BiMat Analysis GUI Guide

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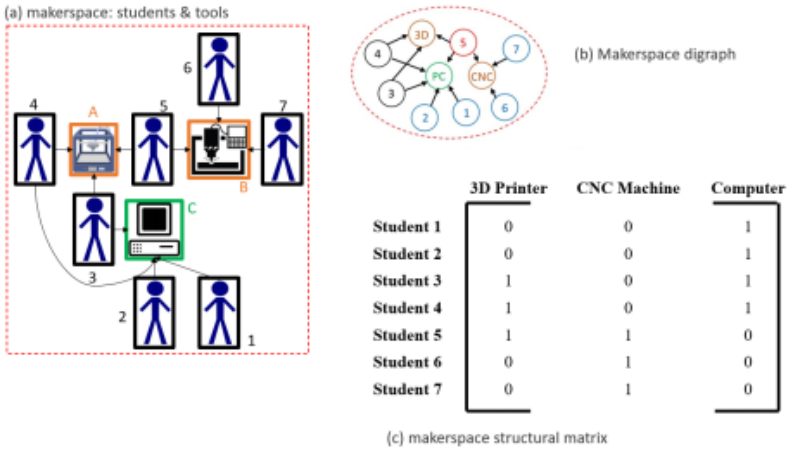
System Requirements and Expectations

- MATLAB® 2021a. This GUI may work in previous or newer versions but was not tested on them.
  - Verify that the version of MATALB being used has the AppDesigner Library
  - It is a common error within this program to be missing the nansum() function. If this happens, its recommended that that MATLAB is reinstalled.
- The user is expected to have basic MATLAB® knowledge.
- The user is also expected to have a basic understanding of the Bipartite analysis being done, such that the vocabulary used is not foreign.
- If the user has any questions regarding the GUI and its functions, then contact Carson Kennedy at cmk012000@gmail.com
- Read the “BiMat: Start Guide” within the “BiMat-Master” Folder of the program for an extensive documentation for the BiMat Library.
- Visit the BiMat git hub at https://bimat.github.io/ for even more documentation regarding the BiMat Library

Introduction

A bipartite network is a representation of the interactions between the column and row nodes. A value of one or zero is used to quantitatively represent the interactions in a matrix form, where a one represents an interaction and a zero represents no interaction. See Figure 1 for an example of how a bipartite matrix is created. In the future it is a goal to be able to use magnitudes within the bipartite analysis, but this GUI and the BiMat Library cannot currently analyze a bipartite matrix with magnitudes.



	3D Printer	CNC Machine	Computer
Student 1	0	0	1
Student 2	0	0	1
Student 3	1	0	1
Student 4	1	0	1
Student 5	1	1	0
Student 6	0	1	0
Student 7	0	1	0

Figure 1: Bipartite network analysis for tools and student interactions [1].

The modularity analysis consists of two major steps: Partitioning the modules and calculating the P-value and z-score. Using the methods detailed in *"Using A Modularity Analysis to Determine Tool and Student Roles within Makerspaces"* [1], the MATLAB package BiMat allows for the corresponding analysis of a bipartite matrix. One important part of this document is the explanation of how BiMat can use a few different modularity algorithms that define the modules and the standard modularity metric. This paper also explains how the P and Z values are defined, as well as an example as to how the modularity is determined using the Leading Eigenvector Method for optimization.

The BiMat software used within this GUI was developed by: Cesar O. Flores, Timothee Poisot, Sergi Valverde, and Joshua S. Weitz. "BiMat: a MATLAB(R) package to facilitate the analysis of bipartite networks."

Algorithms in BiMat were first developed in the following publications:

- NODF algorithm: Mario Almeida-Neto, Paulo Guimaraes, Paulo R. Guimaraes Jr, Rafael D. Loyola, and Werner Ulrich. "A consistent metric for nestedness analysis in ecological systems: reconciling concept and measurement." Oikos, 117(8):1227-1239, 2008.
- NTC algorithm: Wirt Atmar and Bruce D. Patterson. "The measure of order and disorder in the distribution of species in fragmented habitat." Oecologia, 96:373-382, 1993.
- Adaptive Brim Algorithm: Michael Barber. "Modularity and community detection in bipartite networks." Physical Review E, 76:066102, 2007.
- LP&Brim algorithm: Xin Liu and Tsuyoshi Murata. "Community Detection in Large-Scale Bipartite Networks." Proceedings of the International Conference on Web Intelligence and Intelligent Agent Technology, 1: 50-57, 2009.
- Leading Eigenvector Algorithm: M. E. J. Newman. "Modularity and community structure in networks." Proc Natl Acad Sci, 103: 8577-8582, 2006.

To take the modularity analysis one step further the nodes are assigned a P-value and z-score. The Z-score quantifies the intra-module degree of interactions. For example, if many students that use the same set of tools are also all using the laser cutter, the laser cutter would have a high connectivity value. Whereas the P-Value quantifies the intra-module degree of interactions. For example, two nodes with the same z-score will probably play different roles if one of them is connected to several nodes in other modules while the other is not. From there the two degrees of interactions can be placed onto a scatter plot that groups them into seven different roles: Non-Hubs - Ultra-peripheral nodes ($P \simeq 0.02$), Peripheral nodes ($0.02 > P < 0.625$), Non-hub connectors ($0.625 >= P < 0.8$), Non-hub kinless nodes ($P > 0.8$) and Hubs - Provincial hubs ($P < 0.3$), Connector hubs ($0.3 >= P < 0.75$), Kinless hubs ($P > 0.75$). Below this scatter plot and the different regions can be seen in Figure 2. See *"Using A Modularity Analysis to Determine Tool and Student Roles within Makerspaces"* [1] and *"Cartography of complex networks: modules and universal roles"* [4] for a detailed description of how to obtain the P and Z values as well as how to define the roles and their importance.

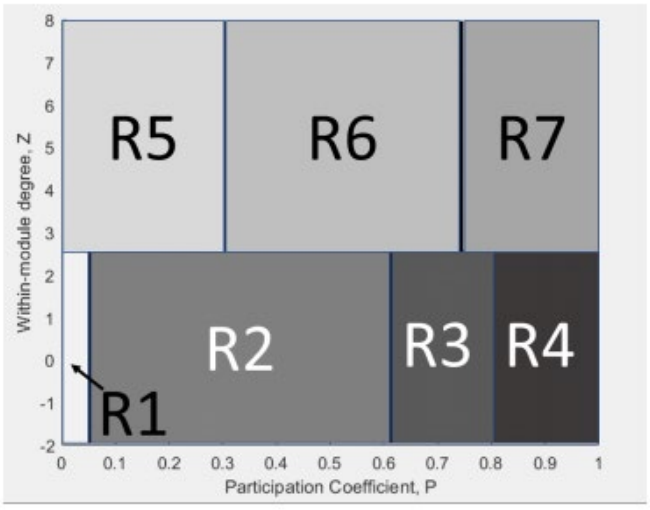


Figure 2: Modularity analysis sectioning determined by connectivity (z) and participation (p) values. Figure from [1].

"For networks of species interactions, nestedness occurs when specialist species tend to interact with proper subsets of the species that interact with more generalist species [5]." This paper explains how the NODF method calculates the Nestedness for the rows, column, and the collective matrix. Calculating this nestedness also requires that the bipartite matrix is optimized to be that the columns with the largest sum should be placed furthest to the left, and that the row with the largest sum are placed closest to the Top. The NODF method then splits the column and rows up into pairs and calculates their nestedness. From there, the nestedness of the column and row pairs were averaged to create the average nestedness amongst rows and columns. Then the two can be averaged into the nestedness metric for the collective matrix.

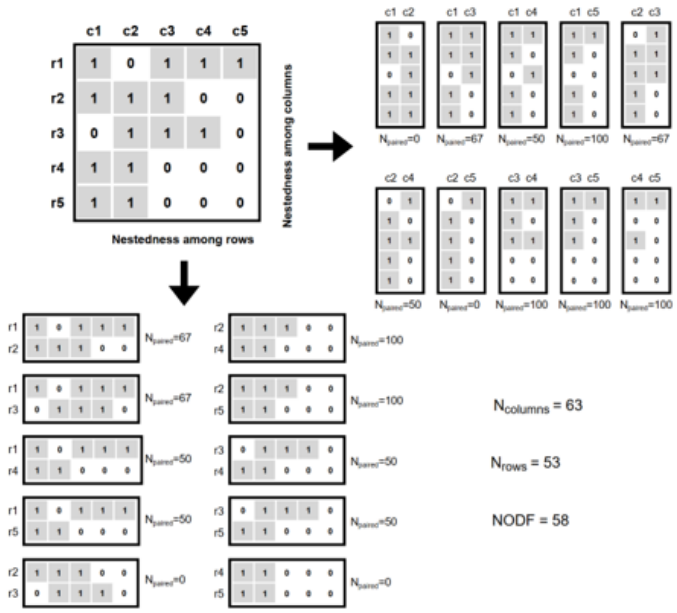


Figure 3: Illustration of the way by which nestedness is quantified according to NODF [2].

Summary of the Guide

The purpose of this guide is to assist in the installation and operation of the GUI, as well as provide a summary of each individual function within the program. The GUI is a visual way of running the BiMat analysis on nestedness and modularity of bipartite networks. These networks can be entered manually into the program by using the Input Step (A.2.3) or by creating a new preformatted sheet with Section (A.4). For a detailed description of how the BiMat analyzes the data see the extended documentation of the BiMat library on: http:bimat.github.io/ as well as the BiMat Start Guide within the BiMat-Master folder. This is also the folder that contains the scripts that run the analysis and used for variable definition or operations within this GUI.

The results of this analysis are shown in many ways throughout the program. The most important results are featured in the Tabs window on the right side of the GUI. These results are split into 4 major tabs and a fifth used for comparison. The General properties tab shows the basic information about the bipartite matrix that is being analyzed like its size, connectance, and number of interactions.

Next, the Modularity tab displays the general modularity statistics like Number of modules and the Standard Modularity metric for whichever algorithm is selected. These metrics are defined using the "detect" function within the "LPBrim.m", "LeadingEigenVector.m", or "AdaptiveBrim.m" script in combination with the "detect" function within the "BipartiteModularity" script. The contents of these modules themselves can also be shown using the "Show Modules" button on this tab. The button opens a separate window that allows for a module to be selected and shown.

The third tab is the P and Z tab, which is the most complex as it shows the general results within the tab and open the separate P and Z page. The information shown on this tab is the name, p value, z score, and role for each individual element. Specifically for the rows or columns exclusively because the P and Z values are defined using only the rows or only the columns. The "Modules Switch" is used to toggle between the row and column elements. Clicking on the Plot Button opens the P and Z page in a separate window. This window shows the same elements as the original P and Z tab but ordered into columns based on their roles, as well as plots each element on a scatter plot based on their P and Z values. This plot shows how the roles are defined by grouping the P and Z values.

The Nestedness tab shows the nestedness values for the rows, columns, and the collective matrix. These metrics are defined using the "detect" function within the "Nestedness.m" script. It is also possible to view the nested matrix on this tab by using the "View Nested Matrix" button. This shows the bipartite matrix rearranged into the most nested matrix possible using the "SORT_MATRIX" function within the "MatrixFunctions" script.

The last tab is the Compare tab this tab allows for a quick comparison between different bipartite matrices by displaying the results from the major four tabs in one column. This table is only cleared once the program is closed.

The GUI is also capable of displaying four different graphs from the "PlotWebs.m" function with their prospective functions. These graphs include the Modular Graph, Matrix, Modular Matrix, and Nested Matrix. They can be viewed one at a time with the generate tab or all at once with the view all graphs button, which requires that the "Export" button has been clicked with the "Export Plots" checkbox checked.

To use these results outside of the GUI, the Export Panel can be used to save all the results to a specified excel sheet and tab. This export includes all the results from the main four tabs being saved in the excel sheet, as well as saves an image of the four plots in the “Graphs” folder within the “Results” folder.

References

1) S. E. Blair, & Banks, H. D., & Linsey, J. S., & Layton, A., " Modularity Analysis of Makerspaces to Determine Potential Hubs and Critical Tools in the Makerspace," ASEE Virtual Annual Conference, 2022.
2) S. E. Blair, & Banks, H. D., & Linsey, J. S., & Layton, A., "Bipartite Network Analysis Utilizing Survey Data to Determine Student and Tool Interactions in a Makerspace," ASEE Virtual Annual Conference, 2021.
3) C. Brehm, J. Linsey, and A. Layton, "Using a Modularity Analysis to Determine Tool and Student Roles within Makerspaces," presented at the 2020 ASEE Virtual Annual Conference, Virtual Online, June 22-26, 2020, 29636
4) R. Guimerà and L. A. N. Amaral, "Cartography of complex networks: modules and universal roles," Journal of Statistical Mechanics: Theory and Experiment, vol. 2005, no. 02, p. P02001, 2005/02/02 2005, doi: 10.1088/1742-5468/2005/02/p02001
5) Almeida-Neto, M., Guimarães, P., Guimarães, P.R., Jr, Loyola, R.D. and Ulrich, W. (2008), A consistent metric for nestedness analysis in ecological systems: reconciling concept and measurement. Oikos, 117: 1227-1239.

Table of Contents

A: Program Operation

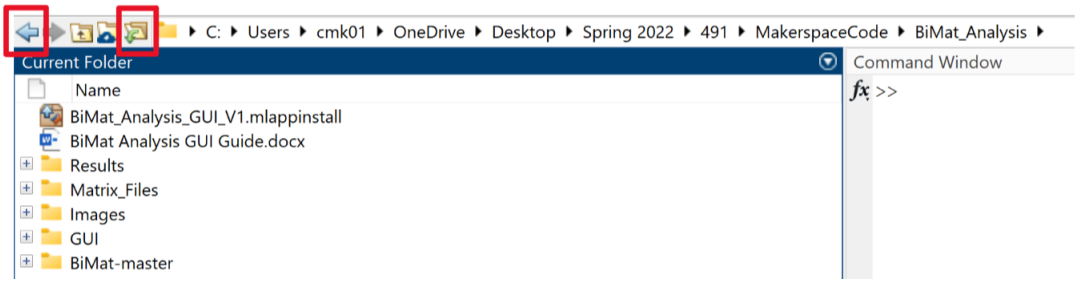
1 Installing App

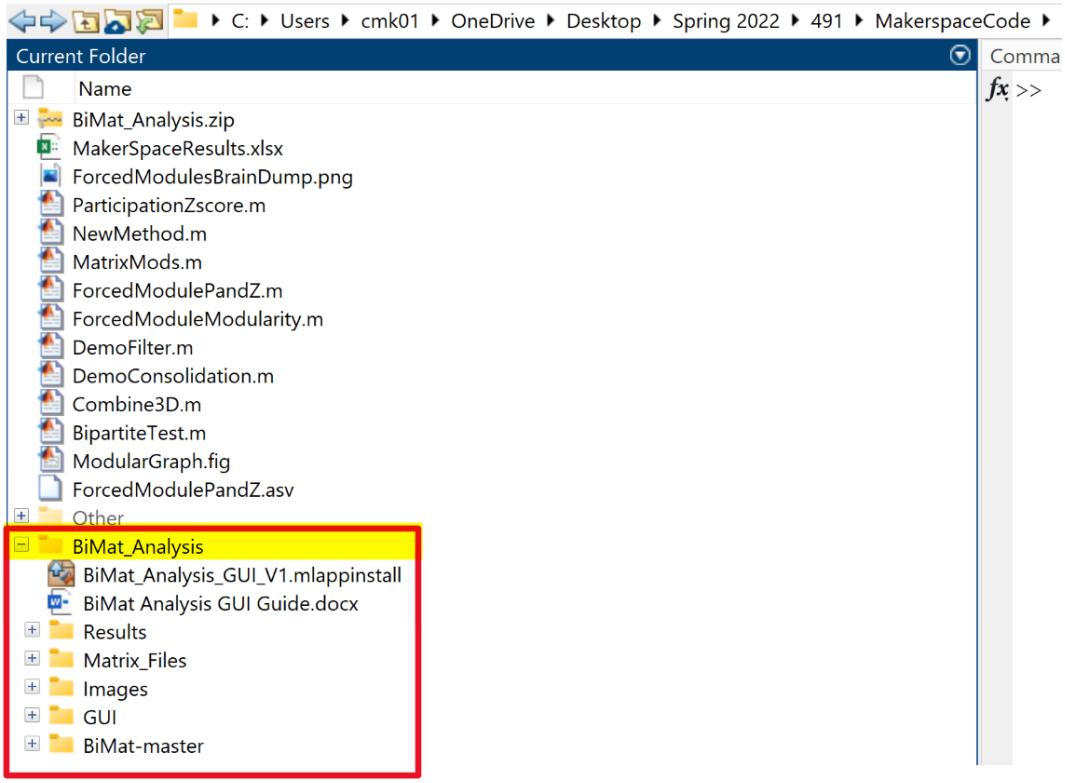
I. Download and Unzip the “BiMat_Analysis” folder to a specific location on your computer

II. Open this folder in your MATLAB directory. Not the actual “BiMat_Analysis” folder, specifically the folder that you put it in. Otherwise, the export functions will not be able to locate their destination

   a. The open folder button is highlighted in the first image below.

   b. If you open the “BiMat_Analysis” folder you can use the back arrow to return to its location. The directory is the second image below can be used as an example, whereas the first image is incorrect and highlights the back arrow.



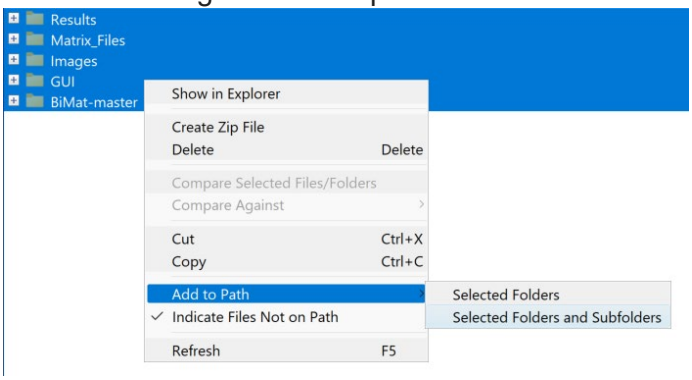


III. Make sure that all of the folders and files within "BiMat_Analysis" are added to your path

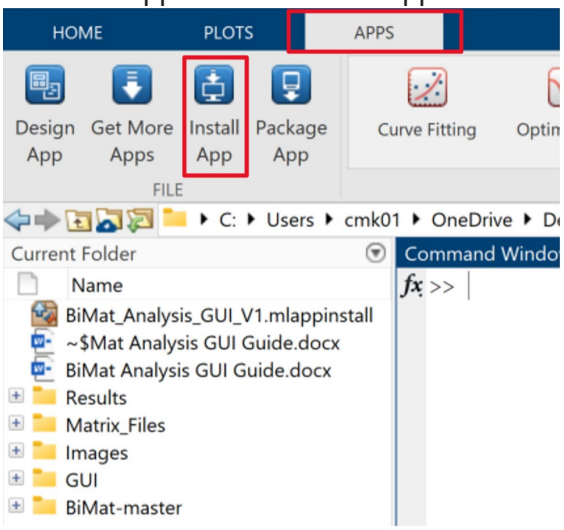
   a. Select All of the Folders

   b. Right Click on any of the selected folders

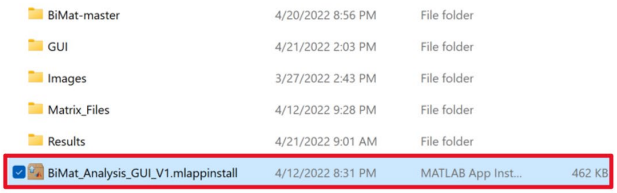
c. Select “Add to Path” and then “Selected Folders and Subfolders”
d. The selected files should go from transparent to solid

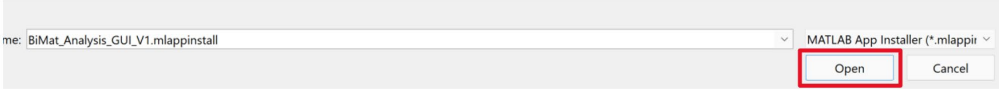


IV. Locate the and Click the “Install App” button on the “Apps” tab at the top of the screen

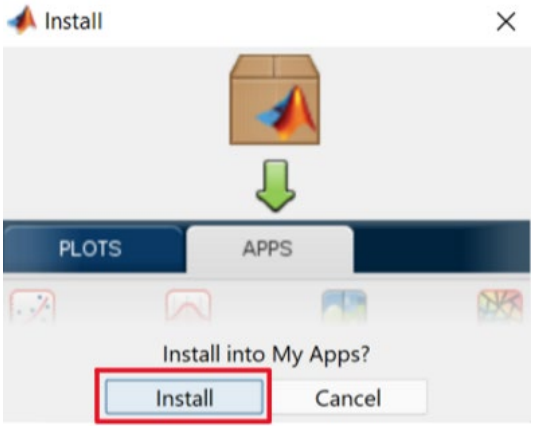


V. Select and Open the “BiMat_Analysis_GUI_V1.mlappinstall” file within the folder that you just unzipped



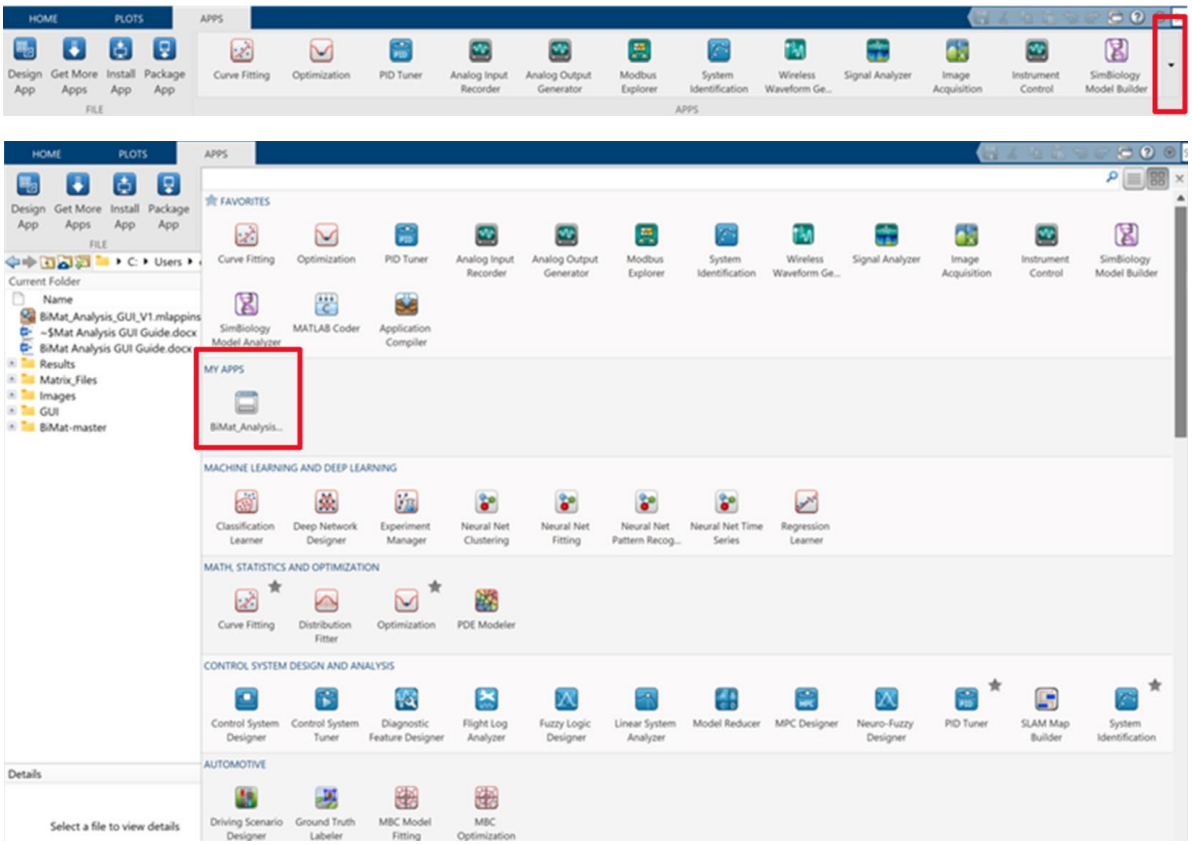


VI. Click Install



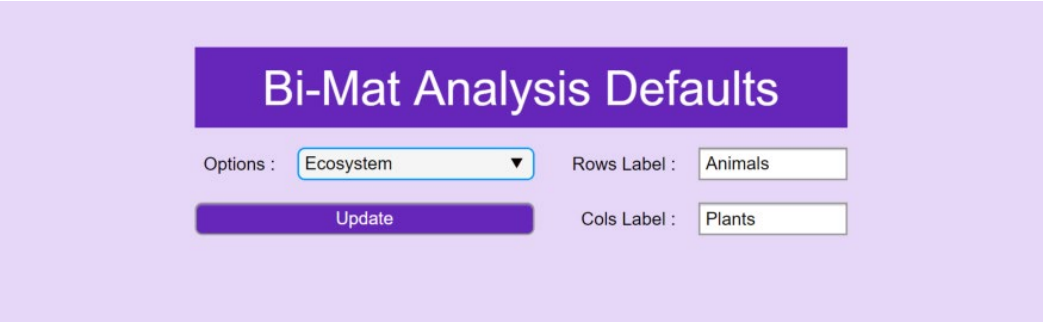
VII. Now you can run the GUI by selecting it in the Apps tab

a. If it is not visible select the arrow opening the drop down to the right of all of your apps. It should be in the "My Apps" row.



