



UNIVERSITY OF CAPE TOWN

DEPARTMENT OF STATISTICAL SCIENCES

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# **MDS-GUI**

## Users Manual

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The MDS-GUI Version 0.1

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## The MDS-GUI Users Manual

This manual serves to provide information regarding the layout and features of the MDS-GUI (Multidimensional Scaling Graphical User Interface). The four sections of this document will cover: the layout of the GUI, the various plots, the menus and features of the GUI, and finally features of the GUI that are not menu based.

The layout of the document is point form in an indented four tier format. In descending order, the tiers are represented by the following symbols: ●, ◇, \*, ○. The manual will make use of screenshots of GUI in the descriptions of menus and features, each of which will be described in the text. The document will also make extensive use of hypertext links for those reading the manual electronically. To avoid confusion, when menus

are discussed, this will be indicated by ‘MENU’ at the beginning of the paragraph. Discussion of features will be indicated by ‘FEATURE’. In addition, when a pop-out options window is discussed, the options in which it contains will be presented in a framed text box.

The users manual will not contain any theory on Multidimensional Scaling or any other Multivariate techniques. For a useful source on MDS techniques, read *Multidimensional Scaling: Second Edition* (Cox and Cox, 2001) and *Modern Multidimensional Scaling Theory and Applications: Second Edition* (Borg and Groenen, 2005). For more information on the practical use of the MDS-GUI and MDS result interpretation, see the Vignette of the **MDSGUI** package.

The MDS-GUI was developed with and makes use of a number of other *R* packages. These include: **tkrplot** (Tierney, 2011), **teltk2** (Grosjean, 2011), **MASS** (Venables and Ripley, 2002), **boot** (Canty and Ripley, 2010), **RColorBrewer** (Neuwirth, 2011), **rgl** (Adler and Murdoch, 2011) and **scatterplot3d** (Ligges and Mächler, 2003).

## GUI Areas

The MDS-GUI has a layout with various sections. Figure 1: The MDS-GUI below shows the default view of the GUI with each of its major sections labeled one to five. A description of each of these areas will now be given in general terms.

