GraphVar: A user-friendly toolbox for comprehensive graph analyses of functional brain connectivity.

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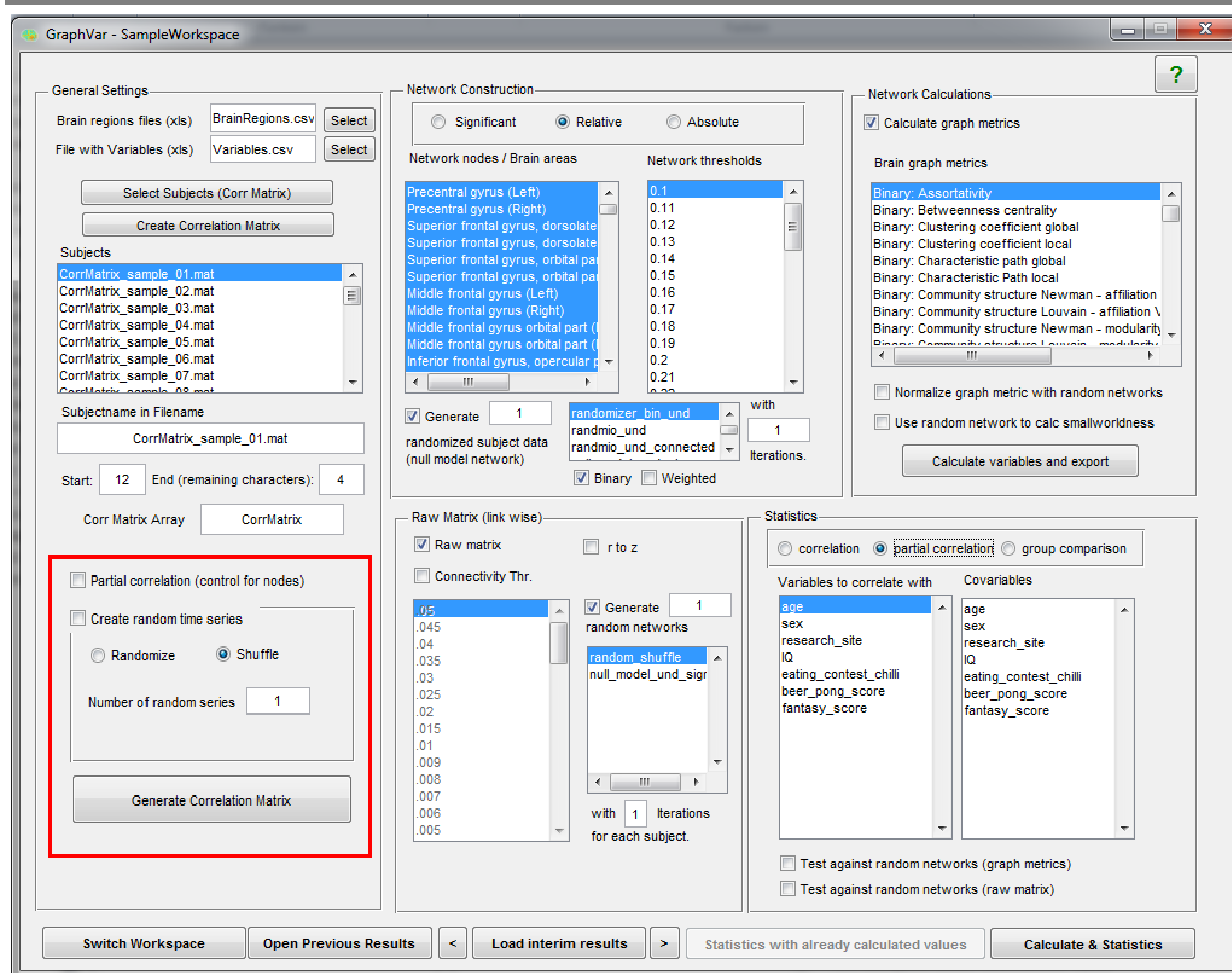
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INTRODUCTION

- Graph theory provides a powerful formalism for comprehensive description of global and local topological network properties of functional brain connectivity (Bullmore and Sporns, 2009; Rubinov and Sporns, 2010).

- Recently developed software packages such as the Brain Connectivity Toolbox (Rubinov and Sporns 2010) have contributed to graph theory's increasing popularity for characterization of functional brain networks.