2 Running the Program

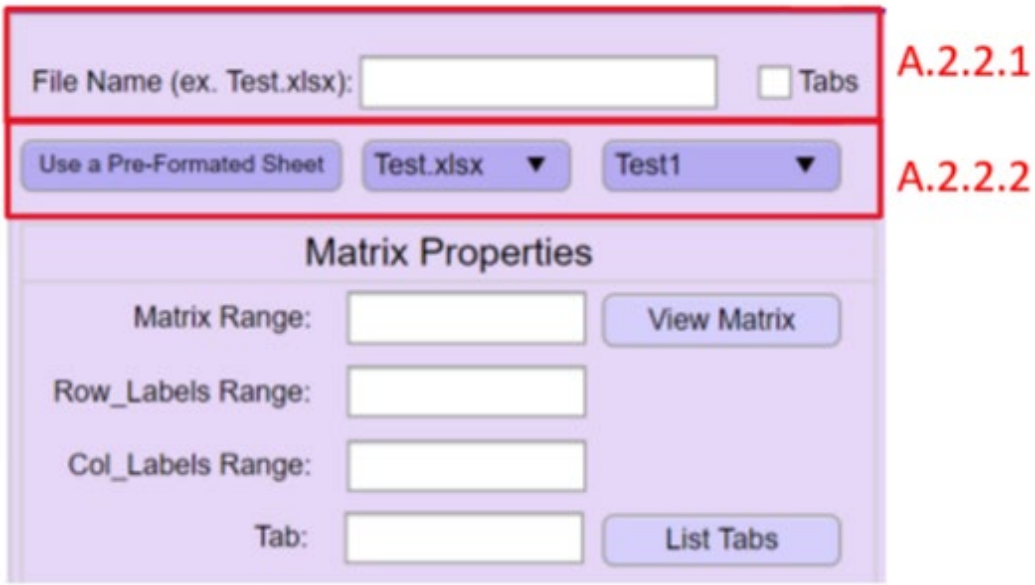
2.1 Selecting Defaults



I. Select the Default Row and Column Labels by using the Options Dropdown
   a. If Custom is Chosen, then the Row and Column labels should be entered manually
   b. Activates Callback B.1.3.2 – Option Dropdown Value Changed

II. Click the Update Button
   a. Activates Callback B.1.3.3 – Update Button Pushed

2.2 File Selection



2.2.1 Manual Entry

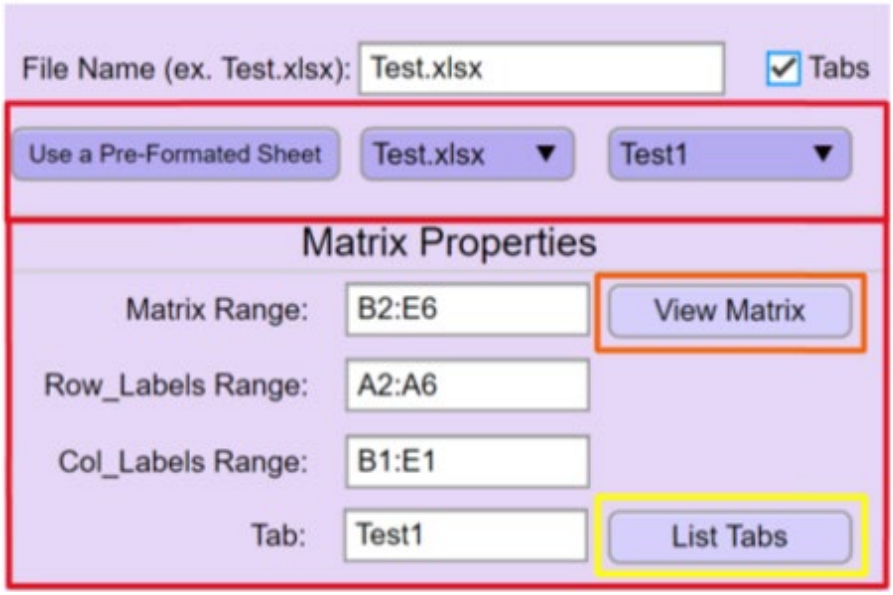
I. Type the filename into the File Name blank
   a. Don't Forget to include the file extension
   b. Make sure the file is in the "Matrix_Files" folder. (See section A.2 for a detailed description of adding a sheet.)
   c. Activates Callback B.1.3.11 – File Name Value Changing
   d. Activates Callback B.1.3.12 – File Name Value Changed

II. Check the Tab Box if you are going to be using a specific Tab
   a. Activates Callback B.1.3.10 – Tabs Check Box Value Changed

2.2.2 Preformatted Sheet

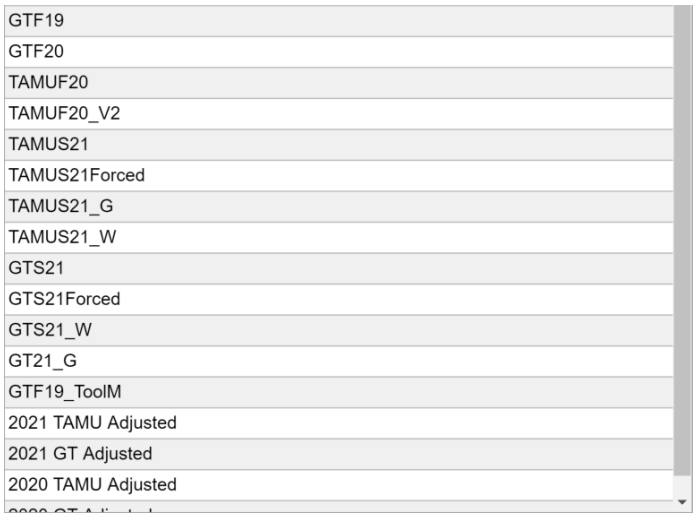
I. Look at Section A.3 for Inputting a Preformatted Sheet
II. Select the Preformatted Sheet Using the File Drop Down
    a. Activates Callback B.1.3.6 – File Dropdown Value Changed
III. Select the Tab using the Tab's Dropdown
    a. Activates Callback B.1.3.7 – Tab Dropdown Value Changed
IV. Click the Use a Pre-Formatted Sheet Button
    a. Activates Callback B.1.3.5 – Use a Pre-Formatted Sheet Button Pushed

2.3 Matrix Input



2.3.1 Manual Entry

I. Input the Matrix Range
    a. The Matrix Range is the cells that contain the matrix data
II. Input the Row Labels Range
    a. The Row Labels Range is the cells that contain the row names
III. Input the Column Label Range
    a. The Column Labels Range is the cells that contain the Column names
IV. Make sure that all of the ranges are specified using a colon not a semi-colon
V. Input the Tab Name within the Sheet that the program is using
    a. This only shows up when the Tabs Checkbox is checked
    b. You can use the List Tabs Button to get a list of Tabs that are available (Yellow Box)
        i. Activates Callback B.1.3.9 – List Tabs Button Pushed

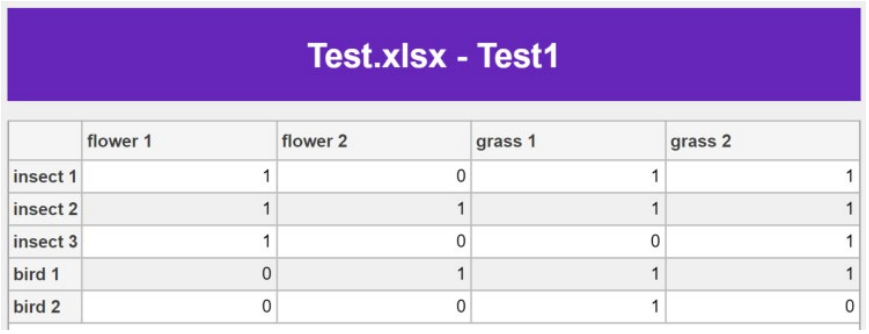


2.3.2 Preformatted sheet

I. Look at Section A.3 for Inputting a Preformatted Sheet
II. Select the Preformatted Sheet Using the File Drop Down
    a. Activates Callback B.1.3.6 – File Dropdown Value Changed
III. Select the Tab using the Tab's Dropdown
    a. Activates Callback B.1.3.7 – Tab Dropdown Value Changed
IV. Click the Use a Pre-Formatted Sheet Button
    a. Activates Callback B.1.3.5 – Use a Pre-Formatted Sheet Button Pushed

2.3.3 Verify Entry

I. Click the View Matrix Button to see how the Matrix and its Labels were inputted
    a. Activates Callback B.1.3.8 – View Matrix Button Pushed



Test.xlsx - Test1

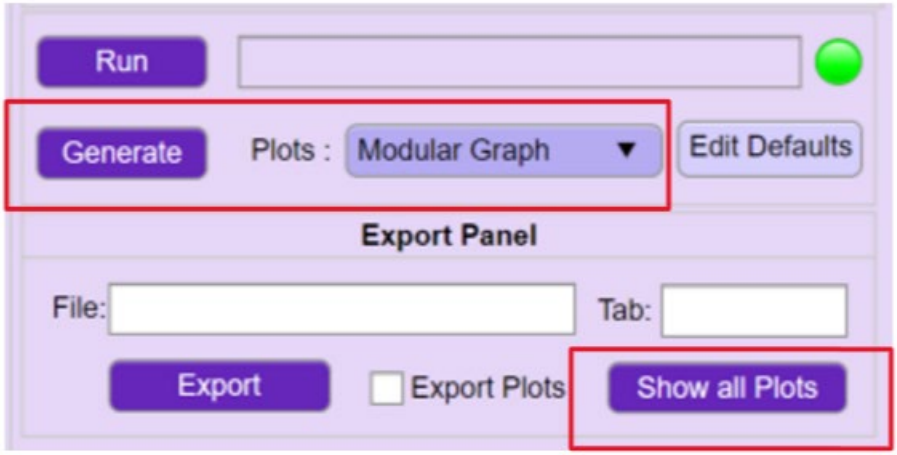
	flower 1	flower 2	grass 1	grass 2
insect 1	1	0	1	1
insect 2	1	1	1	1
insect 3	1	0	0	1
bird 1	0	1	1	1
bird 2	0	0	1	0

2.4 Run Analysis

I. Click the Run Button

II. Verify that the steps above are done correctly. If not, an error message will be returned

2.5 Generating Plots



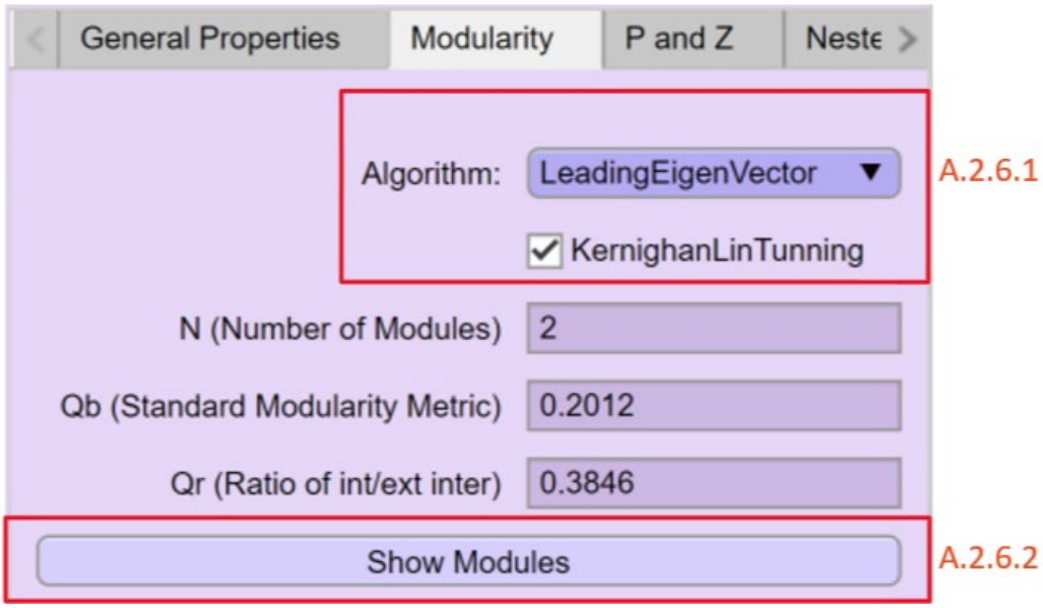
2.5.1 View a Single Plots

I. Select the Graph that you would like to view in the Plot Dropdown
II. Click the Generate Button
    a. Activates Callback B.1.3.20 – Generate Button Pushed

2.5.2 Show all Plots

I. Click the Show all Plots Button
    a. This requires that the export button has been pushed and doesn't show unless the export plots checkbox is checked
        i. If the export has not been completed then the graphs shown will be from the previous time the program was ran, even though the label will be updated
    b. See section A.1.9 for the Export steps
    c. Activates the Callback B.1.3.22 – Show all Plots Button Pushed

2.6 Modularity

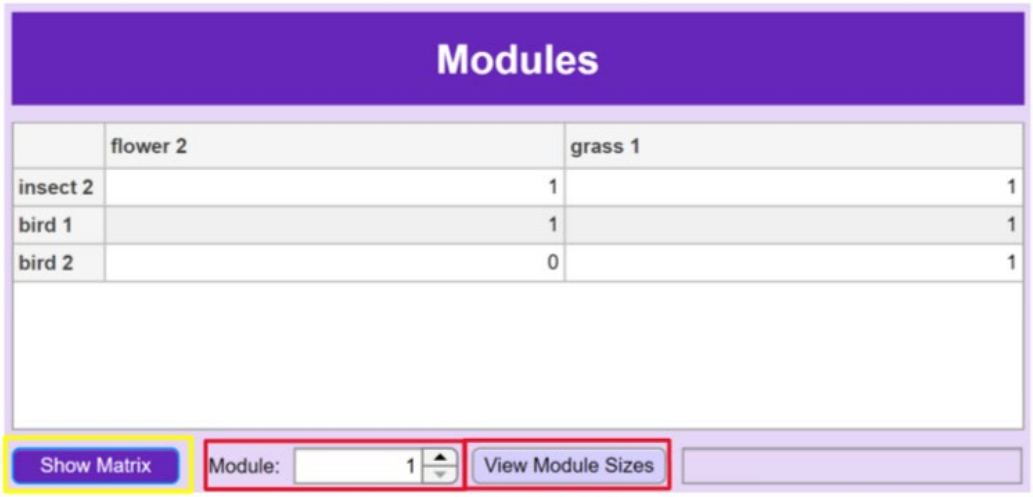


2.6.1 Algorithm Selection

I. Select the Algorithm that you would like to use in the Algorithm Dropdown
   a. The KerninghanLin Checkbox Only shows when LeadingEigenVector is chosen
   b. Activates Callback B.1.3.14 – Algorithm Drop Down Value Changed

2.6.2 Viewing Modules

I. Click the Show Modules Button
   a. Activates Callback B.1.3.15 – Show Modules Button Pushed
II. Use the steps below in A.1.5.2.1 and A.1.5.2.2 to select the module you would like to view
III. Click the Show Matrix Button (yellow box)
   a. Activates Callback B.2.2.3 – Show Matrix Button Pushed



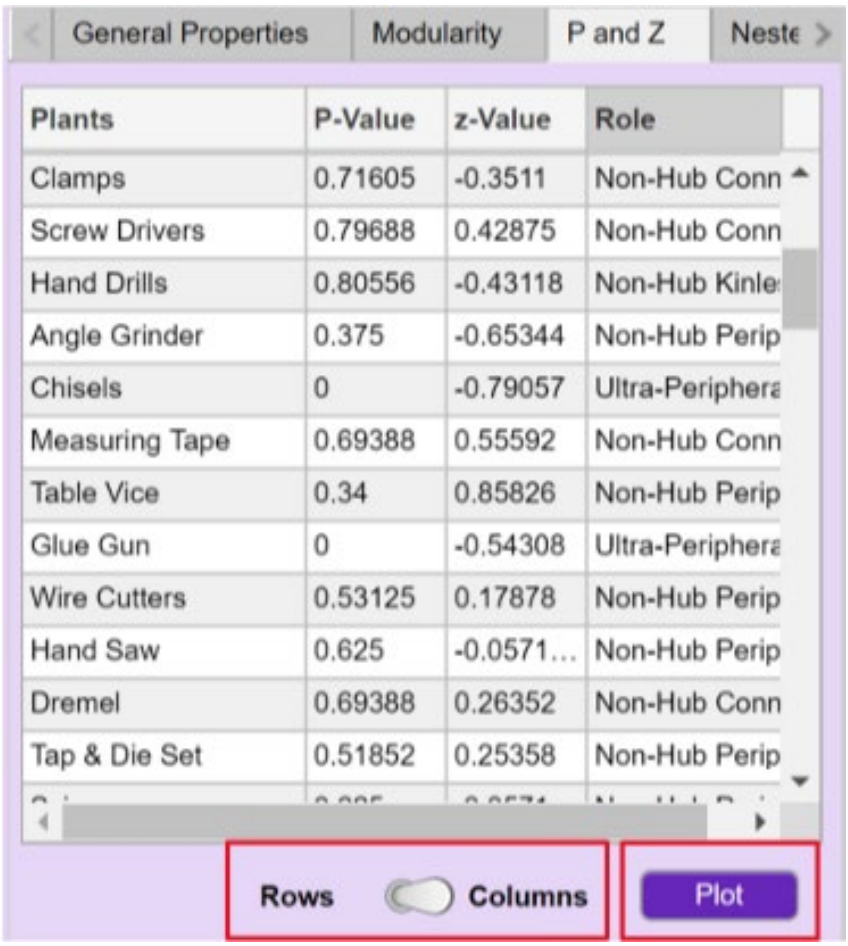
2.6.2.1 Module Selection

I. Select the Module using the spinner
   a. Activates Callback B.2.2.2 – Module Spinner Value Changed
   b. If you select a number larger than the number of modules an error will be returned

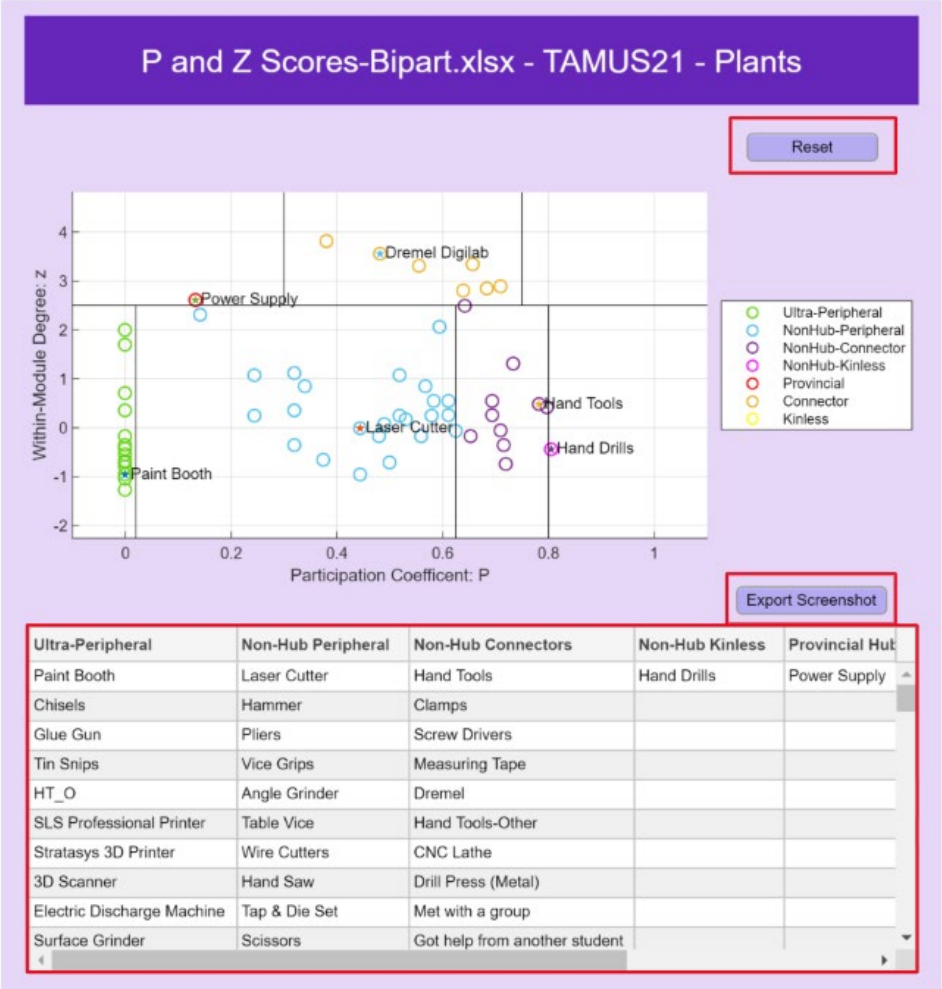
2.6.2.2 Module Sizes

I. Click the View Module Sizes Button if you would like to see the number of modules and their sizes
   a. Activates Callback B.2.2.4 – View Module Sizes Button Pushed
   b. If you select a number larger than the number of modules an error will be returned