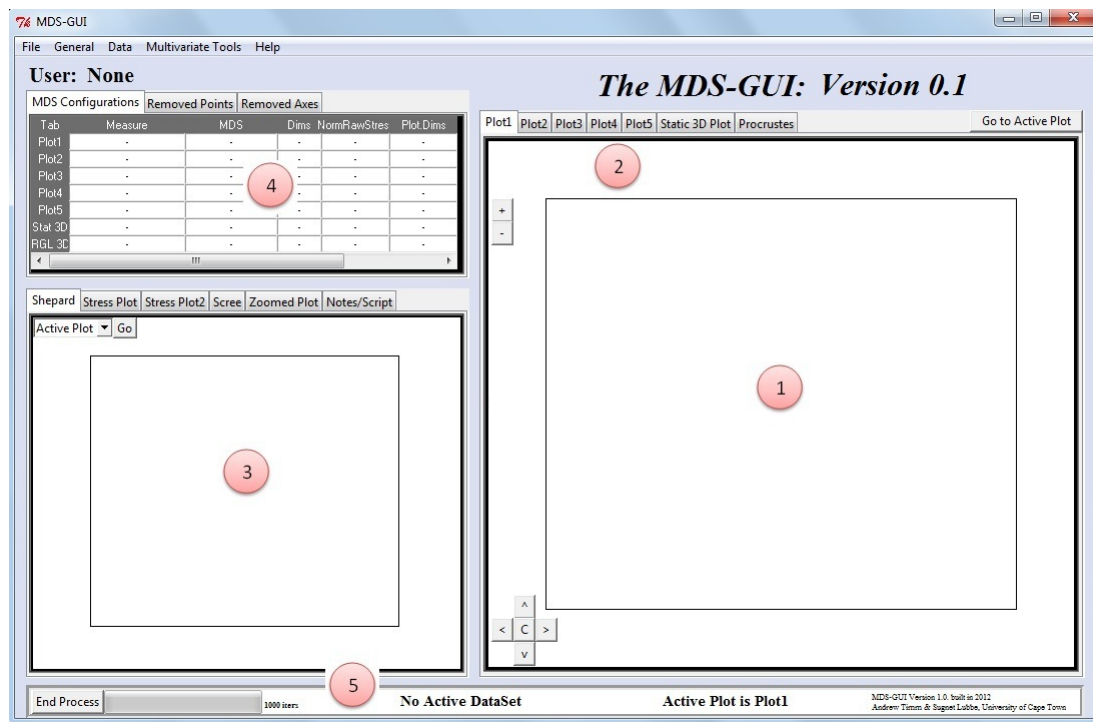


Figure 1: The MDS-GUI

**Main Plotting Area** 1: The area labeled as ‘one’ is the area on which the • **MDS Configuration Plot** in two dimensions ( $p = 2$  is default). The Euclidean distances,  $d$ , are illustrated in area one. The aspect ratio of the plotting area is one thus preserving the interpretation of the distances regardless of the orientation of

the axes.

**Plotting Tabs** 2: Five plotting tabs are available to perform independent MDS procedures with individual settings. These results may then be compared. In addition, the ‘Static 3D Plot’ tab shows • **Static 3D Plot**, the output of the two dimensional depiction of the result when  $p = 3$  and the ‘Procrustes’ tab shows the result of a Procrustes analysis between two separate configurations with the • **Procrustes Analysis Plot**.

**Secondary Plotting Area** 3: This smaller area houses multiple diagnostic outputs generated as a default for most of the MDS processes. Each of the Tabs of the area show a different utility. These include: • **Shepard Plot**, • **Stress Plot**, • **Stress Plot2**, • **Scree Plot**, • **Zoomed Plot** and • **NotesScript**.

**Table Section** 4: The window on the top left of the GUI holds the relevant tables included in the software. The front most table is called the ♦ **MDS Configurations** table and holds important information relating to each of the MDS configurations in all main plotting tabs. The second and third tables are called the ♦ **Removed Points** and ♦ **Removed Axes** tables respectively. Features of the MDS-GUI include the option to ♦ **Remove a Point** from the configuration and also remove ♦ **Remove Axes of Variable(s)** from the display. The information contained in these tables pertain to these scenarios.

**Information Panel** 5: The final numbered label refers to the Information Pane located at the bottom of the GUI. This area displays various information relevant to the applications of the user. The pane includes information regarding the data set being used, the current plotting area and the software developer details.

## Available Plots

• **MDS Configuration Plot** : When  $p = 2$ , this plot is found in the **Main Plotting Area**.

FEATURE – The MDS Configuration Plot displays the  $\mathbf{X}:n \times p$  configuration from the MDS process. When  $p = 3$  it can be shown in the • **Static 3D Plot**.

FEATURE – Clicking any point on the configuration with the mouse will label that point.

FEATURE – May Zoom in and Out manually using the ‘+’ and ‘-’ buttons next to the plot.

FEATURE – May move the configuration left, right, up, down, or return to original orientation using the  $\leftarrow$ ,  $\rightarrow$ ,  $\uparrow$ ,  $\downarrow$  and ‘C’ buttons next to the plot respectively.

FEATURE – May drag individual points manually around the plot by clicking and holding the left mouse button. This causes real time changes to both • **MDS Configuration Plot**, • **Shepard Plot** and stress value shown in the ♦ **MDS Configurations** tab of the • **Information Table**.

FEATURE – The • **Main Plot Menu** provides numerous other features of this plot.

• **Shepard Plot** : Found in the Shepard tab of **Secondary Plotting Area**.

FEATURE – Plots  $d_{ij}$  vs.  $\delta_{ij}$ .

FEATURE – Clicking any point on the plot will highlight the point and draw the connection between the corresponding point on the • **MDS Configuration Plot**. Both point and line will be the same colour. The first ten selected points will be labeled and thereon none are labeled.

FEATURE – ‘Brushing’ the plot by dragging a box over the plot will label each of the points contained in the box as described above.

FEATURE – The appropriate • **Secondary Plot Menu** provides further features for this plot.

- **Stress Plot** : Found in the Stress Plot1 tab of **Secondary Plotting Area**.

FEATURE – Plots stress vs. iterations.

FEATURE – The appropriate • **Secondary Plot Menu** provides further features for this plot.

- **Stress Plot2** : Found in the Stress Plot2 tab of **Secondary Plotting Area**.

FEATURE – Plots the logged difference of stress values over iterations

FEATURE – The appropriate • **Secondary Plot Menu** provides further features for this plot.