- However, most current software packages are command-line based and may require some programming experience. This precludes their use by many users without a computational background, including psychologists and physicians, whose research could otherwise benefit from graph-theoretical methods.

METHODS

- Here we developed "GraphVar", a user-friendly graphical-user-interface (GUI)-based toolbox for comprehensive graph-theoretical analyses of brain connectivity, including network construction and characterization, statistical analysis on network topological measures, and interactive exploration of results.

- By combining together features across multiple current toolboxes, such as the Brain Connectivity Toolbox, the Graph Analysis Toolbox, and the Network Based Statistic Toolbox (BCT, Rubinov and Sporns 2010; GAT, Hosseini et al., 2012; NBS, Zalesky et al., 2010), GraphVar represents a comprehensive collection of graph analysis routines for functional neuroimaging researchers.

SETUP AND FEATURES

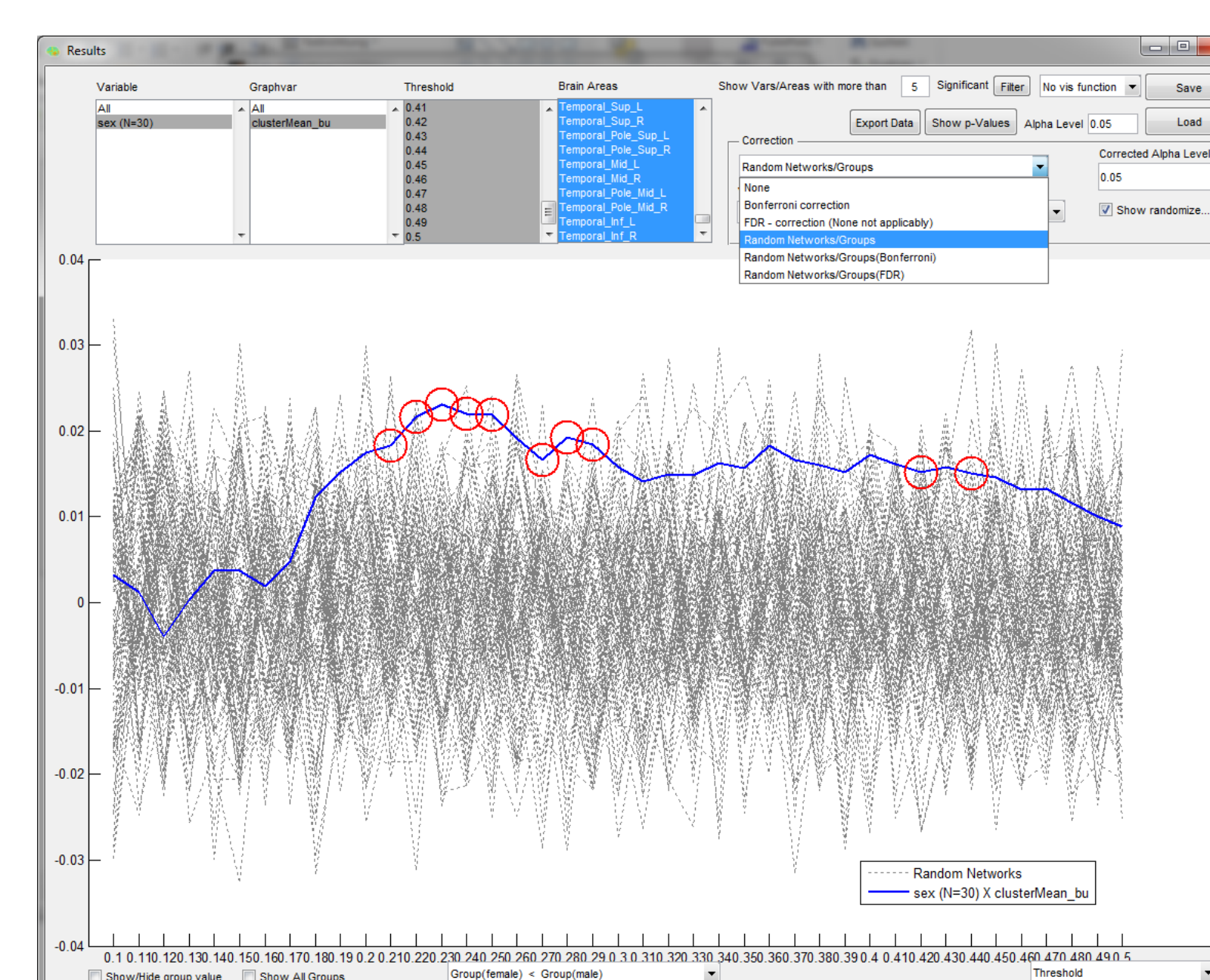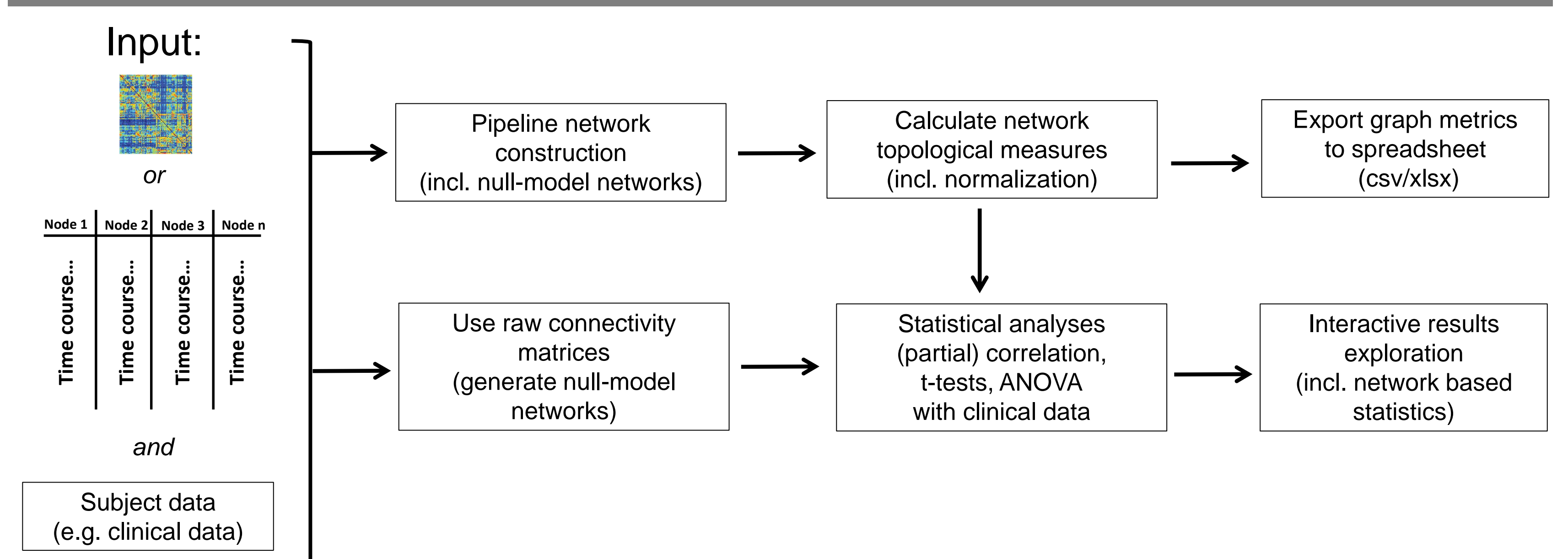## WORKFLOW AND RESULTS EXPLORATION