2.7 P and Z



I. The P and Z functions are for a Unipartite Function so you must select whether you would like to analyze the row or column elements. This is done with the Modules Switch
    a. Activates Callback B.1.3.16 – Modules Switch Value Changed
II. Click the Plot button to view a more detailed view of the P and Z analysis
    a. Activates Callback B.1.3.17 – Plot Button Pushed



2.7.1 P and Z Page

2.7.1.1 Cell Selection

I. Click on any of the cells with text within the Roles table
   a. Activates Callback B.3.2.2 – Roles Table Cell Selection

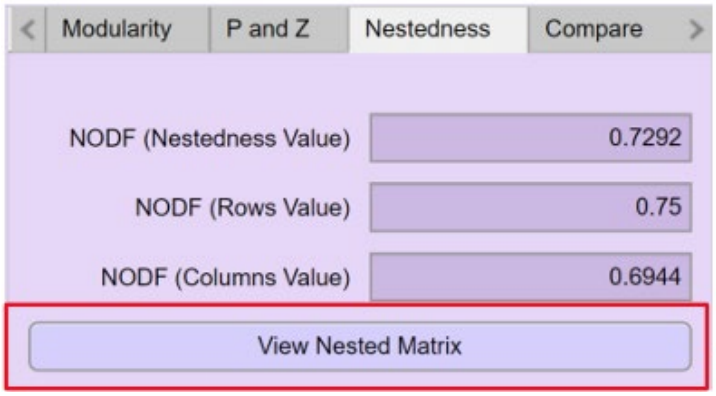
2.7.1.2 Reset Labels

I. Click on the Reset Button to remove any of the labels created by the Cell selections
   a. Activates Callback B.3.2.3 – Reset Button Pushed

2.7.1.3 Export Screenshot

I. Click on the Export Screenshot Button to save an image of the window including any of the labels created by the Cell selections to the “P and Z” folder within the “Results” folder
   a. Activates Callback B.3.2.3 – Reset Button Pushed

2.8 Nestedness



2.8.1 Viewing Nested Matrix

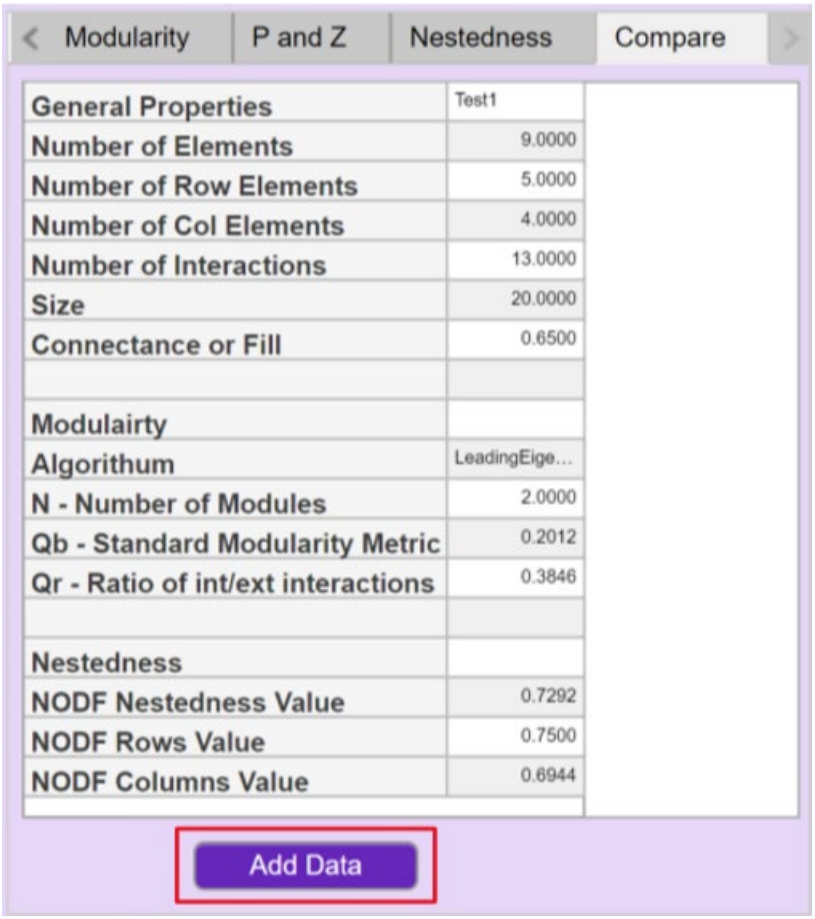
II. Click the View Nested Matrix

a. Activates Callback B.1.3.18 – View Nested Matrix Button Pushed

Test.xlsx - Test1

	grass 1	grass 2	flower 1	flower 2
insect 2	1	1	1	1
insect 1	1	1	1	0
bird 1	1	1	0	1
insect 3	0	1	1	0
bird 2	1	0	0	0

2.9 Compare



I. For a quick comparison between two different tabs or sheets, the comparison tab uses the Add Data button to show the results of each analysis in separate columns.
   a. Activates Callback B.1.3.19 – Add Data Button Pushed

2.10 Export Results

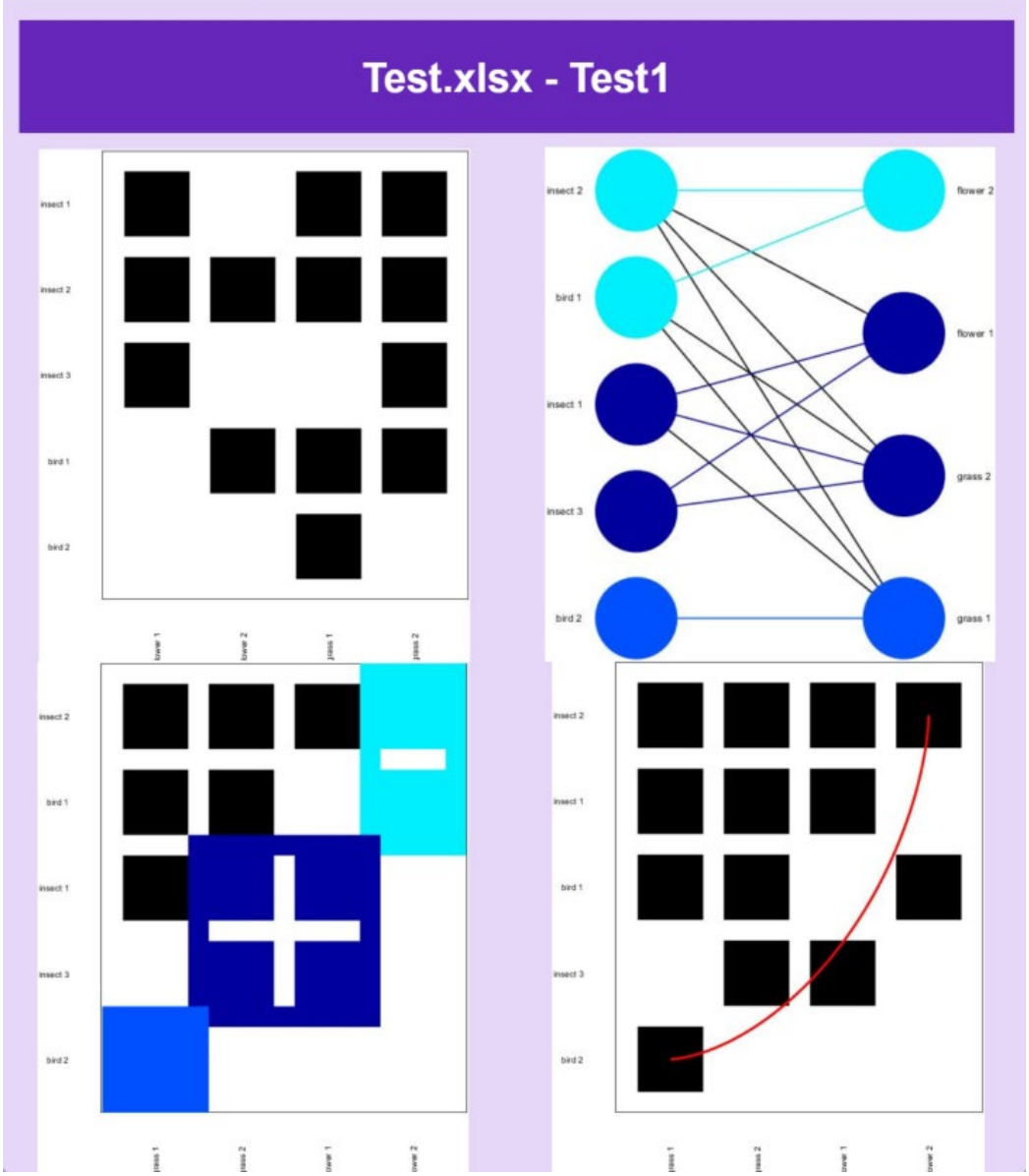
2.10.1 Export Data to Results Sheet

I. Fill in the File and Tab Blanks with the File name that the results should be exported to.
   a. Make sure to include the file extension in the filename
   b. Refer to Section A.4 for the results file location and the steps to add one

II. Check the Export Plots checkbox if you would like to export the 4 plots into the “Graphs” within the “Results” folder
    a. This is required for the Show all Plots button to be visible
III. Click the Exports button
    a. This is also required for the Show all Plots button to be visible

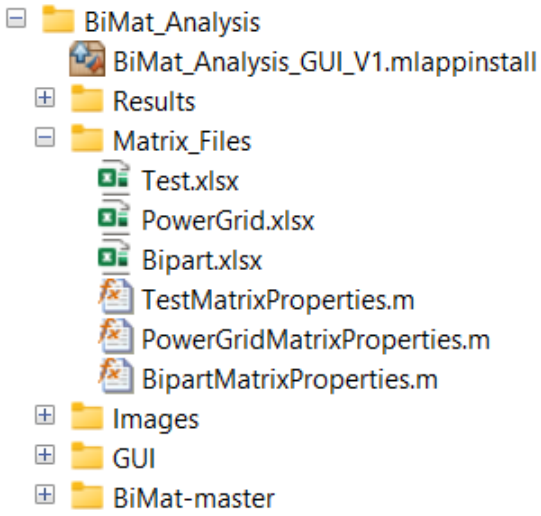
2.10.2 Show all Plots

I. Click the Show all Plots Button
    a. Activates Callback B.1.3.22 – Show all Plots Button Pushed



3 Adding a Data Sheet

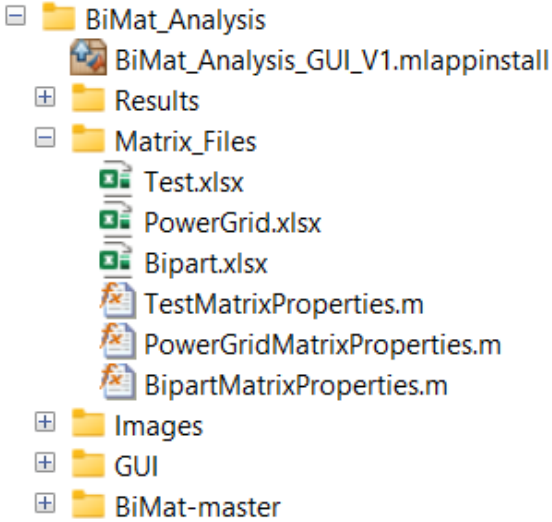
To add a data sheet, the process is simply adding a excel sheet to the “Matrix_Files” folder within “BiMat_Analysis”. If the user would like this sheet to be in the file and tabs dropdowns, then use “Adding a Preformatted Sheet” (A.4) If not then the ranges will need to be inputted manually.



4 Adding a Preformatted Sheet

4.1 File Location

To add a data sheet, the process is simply adding a excel sheet to the “Matrix_Files” folder within “BiMat_Analysis”.



4.2 Matrix Properties Script

This sheet replaces the step of adding the range values to the matrix properties panel, by having them defined in a separate MATLAB script. To create a new one its easiest to use the "TestMatrixProperties.M" file as an example. Also see the *Name*MatrixProperties section (B.6). A detailed list of the steps to create a similar script are below.

I. Create a new MATLAB sheet and paste the "TestMatrixProperties.m" script into this sheet
   a. Name this file using the notation "*Name*MatrixProperties.m".
II. Replace the function name with the same name as the file
III. Copy the elseif statement and paste it below the previous one
   a. Change the original if and elseif statements using the steps below
   b. Change the string value within the strcmp() function to represent the name of each tab
   c. Change the range values to represent the cell locations of the Row and Column labels as well as the matrix data

```
function [matrix_range, row_labels_range, col_labels_range, tabs] = TestMatrixProperties(tab_name, file)
    raw_tabs = sheetnames(file);
    %accepted_tabs = {};
    tabs = raw_tabs;
    %disp(tabs);

    if strcmp(tab_name, 'Test1') == true
        matrix_range = 'B2:E6';
        row_labels_range = 'A2:A6';
        col_labels_range = 'B1:E1';
    elseif strcmp(tab_name, 'Test2') == true
        matrix_range = 'B2:E6';
        row_labels_range = 'A2:A6';
        col_labels_range = 'B1:E1';
    else
    end
end
```

4.3 File Drop Down

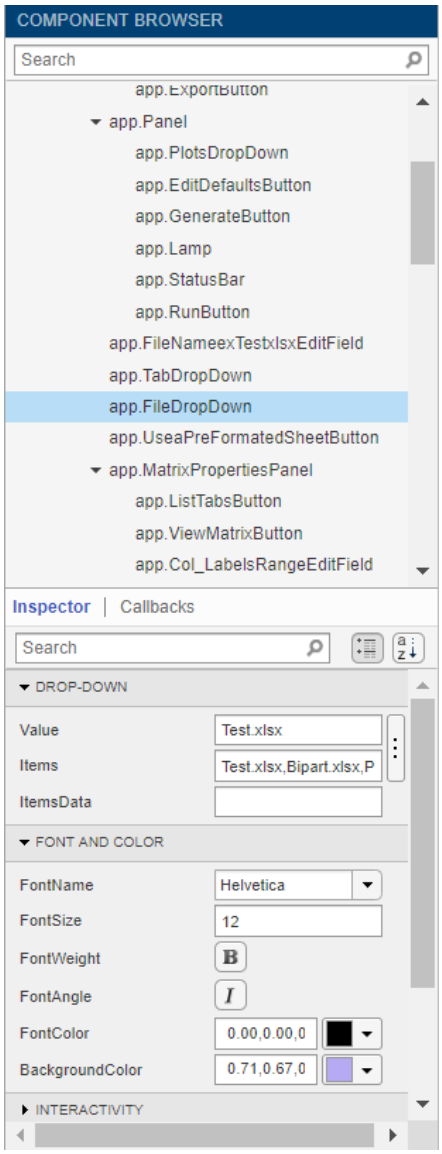
I. Use the Component designer within AppDesigner to locate and select the “app.FileDropDown”.

II. Once selected, look in the lower half of the component browser window, specifically the Inspector tab.

III. Find the “Drop-Down” section and add the new value into the “items” comma separated list.

IV. The “value” listed above the items list is the default option that the drop down shows

V. Alternatively, the 3 dots can be used to use a vision version of these operations. This window has the ability to add, subtract, or rename the values as well as select the default.



4.4 Generate Tab Options Function

I. Copy one of the elseif statements and paste it below the previous one, but above the else statement

II. Change the string value within the strcmp() function to represent the name of the excel file

III. Define the “default_tab” as the string of the tab that you would like to be showed first

IV. Change the *Name*MatrixProperties() function callback to be the name of the script created in (A.3.2)

```
562         % GenerateTabOptions - Generates the Tab options for premade Matrices
563         %                    - by calling upon the correct ###MatrixProperties script
564         %           default_tab = allows for the tab drop down to be filled once a file is chosen
565         %           tab_name = the selected tab within the dropdown
566         function GenerateTabOptions(app, file)
567
568             if strcmp(app.FileDropDown.Value, 'Bipart.xlsx')
569                 default_tab = 'TAMUS21';
570                 tab_name = default_tab;
571
572                 [~, ~, ~, tabs] = BipartMatrixProperties(tab_name, file);
573                 app.TabDropDown.Items = tabs;
574
575             elseif strcmp(app.FileDropDown.Value, 'Test.xlsx')
576                 default_tab = 'Test1';
577                 tab_name = default_tab;
578
579                 [~, ~, ~, tabs] = TestMatrixProperties(tab_name, file);
580                 app.TabDropDown.Items = tabs;
581
582             elseif strcmp(app.FileDropDown.Value, 'PowerGrid.xlsx')
583                 default_tab = 'Original 5 Bus';
584                 tab_name = default_tab;
585
586                 [~, ~, ~, tabs] = PowerGridMatrixProperties(tab_name, file);
587                 app.TabDropDown.Items = tabs;
588
589             else
590                 app.TabDropDown.Items = {'N/A'};
591
592             end
593         end
```

4.5 Construct Premade Matrix Function

I. Copy one of the elseif statements and paste it below the previous one, but above the end statement

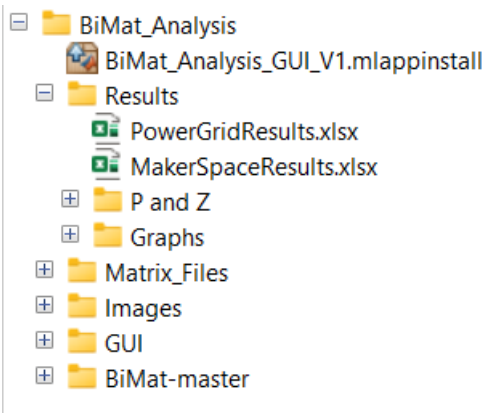
II. Change the string value within the strcmp() function to represent the name of the excel file

III. Change the *Name*MatrixProperties() function callback to be the name of the script created in (A.3.2)

```
596
597         % ConstructPremadeMatrix - Fills the Matrix ranges using the Pre-set ranges within the sheets persepctive matlab script
598         %                  - by calling upon the correct ###MatrixProperties script
599         function [matrix_range, row_labels_range, col_labels_range] = ConstructPremadeMatrix(app)
600
601             [~,file] = FilePath(app);
602             tab_name = app.TabDropDown.Value;
603
604             if strcmp(app.FileDropDown.Value, "Bipart.xlsx")
605                 app.TabsCheckBox.Value = 1;
606                 app.TabEditField.Visible = "on";
607                 [matrix_range, row_labels_range, col_labels_range, ~] = BipartMatrixProperties(tab_name, file);
608             elseif strcmp(app.FileDropDown.Value, "Test.xlsx")
609                 [matrix_range, row_labels_range, col_labels_range, ~] = TestMatrixProperties(tab_name, file);
610             elseif strcmp(app.FileDropDown.Value, "PowerGrid.xlsx")
611                 [matrix_range, row_labels_range, col_labels_range, ~] = PowerGridMatrixProperties(tab_name, file);
612             end
613
         end
```

5 Adding a Results Sheet

It is not necessary to add a results sheet to the program files, because the export function can create a new sheet if the specified sheet does not exist yet. However, if the user would like to do so, they can simply save an excel sheet to the results folder within the “BiMat_Analysis” folder. It is also possible for the location value to be set when the defaults are assigned. (A.6.2)



6 Adding a Default

6.1 Adding the Dropdown Value

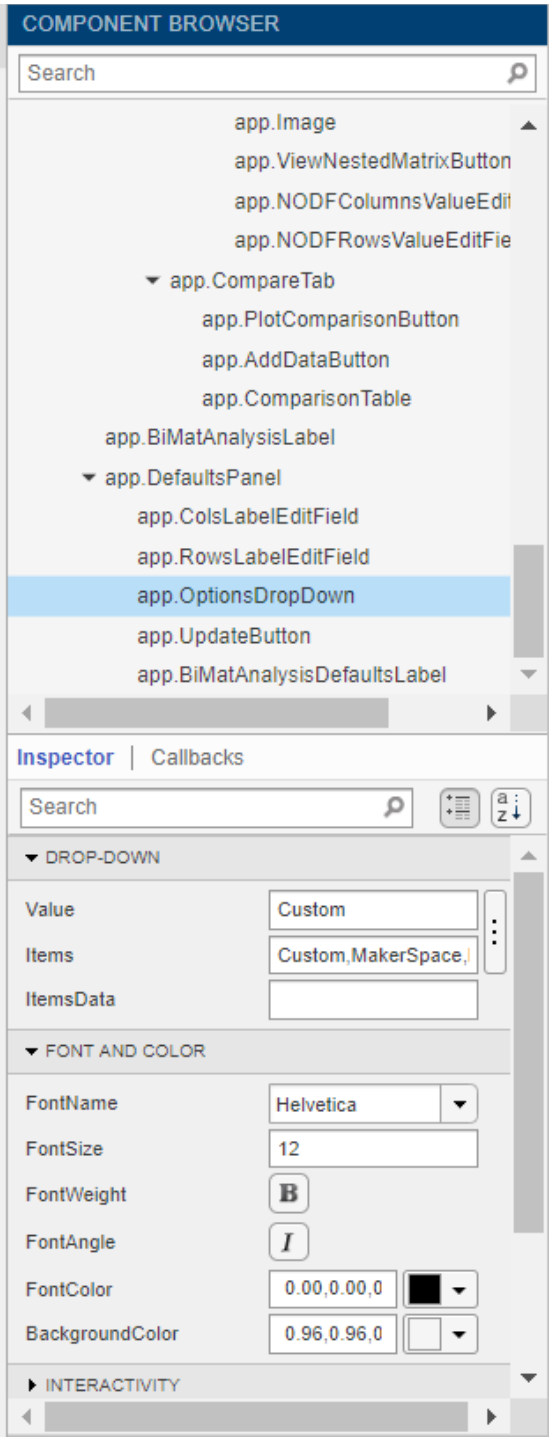
I. Use the Component designer within AppDesigner to locate and select the “app.OptionsDropDown”.