- **Scree Plot** : Found in the Scree tab of **Secondary Plotting Area**.

FEATURE – Plots the logged difference of stress values over iterations.

FEATURE – Illustrates both current dimension and optimum dimension.

FEATURE – The appropriate • **Secondary Plot Menu** provides further features for this plot.

- **Zoomed Plot** : Found in the Zoomed Plot tab of **Secondary Plotting Area**.

FEATURE – Shows an isolated zoomed area of **Main Plotting Area** when ◊ **Advanced Zoom** is used.

- **RGL 3D Plot** : Plot is placed in the R console and uses the rgl package (Adler and Murdoch, 2011).

FEATURE – Produces dynamic 3D rendition of the configuration when  $p = 3$ .

FEATURE – User has full control over plot in terms of rotation and zoom.

- **Static 3D Plot** : Plot is placed in the Static 3D Plot tab of **Plotting Tabs**. Uses scatterplot3d package (Ligges and Mächler, 2003).

FEATURE– Produces static 3D rendition of the configuration when  $p = 3$ .

FEATURE– User May rotate the horizontal plane of the plot using the ← and → buttons.

FEATURE– User may extend the length of the horizontal plane using the ↑ and ↓ buttons. ‘C’ buttons returns to original position.

FEATURE– The appropriate • **Secondary Plot Menu** provides further features for this plot.

- **Procrustes Analysis Plot** : Plot is placed in the Procrustes tab of **Plotting Tabs**.

FEATURE – Result of Procrustes Analysis from any two separate active plots in **Plotting Tabs**.

FEATURE– The appropriate • **Secondary Plot Menu** provides further features for this plot.

- **Popped-Out Plot** :

FEATURE – All of the above plots may be popped out to a separate window from their respective right click menus.

## Menus → Functions

- **Top-Menu** : The menu system found across the top panel of the GUI.

MENU– The top menu provides access to the majority of processes contained in the MDS-GUI.

◇ **File** : The first menu option of ● **Top-Menu**.

MENU- The file menu focuses on the handling of the specific files and workspaces of the user.

\* **New User** : Opens the **New User Window**.

MENU- Provides means of the user inputting their name for convenient research labeling.



Figure 2: New User Window

### Options of **New User Window**

**Enter Your Name** : Requires Text Input

FEATURE- Provided name will reflect on the MDS-GUI frontend and the PDF files when \* **Export** is used.

\* **Save User Workspace** : Opens native operating system Save-File window

FEATURE- Saves all plots, figures and settings to external file of user's choosing.

\* **Load User Workspace** : Opens native operating system Load-File window

FEATURE- Load all plots, figures and settings from external file of user's choosing. Replots automatically.

\* **Print** : Opens native operating system print options window.

FEATURE- Prints the ● **MDS Configuration Plot** of the topmost plotting tab of **Plotting Tabs**

\* **Clear All** : Provides fresh workspace

FEATURE- Clears all plots, details and restores setting defaults.

\* **Exit MDS-GUI** : Opens window asking user whether they would like to save their workspace before quitting.

FEATURE- Exits workspace safely after either saving or not saving the workspace.

◇ **General** : The second menu option of ● **Top-Menu**.

MENU- Contains wide range of options concerning the GUI and its internal settings.

\* **Undo** : Available only after the ● **MDS Configuration Plot** has been manually altered in some way. Either by dragging or ◇ **Relocate a Group of Points**.

FEATURE- The most recent alteration made to the configuration is reverted back to its previous state. Changing plot, performing another MDS procedure or making another alteration removes opportunity to undo the original alteration.

\* **Appearance Settings** : Opens the **Appearance Settings** window.

MENU- Provides user with means to make colour adjustments to the MDS-GUI itself.

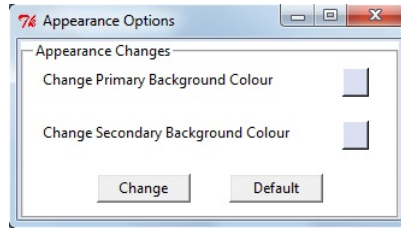


Figure 3: Appearance Settings

### Options of Appearance Settings

**Change Primary Background Colour** : Click Colour Box to open native colour choice window.

FEATURE– Select colour for background of the MDS-GUI.

**Change Primary Background Colour** : Click Colour Box to open native colour choice window.

FEATURE– Select colour for background of pop out plots and windows.

