance; continuous dimensions are standardized before the combined Blau distance is calculated.
- If network data are loaded, network-enhanced measures are added automatically to the relevant Blau Bubble outputs.

Results are organized into four tabs:

- Blau Distance Matrix – pairwise Blau-space distances.
- Blau Bubble Matrix – whether each pair falls within the selected radius.
- Blau Bubble List – pairs of nodes in the same Blau bubble and their distance, plus network measures when available.
- Nodal Bubble List – the number/list of alters in each node's Blau bubble and additional network coincidence measures when network data are available.

The interface previews up to the first 100 rows for long tables; downloads use the full result.

8. CALCULATION STATUS

The "Calculation Status" summarizes the most recent completed analysis. Depending on the selected analysis, it reports items such as the source file, number of rows used, selected dimensions/groups, ecology or time information, category counts, alpha, radius, and whether network measures were used. It shows "No calculation has been run" before any analysis.

9. HELP

- About Blaunet – opens a dialog showing the package title, version, authors, maintainer, description, license, CRAN repository label, Blaunet Users Facebook group, and funding information.
- Graphic Package Manual (PDF) – downloads this graphical-interface manual when it is installed with the package.
- Command Line Manual (PDF) – downloads the command-line manual when it is installed with the package.

10. EXAMPLE DATA

10.1 BSANet.rda

- *BSANet.rda* is a small dataset containing 10 individuals in two non-overlapping locations (New York and San Francisco), created solely to illustrate the functions of the Blaunet package. It contains demographic information such as the individuals' age, education, and income; group affiliation information of memberships in a liberal or conservative organization (or both); and network information among the 10 individuals available in both adjacency matrix and edge list formats.

10.2 gss74_87.rda

- The *gss74_87.rda* dataset excerpted from the General Social Survey, 1972-2012, available from both the Interuniversity Consortium for Political and Social Research (ICPSR) website (<http://www.icpsr.umich.edu/icpsrweb/NACJD/studies/34802>) and the NORC website (<http://gss.norc.umd.edu/get-the-data/>). The demographic information includes the education level and occupational prestige scores of 13,865 respondents surveyed in 1974, 1975, 1977, 1978, 1980, 1983, 1984, 1986, and 1987; and the group affiliation information includes membership in 16 types of organizations. This is the dataset used in McPherson and Ranger-Moore (1991) though the number of cases used in the paper and in the example dataset is different.

10.3 Schlattr.Rda & Schlnet.Rda

- This data includes a set of 100 respondents is randomly drawn from the wave I public use data of National Longitudinal Study of Adolescent to Adult Health (Add Health), available from the Interuniversity Consortium for Political and Social Research (ICPSR) website (<http://www.icpsr.umich.edu/icpsrweb/DSDR/studies/21600>). The *schlattr.rda* file includes demographic information for 20 individual characteristics; and the group affiliation information for memberships in 5 kinds of organizations. The *schlnet.rda* file contains artificial network information that is simulated from an exponential family random graph (ERG) model.

10.4 TwoCities.rda

- The *TwoCities.rda* dataset is excerpted, with permission, from the Social Capital Benchmark Survey, which was collected by Professor Robert D. Putnam of the Saguaro Seminar: Civic Engagement in America, a project of the John F. Kennedy School of Government at Harvard University and numerous community foundations nationwide, and made available through the Roper Center for Public Opinion Research. The dataset contains 1,008 individuals from two cities in the United States: Bismarck, North Dakota, and Grand Rapids, Michigan. The demographic information includes 4 individual characteristics – age, income, education level, and work time; and the group affiliation information includes membership in 18 voluntary organizations. There are also six other assorted variables.

More details on the key variable types (node.ids, ecology.ids, attributes, groups) as well as whether the dataset has a network component are summarized in Table 1 on the next page.

11. REFERENCES

- Genkin, Michael, Cheng Wang, George Berry, and Matthew E. Brashears. 2018. "Blaunet: An R-based Graphical User Interface Package to Analyze Blau Space." *PLoS ONE* 13(10): e0204990
- McPherson, J. Miller. 1983. "An Ecology of Affiliation". *American Sociological Review* 48(4): 519–532.

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- McPherson, J. Miller, and James R. Ranger-Moore. 1991. "Evolution on a Dancing Landscape: Organizations and Networks in Dynamic Blau Space." *Social Forces* 70(1): 19-42.
- McPherson, J. Miller, Pamela A. Popielarz, and Sonja Drobnic. 1992. "Social Networks and Organizational Dynamics." *American Sociological Review* 57(2): 153–170.
- McPherson, J. Miller, and Thomas Rotolo. 1996. "Testing a Dynamic Model of Social Composition: Diversity and Change in Voluntary Groups." *American Sociological Review* 61(2): 179–202.

Table 1: Details of the four example datasets.

Dataset	Node.ids	Ecology.ids	Attributes		Groups	Network
			<i>Continuous (Dimensions)</i>	<i>Categorical</i>		
<i>BSANet.rda</i>	person	city	age, income, educ		grp_conservative, grp_liberal	Yes
<i>gss74_87.rda</i>	ID	YEAR	PRESTIGE, EDUC		MEMFRAT, MEMSERV, MEMVET, MEMPOLIT, MEMUNION, MEMSPORT, MEMYOUTH, MEMSCHL, MEMHOBBY, MEMGREEK, MEMNAT, MEMFARM, MEMLIT, MEMPROF, MEMCHURH, MEMOTHER	No
<i>schlattr.rda & schlnet.rda</i>	id		age, ppvt, pmaturity, bmi, happy, depressed, physicalattract, personalityattract, houseincome, parenteduc	female, white, black, indian, asian, other, grade, bornus, languagehome, religion	studygroup, artisticgroup, sportteam, religiongroup, ganggroup	Yes
<i>TwoCities.rda</i>	respID	samp	age, income, educ, worktime, trust, friends, divrsity	gender, race, ideo	grprel, grpsport, grpyouth, grppta, grpvet, grpnei, grpeld, grpsoc, grplab, grpprof, grpfrat, grpeth, grppol, grpart, grphob, grpself, grpwww, grpothr	No