II. Once selected, look in the lower half of the component browser window, specifically the Inspector tab.

III. Find the “Drop-Down” section and add the new value into the “items” comma separated list.

IV. The value listed above the items list is the default option that the drop down shows

V. Alternatively, the 3 dots can be used to use a vision version of these operations. This window has the ability to add, subtract, or rename the values as well as select the default.



6.2 Editing the Options Drop Down Value Changed callback(B.1.3.2)

I. Locate the “OptionDropDownValueChanged” callback (B.1.3.2)

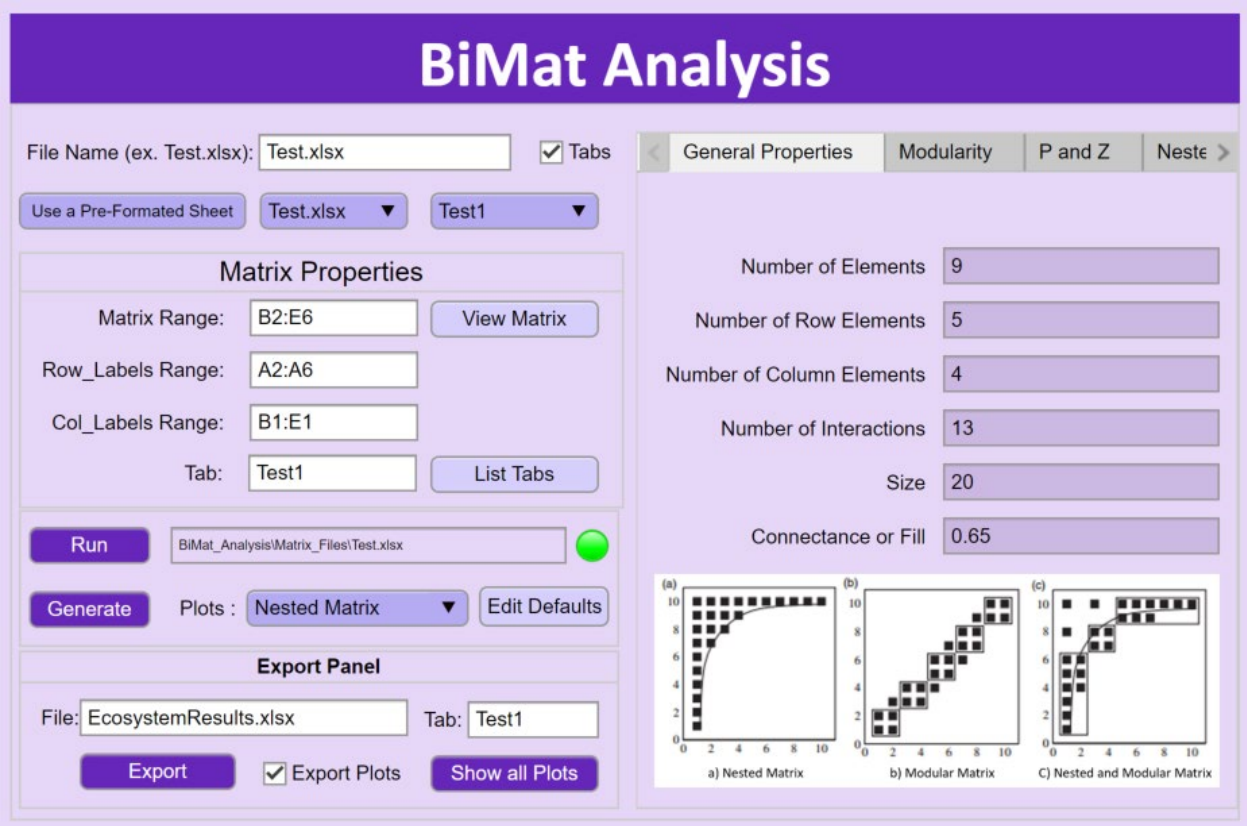
II. Copy and paste one of the elseif statements

III. Set the Row and Column Labels by editing their corresponding edit field values

IV. It is also possible to set the Results file name within this elseif statement

```
969         % Value changed function: OptionsDropDown
970         function OptionsDropDownValueChanged(app, event)
971             value = app.OptionsDropDown.Value;
972 
973             app.Lamp.Color = 'red';
974 
975             % sets the row and col labels as well as the file name for the results based on the default chosen
976             if strcmp(value, 'MakerSpace')
977                 app.RowsLabelEditField.Value = 'Students';
978                 app.ColsLabelEditField.Value = 'Tools';
979                 app.FileEditField.Value = 'MakerSpaceResults.xlsx';
980             elseif strcmp(value, 'Ecosystem')
981                 app.RowsLabelEditField.Value = 'Animals';
982                 app.ColsLabelEditField.Value = 'Plants';
983                 app.FileEditField.Value = 'EcosystemResults.xlsx';
984             elseif strcmp(value, 'Social Network')
985                 app.RowsLabelEditField.Value = 'People';
986                 app.ColsLabelEditField.Value = 'Events';
987             elseif strcmp(value, 'Transportation Network')
988                 app.RowsLabelEditField.Value = 'Locations';
989                 app.ColsLabelEditField.Value = 'Routes';
990             elseif strcmp(value, 'Power Grid')
991                 app.RowsLabelEditField.Value = 'Suppliers';
992                 app.ColsLabelEditField.Value = 'Receivers';
993                 app.FileEditField.Value = 'PowerGridResults.xlsx';
994             end
995         end
```

B: Program Description



1 Main Page

1.1 Analysis Functions

1.1.1 File Path

```
% FilePath - Defines the path for file within the "Matrix_Files" folder
%               - by combining the preset path with the manually inputted file name
%           path = the address for the file of choice excluding the actual file name
%               - this is currently locked to the Matrix Files folder within the master file
%           file = the actual file name for the file
%               - this is a manual input within the GUI
function [path, file] = FilePath(app)
    file = app.FileNameexTestxlsxEditField.Value;
    origin = "BiMat_Analysis\Matrix_Files\"; % this what forces the file loaction to be in the Matix_Files folder
    path = append(origin, file);
end
```

1.1.1.1 Purpose

Defines the location or path for the program to use when scrapping the data from the file. It does so by combining the path to the Matrix Files folder with the file name. The file location must be within the “Matrix_Files” Folder

- The file location must be within the “Matrix_Files” Folder

1.1.1.2 Variables

- Output Variables
  - file – the filename for the sheet that is being used
    - Specifically, the File Name Edit Field at the top left corner

- path – the combination of the Origin and File
- Operation Variables
  - origin – the premade path to the “Matrix_Files” folder

1.1.2 Define Matrix

```
% DefineMatrix - Defines the Matrix using the ranges from the Matrix Properties panel
%                   - by reading the selected file and using the ranges to find the corret data
%           matrix_range = the cells that contain the actual data for the Adjacency Matrix
%                   - this can defined manually or by using a predefined sheet
%           row_labels_range = the cells that contain the row labels for the Adjacency Matrix
%                   - this can defined manually or by using a predefined sheet
%           col_labels_range = the cells that contain the column labels for the Adjacency Matrix
%                   - this can defined manually or by using a predefined sheet
%           tab = the tab within the specified sheet that the function will be using
%           matrix = the  binary matrix that represents the Adjacency Matrix Data moving foward
%           row_labels = the matrix the represents the Adjacency Matrix row labels moving foward
%           col_labels = the matrix the represents the Adjacency Matrix column labels moving foward
function [matrix, row_labels, col_labels] = DefineMatrix(app)

    [path,file] = FilePath(app);
    matrix_range = app.MatrixRangeEditField.Value;
    row_labels_range = app.Row_LabelsRangeEditField.Value;
    col_labels_range = app.Col_LabelsRangeEditField.Value;

    % Defining the Matrix depending on if the sheet has tabs or not
    if app.TabsCheckBox.Value == 1
        tab = app.TabEditField.Value;
        matrix = readmatrix(path,'Sheet',tab, 'Range', matrix_range);
        row_labels = readmatrix(path,'Sheet',tab,'Range',row_labels_range,'OutputType','string');
        col_labels = readmatrix(path,'Sheet',tab,'Range',col_labels_range,'OutputType','string');
    else
        raw_tabs = sheetnames(file);
        tab = raw_tabs(1,1);
        matrix = readmatrix(path,'Sheet',tab, 'Range', matrix_range);
        row_labels = readmatrix(path,'Sheet',tab,'Range',row_labels_range,'OutputType','string');
        col_labels = readmatrix(path,'Sheet',tab,'Range',col_labels_range,'OutputType','string');
    end

    matrix = matrix > 0;
    matrix = double(matrix);

    app.StatusBar.Value = path; %shows the enitre file location in the status bar

end
```

1.1.2.1 Purpose

Defines the Matrix using the ranges from the Matrix Properties panel and then reading the selected file. It does so by using the ranges to find the correct cells within the specified sheet and stores the data within them as an array. These ranges are split into three groups: Row Labels, Column Labels, and the Adjacency Matrix.

- The user may or may not be using tabs within their sheet, which is what the Tabs Check box(1.3.10) is for.
  - The Define Matrix function checks if this box is in fact checked or not to define a location within the sheet of interest.
    - If it is not checked, the function will automatically select the first tab no matter what it is named.
- All of the Range Values, as well as the Tab value, can be defined manually or by using a preformatted matrix.
  - Either way this function uses the values that are within the edit fields on the matric properties panel. Which is why the preformatted button is necessary (1.3.5). This button will fill the

edit fields based on the values chosen in the file and tab drop downs.

1.1.2.2 Variables

- Output Variables
  - matrix - the matrix that represents the Adjacency Matrix moving forward
  - row_labels - the matrix the represents the Adjacency Matrix row labels moving forward
  - col_labels - the matrix the represents the Adjacency Matrix column labels moving forward
- Operation Variables
  - matrix_range - the cells that contain the actual data for the Adjacency Matrix
  - row_labels_range - the cells that contain the row labels for the Adjacency Matrix
  - col_labels_range - the cells that contain the column labels for the Adjacency Matrix
  - raw_tabs – is an array of all the tab names within the specified sheet
    - raw_tabs is only used when the Tabs Check Box(1.3.10) is not checked
  - tab - the tab within the specified sheet that the function will be using

1.1.3 Define Bipartite Matrix

```
169
170
171
172
173
174
175 -
176 -
177 -
178
179 -
180 -
181 -
182
183 -
```

```
% DefineBipartiteMatix - Defines the Bipartite Matrix
%                   - by using the Bipartite function within the main folder of BiMat Analysis
%           bp = the BipartiteMatrix defined by BiMat_Analysis' primary script
%           bp_row_labels = the row labels of the bp matrix
%           bp_col_labels = the col labels of the bp matrix
function [bp, bp_row_labels, bp_col_labels] = DefineBipartiteMatrix(app)
    [matrix, row_labels, col_labels] = DefineMatrix(app);
    bp_row_labels = row_labels;
    bp_col_labels = col_labels;

    bp = Bipartite(matrix);
    bp.row_labels = bp_row_labels;
    bp.col_labels = bp_col_labels;

end
```

1.1.3.1 Purpose

Defines the Bipartite Matrix by using the Bipartite function in the Bipartitie.m script within the main folder of BiMat Analysis. The function Bipartite creates a bipartite object using a quantitative matrix web.

- See the Bipartite.m script within the “main” folder of BiMat-master.
- The bp_row and bp_col labels are equivalent to the adjacency matrix labels

1.1.3.2 Variables

- Output Variables
  - bp_row_labels – the row labels that will be used later for the bp obj
  - bp_col_labels - the col labels that will be used later for the bp obj
  - bp – the bipartite obj defined by the Bipartite function within the Bipartite.m script
    - bp.row_labels – the row labels for the bp object
    - bp.col_labels – the col labels for the bp object
- Operation Variables
  - matrix - the matrix defined by the Define Matrix Function (1.1.2)

1.1.4 General Properties

```
% General Properties - Defines and Displays the General Properties of the Matrix
%                     - by either calculating the values or calling on functions within MatrixFunctions.m
%          webmatrix = the same as "matrix" but not necessarily binary
%          num_of_species = the combined amount of both the row and column nodes in the Bipartite Matrix
%          num_of_row_species = the amount rows in the Bipartite Matrix
%          num_of_col_species = the amount Cols in the Bipartite Matrix
%          num_of_interactions = the amount of rows and columns that interact(the number of cells that contian a "1")
%          m_size = the amount of possible interactions (the amount of cells within the Bipartie Matrix)
%          connectance = the Fill of "webmatrix"
function [num_of_species, num_of_row_species, num_of_col_species, num_of_interactions, m_size, connectance] = GeneralProperties(app)
    [matrix, ~, ~] = DefineMatrix(app);
    webmatrix = 1 * (matrix > 0);

    % Calculating Values
    num_of_species = size(matrix,1) + size(matrix,2);
    [num_of_row_species,num_of_col_species] = size(matrix);
    num_of_interactions = sum(webmatrix,"all");
    m_size = num_of_col_species * num_of_row_species;
    connectance = num_of_interactions/m_size;

    % Displaying Values
    app.NumberofElementsEditField.Value = num_of_species;
    app.NumberofRowElementsEditField.Value = num_of_row_species;
    app.NumberofColumnElementsEditField.Value = num_of_col_species;
    app.NumberofInteractionsEditField.Value = num_of_interactions;
    app.SizeEditField.Value = m_size;
    app.ConnectanceorFillEditField.Value = connectance;

end
```

1.1.4.1 Purpose

Defines and Displays the General Properties of the Matrix. All of these General Properties values are simple enough to be calculated within the function.

- The webmatrix is used in many of these calculations because there is no way for these calculations to consider weighted interactions.
  - All interactions must be represented by a 1, which is what the webmatrix does to the original adjacency matrix

1.1.4.2 Variables

- Output Variables
  - num_of_species – the total number of row and column species
  - num_of_row_species – the number of row species
  - num_of_col_species – the number of column species
  - num_of_interactions – the sum of all interactions within the webmatrix
  - m_size – the total number of possible interactions
  - connectance – the ratio of realized connections to possible connections in the webmatrix

- Operation Variables
  - matrix – the matrix defined by the Define Matrix Function (1.1.2)
  - webmatrix – the binary matrix that represents the Adjacency Matrix Data. Specifically, only with values of 0 and 1.

1.1.5 Modularity

```
% Modularity - Defines and Displays the Values for Modularity from the chosen alogrithm
%                   - by calling upon the Detect function within the community folder of
%                     BiMat_Analysis once the specified algorithm is ran
%           community = represents the Bipartite Adjacency Matrix that will be used to
%                       calcualte modularity
%           obj = a variable frame that allows for the Modularity values to be defined
%                 based on the correct algorithm
%           N = number of modules
%           Qb = standard modularity metric
%           Qr = ratio of interactions (internal/external)
%           A = matrix that represents the row interactions
%           B = matrix that represents the column interactions
function [N, Qb, Qr, A, B] = Modularity(app)

    [bp, ~, ~] = DefineBipartiteMatrix(app);

    % Selecting Algorithm with the Drop Down

    % LeadingEigenVector
    if strcmp(app.AlgorithmDropDown.Value, 'LeadingEigenVector') == true

        % KernighanLinTunning checkbox
        %if app.KernighanLinTunningCheckBox.Value == 0
        %    bp.community.DoKernighanLinTunning = false;
        %else
        %   bp.community.DoKernighanLinTunning = true;
        %end

        bp.community = LeadingEigenvector(bp.matrix);

    % ApadtiveBrim
    elseif strcmp(app.AlgorithmDropDown.Value, 'AdaptiveBrim') == true
        bp.community = AdaptiveBrim(bp.matrix);

    % LPBrim
    elseif strcmp(app.AlgorithmDropDown.Value, 'LPBrim') == true
        bp.community = LPBrim(bp.matrix);
    end

    % Defining Modularity Values
    obj = Detect(bp.community);
    N = obj.N;
    Qb = obj.Qb;
    Qr = obj.Qr;

    A = bp.community.row_modules;
    B = bp.community.col_modules;

    % Displaying Modularity Values
    app.NNumberofModulesEditField.Value = N;
    app.QbStandardModularityMetricEditField.Value = Qb;
    app.QrRatioofintextinterEditField.Value = Qr;

end
```

1.1.5.1 Purpose

Defines and Displays the Values for Modularity from the chosen algorithm (1.3.14). It does so by calling upon the Detect function within the “community” folder of BiMat_Master once the specified algorithm is ran.

- See the LeadingEigenVector.m, AdaptiveBrim.m, LPBrim.m, and BipartiteModularity.m scripts within the community folder in BiMat-Master.

- Creates a *selected algorithm* (1.3.14) object “obj” using a bipartite matrix that will then be used to calculate modularity
- Uses the Detect function within BipartiteModularity.m to calculate the modularity by first dividing the network (matrix) into isolated components. The modularity is then optimized in each component separately. The modularity is optimized globally by default, for optimizing components independently of the rest change properties “optimize_by_component” to true before calling this method.

1.1.5.2 Variables

- Output Variables
  - N – the number of modules
  - Qb – Standard Modularity function
  - Qr – Ratio of interactions (internal/external)
  - A – matrix that represents the row interactions
  - B – matrix that represents the column interactions
- Operation Variables
  - bp – the bipartite obj defined by the Define Bipartite Matrix Function (1.1.3)
    - bp.community – represents the Bipartite Adjacency Matrix that will be used to calculate modularity
      - will be run in any of the three algorithm scripts: LeadingEigenVector.m, AdaptiveBrim.m, or LPBrim.m depending on the value of the Algorithm Dropdown (1.3.14)
  - obj – a variable frame that allows for the Modularity values to be defined using the Detect function in the community folder, and is based on the correct algorithm

1.1.6 Nestedness

```
273         % Nestedness - Defines and Displays the Values for Nestedness
274         %                  - by calling upon the Detect function within the nestedness.m script
275         %                    within the nestedness folder of BiMat_Analysis
276         %           obj = a variable frame that allows for the Nestedness values to be defined
277         %           nestedness = the nestedness of the Bipartite matrix
278         %           N_rows =
279         %           N_cols =
280         function [nestedness, N_rows, N_cols] = Nestedness(app)
281
282             [bp, ~, ~] = DefineBipartiteMatrix(app);
283
284             % Defining Nestedness Values
285             obj = Detect(bp.nestedness);
286             nestedness = obj.N;
287             N_rows = obj.N_rows;
288             N_cols = obj.N_cols;
289
290             % Displaying Nestedness Value
291             app.NODFNestednessValueEditField.Value = nestedness;
292             app.NODFRowsValueEditField.Value = N_rows;
293             app.NODFColumnsValueEditField.Value = N_cols;
294         end
```

1.1.6.1 Purpose

Defines and Displays the Values for Nestedness by calling upon the Detect function within the nestedness.m script within the nestedness folder of BiMat_Analysis.Nestedness.m uses the nestednessNODF.m to define the actual values for nestedness.

- See nestedness.m and nestednessNODF.m scripts within the nestedness folder in BiMat-Master

1.1.6.2 Variables

- Output Variables
  - nestedness – the combined NODF nestedness value
  - N_rows – the NODF nestedness for the rows
  - N_cols – the NODF nestedness for the cols
- Operation Variables
  - bp – the bipartite obj defined by the Define Bipartite Matrix Function (1.1.3)
  - obj – a variable frame that allows for the Nestedness values to be defined from the calculated values within the Nestedness.m script which uses the NestednessNODF.m script

1.1.7 NestedMatrix

1.1.7.1 Purpose

Displays the Matrix that the nestedness calculations use. By calling upon the "SORT_MATRIX" function within the MatrixFunctions script and showing it on the Matrix Page (B.5). Although this function sorts the matrix itself it does not sort the labels, so this function must resort them.