**Change and Default** : Buttons to either make selection or revert to defaults.

\* **General Settings** : Opens the **General Settings** menu.

\* **Export** : Uses Sweave (Leisch, 2002) and latex to create a PDF file. Any selection produces the important instructions shown in **Export Instructions**

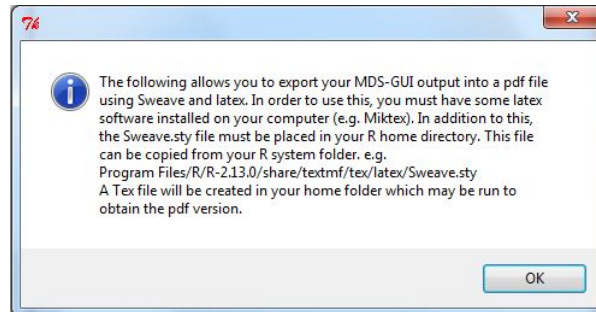


Figure 4: Export Instructions

FEATURE– In all cases, the PDF produced will provide all stress values, MDS configuration, Shepard Plot and Scree Plot for every included plotting area.

◦ **All** : Produces a PDF document with information for all utilised plotting areas.

◦ **Plot (1-5) info** : Produces PDF document for specific plotting area.

◇ **Data** : The third menu option of **Top-Menu**.

MENU– Provides all options relating to the user upload of data on which the MDS procedures are performed. The data may originally be provided in a number of different forms, all of which are allowable by the MDS-GUI. The user is able to upload: a samples by variables matrix  $\mathbf{Z}:n \times m$ ;

a distance matrix  $\Delta: n \times n$ ; or an  $n \times n$  similarity or correlation matrix. In the case where  $\Delta$  is not uploaded, appropriate calculations and transformations are performed automatically in order to construct  $\Delta$ , which is used in all MDS procedures.

\* **Load Dataset** : Opens the **New Active Dataset** window.

FEATURE–Uploads  $Z: n \times m$  matrix.  $\Delta$  is calculated from this using the selected option from \* **Load Dissimilarity Matrix**.

Figure 5: New Active Dataset

### Options of **New Active Dataset**

**Enter the name of your Dataset** : Requires Text input

FEATURE– The name of the data will appear on **Information Panel**, all of the resulting MDS plots and \* **Export** documents.

**Transpose Active Data** : Requires checkbox selection

FEATURE–  $\Delta$  is created exclusively from a matrix with objects as rows and variables as columns. If this is the other way round, the dissimilarity matrix will be  $m \times m$  and treat variables as objects. Selecting this allows for a correction if the data has variables  $\times$  objects.

**Scale your Active Data** : Require checkbox selection

FEATURE– Provides option to scale each variable column to range between 0 and 1.

**Category Information** : Only applicable when a column of categories is present. Requires checkbox selection and indication of where category column is in data.

FEATURE– This column is stored only as categorical information and removed from the data. All objects are assigned a colour according to their defined category.

**OK** : Executes all specified assignments on data.

\* **Load Dissimilarity Matrix** : Produces window similar to **New Active Dataset**.

FEATURE- Uploads  $\Delta$  directly.

- \* **Load Similarity Matrix** : Produces window similar to **New Active Dataset**.

FEATURE- Uploads **S** matrix.  $\Delta$  is calculated by scaling **S** and subtracting it from the  $n \times n$  **1** matrix.

- \* **Load Correlation Matrix** : Produces window similar to **New Active Dataset**.

FEATURE- Uploads **S** matrix.  $\Delta$  is calculated by  $n \times n$  **1** matrix - **S**.

- \* **Data Colour Index** : Produces a matrix editor window using a variation of the **tk2** (Grosjean, 2011) **tk2edit** function.

FEATURE- Each object is displayed with their corresponding colour code. Manual alteration of this to another legitimate code will change the points display on the **MDS Configuration Plot**.

- \* **Colour Categories** : Opens the **Colour Categories Options** window.

MENU- Provides means of making visual adjustments to the way the defined categories are shown on the **MDS Configuration Plot**

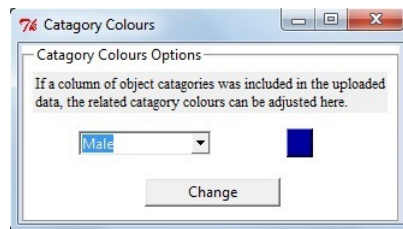


Figure 6: Colour Categories Options

### Options of **Colour Categories Options**

**Category Selection** : Use drop down box to select category.

FEATURE- Each category option listed when uploading data will be present in this list.