Figure 1 : x-axis: thesholds/ y-axis: correlation/ blue line: original networks/ grey lines: random networks

- GraphVar offers an interactive viewer that allows intuitive exploration of statistical results as well as entails correction methods for multiple comparisons, including Bonferroni correction and false discovery rate.

- Results can easily be exported (csv/xlsx), saved, and reloaded.

- The program entails a detailed manual that includes usage instructions and a description of all the implemented functions.
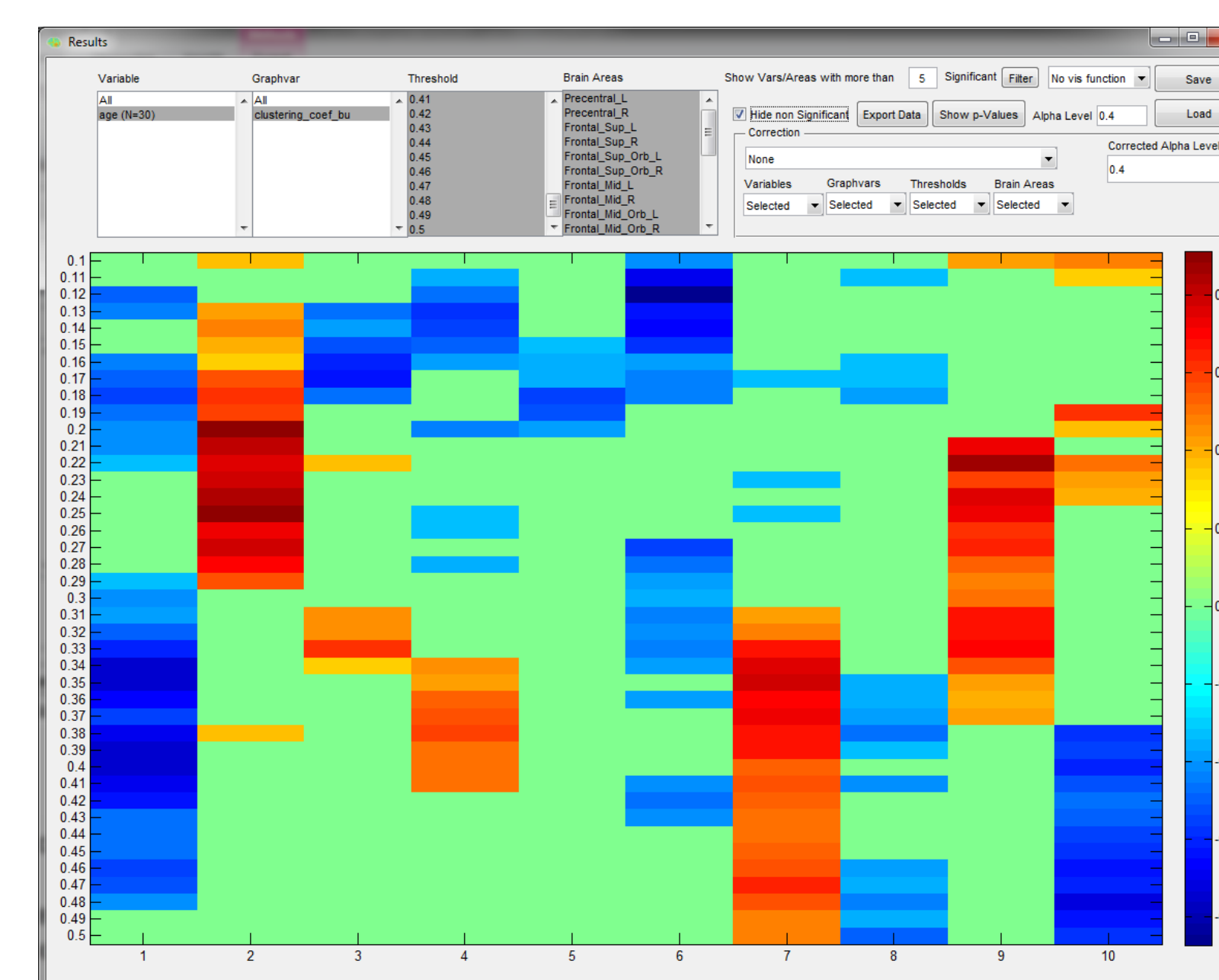
- GraphVar is a GUI-based toolbox which runs MATLAB (MathWorks, Inc.) but does not require any programming experience from the user.

- GraphVar contains most functions included in the Brain Connectivity Toolbox, and allows users to add custom functions which can subsequently be accessed via the GUI.

- GraphVar accepts correlation matrices as input and can also generate correlation or partial correlation matrices from input time series. The user may also input demographic, clinical and other subject specific data (in spreadsheet format) for statistical analyses.

Toolbox features:

- Generate correlation or partial correlation matrices from input time series
- Pipeline construction of graph networks
- Generate subject specific null-model networks
- Perform sub-network analyses
- Calculation, normalization, and export of binary and weighted network measures

- _Statistical analyses_:

  - Correlation and partial correlation analyses and group comparisons (t-test, ANOVA) on the network measures _but also_ on the raw connectivity matrices (i.e., network based statistics including identification of graph components)
  - Statistical testing in parametric and non-parametric fashion (i.e., testing against null-model networks, non-parametric permutation testing)

Figure 2 : x-axis: nodes/ y-axis: thresholds/ colour: correlation

Figures results exploration:

- **Fig 1:** example non-parametric correlation testing with random networks and global clustering coefficient across densities
- **Fig 2:** example correlation testing with local clustering coefficient in 10 brain regions across densities
- **Fig 3:** example results of a group comparison on the raw correlation matrices
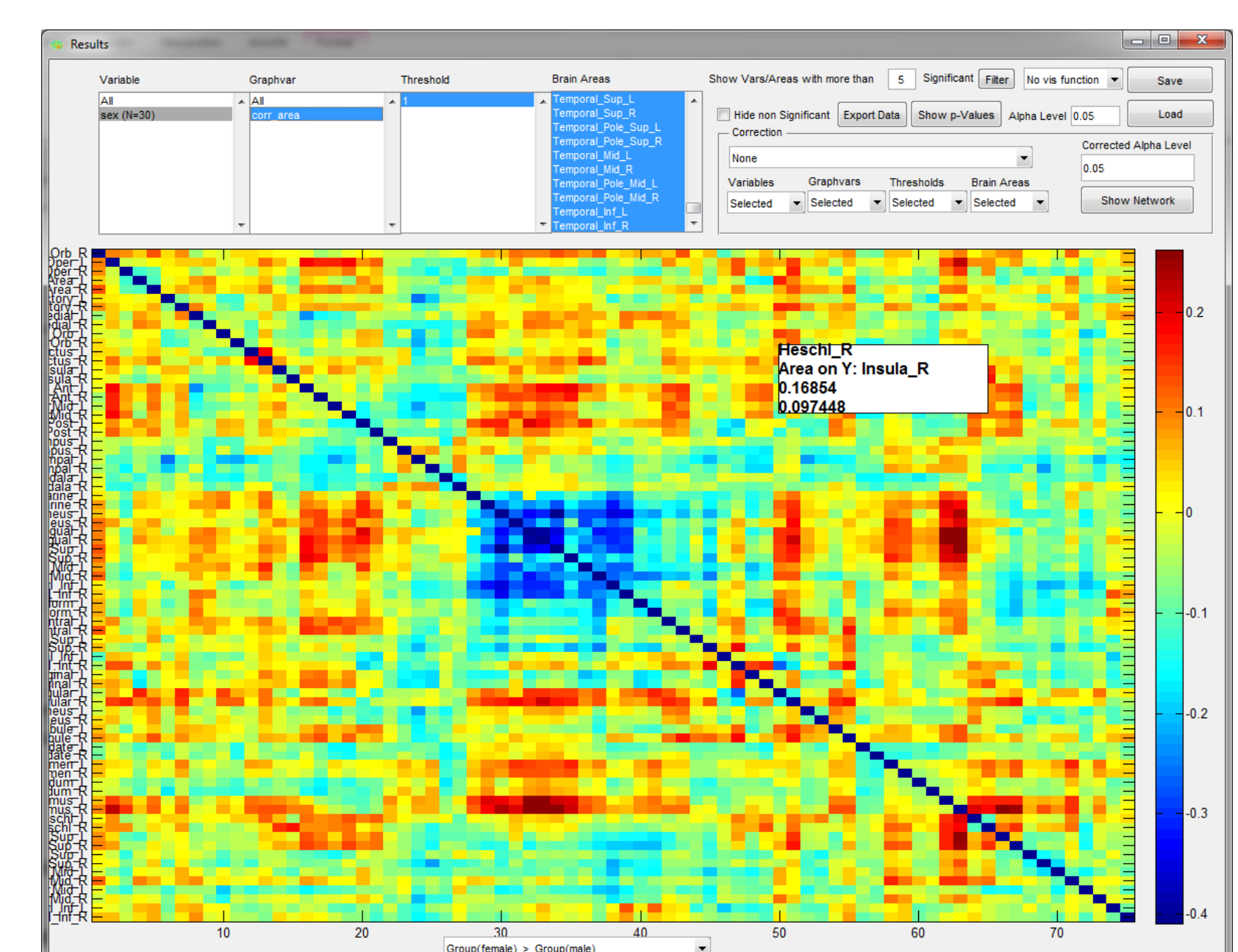- **Fig 4:** "network inspector" which may be used to identify graph components

Figure 4: left: probability table/ right: graph component

Figure 3 : x-axis: nodes/ y-axis: nodes/ colour: group difference

CONCLUSIONS

for beta testing please email to: _johann.kruschwitz@charite.de_

- GraphVar is a new comprehensive and user-friendly toolbox for easy pipeline network construction, graph analysis, statistical analysis on network topological measures, network based statistics, and interactive results exploration.
- The availability of such comprehensive network analysis tools may increase the accessibility of graph-theoretical connectivity to neuroimaging researchers.

REFERENCES

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