1.1.7.2 Variables

- Output
  - sorted_row_labels – the sorted version of the bp_row_labels
  - sorted_col_labels – the sorted version of the bp_col_labels
  - sorted_matrix – the sorted Bipartite matrix that is in the most nested form defined by the the "SORT_MATRIX" function within the MatrixFunctions script.
- Operational Variables
  - bp – the bipartite obj defined by the Define Bipartite Matrix Function (B.1.1.3)
  - bp_row_labels – the row labels defined by the Define Bipartite Matrix function (B.1.1.3)

- bp_col_labels - the column labels defined by the Define Bipartite Matrix function (B.1.1.3)
- ir – an array of the row's (index_row) indices positioned in their new positions. Not the actual values but the original index number reordered. Defined by the the "SORT_MATRIX" function within the MatrixFunctions script.
- ic – an array of the col's (index_col) indices positioned in their new positions. Not the actual values but the original index number reordered. Defined by the the "SORT_MATRIX" function within the MatrixFunctions script.
- col_index – a dummy variable defined by the specific column index from the ic array
- row index – a dummy variable defined by the specific row index from the ir array

1.1.8 P and Z

```
297         % PandZ - Solves for the P and z values based on the Row or Col Modules
298         %                   - by
299         %           C = the maxiumum value within the "A" matirx
300         %           D = the maxiumum value within the "B" matirx
301         %           Nm = the maxiumum value between "C" and "D"
302         %           Nsm = an empty array with the ordered values of Nc and Nr
303         %           Nr = the length of the row matrix ("A")
304         %           Nc = the length of the row matrix ("B")
305         %           kir = the Total Degree or the row nodes
306         %           kic = the Total Degree or the column nodes
307         %           kitr = the links from row node i to a specific module
308         %           kitc = the links from column node i to a specific module
309         %           P = a opertaional variable that allows for Pr or Pc to be defined
310         %           Pr = the P values for the row nodes
311         %           Pc = the P values for the column nodes
312         %           kisr = the links from row node i to other nodes within its own module
313         %           kisc = the links from column node i to other nodes within its own module
314         %           kim = an array of each kis value for each module (for mean and stdev)
315         %           zr = the z values for the row nodes
316         %           zc = the z values for the col nodes
317         function [Pr, zr, Pc, zc] = PandZ(app)
318
319             %[matrix, row_labels, col_labels] = DefineMatrix(app);
320             [bp, bp_row_labels, bp_col_labels] = DefineBipartiteMatrix(app);
321             matrix = bp.matrix;
322
323             [~, ~, ~, A, B] = Modularity(app);
324
325             C=max(A);
326             D=max(B);
327             Nm=max(C,D);
328
329             % Finding participation (connectivity)(with other modules)
330             % Finding ki values for all row and column species
331             Nr=length(A);
332             Nc=length(B);
333             kir=zeros(Nr,1);
334             for i=1:Nr
335                 kir(i)=sum(matrix(i,:));
336             end
337             kic=zeros(Nc,1);
338             for i=1:Nc
339                 kic(i)=sum(matrix(:,i));
340             end
```

```
341
342         % Finding kit values for all row and column species
343 -       kitr=zeros(Nr,Nm);
344 -       kitc=zeros(Nc,Nm);
345 -       for i=1:Nr
346 -           for j=1:Nc
347 -               if matrix(i,j)==1
348 -                   mod=B(j);
349 -                   kitr(i,mod)=kitr(i,mod)+1;
350 -               end
351 -           end
352 -       end
353 -       for j=1:Nc
354 -           for i=1:Nr
355 -               if matrix(i,j)==1
356 -                   mod=A(i);
357 -                   kitc(j,mod)=kitc(j,mod)+1;
358 -               end
359 -           end
360 -       end
361
362         % Calculating P for each species
363 -       Pr=zeros(Nr,1);
364 -       Pc=zeros(Nc,1);
365 -       for i=1:Nr
366 -           P=1;
367 -           for j=1:Nm
368 -               P=P-(kitr(i,j)/kir(i))^2;
369 -           end
370 -           Pr(i)=P;
371 -       end
372 -       for i=1:Nc
373 -           P=1;
374 -           for j=1:Nm
375 -               P=P-(kitc(i,j)/kic(i))^2;
376 -           end
377 -           Pc(i)=P;
378 -       end
379
380         % Finding intra-module degree (z) (within their own module)
381         % Finding number of species in each module
382 -       Nsm=zeros(Nm,1);
383 -       for i=1:Nm
384 -           for j=1:Nr
385 -               if A(j)==i
386 -                   Nsm(i)=Nsm(i)+1;
387 -               end
388 -           end
389 -           for j=1:Nc
390 -               if B(j)==i
391 -                   Nsm(i)=Nsm(i)+1;
392 -               end
393 -           end
394 -       end
```

```
395
396             % Finding kis values for all row and column species
397             kisr=zeros(Nr,1);
398             kisc=zeros(Nc,1);
399             for i=1:Nr
400                 kisr(i)=kitr(i,A(i));
401             end
402             for i=1:Nc
403                 kisc(i)=kitc(i,B(i));
404             end
405
406             % Creating matrix of each kis value for each module (for mean and stdev)
407             kim=zeros(Nm,max(Nsm));
408             kimIndex=ones(Nm,1); % This will be used to insert each new species into a blank space in the appropriate row
409             for i=1:Nr
410                 mod=A(i);
411                 kim(mod,kimIndex(mod))=kisr(i);
412                 kimIndex(mod)=kimIndex(mod)+1;
413             end
414             for i=1:Nc
415                 mod=B(i);
416                 kim(mod,kimIndex(mod))=kisc(i);
417                 kimIndex(mod)=kimIndex(mod)+1;
418             end
419
420             % Finding mean and stdev values for each module's kis values
421             meanstdev=zeros(Nm,2);
422             for i=1:Nm
423                 meanstdev(i,1)=mean(kim(i,1:Nsm(i)));
424                 meanstdev(i,2)=std(kim(i,1:Nsm(i)));
425             end
426
427             % Calculating z for each species
428             zr=zeros(Nr,1);
429             zc=zeros(Nc,1);
430             for i=1:Nr
431                 zr(i)=(kisr(i)-meanstdev(A(i),1))/(meanstdev(A(i),2));
432             end
433             for i=1:Nc
434                 zc(i)=(kisc(i)-meanstdev(B(i),1))/(meanstdev(B(i),2));
435             end
436
437             % Compiling final tables
438             ROutput=[bp_row_labels,Pr,zr];
439             COutput=[bp_col_labels',Pc,zc];
440
441         end
```

1.1.8.1 Purpose

Solves for the P and Z values of each node based on both the row and column elements. The method used to obtain these values can only work on one group at a time, which is why there is a distinction between rows and columns. This function iteratively defines them both semi-simultaneously and outputs them as sperate arrays for both P and z.(Pr, Pc, zr, zc)

1.1.8.2 Variables

- Output Variables
  - Pr – an array of P values for the row elements
  - zr – an array of z values for the row elements
  - Pc – an array of P values for the column elements
  - zc – an array of z values for the column elements
- Operation Variables
  - bp – the bipartite obj defined by the Define Bipartite Matrix Function (1.1.3)
  - bp_row_labels – the row labels defined by the Define Bipartite Matrix function (1.1.3)
  - bp_col_labels - the column labels defined by the Define Bipartite Matrix function (1.1.3)

- matrix – the adjacency matrix that used in the analysis defined by the bipartite object, bp.
- A – an array that represents the row interactions defined by the Modularity function (B.1.1.5)
- B – an array that represents the col interactions defined by the Modularity function (B.1.1.5)
- C – the maximum value within the A array
- D – the maximum value within the B array
- Nm – the maximum value between the C and D array
- Nc – the length of the col matrix (“A”)
- Nr – the length of the row matrix (“B”)
- kir – the total degree of the row nodes
- kic – the total degree of the col nodes
- kitr – the links from row node i to a specific module
- kitc – the links from column node i to a specific module
- Nsm – an empty array with the ordered values of Nc and Nr
- kisr – the links from row node i to other nodes within its own module
- kisc – the links from column node i to other nodes within its own module
- kim – an array of each kis value for each module (for mean and stdev)
- kimIndex – an array used to insert each new species into a blank space in the appropriate row
- meanstdev – an array of the mean and stdev values for each module's kis values

1.1.9 Define Roles

```
% DefineRoles - Assigns each node to their role based on their P and Z values
%                   - by iterating through each nodes correlated P and Z values
%          N = the number or rows within the matrix
%          ultra_peripheral = a redordered column array of the nodes that are defined by the ultra peripheral role
%          peripheral = a redordered column array of the nodes that are defined by the peripheral role
%          nonhub_connector = a redordered column array of the nodes that are defined by the non-hub connector role
%          nonhub_kinless = a redordered column array of the nodes that are defined by the non-hub kinless role
%          provincial = a redordered column array of the nodes that are defined by the provincial role
%          connector = a redordered column array of the nodes that are defined by the connector role
%          kinless = a redordered column array of the nodes that are defined by the kinless role
%          roles = a combined array containg all of the role arrays above
%          role_col = a combined column array of roles that remains in the orginial order
function [roles, ultra_peripheral, peripheral, nonhub_connector, nonhub_kinless, provincial, connector, kinless, role_col] = DefineRoles(app, p, z, labels)
    N = length(p); %Sets the length of the iteration

    % Intializes empty role arrays
    ultra_peripheral =[];
    peripheral = [];
    nonhub_connector =[];
    nonhub_kinless = [];
    provincial = [];
    connector = [];
    kinless = [];
    roles = strings([N,7]);
    role_col = strings([N,1]);

    % Fills the role arrays
    for i=1:N
        % Non-Hub Roles
        if z(i) < 2.5
            if p(i) <= .1
                ultra_peripheral = [ultra_peripheral; labels(i)];
                role_col(i, 1) = 'Ultra-Peripheral';
            elseif p(i) >= .1 && p(i) <= .625
                peripheral = [peripheral; labels(i)];
                role_col(i, 1) = 'Non-Hub Peripheral';
            elseif p(i) >= .625 && p(i) <= .8
                nonhub_connector =[nonhub_connector; labels(i)];
                role_col(i, 1) = 'Non-Hub Connector';
            elseif p(i) >= .8
                nonhub_kinless = [nonhub_kinless; labels(i)];
                role_col(i, 1) = 'Non-Hub Kinless';
            end
        % Hub Roles
        elseif z(i) >= 2.5
            if p(i) <= .3
                provincial = [provincial; labels(i)];
                role_col(i, 1) = 'Provincial';
            elseif p(i) >= .3 && p(i) <= .75
                connector = [connector; labels(i)];
                role_col(i, 1) = 'Connector';
            elseif p(i) >= .75
                kinless = [kinless; labels(i)];
                role_col(i, 1) = 'Non-Hub Kinless';
            end
        end
    end
```

```
    % Reordering the Nodes
    for i=1:length(ultra_peripheral)
        roles(i,1) = ultra_peripheral(i);
    end
    for i=1:length(peripheral)
        roles(i,2) = peripheral(i);
    end
    for i=1:length(nonhub_connector)
        roles(i,3) = nonhub_connector(i);
    end
    for i=1:length(nonhub_kinless)
        roles(i,4) = nonhub_kinless(i);
    end
    for i=1:length(provincial)
        roles(i,5) = provincial(i);
    end
    for i=1:length(connector)
        roles(i,6) = connector(i);
    end
    for i=1:length(kinless)
        roles(i,7) = kinless(i);
    end

end
```

1.1.9.1 Purpose

Assigns each element to a role based on its P and Z values. Similar to the P and Z function, this can only do one at a time. Therefore, either the row elements or the column elements can be defined. However, unlike the P and Z function the Define Roles function can't define them semi-simultaneously. This is why the input variables are simply P, z, and labels rather than Pr, zr, and row_labels.

- The ModulesSwitch(1.3.16) can be used to toggle between row or column elements in the analysis.

1.1.9.2 Variables

- Output Variables

- ultra_peripheral – a column array of the nodes that are ultra-peripherals
- peripheral – a column array of the nodes that are peripherals
- nonhub_connector – a column array of the nodes that are nonhub connectors
- nonhub_kinless – a column array of the nodes that are nonhub kinless'
- provincial – a column array of the nodes that are provincials
- connector – a column array of the nodes that are connectors
- kinless – a column array of the nodes that are kinless'
- roles – a combined array of all the role column arrays
- role _col – a single column of the roles that are assigned to each element in their original order

- Input Variables
  - P – an array of the P values for each node
  - z – an array of the z values for each node
  - labels – an array of the names for each node
- Operation Variables
  - N – the length of iteration that the role defining steps use. Defined by the length of the P array.

1.2 GUI Functions

1.2.1 Run BiMat

```
527
528     % RunBiMat - The Main function of the GUI that steps though the analysis functions
        function RunBiMat(app)
529
530
531 -       % General Properties - Defines and Displays the General Properties of the Matrix
            GeneralProperties(app);
532
533
534 -       % Modularity - Defines and Displays the Values for Modulairty from the chosen alogrithum
            Modularity(app);
535
536
537 -       % Nestedness - Defines and Displays the Values for Nestedness
            Nestedness(app);
538
539
540 -       % FillPandZ - Combines the P and Z values with their roles and Displays them
            FillPandZ(app);
541
542
543 -       % Progress Lamp
            app.Lamp.Color = '0.00,1.00,0.00'; % Green
544
545 -   end
```

1.2.1.1 Purpose

The Main function of the GUI that steps though the analysis functions.

1. General Properties() (1.1.4)
2. Modularity() (1.1.5)
3. Nestedness() (1.1.6)

4. FillPandZ() (1.1.8)

1.2.2 Generate Plots

```
548
549     % GeneratePlots - Shows the Plot that is Chosen in the Dropdown as a seperate window
        function GeneratePlots(app)
550
551         [bp, ~, ~] = DefineBipartiteMatrix(app);
552         f = figure('Visible','on');
553
554         if strcmp(app.PlotsDropDown.Value, 'Modular Graph')
555             bp.plotter.PlotModularGraph();
556         elseif strcmp(app.PlotsDropDown.Value, 'Matrix')
557             bp.plotter.PlotMatrix();
558         elseif strcmp(app.PlotsDropDown.Value, 'Modular Matrix')
559             bp.plotter.PlotModularMatrix();
560         elseif strcmp(app.PlotsDropDown.Value, 'Nested Matrix')
561             bp.plotter.PlotNestedMatrix();
562         end
563
564     end
```

1.2.2.1 Purpose

Generates the Plot that is Chosen in the Plot Dropdown as a separate window. It does so by using the bp object with the specific plotting functions within the PlotWebs.m script within the “draw” folder of BiMat-Master

1.2.2.2 Variables

- bp – the bipartite obj defined by the Define Bipartite Matrix Function(1.1.3)

1.2.3 Generate Tab Options

```
567     % GenerateTabOptions - Generates the Tab options for premade Matrices
568     %                   - by calling upon the correct ###MatrixProperties script
569     %           default_tab = allows for the tab drop down to be filled once a file is chosen
570     %           tab_name = the selected tab within the dropdown
571     function GenerateTabOptions(app, file)
572
573         if strcmp(app.FileDropDown.Value, 'Bipart.xlsx')
574             default_tab = 'TAMUS21';
575             tab_name = default_tab;
576
577             [~, ~, ~, tabs] = BipartMatrixProperties(tab_name, file);
578             app.TabDropDown.Items = tabs;
579
580         elseif strcmp(app.FileDropDown.Value, 'Test.xlsx')
581             default_tab = 'Test1';
582             tab_name = default_tab;
583
584             [~, ~, ~, tabs] = TestMatrixProperties(tab_name, file);
585             app.TabDropDown.Items = tabs;
586
587         elseif strcmp(app.FileDropDown.Value, 'PowerGrid.xlsx')
588             default_tab = 'Original 5 Bus';
589             tab_name = default_tab;
590
591             [~, ~, ~, tabs] = PowerGridMatrixProperties(tab_name, file);
592             app.TabDropDown.Items = tabs;
593
594         else
595             app.TabDropDown.Items = {'N/A'};
596
597         end
598     end
```

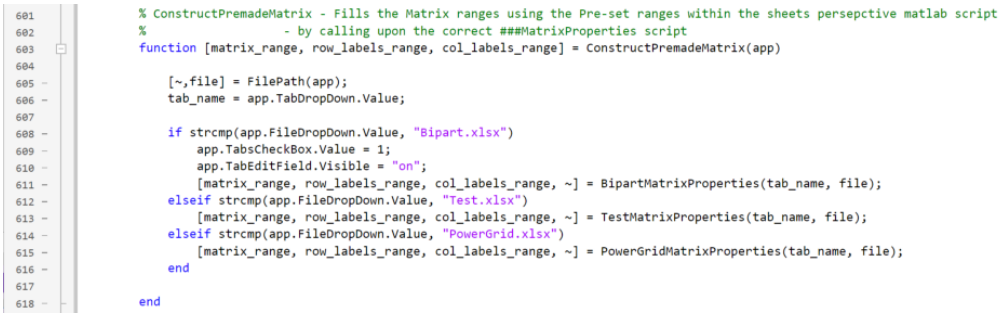
1.2.3.1 Purpose

Generates the Tab options (all the tabs within the specified sheet) for premade Matrices by calling upon the correct "*Name*MatrixProperties.m" script.

1.2.3.2 Variables

- Input Variables
  - file - the filename for the sheet that is being used defined by the File Path function (B.1.1.1)
- Operation Variables
  - tabs – an array of the different tabs within the specified sheet
  - default_tab – specified when the sheet is formatted and allows for the tab drop down to be filled once a file is chosen
  - tab_name - the selected tab within the dropdown

1.2.4 Construct Premade Matrix



```
% ConstructPremadeMatrix - Fills the Matrix ranges using the Pre-set ranges within the sheets persepctive matlab script
%                   - by calling upon the correct ###MatrixProperties script
function [matrix_range, row_labels_range, col_labels_range] = ConstructPremadeMatrix(app)

    [~,file] = FilePath(app);
    tab_name = app.TabDropDown.Value;

    if strcmp(app.FileDropDown.Value, "Bipart.xlsx")
        app.TabsCheckBox.Value = 1;
        app.TabEditField.Visible = "on";
        [matrix_range, row_labels_range, col_labels_range, ~] = BipartMatrixProperties(tab_name, file);
    elseif strcmp(app.FileDropDown.Value, "Test.xlsx")
        [matrix_range, row_labels_range, col_labels_range, ~] = TestMatrixProperties(tab_name, file);
    elseif strcmp(app.FileDropDown.Value, "PowerGrid.xlsx")
        [matrix_range, row_labels_range, col_labels_range, ~] = PowerGridMatrixProperties(tab_name, file);
    end

end
```

1.2.4.1 Purpose

Fills the Matrix ranges using the Pre-set ranges within the sheets perspective MATLAB script by calling upon the correct "*Name*MatrixProperties.m" script.

1.2.4.2 Variables

- Output Variables
  - matrix_range - the cells that contain the actual data for the Adjacency Matrix defined by the "*Name*MatrixProperties.m"
  - row_labels_range - the cells that contain the row labels for the Adjacency Matrix defined by the "*Name*MatrixProperties.m"
  - col_labels_range - the cells that contain the column labels for the Adjacency Matrix defined by the "*Name*MatrixProperties.m"
- Operation Variables

- file – defined by the FilePath function(1.1.1)
- tab_name – the selected tab within the dropdown

1.2.5 Fill P and Z

```
% FillPandZ - Combines the P and Z values with their roles and Displays them
%           p = a column array of the P values(either based on rows or columns)
%           z = a column array of the the z values(either based on rows or columns)
%           labels = a column array of the the labels(either based on rows or columns)
%           label = the labels value chosen on the default page(either based on rows or columns)
%                 - this can defined manually or by using the predefined options
function FillPandZ(app)
    [Pr, zr, Pc, zc] = PandZ(app);

    [~, bp_row_labels, bp_col_labels] = DefineBipartiteMatrix(app);

    % Defines Value based on either Rows or Columns
    if strcmp(app.ModulesSwitch.Value, 'Rows')
        p = Pr;
        z = zr;
        labels = bp_row_labels;
        label = app.RowsLabelEditField.Value;
    elseif strcmp(app.ModulesSwitch.Value, 'Columns')
        p = Pc;
        z = zc;
        labels = transpose(bp_col_labels);
        label = app.ColsLabelEditField.Value;
    end

    [~, ~, ~, ~, ~, ~, ~, ~, role_col] = DefineRoles(app, p, z, labels);

    % Combines the P and Z scores with their node label and role.
    app.PandZTable.Data = horzcat(labels, p, z, role_col);

    % Displays the combined array
    app.PandZTable.ColumnName = {label, 'P-Value', 'z-Value', 'Role'};

end
```

1.2.5.1 Purpose

Shows the P and Z values along with their role for each row or column element depending on the modules switch (1.3.16). This is done by combining the labels array, p array, z array, and the role_col array.

- See the Define Roles function (1.1.18) for the role assignments/definitions
- See the P and Z page for a more detailed view of the role assignments. (3)

1.2.5.2 Variables

- Operation Variables
  - Pr – an array of P values for the row elements
  - zr – an array of z values for the row elements
  - Pc – an array of P values for the column elements
  - zc – an array of z values for the column elements
  - bp_row_labels – the row labels defined by the Define Bipartite Matrix function (1.1.3)
  - bp_col_labels - the column labels defined by the Define Bipartite Matrix function (1.1.3)

- p – an array of P values either for the row or column elements based on the modules switch(1.3.16)
- z – an array of z values either for the row or column elements based on the modules switch(1.3.16)
- labels – an array of element names from either the row or column elements depending on the modules switch value(1.3.16)
- label – the last element of the P and Z pages title defined by the defaults page. It is either the row or column label in the defaults page depending on the modules switch value(1.3.16)
- role_col – a column array of the roles for each node defined by the Define Roles function (B.1.1.9).

1.2.6 Launch P and Z

```
656
657
658
659
660 -
661 -
662 -
663
664
665 -
666 -
```

```
% LaunchPandZ - Opens the PandZPage and plots the P and Z values
% on a scatter plot as well as displays their roles
function LaunchPandZ(app, labels, p, z, label)

    [~, file] = FilePath(app);
    tab = app.TabEditField.Value;
    [roles, ~, ~, ~, ~, ~, ~, ~, role_col] = DefineRoles(app, p, z, labels);

    % Opens the P and Z app
    app.PandZPage = PandZPage(file, tab, labels, p, z, label, roles, role_col);
end
```

1.2.6.1 Purpose

Opens the P and Z Page and plots the P and Z values on a scatter plot as well as displays their roles.

- See the P and Z Page section (3) for a detailed description of what this page is used for.

1.2.6.2 Variables

- Input Variables
  - p – an array of the p values
  - z – an array of the z values
  - label – the last element of the P and Z pages title
- Operation Variables
  - file – the file named defined by the File Path function (1.1.1).
  - tab – the tab name defined in the Tab Edit Field
  - labels – an array of the element labels defined as in input to the function
  - roles – an array of the elements placed into the column that represents the different roles

- role_col – a column array that list the elements role in the order that the labels are originally in

1.2.7 Export to Excel

```
669         % ExporttoExcel - Combines all of the GUI results into a single cell array and
670         % prepares it to be exported to a specified excel sheet and tab
671         function results = ExporttoExcel(app)
672             file = append('BiMat_Analysis\Results\' , app.FileEditField.Value);
673             tab = app.TabEditField_2.Value;
674
675             [~, bp_row_labels, bp_col_labels] = DefineBipartiteMatrix(app);
676             [num_of_species, num_of_row_species, num_of_col_species, num_of_interactions, m_size, connectance] = GeneralProperties(app);
677             [N, Qb, Qr, ~, ~] = Modularity(app);
678             algorithm = app.AlgorithmDropDown.Value;
679             [nestedness, N_rows, N_cols] = Nestedness(app);
680             [Pr, zr, Pc, zc] = PandZ(app);
681             [~, ~, ~, ~, ~, ~, ~, ~, r_role_col] = DefineRoles(app, Pr, zr, bp_row_labels);
682             [~, ~, ~, ~, ~, ~, ~, ~, c_role_col] = DefineRoles(app, Pc, zc, bp_col_labels);
683             r_label = app.RowsLabelEditField.Value;
684             c_label = app.ColsLabelEditField.Value;
685             Title = append(app.FileEditField.Value,' - ',tab);
686
687             if length(Pr) > length(Pc)
688                 n = 20 + length(Pr);
689             else
690                 n = 20 + length(Pc);
691             end
692
693             results = cell(n,8);
694
695             results{1,2} = Title;
696
697             results{3,1} = 'General Properties';
698             results{4,1} = 'Number of Elements';
699             results{4,2} = num_of_species;
700             results{5,1} = 'Number of Row Elements';
701             results{5,2} = num_of_row_species;
702             results{6,1} = 'Number of Col Elements';
703             results{6,2} = num_of_col_species;
704             results{7,1} = 'Number of Interactions';
705             results{7,2} = num_of_interactions;
706             results{8,1} = 'Size';
707             results{8,2} = m_size;
708             results{9,1} = 'Connectance or Fill';
709             results{9,2} = connectance;
```

```
710
711             results{11,1} = 'Modulairty';
712             results{12,1} = 'Algorithum';
713             results{12,2} = algorithm;
714             results{13,1} = 'N - Number of Modules';
715             results{13,2} = N;
716             results{14,1} = 'Qb - Standard Modularity Metric';
717             results{14,2} = Qb;
718             results{15,1} = 'Qr - Ratio of int/ext interactions';
719             results{15,2} = Qr;
720
721             results{17, 1} = 'Nestedness';
722             results{18, 1} = 'NODF Nestedness Value';
723             results{18, 2} = nestedness;
724             results{19, 1} = 'NODF Rows Value';
725             results{19, 2} = N_rows;
726             results{20, 1} = 'NODF Columns Value';
727             results{20, 2} = N_cols;
728
729             results{22,1} = r_label;
730             results{22,2} = 'P-Value';
731             results{22,3} = 'z-Value';
732             results{22,4} = 'Role';
733             for i=1:(length(Pr))
734                 results{(22+i),1} = bp_row_labels(i);
735                 results{(22+i),2} = Pr(i);
736                 results{(22+i),3} = zr(i);
737                 results{(22+i),4} = r_role_col(i);
738             end
739
740
741             results{22,6} = c_label;
742             results{22,7} = 'P-Value';
743             results{22,8} = 'z-Value';
744             results{22,9} = 'Role';
745             for i=1:(length(Pc))
746                 results{(22+i),6} = bp_col_labels(i);
747                 results{(22+i),7} = Pc(i);
748                 results{(22+i),8} = zc(i);
749                 results{(22+i),9} = c_role_col(i);
750             end
751
752         end
753
754     end
755
```

1.2.7.1 Purpose

Combines all of the GUI results into a single cell array and prepares it to be exported to a specified excel sheet and tab.