**Colour Box** : Click box to bring up native operating system colour selection window.

FEATURE- Whichever colour is selected will be reflected immediately both in the **MDS Configuration Plot** and the **Data Colour Index**. This setting holds for all plotting areas.

**Change** : Select button to make all appropriate changes.

- \* **Edit** Opens the Edit submenu.

MENU- Provides user access to view and make alterations to every applicable form of data in the MDS-GUI instance.

- o **Active Data** : Produces a matrix editor window using a variation of the **tk2** (Grosjean, 2011) **tk2edit** function.

FEATURE- Displays the  $Z:n \times m$  data matrix (if data uploaded using **Load Dataset** option). Elements of the matrix can be altered. valid changes are reflected with immediate effect.

- o **Active Dissimilarity Matrix** : Produces a matrix editor window using a variation of the **tk2** (Grosjean, 2011) **tk2edit** function.

- FEATURE– Displays the  $\Delta:n \times n$  dissimilarity matrix of the active plotting area of the **Plotting Tabs**. Elements of the matrix can be altered. valid changes are reflected with immediate effect.
- **Active Similarity Matrix** : Produces a matrix editor window using a variation of the **tcltk2** (Grosjean, 2011) `tk2edit` function.  
FEATURE– Displays the  $S:n \times n$  matrix (if data uploaded using the \* **Load Similarity Matrix** option). valid changes are reflected with immediate effect.
  - **Active Correlation Matrix** : Produces a matrix editor window using a variation of the **tcltk2** (Grosjean, 2011) `tk2edit` function.  
FEATURE– Displays the correlation  $S:n \times n$  matrix (if data uploaded using the \* **Load Correlation Matrix** option). valid changes are reflected with immediate effect.
  - **Active Coordinate Vectors** : Produces a matrix editor window using a variation of the **tcltk2** (Grosjean, 2011) `tk2edit` function.  
FEATURE– Displays the  $X:n \times p$  coordinate matrix of the active plotting area of the **Plotting Tabs**. valid changes are reflected with immediate effect.
- \* **Save** : Opens the Save submenu.  
MENU– Provides user access to save the relevant datasets to external files.
- **Dataset** : Opens the native operating system save-file window.  
FEATURE– The  $Z:n \times m$  data matrix (if data uploaded using \* **Load Dataset** option) is saved to an external file for external use.
  - **Dissimilarity Matrix** : Opens the native operating system save-file window.  
FEATURE– The active  $\Delta$  dissimilarity matrix is saved to an external file for external use.
  - **Similarity Matrix** : Opens the native operating system save-file window.  
FEATURE– The  $S:n \times n$  similarity matrix (if data uploaded using \* **Load Similarity Matrix** option) is saved to an external file for external use.
  - **Correlation Matrix** : Opens the native operating system save-file window.  
FEATURE– The correlation  $S:n \times n$  similarity matrix (if data uploaded using \* **Load Correlation Matrix** option) is saved to an external file for external use.
  - **MDS Coordinate Matrix** : Opens the native operating system save-file window.  
FEATURE– The active  $X:n \times p$  is saved to an external file for external use.
- \* **Data Options** : Opens the • **Data Options Menu** options window.
- ◊ **Multivariate Tools** : Opens the fourth menu option of • **Top-Menu**.  
MENU– This menu provides access to all the multivariate capabilities of the MDS-GUI.
- \* **MDS** : Opens the MDS submenu.  
MENU–The MDS menu allows for use of the eight Multidimensional Scaling methods utilisable in the MDS-GUI.
- **Classical Scaling** : Uses `cmdscale` function from **stats** package (R Development Core Team, 2011).  
FEATURE– Performs the metric method called Classical Scaling on  $\Delta$ .