- The output location must be within the results folder of the BiMat_Analysis folder.

1.2.7.2 Variables

- Output Variables
  - results – a large array that combines all of the results from general properties, Modularity, Nestedness, as well as the P and Z values.
- Operation Variables
  - file – the filename for the sheet that is being used defined by the File Path function (B.1.1.1)
  - tab – the tab within the specified sheet that the function will be using
  - bp – the bipartite obj defined by the Define Bipartite Matrix Function (B.1.1.3)
  - matrix – the matrix within the bp object from the Bipartite Matrix function(B.1.1.3)
  - bp_row_labels – the row labels defined by the Define Bipartite Matrix function (B.1.1.3)
  - bp_col_labels - the column labels defined by the Define Bipartite Matrix function (B.1.1.3)
  - num_of_species – the total number of row and column species
  - num_of_row_species – the number of row species
  - num_of_col_species – the number of column species
  - num_of_interactions – the sum of all interactions within the webmatrix
  - m_size – the total number of possible interactions
  - connectance – the ratio of realized connections to possible connections in the webmatrix
  - N – the number of modules
  - Qb – Standard Modularity function
  - Qr – Ratio of interactions (internal/external)
  - algorithm – the algorithm that's used for the modularity functions
  - nestedness – the combined NODF nestedness value
  - N_rows – the NODF nestedness for the rows
  - N_cols – the NODF nestedness for the cols
  - sorted_row_labels – the sorted version of the bp_row_labels. Defined by the Nested Matrix function (B.1.1.7)
  - sorted_col_labels – the sorted version of the bp_col_labels Defined by the Nested Matrix function (B.1.1.7)

- sorted_matrix – the sorted Bipartite matrix that is in the most nested form defined by the the “SORT_MATRIX” function within the MatrixFunctions script. Defined by the Nested Matrix function (B.1.1.7)
- Pr – an array of P values for the row elements
- zr – an array of z values for the row elements
- Pc – an array of P values for the column elements
- zc – an array of z values for the column elements
- r_role_col – a column array of the roles for each row node defined by the Define Roles function (B.1.1.9).
- c_role_col – a column array of the roles for each col node defined by the Define Roles function (B.1.1.9).
- r_label – the row label value form the defaults page defined by the option dropdown value change callback (B.1.3.2)
- c_label – the col label value form the defaults page defined by the option dropdown value change callback (B.1.3.2)
- Title – the title shown at the top right of the data defineds by combining the export file name and the tab
- n – the length of iteration that the role defining steps use. Defined by the length of either the Pr or Pc array.

1.3 Callbacks

1.3.1 Startup Function

```
758         % Code that executes after component creation
759         function startupFcn(app)
760             file = app.FileDropDown.Value;
761             app.MatrixPropertiesPanel.Visible = 'off';
762             app.TabEditField.Visible = 'off';
763             app.TabEditFieldLabel.Visible = 'off';
764             app.ShowallPlotsButton.Visible = 'off';
765 
766             GenerateTabOptions(app, file);
767             app.Lamp.Color = 'red';
768 
769             app.BiMatPanel.Visible = 'off';
770             app.DefaultsPanel.Visible = 'on';
771         end
```

1.3.1.1 Purpose

Hides the Majority of the panels that make up the GUI, and only shows the defaults panel. It also generates the tabs for the default file within the file drop down to prevent any errors.

1.3.2 Option Drop Down Value Changed

```
773         % Value changed function: OptionsDropDown
774         function OptionsDropDownValueChanged(app, event)
775             value = app.OptionsDropDown.Value;
776 
777             app.Lamp.Color = 'red';
778 
779             % sets the row and col labels as well as the file name for
780             % the results based on the default chosen
781             if strcmp(value, 'MakerSpace')
782                 app.RowsLabelEditField.Value = 'Students';
783                 app.ColsLabelEditField.Value = 'Tools';
784                 app.FileEditField.Value = 'MakerSpaceResults.xlsx';
785             elseif strcmp(value, 'Ecosystem')
786                 app.RowsLabelEditField.Value = 'Animals';
787                 app.ColsLabelEditField.Value = 'Plants';
788                 app.FileEditField.Value = 'EcosystemResults.xlsx';
789             elseif strcmp(value, 'Social Network')
790                 app.RowsLabelEditField.Value = 'People';
791                 app.ColsLabelEditField.Value = 'Events';
792             elseif strcmp(value, 'Transportation Network')
793                 app.RowsLabelEditField.Value = 'Locations';
794                 app.ColsLabelEditField.Value = 'Routes';
795             elseif strcmp(value, 'Power Grid')
796                 app.RowsLabelEditField.Value = 'Suppliers';
797                 app.ColsLabelEditField.Value = 'Receivers';
798                 app.FileEditField.Value = 'PowerGridResults.xlsx';
799             end
800         end
```

1.3.2.1 Purpose

Generates and Defines the Row and Column labels based on what option is chosen. It can also predefine the results location to save a step later in the export process.

1.3.3 Update Button Pushed

```
802         % Button pushed function: UpdateButton
803         function UpdateButtonPushed(app, event)
804             app.DefaultsPanel.Visible = 'off';
805             app.BiMatPanel.Visible = 'on';
806         end
```

1.3.3.1 Purpose

Hides the defaults panel and reveals the rest of the GUI.

1.3.4 Edit Defaults Button Pushed

```
808         % Button pushed function: EditDefaultsButton
809         function EditDefaultsButtonPushed(app, event)
810             app.BiMatPanel.Visible = 'off';
811             app.DefaultsPanel.Visible = 'on';
812         end
```

1.3.4.1 Purpose

Returns to the Defaults Panel so the user can redefine the Row and Column labels, by hiding the majority of the GUI and only showing the Defaults Panel.

1.3.5 Use a Preformatted Sheet Button Pushed

```
814         % Button pushed function: UseaPreFormatedSheetButton
815         function UseaPreFormatedSheetButtonPushed(app, event)
816             app.MatrixPropertiesPanel.Visible = 'on';
817 
818             app.FileNameexTestxlsxEditField.Value = app.FileDropDown.Value;
819 
820             % Defines the Ranges based on the premade selections
821             [matrix_range, row_labels_range, col_labels_range] = ConstructPremadeMatrix(app);
822 
823             % Shows the Ranges based on the premade selections
824             app.MatrixRangeEditField.Value = matrix_range;
825             app.Row_LabelsRangeEditField.Value = row_labels_range;
826             app.Col_LabelsRangeEditField.Value = col_labels_range;
827             app.TabEditField.Value = app.TabDropDown.Value;
828 
829         end
```

1.3.5.1 Purpose

Reveals the Matrix properties Panel and fills in the filename input based on the file dropdown value (B.1.3.12), as well as the tab value based on the tabs dropdown (B.1.3.7). Then defines and displays the ranges using the Construct Predefined Matrix function.

1.3.6 File Dropdown Value Changed

```
831         % Value changed function: FileDropDown
832         function FileDropDownValueChanged(app, event)
833             file = app.FileDropDown.Value;
834             app.FileNameexTestxlsxEditField.Value = file;
835             GenerateTabOptions(app, file);
836 
837             % Emptys the Ranges so that user knows to update them with
838             % the "Use Preformated Sheet" button
839             app.MatrixRangeEditField.Value = '';
840             app.Row_LabelsRangeEditField.Value = '';
841             app.Col_LabelsRangeEditField.Value = '';
842 
843             app.ShowallPlotsButton.Visible = 'off';
844 
845             app.Lamp.Color = 'red';
846         end
```

1.3.6.1 Purpose

Generates the tabs options in the tabs dropdown (B.1.3.7) using the Generate Tab Options function (B.1.2.3). It then empties the ranges to prevent operational errors.

1.3.7 Tab Dropdown Value Changed

```
848         % Value changed function: TabDropDown
849         function TabDropDownValueChanged(app, event)
850             value = app.TabDropDown.Value;
851 
852             % Emptys the Ranges so that user knows to update them with
853             % the "Use Preformated Sheet" button
854             app.MatrixRangeEditField.Value = ' ';
855             app.Row_LabelsRangeEditField.Value = ' ';
856             app.Col_LabelsRangeEditField.Value = ' ';
857 
858             app.ShowallPlotsButton.Visible = 'off';
859 
860             app.TabEditField_2.Value = value; % sets the value for the tab to export to
861 
862             app.Lamp.Color = 'red';
863         end
```

1.3.7.1 Purpose

Sets the tab for the export functions to target and empties the ranges to prevent operational errors.

1.3.8 View Matrix Button Pushed

```
865         % Button pushed function: ViewMatrixButton
866         function ViewMatrixButtonPushed(app, event)
867             [matrix,row_labels, col_labels] = DefineMatrix(app);
868             [~, file] = FilePath(app);
869
870             % defines the tab based on if the tabs checkbox is filled or not
871             if app.TabsCheckBox.Value == 1
872                 tab = app.TabEditField.Value;
873             else
874                 raw_tabs = sheetnames(file);
875                 tab = raw_tabs(1,1);
876             end
877
878             app.MatrixPage = MatrixPage(matrix, row_labels, col_labels, file, tab); % opens and fills the MatrixPage
879
880
881         end
```

1.3.8.1 Purpose

Launches the matrix page so that the user can view the matrix that the program will be using. This includes the matrix and its labels, so it is a great way of checking that the ranges worked correctly.

1.3.8.2 Variables

- Operational Variables
  - matrix - the matrix that represents the Adjacency Matrix defined by the Define Matrix function (B.1.1.2)
  - row_labels - the matrix defined by the Define Matrix function (B.1.1.2)
  - col_labels - the matrix defined by the Define Matrix function (B.1.1.2)
  - file – the filename for the sheet that is being used defined by the File Path function (B.1.1.1)
  - tab – the tab within the excel file that the program is using

1.3.9 List Tabs Button Pushed

```
883         % Button pushed function: ListTabsButton
884         function ListTabsButtonPushed(app, event)
885             [~, file] = FilePath(app);
886             tabs = sheetnames(file);
887             app.ListPage = ListPage(tabs); % Opens the ListPage
888         end
```

1.3.9.1 Purpose

Launches the List page to show the list of tabs defined within the callback. This can be used to verify that the tab selected is in fact within the specified sheet.

1.3.9.2 Variables

- Operational Variables

- file – the filename for the sheet that is being used defined by the File Path function (B.1.1.1)
- tabs – a list of the tabs within the file

1.3.10 Tabs Check Box Value Changed

```
890         % Value changed function: TabsCheckBox
891         function TabsCheckBoxValueChanged(app, event)
892             value = app.TabsCheckBox.Value;
893 
894             % Shows the Tab edit field in the "Matrix Properties Panel"
895             % if the the Tab checkbox is filled
896             if value == 1
897                 app.TabEditField.Visible = 'on';
898                 app.TabEditFieldLabel.Visible = 'on';
899             elseif value == 0
900                 app.TabEditField.Visible = 'off';
901                 app.TabEditFieldLabel.Visible = 'off';
902             end
903         end
```

1.3.10.1 Purpose

Shows the tabs input in the matrix properties panel if the check box is filled and hides it otherwise.

1.3.11 File Name Value Changing

```
905         % Value changing function: FileNameexTestxlsxEditField
906         function FileNameexTestxlsxEditFieldValueChanging(app, event)
907             %changingValue = event.Value;
908             app.MatrixPropertiesPanel.Visible = 'on';
909         end
```

1.3.11.1 Purpose

Shows the Matrix Properties Panel

1.3.12 File Name Value Changed

```
911         % Value changed function: FileNameexTestxlsxEditField
912         function FileNameexTestxlsxEditFieldValueChanged(app, event)
913             app.MatrixPropertiesPanel.Visible = 'on';
914 
915             % Emptys the Ranges so that user knows to update them with
916             % the "Use Preformated Sheet" button
917             app.MatrixRangeEditField.Value = ' ';
918             app.Row_LabelsRangeEditField.Value = ' ';
919             app.Col_LabelsRangeEditField.Value = ' ';
920 
921             app.Lamp.Color = 'red';
922 
923         end
```

1.3.12.1 Purpose

Empties the ranges to prevent operational errors.

1.3.13 Run Button Pushed

```
925         % Button pushed function: RunButton
926         function RunButtonPushed(app, event)
927             [path, ~] = FilePath(app);
928 
929             % Displays error message if the matirx has not ben specified
930             if isempty(app.FileNameexTestxlsxEditField.Value)
931                 app.StatusBar.Value = "Specify a Matrix";
932                 app.StatusBar.FontWeight = 'bold';
933                 app.StatusBar.FontColor = 'red';
934             % Displays error message if the matirx range has not ben specified
935             elseif isempty(app.MatrixRangeEditField.Value)
936                 app.StatusBar.Value = "Specify a Matrix Range";
937                 app.StatusBar.FontWeight = 'bold';
938                 app.StatusBar.FontColor = 'red';
939             % Displays error message if the row labels range has not ben specified
940             elseif isempty(app.Row_LabelsRangeEditField.Value)
941                 app.StatusBar.Value = "Specify a Row Labels Range";
942                 app.StatusBar.FontWeight = 'bold';
943                 app.StatusBar.FontColor = 'red';
944             % Displays error message if the col labels range has not ben specified
945             elseif isempty(app.Col_LabelsRangeEditField.Value)
946                 app.StatusBar.Value = "Specify a Col Labels Range";
947                 app.StatusBar.FontWeight = 'bold';
948                 app.StatusBar.FontColor = 'red';
949             else
950             % Run Analysis
951                 app.StatusBar.Value = path;
952                 app.StatusBar.FontWeight = 'normal';
953                 app.StatusBar.FontColor = 'black';
954                 app.Lamp.Color = '0.93,0.69,0.13';
955                 drawnow();
956                 RunBiMat(app);
957             end
958 
959         end
```

1.3.13.1 Purpose

Verifies that the program has inputted a matrix and check is the ranges are filled out. If not, an error message is displayed in the status bar. If it passes all the checks, then it calls on the Run BiMat function. (B.1.2.1)

1.3.14 Algorithm Drop Down Value Changed

```
961         % Value changed function: AlgorithmDropDown
962         function AlgorithmDropDownValueChanged(app, event)
963             value = app.AlgorithmDropDown.Value;
964
965             % Shows the KernighanLinTunning Check box if the
966             % LeadingEigenVector Algorithum is chosen
967             if strcmp(value, "LeadingEigenVector")
968                 app.KernighanLinTunningCheckBox.Visible = 'on';
969             else
970                 app.KernighanLinTunningCheckBox.Visible = 'off';
971             end
972
973             % Reruns the Modularity function for the
974             % algorithum thats chosen
975             Modularity(app);
976
977         end
```

1.3.14.1 Purpose

Reruns the Modularity function (B.1.1.5) with the new algorithm. As well as shows the Kernighan Lin Tunning Check Box if the algorithm is the Leading Eigen Vector.

1.3.15 Show Modules Button Pushed

```
979         % Button pushed function: ShowModulesButton
980         function ShowModulesButtonPushed(app, event)
981             [~, bp_row_labels, bp_col_labels] = DefineBipartiteMatrix(app);
982             [N, ~, ~, ~, ~] = Modularity(app);
983             [matrix, ~, ~] = DefineMatrix(app);
984
985             %% Selecting Algorithm with the Drop Down
986             % LeadingEigenVector
987             if strcmp(app.AlgorithmDropDown.Value, 'LeadingEigenVector') == true
988                 algorithm = 'LeadingEigenVector';
989
990             % ApadtiveBrim
991             elseif strcmp(app.AlgorithmDropDown.Value, 'AdaptiveBrim') == true
992                 algorithm = 'AdaptiveBrim';
993
994             % LPBrim
995             elseif strcmp(app.AlgorithmDropDown.Value, 'LPBrim') == true
996                 algorithm = 'LPBrim';
997             end
998
999             app.ModulesPage = ModulesPage(algorithm, N, matrix, bp_row_labels, bp_col_labels);
1000        end
```

1.3.15.1 Purpose

Launches the Modules Page (B.2) allowing for the user to view the modules and what elements are within them. See section B.2 for the operation of this Page.

1.3.15.2 Variables

- Operational Variables
  - bp_row_labels – the row labels defined by the Define Bipartite Matrix (B.1.1.3)
  - bp_col_labels - the col labels defined by the Define Bipartite Matrix (B.1.1.3)

- algorithm – the algorithm that's used for the modularity functions
- N – the number of modules defined by the Modularity function (B.1.1.5)
- matrix - the matrix that represents the Adjacency Matrix defined by the Define Matrix function (B.1.1.2)

1.3.16 Modules Switch Value Changed

```
1002          % Value changed function: ModulesSwitch
1003          function ModulesSwitchValueChanged(app, event)
1004              app.Lamp.Color = '0.93,0.69,0.13';
1005              drawnow();
1006
1007              % Reruns the FillPandZ function for the new switch value
1008              FillPandZ(app);
1009
1010              app.Lamp.Color = 'green';
1011              drawnow();
1012          end
```

1.3.16.1 Purpose

Reruns the Fill P and Z function (B.1.2.5) based on the value of the modules switch value. (Rows or Columns)

1.3.17 Plot Button Pushed

```
1014      % Button pushed function: PlotButton
1015      function PlotButtonPushed(app, event)
1016          app.Lamp.Color = '0.93,0.69,0.13';
1017          drawnow();
1018
1019          % Displays error message if Anaylisis has not been run yet
1020          if isempty(app.PandZTable.Data)
1021              app.StatusBar.Value = 'Please Run the Analysis';
1022              app.StatusBar.FontWeight = 'bold';
1023              app.StatusBar.FontColor = 'red';
1024          % Opens the PandZPage based on the Modules Switch Value (rows or columns)
1025          else
1026              [Pr, zr, Pc, zc] = PandZ(app);
1027              %[~, row_labels, col_labels] = DefineMatrix(app);
1028              [~, bp_row_labels, bp_col_labels] = DefineBipartiteMatrix(app);
1029
1030
1031              if strcmp(app.ModulesSwitch.Value, 'Rows')
1032                  label = app.RowsLabelEditField.Value;
1033                  LaunchPandZ(app, bp_row_labels, Pr, zr, label);
1034              elseif strcmp(app.ModulesSwitch.Value, 'Columns')
1035                  label = app.ColsLabelEditField.Value;
1036                  col_labels = transpose(bp_col_labels); %Converts the column labels into a vertical array
1037                  LaunchPandZ(app, col_labels, Pc, zc, label);
1038              end
1039          end
1040
1041          app.Lamp.Color = 'green';
1042          drawnow();
1043      end
```

1.3.17.1 Purpose

Launches the PandZ Page (B.3) with either the Row or column elements. It also verifies that the program has been ran before it tries and opens the program.

1.3.17.2 Variables

- Operational Variables

- Pr – an array of P values for the row elements defined by the PandZ function (B.1.1.8)
- zr – an array of z values for the row elements defined by the PandZ function (B.1.1.8)
- Pc – an array of P values for the column elements defined by the PandZ function (B.1.1.8)
- zc – an array of z values for the column elements defined by the PandZ function (B.1.1.8)
- bp_row_labels – the row labels defined by the Define Bipartite Matrix function (1.1.3)
- bp_col_labels - the column labels defined by the Define Bipartite Matrix function (1.1.3)
- col_labels – the transpose of bp_col_labels so that it can be iterated through and shown properly
- label – the last element of the P and Z pages title defined by the defaults page. It is either the row or column label in the defaults page depending on the modules switch value (1.3.16)

1.3.18 View Nested Matrix Button Pushed

```
1045        % Button pushed function: ViewNestedMatrixButton
1046        function ViewNestedMatrixButtonPushed(app, event)
1047            %[matrix,row_labels, col_labels] = DefineMatrix(app);
1048            [bp, bp_row_labels, bp_col_labels] = DefineBipartiteMatrix(app);
1049            [~, file] = FilePath(app);
1050            [sorted_matrix, ir,ic] = MatrixFunctions.SORT_MATRIX(bp.matrix);
1051
1052            % defines the tab based on if the tabs checkbox is filled or not
1053            if app.TabsCheckBox.Value == 1
1054                tab = app.TabEditField.Value;
1055            else
1056                raw_tabs = sheetnames(file);
1057                tab = raw_tabs(1,1);
1058            end
1059
1060            % sorts the Row and Column labels to align with their orignal data entries
1061            [M,N] = size(bp.matrix);
1062            sorted_row_labels = strings([M,1]);
1063            sorted_col_labels = strings([N,1]);
1064            for i=1:N
1065                col_index = ic(i);
1066                sorted_col_labels(i,1) = bp_col_labels(1,col_index);
1067            end
1068            for i=1:M
1069                row_index = ir(i);
1070                sorted_row_labels(i,1) = bp_row_labels(row_index,1);
1071            end
1072
1073            app.MatrixPage = MatrixPage(sorted_matrix, sorted_row_labels, sorted_col_labels, file, tab); % opens and fills the MatrixPage
1074
1075        end
```

1.3.18.1 Purpose

Launches the matrix page so that the user can view the nested matrix that the program will be using. This includes the matrix and its labels in the nested order.

1.3.18.2 Variables

- Operational Variables
  - file – the filename for the sheet that is being used defined by the File Path function (B.1.1.1)

- sorted matrix – the sorted Bipartite matrix that is in the most nested form defined by the NestedMatrix function. (B.1.1.7)
- sorted_row_labels – the sorted version of the bp_row_labels. Defined by the NestedMatrix function. (B.1.1.7)
- sorted_col_labels – the sorted version of the bp_col_labels Defined by the NestedMatrix function. (B.1.1.7)
- tab – the tab within the excel file that the program is using

1.3.19 Add Data Button Pushed

```
1077        % Button pushed function: AddDataButton
1078        function AddDataButtonPushed(app, event)
1079            app.Lamp.Color = '0.93,0.69,0.13';
1080            drawnow();
1081
1082            % Defines the Title of the Combined Results based on if the tabs check box is checked or not
1083            if app.TabsCheckBox.Value == true
1084                Title = app.TabEditField.Value;
1085            else
1086                Title = app.FileNameexTestxlsxEditField.Value;
1087            end
1088
1089            results = ExporttoExcel(app); %Defines the combined results
1090
1091            result = results(3:20, 2); %Defines a temporary array of the most recently ran results
1092            result{1,1} = (Title); % adds the Title name to the temporary result array
1093
1094            app.ComparisonTable.Data = [app.ComparisonTable.Data,result]; % adds temporary result to the data table
1095            app.ComparisonTable.RowName = results(3:20,1); % adds the row labels to the data table
1096
1097            app.Lamp.Color = 'green';
1098            drawnow();
1099        end
```

1.3.19.1 Purpose

Shows the Results for the entire analysis, excluding the P and Z values, into a single column on the compare tab by using the results array created by the Export to Excel function (B.1.2.7). This allows for a quick comparison between different results.

1.3.19.2 Variables

- Operation Variables
  - Title – either the tab or file name of the sheet being used depending on the tab check box value
  - results – a large array that combines all of the results from general properties, Modularity, Nestedness, as well as the P and Z values. Defined by the "Export to Excel" function (B.1.2.7).
    - The results array is shortened to exclude the P and Z values

1.3.20 Generate Button Pushed

```
        % Button pushed function: GenerateButton
        function GenerateButtonPushed(app, event)
            app.Lamp.Color = '0.93,0.69,0.13';
            drawnow();

            % Generates Plot chosen in the "Plots" dropdown
            GeneratePlots(app);

            app.Lamp.Color = 'green';
            drawnow();
        end
```

1.3.20.1 Purpose

Runs the Generate Plots function (B.1.2.2)

1.3.21 Export Button Pushed

```
        % Button pushed function: ExportButton
        function ExportButtonPushed(app, event)
            app.Lamp.Color = '0.93,0.69,0.13';
            drawnow();

            [bp, ~, ~] = DefineBipartiteMatrix(app);
            [path, ~] = FilePath(app);
            location = append("BiMat_Analysis\Results\",app.FileEditField.Value);
            tab = app.TabEditField_2.Value;

            % Displays error message if Anaylisis has
            % not been run yet
            if app.NumberofElementsEditField.Value == 0
                app.StatusBar.Value = 'Please Run the Analysis';
                app.StatusBar.FontWeight = 'bold';
                app.StatusBar.FontColor = 'red';
            % Displays error message if the filename for the
            % export has not ben specified
            elseif strcmp(app.FileEditField.Value, '')
                app.StatusBar.Value = 'Please Specify a File';
                app.StatusBar.FontWeight = 'bold';
                app.StatusBar.FontColor = 'red';
            % Displays error message if the tab for the
            % export has not ben specified
            elseif strcmp(tab, '')
                app.StatusBar.Value = 'Please Specify a Tab';
                app.StatusBar.FontWeight = 'bold';
                app.StatusBar.FontColor = 'red';
            % Exports the Results using the ExporttoExcel function
            else
                results = ExporttoExcel(app);
                writecell(results, location, 'Sheet', tab)
                app.StatusBar.Value = path;
                app.StatusBar.FontWeight = 'normal';
                app.StatusBar.FontColor = 'black';

                % Exports all of the Plots to the "Graphs" folder within
                % "Results" folder of "BiMat_Analysis"
                if app.ExportPlotsCheckBox.Value == true
                    app.ShowallPlotsButton.Visible = 'on';
```

```
1159
1160                    % Modular Graph
1161                    plt = "ModularGraph.jpg";
1162                    plt_path = append("BiMat_Analysis\Results\Graphs\", plt);
1163                    f = figure('Visible','off');
1164                    bp.plotter.PlotModularGraph();
1165                    exportgraphics(f,plt_path)
1166
1167                    % Matrix Plot
1168                    plt = "MatrixPlot.jpg";
1169                    plt_path = append("BiMat_Analysis\Results\Graphs\", plt);
1170                    f = figure('Visible','off');
1171                    bp.plotter.PlotMatrix();
1172                    exportgraphics(f,plt_path)
1173
1174                    % Modular Matrix Plot
1175                    plt = "ModularMatrixPlot.jpg";
1176                    plt_path = append("BiMat_Analysis\Results\Graphs\", plt);
1177                    f = figure('Visible','off');
1178                    bp.plotter.PlotModularMatrix();
1179                    exportgraphics(f,plt_path)
1180
1181                    % Nested Matrix Plot
1182                    plt = "NestedMatrixPlot.jpg";
1183                    plt_path = append("BiMat_Analysis\Results\Graphs\", plt);
1184                    f = figure('Visible','off');
1185                    bp.plotter.PlotNestedMatrix();
1186                    exportgraphics(f,plt_path)
1187
1188                end
1189
1190            end
1191
1192            app.Lamp.Color = 'green';
1193            drawnow();
1194        end
```

1.3.21.1 Purpose

Writes the results array from the “Export to Excel” function to the excel sheet and tab specified by the file and tab name blanks near the export button. This function also exports the four graphs in this analysis to the “Graphs” folder within the “Results” folder. This is required to view the Plots Page (B.4).

1.3.21.2 Variables

- Operation Variables
  - bp – the bipartite obj defined by the Define Bipartite Matrix Function (1.1.3)
  - path – the combination of the Origin and File defined by the Define File function (B.1.1.1)
  - location – the location where the results will be exported to
  - tab – the tab within the specified sheet that the export will write too
  - results – a large array that combines all of the results from general properties, Modularity, Nestedness, as well as the

P and Z values. Defined by the “Export to Excel” function (B.1.2.7).

- plt – the file name for each individual plot
- plt_path – the location that each individual plot will be saved to
- f – the figure that each plot is plotted into

1.3.22 Show all Plots Button Pushed

```
1196        % Button pushed function: ShowallPlotsButton
1197        function ShowallPlotsButtonPushed(app, event)
1198            [~, file] = FilePath(app);
1199
1200            % defines the tab based on if the tabs checkbox is filled or not
1201            if app.TabsCheckBox.Value == 1
1202                tab = app.TabEditField.Value;
1203            else
1204                raw_tabs = sheetnames(file);
1205                tab = raw_tabs(1,1);
1206            end
1207
1208            app.PlotsPage = PlotsPage(file,tab);
1209        end
1210    end
```

1.3.22.1 Purpose

Launches the Plots page (B.4) so that the user can view the all of the graphs that the program can create in one window. This Page requires that the export button has been pushed and that they export graphs checkbox has been checked. See section B.4 for how this function is used and operates.

1.3.22.2 Variables

- Operational Variables
  - file – the filename for the sheet that is being used defined by the File Path function (B.1.1.1)
  - tab – the tab within the excel file that the program is using

1.4 Future Work

- Include the Compare Data in the Excel export functions.
- Include the “Modules Page” information in the Excel export functions.

2 Modules Page

Modules

	flower 2	grass 1
insect 2	1	1
bird 1	1	1
bird 2	0	1

Show Matrix Module: 1 View Module Sizes

3x2
2x2

2.1 Functions

2.1.1 Fill Matrix

```
29          function FillMatrix(app, module_rows, module_cols, module_matrices, bp_row_labels, bp_col_labels)
30              module_num = app.ModuleSpinner.Value;
31
32              % Defines the Row and Col Indexes based on which module is selected
33              row_indexes = module_rows{module_num};
34              col_indexes = module_cols{module_num};
35
36              % Creates Empty Lists for the Row and Col names
37              row_names = string([]);
38              col_names = string([]);
39
40              % Selects the Row and Col names based on the Index Values
41              for i=1:length(row_indexes)
42                  index = row_indexes(i);
43                  label = bp_row_labels(index);
44                  row_names(i) = label;
45              end
46              for i=1:length(col_indexes)
47                  col_names(1,i) = bp_col_labels(1,col_indexes(i));
48              end
49
50              app.UITable.Data = int8(module_matrices{module_num}); % Shows Module's Adjacency Matrix
51              app.UITable.ColumnName = col_names; % Shows the sorted Column Names
52              app.UITable.RowName = row_names; % Shows the sorted Row Names
53          end
54      end
```

2.1.1.1 Purpose

Shows the selected matrix defined by the spinner in the Modules table, and uses the variables defined in the Show Modules Button Pushed callback to do so.

2.1.1.2 Variables

- Input Variables – defined within the Show Matrix Button Pushed Callback (B.2.2.3)
  - module_rows – a cell array of the indexes for each row element within each module
  - module_cols – a cell array of the indexes for each column element within each module
  - module_matrices – a cell array of the adjacency matrices for each module
  - bp_row_labels – the row labels defined by the Define Bipartite Matrix function (B.1.1.3)
  - bp_col_labels - the column labels defined by the Define Bipartite Matrix function (B.1.1.3)
- Operation Variables
  - module_num – the module selected by the module spinner (B.2.2.2)
  - row_indexes – an array of the indexes for each row element within the specified module
    - the specific array is defined by using the module_num to select a specific cell from the module_rows cell array

- col_indexes – an array of the indexes for each column element within the specified module
  - the specific array is defined by using the module_num to select a specific cell from the module_rows cell array
- row_names – an array of the labels for each row element
  - the specific labels are defined by using the row_indexes to define the correct row labels from the bp_row_labels array
- col_names – an array of the indexes for each column element within the specified module from the module_rows cell array
  - the specific labels are defined by using the col_indexes to define the correct column labels from the bp_row_labels array

2.2 Callbacks

2.2.1 Startup Function

```
60          % Code that executes after component creation
61          function startupFcn(app, algorithm, N, raw_matrix, bp_row_labels, bp_col_labels)
62              % Fills the Hidden Edit Fields and Tables that will be used as Global Variables
63              app.AlgorithmEditField.Value = algorithm;
64              app.NEditField.Value = N;
65              app.RowLabels.Data = bp_row_labels;
66              app.ColLabels.Data = bp_col_labels;
67              app.matrix.Data = raw_matrix;
68          end
```

2.2.1.1 Purpose

Defines the Page input variables as global variables by defining them in hidden edit field and tables. If you would like to view the hidden values, go to the component browser, and hide the Modules Table by using the interactivity tab within the inspector. Then show the NEditField, matrix, ColLabels, RowLabels, and AlgorithmEditField using the same method.

2.2.1.2 Variables

- Input Variables
  - algorithm – the selected algorithm within the algorithm drop down in the Modularity Tab defined by Show Modules Button Pushed callback (B.1.3.15)
  - N – the number of modules defined by the Modularity Function (B.1.1.5)
  - bp_row_labels – the row labels defined by the Define Bipartite Matrix function (B.1.1.3)
  - bp_col_labels - the column labels defined by the Define Bipartite Matrix function (B.1.1.3)

- raw_matrix – is the adjacency Matrix defined by the Define Matrix function (B.1.1.2)

2.2.2 Module Spinner Value Changed

```
70          % Value changed function: ModuleSpinner
71          function ModuleSpinnerValueChanged(app, event)
72              % Clears the Data Table
73              app.UITable.Data = [];
74              app.UITable.ColumnName = [];
75              app.UITable.RowName = [];
76          end
```

2.2.2.1 Purpose

Clears the Table whenever the spinner value changes, so the module data can never be mistaken for the wrong module number.

2.2.3 Show Matrix Button Pushed

```
78          % Button pushed function: ShowMatrixButton
79          function ShowMatrixButtonPushed(app, event)
80              % Defines the Global Variables from the Hidden Edit Fields and Tables
81              module_num = app.ModuleSpinner.Value;
82              algorithm = app.AlgorithmEditField.Value;
83              raw_matrix = app.matrix.Data;
84              bp = Bipartite(raw_matrix);
85              N = app.NEditField.Value;
86              bp_row_labels = app.RowLabels.Data;
87              bp_col_labels = app.ColLabels.Data;
88
89              % Selecting Algorithm with the Drop Down
90              % LeadingEigenVector
91              if strcmp(algorithm, 'LeadingEigenVector') == true
92                  bp.community = LeadingEigenvector(bp.matrix);
93
94              % ApadtiveBrim
95              elseif strcmp(algorithm, 'AdaptiveBrim') == true
96                  bp.community = AdaptiveBrim(bp.matrix);
97
98              % LPBrim
99              elseif strcmp(algorithm, 'LPBrim') == true
100                 bp.community = LPBrim(bp.matrix);
101             end
102
103             obj = Detect(bp.community);
104             [module_rows, module_cols] = ExtractCommunityIndexes(obj); % Defines the Indexes of Each Node within each Module
105             module_matrices = ExtractCommunityMatrices(obj); % Defines the Adjancecy Matrix of each Module
106
107             % Verifies that the Selected Moudle Number is actually defined
108             if module_num <= N
109                 FillMatrix(app, module_rows, module_cols, module_matrices, bp_row_labels, bp_col_labels);
110             else
111                 app.StatusBar.Value = "Selected Module does not exist";
112                 app.StatusBar.FontWeight = 'bold';
113                 app.StatusBar.FontColor = 'red';
114             end
115         end
```

2.2.3.1 Purpose

Defines the necessary variables for the selected matrix to be shown by the Fill Matrix Function (B.2.1.1). The selected matrix is defined by the spinner in the Modules table. The spinner has a minimum value of 1 and no maximum. However, if the selection is larger than the number of modules an error will be displayed in the status bar.

2.2.3.2 Variables

- Operation Variables
  - module_num – the module selected by the module spinner (B.2.2.2)
  - algorithm – the algorithm that's used for finding modularity defined by the algorithm dropdown defined by the Startup Function (B.2.2.1)
  - N – the number of modules defined by the Startup Function (B.2.2.1)
  - bp_row_labels – the row labels defined by the Startup Function (B.2.2.1)
  - bp_col_labels - the column labels defined by the Startup Function (B.2.2.1)
  - raw_matrix – is the adjacency Matrix defined by the Startup Function (B.2.2.1)
  - bp – the bipartite obj defined by the Define Bipartite Matrix Function (B.1.1.3)
    - bp.community – represents the Bipartite Adjacency Matrix that will be used to calculate modularity
      - will be run in any of the three algorithm scripts: LeadingEigenVector.m, AdaptiveBrim.m, or LPBrim.m depending on the value of the Algorithm Dropdown (B.1.3.14)
  - obj – a variable frame that allows for the Modularity values to be defined based on the correct algorithm
  - module_rows – a cell array of the indexes for each row element within each module
  - module_cols – a cell array of the indexes for each column element within each module
  - module_matrices – a cell array of the adjacency matrices for each module

2.2.4 View Module Size Button Pushed

```
        % Button pushed function: ViewModuleSizesButton
        function ViewModuleSizesButtonPushed(app, event)
            % Defines the Global Variables from the Hidden Edit Fields and Tables
            algorithm = app.AlgorithmEditField.Value;
            raw_matrix = app.matrix.Data;
            bp = Bipartite(raw_matrix);
            N = app.NEditField.Value;

            % Selecting Algorithm with the Drop Down
            % LeadingEigenVector
            if strcmp(algorithm, 'LeadingEigenVector') == true

                bp.community = LeadingEigenvector(bp.matrix);

            % ApadtiveBrim
            elseif strcmp(algorithm, 'AdaptiveBrim') == true
                bp.community = AdaptiveBrim(bp.matrix);

            % LPBrim
            elseif strcmp(algorithm, 'LPBrim') == true
                bp.community = LPBrim(bp.matrix);
            end

            obj = Detect(bp.community);
            module_matrices = ExtractCommunityMatrices(obj); % Defines the Adjancecy Matrix of each Module
            module_sizes = string([]); % Creates an Empty Array for the sizes to be appended to

            % Converts each cell of the base module_sizes matrix into a string
            for i=1:N
                module_sizes(i) = append(string(size(module_matrices{i},1)), 'x', string(size(module_matrices{i},2)));
            end

            app.ListPage = ListPage(transpose(module_sizes)); % Opens the ListPage
        end
    end
```

2.2.4.1 Purpose

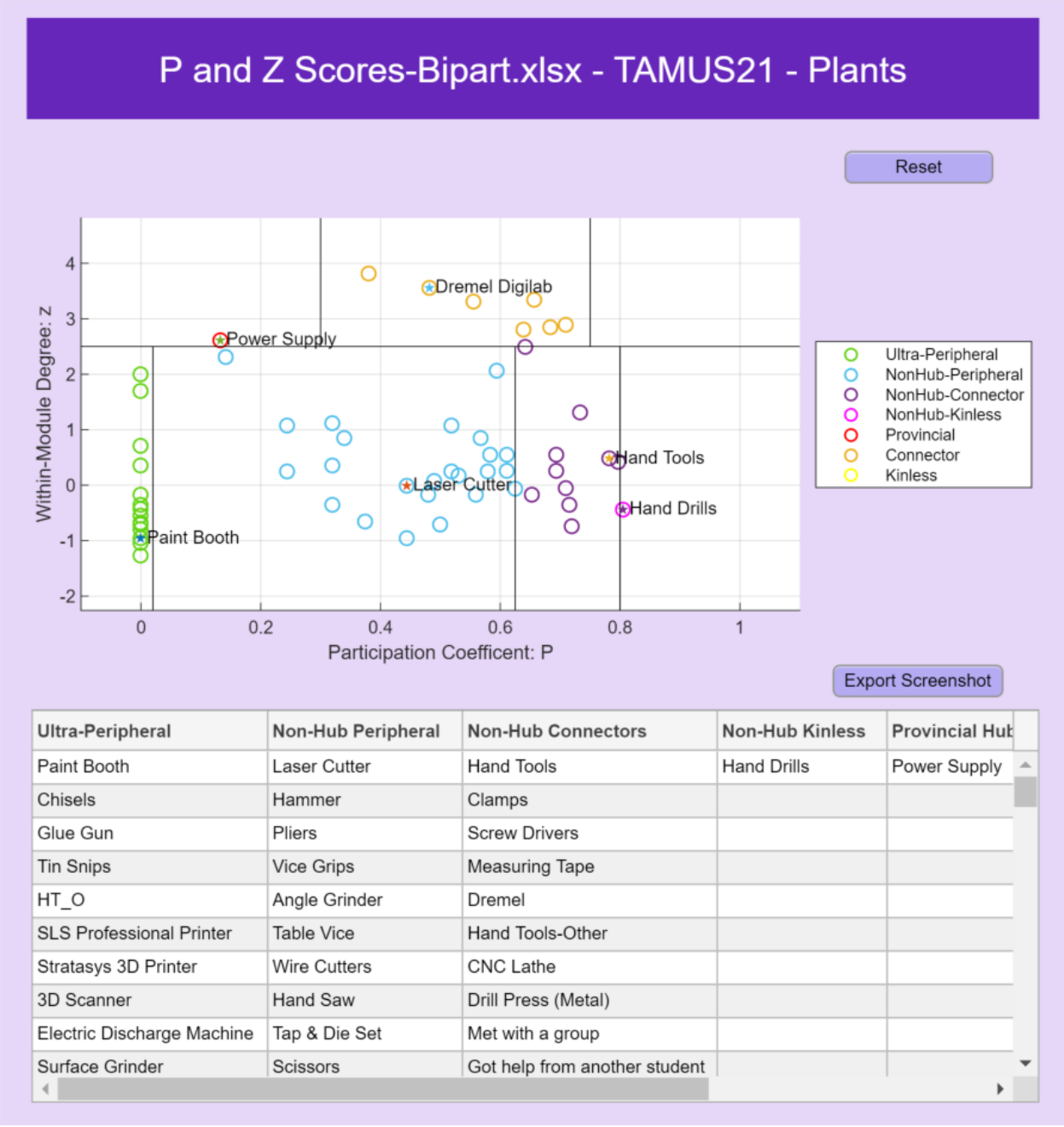
Converts the listed sizes of each module matrix from a cell array of arrays to an array of strings, so that it can be displayed on the List Page (B.1.5)

2.2.4.2 Variables

- Operation Variables
  - algorithm – the algorithm that's used for finding modularity defined by the Startup Function (B.2.2.1)
  - N – the number of modules defined by the Startup Function (B.2.2.1)
  - raw_matrix – is the adjacency Matrix defined by the defined by the Startup Function (B.2.2.1)
  - bp – the bipartite obj defined by the Define Bipartite Matrix Function (B.1.1.3)
    - bp.community – represents the Bipartite Adjacency Matrix that will be used to calculate modularity
      - will be run in any of the three algorithm scripts: LeadingEigenVector.m, AdaptiveBrim.m, or LPBrim.m depending on the value of the Algorithm Dropdown (1.3.14)
  - obj – a variable frame that allows for the Modularity values to be defined based on the correct algorithm

- module_matrices – a cell array of the adjacency matrices for each module
- module_sizes – an array of the raw cells within the module matrices in a string format

3 P and Z Page



Ultra-Peripheral	Non-Hub Peripheral	Non-Hub Connectors	Non-Hub Kinless	Provincial Hub
Paint Booth	Laser Cutter	Hand Tools	Hand Drills	Power Supply
Chisels	Hammer	Clamps		
Glue Gun	Pliers	Screw Drivers		
Tin Snips	Vice Grips	Measuring Tape		
HT_O	Angle Grinder	Dremel		
SLS Professional Printer	Table Vice	Hand Tools-Other		
Stratasys 3D Printer	Wire Cutters	CNC Lathe		
3D Scanner	Hand Saw	Drill Press (Metal)		
Electric Discharge Machine	Tap & Die Set	Met with a group		
Surface Grinder	Scissors	Got help from another student		