- **Metric Symmetric SMACOF** : Uses adaptation of contributed code by [LeRoux \(2012\)](#).  
FEATURE-Performs the metric method called Metric SMACOF on  $\Delta$ .
- **Least Squares Scaling** : Uses original code.  
FEATURE- Performs the metric method called Least Squares Scaling on  $\Delta$ .
- **Non-Metric Symmetric SMACOF** : Uses adaptation of contributed code by [LeRoux \(2012\)](#).  
FEATURE-Performs the non-metric method called Non-Metric SMACOF on  $\Delta$ .
- **Kruskal's Analysis** : Uses `isoMDS` function from **MASS** package ([Venables and Ripley, 2002](#)).  
FEATURE-Performs the non-metric method called Kruskal's on  $\Delta$ .
- **Sammon Mapping** : Uses `sammon` function from **MASS** package ([Venables and Ripley, 2002](#)).  
FEATURE-Performs the metric non-method called Sammon Mapping on  $\Delta$ .
- **INDSCAL** : Uses adaptation of `indscal` function from **SensoMineR** package ([Husson et al., 2011](#)).  
FEATURE-Performs the alternative method called INDSCAL Scaling on  $Z$ . Only applicable when \* **Load Dataset** is used.
- **Gifi** : Uses adaptation of `homals` function and related functions from **homals** package ([de Leeuw and Mair, 2009](#)).  
FEATURE-Performs the alternative method called Gifi Scaling on  $Z$ . Only applicable when \* **Load Dataset** is used.
- \* **MDS Options** : Opens the **MDS Options Menu** window.
- \* **Procrustes Analysis** : Produces **Procrustes Options** window.  
MENU- Gives user control over the specifics of their desired Procrustes Analysis.

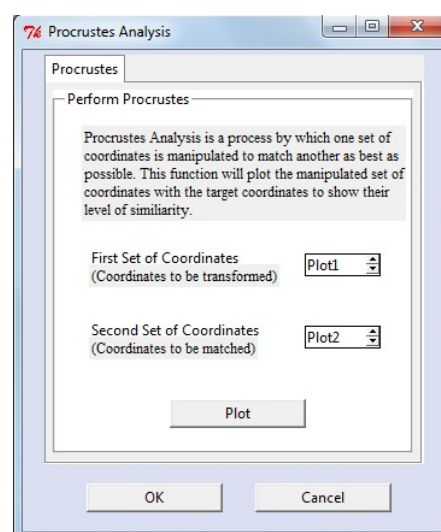


Figure 7: Procrustes Options

### Options of **Procrustes Options**

**First Set of Coordinates** : Requires selection of applicable plot from drop down list.

FEATURE- The selection will be the coordinates that are transformed.

**Second Set of Coordinates** : Requires selection of applicable plot from drop down list.

FEATURE- The selection will be the coordinates that are to be matched.

**Plot** : Selection Button.

FEATURE- When both selections are valid and contain equivalent configurations, this selection will display the • **Procrustes Analysis Plot** in the Procrustes tab of **Plotting Tabs**.

**Cancel** : Selection Button.

FEATURE- Exits the menu with no selections being made.

\* **Dissimilarity Matrix Calculation** : Opens the Dissimilarity Matrix Calculation submenu.

MENU- The Dissimilarity Matrix Calculation menu is in radiobutton format. That is only one of the menu options may be selected at a time and the active selection is indicated by a tick mark on the menu. The menu is only available when data is loaded through \* **Load Dissimilarity Matrix**.

○ **Euclidean** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the Euclidean Metric.

○ **Weighted Euclidean** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the Weighted Euclidean Metric.

○ **Mahalanobis Distance** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the Mahalanobis Distance Metric.

○ **City-Block Metric** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the City-Block Metric.

○ **Minkowski Metric** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the Minkowski Metric.

○ **Canberra Metric** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the Canberra Metric.

○ **Divergence** : Radiobutton menu selection option. Not available when the uploaded **Z** matrix contains zeros.

FEATURE-  $\Delta$  calculated using the Divergence Metric.

○ **Soergel** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the Soergel Metric.

○ **Bhattacharyya Distance** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the Bhattacharyya Metric.

○ **Wave-Hedges** : Radiobutton menu selection option. Not available when the uploaded **Z** matrix contains zeros.

FEATURE-  $\Delta$  calculated using the Wave-Hedges Metric.

- **Angular Separation** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using the Angular Separation Metric.

- **Correlation** : Radiobutton menu selection option.

FEATURE-  $\Delta$  calculated using Correlation.

- ◇ **Help** : Opens the fifth menu of the • **Top-Menu**.

MENU- Provides the user with assistance and details regarding the MDS-GUI itself.

- \* **Function Code** : Opens the **Function Help Menu** Window.

MENU- Gives options relating to the code behind the MDS-GUI.

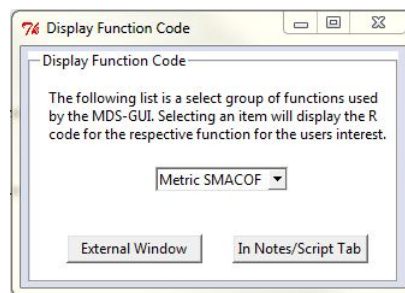


Figure 8: Function Help Menu

### Options for **Function Help Menu**

**Choose Function** : Drop-down menu selection.

FEATURE- Whichever function name is selected from the list will have its code displayed for the users convenience in the environment that they choose. This is purely for observational purposes and any ‘changes’ made to the code will not have any effect to the MDS-GUI.

**External Window** : Section Button.

FEATURE- Selection of this option will display the chosen function’s code in an external telk popped out text box.

**In NotesScript Tab** : Section Button.

FEATURE- Selection of this option will display the chosen functions’s code in the • **NotesScript** tab in the **Secondary Plotting Area**.

- \* **Display Pop-Out Code** : Acts as a checkbox in the menu. Can be activated or deactivated via the menu with the result reflected by a checkmark.

FEATURE- When active, hovering the mouse cursor over various areas of the GUI will produce pop up text boxes that provide help information.

- \* **Vignette** : Internet Link

FEATURE-Opens the vignette PDF document. Internet connection required.

- \* **User Manual** : Internet Link

FEATURE–Opens this PDF document. Internet connection required.

\* **Homepage** : Internet Link

FEATURE–Directs user to both the website for the Department of Statistical Sciences for the University of Cape Town and the CRAN page for the **MDSGUI** package.

\* **About** : Opens Information Text Box.

FEATURE– Provides information about the software and developers.

● **Main Plot Menu** : Menu is accessed via right clicking whilst the mouse is over the **Main Plotting Area**.

MENU– The menu called is specific to the plotting tab selected in the **Plotting Tabs** area. The changes and applications performed from the menu are localised to the active tab from which the menu was called. The tab to which the menu is connected with is shown at the top of the menu.

◇ **Label Specific Point** : Opens the **Label Specific Point** window.

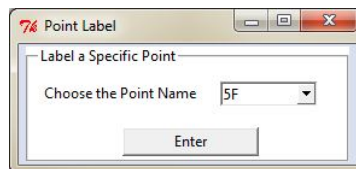


Figure 9: Label Specific Point

### Options for **Label Specific Point**

**Choose the Point Name** : Selection is required from drop down list of object names.

FEATURE– This feature is useful when there are many points on the ● **MDS Configuration Plot** and a specific object needs to be located. Selection of the object will label the point appropriately.

**Enter** : Selection Button.

FEATURE– When pressed the selected point will be labeled.

◇ **Clear Added Point Labels** : Alters the ● **MDS Configuration Plot**.

FEATURE– Any labeled points are cleared.

◇ **Relocate a Group of Points** : Changes mouse cursor and enables selection of points by brushing.

FEATURE– The mouse cursor changes to a cross hair. User must then left-click drag a box over their desired points to move. Upon release of the left mouse button, the user is prompted to select the central point of the new location, i.e. the new location for the center of the brushed box. The next left click will select this point and relocate all selected points keeping their internal configuration intact. The mouse cursor is changed back to its original state. Changes are also reflected in the ● **Shepard Plot** and stress value in the ● **Information Table**.

- ◇ **Remove a Point** : Enables removal of single point by mouse cursor. Changes are also reflected in the
  - **Shepard Plot** and stress value in the ● **Information Table**.

FEATURE- Upon selection, the mouse cursor will change to a cross hair and the user is prompted to select the point they would like to remove. Left clicking the button will remove the point and change the mouse cursor to its original state. All removed points are listed in the ◇ **Removed Points** table of the ● **Information Table**.

- ◇ **Use Coordinates as Starting Configuration** : Alters the ● **MDS Configuration Plot**. Only applicable when active configuration is result of ○ **Metric Symmetric SMACOF**, ○ **Least Squares Scaling**, ○ **Non-Metric Symmetric SMACOF**, ○ **Kruskal's Analysis** or ○ **Sammon Mapping**.