3.1 Functions

3.1.1 Plot P and Z

```
function PlotPandZ(app, labels, p, z, roles)

    N = length(p); %Sets the length of the iteration

    % Intializes the empty grouped data arrays
    ultra_peripheral = strings([N,4]);
    peripheral = strings([N,4]);
    nonhub_connector = strings([N,4]);
    nonhub_kinless = strings([N,4]);
    provincial = strings([N,4]);
    connector = strings([N,4]);
    kinless = strings([N,4]);

    % Puts the Data into Groups based on its role
    for i=1:N
        % Non-Hub Roles
        if z(i) < 2.5
            if p(i) <= .1
                ultra_peripheral(i,1) = labels(i);
                ultra_peripheral(i,2) = p(i);
                ultra_peripheral(i,3) = z(i);
                ultra_peripheral(i,4) = "NonHub-Ultra-Peripheral";
            elseif p(i) >= .1 && p(i) <= .625
                peripheral(i,1) = labels(i);
                peripheral(i,2) = p(i);
                peripheral(i,3) = z(i);
                peripheral(i,4) = "NonHub-Peripheral";
            elseif p(i) >= .625 && p(i) <= .8
                nonhub_connector(i,1) = labels(i);
                nonhub_connector(i,2) = p(i);
                nonhub_connector(i,3) = z(i);
                nonhub_connector(i,4) = "NonHub-Connector";
            elseif p(i) >= .8
                nonhub_kinless(i,1) = labels(i);
                nonhub_kinless(i,2) = p(i);
                nonhub_kinless(i,3) = z(i);
                nonhub_kinless(i,4) = "NonHub-Kinless";
            end
```

```
            % Hub Roles
            elseif z(i) >= 2.5
                if p(i) <= .3
                    provincial(i,1) = labels(i);
                    provincial(i,2) = p(i);
                    provincial(i,3) = z(i);
                    provincial(i,4) = "Hub-Provincial";
                elseif p(i) >= .3 && p(i) <= .75
                    connector(i,1) = labels(i);
                    connector(i,2) = p(i);
                    connector(i,3) = z(i);
                    connector(i,4) = "Hub-Connector";
                elseif p(i) >= .75
                    kinless(i,1) = labels(i);
                    kinless(i,2) = p(i);
                    kinless(i,3) = z(i);
                    kinless(i,4) = "Hub-Kinless";
                end
            end
        end

        sz = 50; %Marker Size

        % Plotting Each Subgroup only when there is data within the generated frame
        if isempty(ultra_peripheral) == 0
            x = str2double(ultra_peripheral(:,2)); % converts the strings from the subgroup arrays into usable numbers
            y = str2double(ultra_peripheral(:,3)); % converts the strings from the subgroup arrays into usable numbers
            plot = scatter(app.UIAxes, x, y, sz,[0.39,0.83,0.07],'LineWidth', 1);
            plot.DataTipTemplate.DataTipRows(1) = dataTipTextRow('Node:',ultra_peripheral(:,1));
            plot.DataTipTemplate.DataTipRows(2) = dataTipTextRow('P:',ultra_peripheral(:,2));
            plot.DataTipTemplate.DataTipRows(3) = dataTipTextRow('z:',ultra_peripheral(:,3));
            plot.DataTipTemplate.DataTipRows(4) = dataTipTextRow('Role:',ultra_peripheral(:,4));
            hold(app.UIAxes, 'on'); % Allows for the next group to be plotted on the same axis
        end
```

```
        lower_bound = min(z) - 1; % Defines the lower y-limit based on the minimum z value
        upper_bound = max(z) + 1; % Defines the upper y-limit based on the maximum z value

        xlim(app.UIAxes, [-0.1,1.1]) % Applies the x-limits to the plot
        ylim(app.UIAxes, [lower_bound, upper_bound]) % Applies the y-limits to the plot

        % Plotting the asymptotes that seperate the subgroups
        line(app.UIAxes, [-0.1,1.1],[2.5,2.5], 'color', 'black');
        line(app.UIAxes, [0.02,0.02],[lower_bound,2.5], 'color', 'black');
        line(app.UIAxes, [0.3,0.3],[2.5,upper_bound], 'color', 'black');
        line(app.UIAxes, [0.625,0.625],[lower_bound,2.5], 'color', 'black');
        line(app.UIAxes, [0.8,0.8],[lower_bound,2.5], 'color', 'black');
        line(app.UIAxes, [0.75,0.75],[2.5,upper_bound], 'color', 'black');

        % Defines the Legend's information and location
        legend(app.UIAxes,["Ultra-Peripheral", "NonHub-Peripheral", "NonHub-Connector", "NonHub-Kinless", "Provincial", "Connector", "Kinless"],
        hold(app.UIAxes, 'on'); % allows for the Cell Sections to be added to the same axes

        app.rolesTable.Data = roles;  % fills in the role table for Cells to be selected

    end
```

3.1.1.1 Purpose

Both fills the Roles table and plots the grouped P and Z data. The table is filled with the “roles” input variable. The Plotting functions are split up by the element defined roles so that the colors could be different. It also defines the “DataTips” for each subgroup, which is the label that shows when hovering over the data point. As well as plots the lines that sperate the roles based on the values that define the roles.

3.1.1.2 Variables

- Input Variables
  - P – an array of P values
  - z – an array of z values
  - labels – an array of element names
  - roles – an array of the elements, where each column represents the elements that share a role
- Operation Variables
  - ultra_peripheral – an array of all the elements that are ultra-peripherals. The columns represent- (1. Label, 2. P value, 3. Z value, 4. Role)

- peripheral – an array of all the elements that are peripherals. The columns represent- (1. Label, 2. P value, 3. Z value, 4. Role)
- nonhub_connector – an array of all the elements that are nonhub_connectors. The columns represent- (1. Label, 2. P value, 3. Z value, 4. Role)
- nonhub_kinless – an array of all the elements that are nonhub_kinless. The columns represent- (1. Label, 2. P value, 3. Z value, 4. Role)
- provincial – an array of all the elements that are provincials. The columns represent- (1. Label, 2. P value, 3. Z value, 4. Role)
- connector – an array of all the elements that are connectors. The columns represent- (1. Label, 2. P value, 3. Z value, 4. Role)
- kinless – an array of all the elements that are kinless. The columns represent- (1. Label, 2. P value, 3. Z value, 4. Role)
- role _col –
- N – the length of the P values array, which sets the length of iteration
- x – an array of the 2nd column of the role arrays, that has been converted to numbers rather than strings
- y – an array of the 3rd column of the role arrays, that has been converted to numbers rather than strings

3.1.2 Reset Plot Labels

```
186        function ResetPlotLabels(app)
187            % These Values are Defined behind the roles table and they are made invisible in the startupfcn()
188            labels = app.labelsTable.Data;
189            p = app.PTable.Data;
190            z = app.zTable.Data;
191            roles = app.rolesTable.Data;
192            role_list = app.role_col.Data;
193
194            cla(app.UIAxes) % Clears figure
195
196            PlotPandZ(app, labels, p, z, roles); % Replots data
197        end
198    end
```

3.1.2.1 Purpose

Clears the figure and the replots the data, so all the cell selection labels disappear.

3.1.2.2 Variables

- Operation Variables
  - p – an array of P values defined by the startup function (B.3.2.1)
  - z – an array of z defined by the startup function (B.3.2.1)

- labels – an array of element names defined by the startup function (B.3.2.1)
- roles – an array of the elements placed into the column that represents the different roles defined by the startup function (B.3.2.1)
- role_list – a column array that list the elements role in the order that the labels are originally in defined by the startup function (B.3.2.1)

3.2 Callbacks

3.2.1 Startup Function

```
204         % Code that executes after component creation
205         function startupFcn(app, file, tab, labels, p, z, label, roles, role_col)
206             app.Label.Text = append('P and Z Scores','-',file,' - ',tab, ' - ', label);
207
208             app.labelsTable.Visible = 'off';
209             app.labelsTable.Data = labels;
210             app.PTable.Visible = 'off';
211             app.PTable.Data = p;
212             app.zTable.Visible = 'off';
213             app.zTable.Data = z;
214             app.role_col.Visible = 'off';
215             app.role_col.Data = role_col;
216
217             PlotPandZ(app, labels, p, z, roles);
218         end
```

3.2.1.1 Purpose

Defines the Page input variables as global variables by defining them in hidden edit field and tables. If you would like to view the hidden values, go to the component browser, and hide the roles Table by using the interactivity tab within the inspector. Then show the role_col, labelsTable, zTable, and PTable using the same method.

3.2.1.2 Variables

- Function Inputs
  - file – the filename for the sheet that is being used
  - tab - the tab within the specified sheet that the function will be using
  - p – an array of P values either for the row or column elements based on the modules switch (B.1.3.16)
  - z – an array of z values either for the row or column elements based on the modules switch (B.1.3.16)
  - labels – an array of element names from either the row or column elements depending on the modules switch value (B.1.3.16)
  - label – the last element of the P and Z pages title defined by the defaults page. It is either the row or column label in the defaults page depending on the modules switch value (B.1.3.16)

- roles – an array of the elements placed into the column that represents the different roles
- role_col – a column array that list the elements role in the order that the labels are originally in

3.2.2 Roles Table Cell Selection

```
220         % Cell selection callback: rolesTable
221         function rolesTableCellSelection(app, event)
222             cell = event.Indices;
223 
224             labels = app.labelsTable.Data;
225             p = app.PTable.Data;
226             z = app.zTable.Data;
227             role_list = app.role_col.Data;
228             role_matrx = app.rolesTable.Data;
229 
230             selected_cell = role_matrx(cell(1,1),cell(1,2));
231 
232             N = length(labels);
233             label = strings([N,1]);
234             role = strings([N,1]);
235 
236             % Check for the selected cell within the original data and re-plots it with different parameters
237             for i=1:N
238               if strcmp(selected_cell,labels(i))
239 
240                   label(:,1) = labels(i);
241                   role(:,1) = role_list(i);
242 
243                   pt = scatter(app.UIAxes, p(i), z(i), 'filled','p'); % Plots
244                   pt.DataTipTemplate.DataTipRows(1) = dataTipTextRow('Node:',label); %Hovering Label row 1
245                   pt.DataTipTemplate.DataTipRows(2) = dataTipTextRow('P:',p(i)); %Hovering Label row 2
246                   pt.DataTipTemplate.DataTipRows(3) = dataTipTextRow('z:',z(i)); %Hovering Label row 3
247                   pt.DataTipTemplate.DataTipRows(4) = dataTipTextRow('Role:',role); %Hovering Label row 4
248                   hold(app.UIAxes, 'on');
249 
250                   text(app.UIAxes, p(i)+0.01,z(i)+0.02,labels(i)); %Fixed Label
251                   hold(app.UIAxes, 'on');
252 
253               end
254             end
255         end
```

3.2.2.1 Purpose

When the user clicks on a cell within the roles table, the data point is highlighted by both the fixed and hovering data labels. These value can be removed by hitting the rest button (B.3.2.3).

3.2.2.2 Variables

- Input Variables
  - event – the selected cell's value
- Operation Variables
  - p – an array of P values from either the row or column elements depending on the modules switch value (B.1.3.16)
  - z – an array of z values from either the row or column elements depending on the modules switch value (B.1.3.16)

- labels – an array of element names from either the row or column elements depending on the modules switch value (B.1.3.16)
- role_list – a column array that list the elements role in the order that the labels are originally in from either the row or column elements depending on the modules switch value (B.1.3.16)
- role_matrix – an array of the elements placed into the column that represents the different roles, They are either the row or column elements depending on the modules switch value (B.1.3.16)
- label – a reordered version of the labels array, so that the cell selection shows the correct role value (B.1.3.16)
- role – a reordered version of the role_list array, so that the cell selection shows the correct role
- N – the length of labels, which sets the length of the iterative calculation

3.2.3 Reset Button Pushed

```
257         % Button pushed function: ResetButton
258         function ResetButtonPushed(app, event)
259             ResetPlotLabels(app);
260         end
```

3.2.3.1 Purpose

The Reset button clears all of the labels created by the cell selection callback (B.3.2.2). It does so by calling on the Reset Plot Labels Function (B.3.1.2).

3.2.4 Export Screenshot Button Pushed

```
262         % Button pushed function: ExportScreenshotButton
263         function ExportScreenshotButtonPushed(app, event)
264             filename = app.Label.Text;
265             path = "BiMat_Analysis\Results\P and Z\";
266             location = append(path, filename, ".jpg");
267             exportapp(app.UIFigure,location)
268         end
269     end
```

3.2.4.1 Purpose

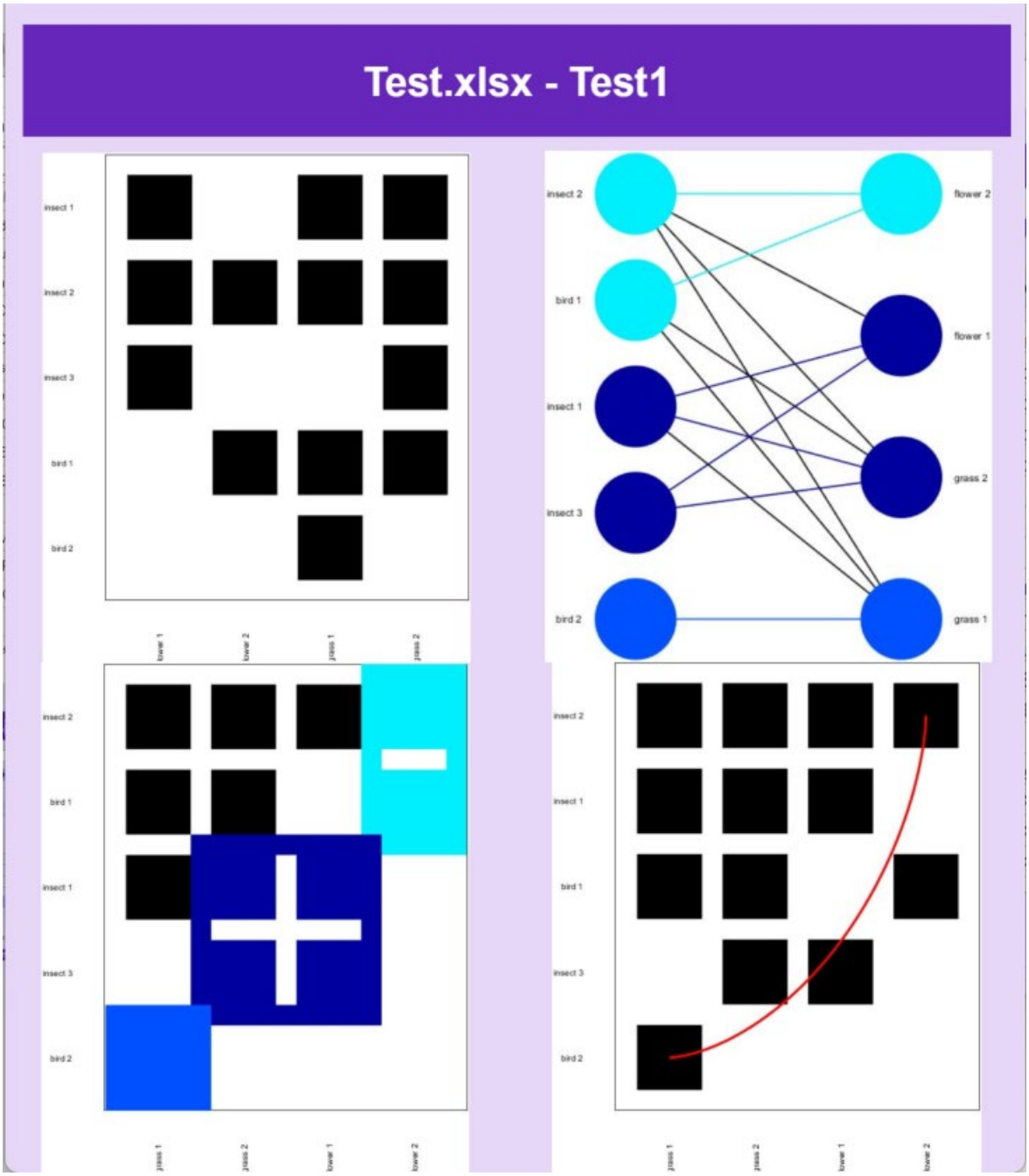
Saves a screenshot of the app in its current status within the “P and Z” folder within the “Results” folder of BiMat_Analysis.

- This screenshot can also capture the labels shown by the cell selection callback (B.3.2.2).
- The filename will be the title that the P and Z page shows at the top of its window.

3.2.4.2 Variables

- Operation Variables
  - filename – the filename that the screenshot will be saved as
  - path – the path that the file will be save with
  - location – the appended values of the filename, path, and file extension

4 Plots Page


Test.xlsx - Test1
insect 1
insect 2
insect 3
bird 1
bird 2
flower 1
flower 2
grass 1
grass 2
insect 2
bird 1
insect 1
insect 3
bird 2
flower 1
flower 2
grass 1
grass 2
insect 2
bird 1
insect 1
insect 3
bird 2
grass 1
grass 2
flower 1
flower 2
insect 2
insect 1
bird 1
insect 3
bird 2
grass 1
grass 2
flower 1
flower 2

```
classdef PlotsPage < matlab.apps.AppBase

    % Properties that correspond to app components
    properties (Access = public)
        UIFigure       matlab.ui.Figure
        ModularMatrix  matlab.ui.control.Image
        NestedMatrix   matlab.ui.control.Image
        Matrix         matlab.ui.control.Image
        ModularGraph   matlab.ui.control.Image
        Label          matlab.ui.control.Label
    end

    % Callbacks that handle component events
    methods (Access = private)

        % Code that executes after component creation
        function startupFcn(app, file, tab)
            app.Label.Text = append(file,' - ',tab); % Shows Title
        end
    end

    % Component initialization
    methods (Access = private) ...

    % App creation and deletion
    methods (Access = public) ...
end
```

4.1 Callbacks

4.1.1 Startup Function

4.1.1.1 Purpose

This function shows the title of the matrix page by appending the file name and tab name. Then it displays the four graphs located in the "Graphs" within the "Results" folder. These four graphs are saved in this location with the Export button (B.1.3.21) when the export plots checkbox is checked.

4.1.1.2 Variables

- Input Variables
  - file – the filename for the sheet that is being used
  - tab - the tab within the specified sheet that the program is analyzing

5 Matrix Page

Test.xlsx - Test1

	flower 1	flower 2	grass 1	grass 2
insect 1	1	0	1	1
insect 2	1	1	1	1
insect 3	1	0	0	1
bird 1	0	1	1	1
bird 2	0	0	1	0

```
classdef MatrixPage < matlab.apps.AppBase

    % Properties that correspond to app components
    properties (Access = public)
        UIFigure     matlab.ui.Figure
        MatrixTable  matlab.ui.control.Table
        Label        matlab.ui.control.Label
    end

    methods (Access = private)

        function FillFigures(app, matrix, row_labels, col_labels)

            app.MatrixTable.Data = matrix; % Shows Adjacency Matrix
            app.MatrixTable.ColumnName = col_labels; % Shows Column Names
            app.MatrixTable.RowName = row_labels; % Shows Row Names
        end
    end

    % Callbacks that handle component events
    methods (Access = private)

        % Code that executes after component creation
        function startupFcn(app, matrix, row_labels, col_labels, file, tab)

            FillFigures(app, matrix, row_labels, col_labels); % Calls the functions that shows the data

            app.Label.Text = append(file,' - ',tab); % Shows Matrix Title
        end
    end

    % Component initialization
    methods (Access = private) ...

    % App creation and deletion
    methods (Access = public) ...
end
```

5.1 Functions

5.1.1 Fill Figures

5.1.1.1 Purpose

This function shows the matrix, row_labels, and col_labels by displaying them in the MatrixTable. The matrix can be any matrix that's defined by the startup function (B.4.2.1). In this program it is used to show both the adjacency, modules, and nestedness matrix.

5.1.1.2 Variables

- Input Variables
  - matrix – the matrix data that is being shown in the Matrix Page
  - row_labels – the row element labels for the matrix that is being shown
  - col_labels - the column element labels for the matrix that is being shown

5.2 Callbacks

5.2.1 Startup Function

5.2.1.1 Purpose

This function shows the title of the matrix page by appending the file name and tab name. Then calls on the Fill Matrix function to show the data (B.4.1.1). This matrix and its label can be anything as long as they are defined when opening this app from another script.

5.2.1.2 Variables

- Input Variables
  - file – the filename for the sheet that is being used
  - tab - the tab within the specified sheet that the program is analyzing
  - matrix – the matrix data that is being shown in the Matrix Page
  - row_labels – the row element labels for the matrix that is being shown
  - col_labels - the column element labels for the matrix that is being shown

6 List Page

```
classdef ListPage < matlab.apps.AppBase

    % Properties that correspond to app components
    properties (Access = public)
        UIFigure   matlab.ui.Figure
        ListTable  matlab.ui.control.Table
    end

    % Callbacks that handle component events
    methods (Access = private)

        % Code that executes after component creation
        function startupFcn(app, list)
            app.ListTable.Data = list; %Shows the List defined as a input variable on the page
        end
    end

    % Component initialization
    methods (Access = private) ...

    % App creation and deletion
    methods (Access = public) ...
end
```

6.1 Callbacks

6.1.1 Startup Function

6.1.1.1 Purpose

Shows the list defined as an input to the function within the ListTable.

6.1.1.2 Variables

- Input Variables
  - list – a column array of values

7 *Name*MatrixProperties.m

7.1 Functions

```
function [matrix_range, row_labels_range, col_labels_range, tabs] = BipartMatrixProperties(tab_name, file)

    raw_tabs = sheetnames(file);
    tabs = raw_tabs;

    if strcmp(tab_name, 'GTF19') == true
        matrix_range = 'B2:W160';
        row_labels_range = 'A2:A160';
        col_labels_range = 'B163:W163';
    elseif strcmp(tab_name, 'GTF20') == true
        matrix_range = 'B3:AQ66';
        row_labels_range = 'A3:A66';
        col_labels_range = 'B2:AQ2';
    elseif strcmp(tab_name, 'TAMUF20') == true
        matrix_range = 'B3:W52';
        row_labels_range = 'A3:A52';
        col_labels_range = 'B2:W2';
```

7.1.1 *Name*MatrixProperties

7.1.1.1 Purpose

Defines the ranges for individual tabs within a specific sheet, so that the user does not have to manually fill out the ranges inputs within the Matrix Properties Panel.

- Each Preformatted sheet needs to have its own *Name*MatrixProperties script

7.1.1.2 Variables

- Input Variables
  - tab_name – the tab name that the program is using
    - since this script is for premade matrices, the tab name will be the value shown in the tabs drop down. (B.1.3.7)
  - file – the filename for the sheet that is being used
    - since this script is for premade matrices, the file name will be the value shown in the file drop down. (B.1.3.6)
- Output Variables
  - matrix_range - the cells that contain the actual data for the Adjacency Matrix within a specific tab
  - row_labels_range - the cells that contain the row labels for the Adjacency Matrix within a specific tab
  - col_labels_range - the cells that contain the column labels for the Adjacency Matrix within a specific tab