FEATURE- Will perform the version of MDS used to produce the configuration and use the current configuration as the starting configuration for the process.

- ◇ **Rotate and Reflect** : Displays the **Rotate and Reflect** window.

MENU- Provides means of performing rotation and reflection operations on the configuration.

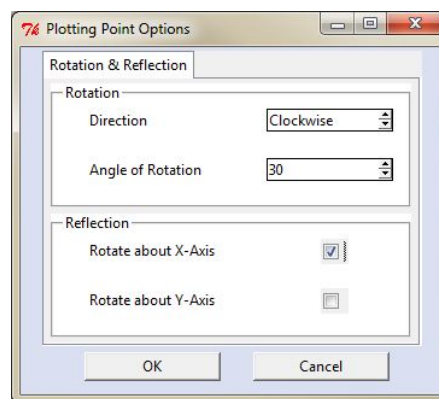


Figure 10: Rotate and Reflect

### Options for **Rotate and Reflect**

**Direction** : Selection made by scrollbox.

FEATURE- Choice of rotating points either clockwise or anticlockwise

**Angle of Rotation** : Selection made by scrollbox.

FEATURE- Choice of degrees by which reflection must be. 0 for no rotation.

**Reflect about X-Axis** : Selection made with checkbox.

FEATURE- Will flip configuration top to bottom.

**Reflect about Y-Axis** : Selection made with checkbox.

FEATURE- Will flip configuration left to right.

**OK** : Selection Button.

FEATURE- Upon selection the ● **MDS Configuration Plot** will have the above changes made.

**Cancel** : Selection Button.

FEATURE- Exit menu with no changes.

◇ **Advanced Zoom** : Displays the **Advanced Zoom** window.

MENU- Provides user with means of performing the zoom function on the • **MDS Configuration Plot** in a more advanced and specific fashion than by using the '+' and '-' buttons.

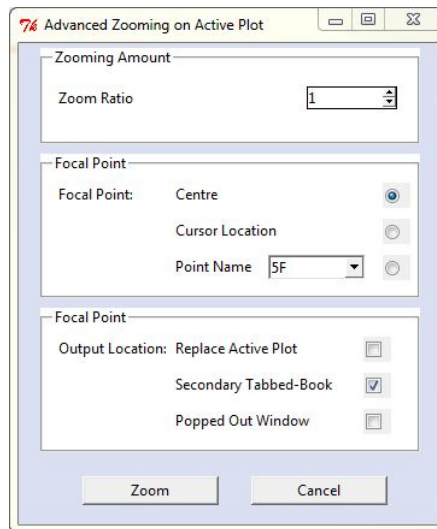


Figure 11: Advanced Zoom

### Options for **Advanced Zoom**

**Zoom Ratio** : Selection made by scrollbox.

FEATURE- Determines the amount by which the zoom is performed.

**Focal Point: Center** : Selection made by radiobutton.

FEATURE- Selection will perform the zoom around the exact center of the configuration.

**Focal Point: Cursor Location** : Selection made by radiobutton.

FEATURE- Selection will perform the zoom at the point of next left click by the user of the configuration.

**Focal Point: Point Name** : Selection made by radiobutton and dropdown menu of point names.

FEATURE- Selection will perform zoom with a specific point as the focal point. Point is selected manually.

**Output Location: Replace Active Plot** : Selection made by radiobutton.

FEATURE- Selection will produce the zoom in the **Main Plotting Area**.

**Output Location: Secondary Tabbed Book** : Selection made by radiobutton.

FEATURE- Selection will produce the zoom as a • **Zoomed Plot** in **Secondary Plotting Area**.

**Popped Out Window** : Selection made by radiobutton.

FEATURE- Selection will produce the zoom in a popped out window.

**Zoom** : Selection Button.

FEATURE- Selection will perform the zoom with specification defined above.

**Cancel** : Selection Button.

FEATURE- Selection will exit the menu with no alterations performed.

◇ **Change Point Colour** : Enables selection of points via brushing.

FEATURE- Upon Selection user is prompted to draw a box around the points they would like to alter the colour of. Releasing the left click will call the native operating system colour selection window whereby selection will change the colour of the selected points. This change supersedes the colours defined according to the object categories.

◇ **Default Point Colours** : Reverts to original state.

FEATURE- Will change all point object colours to the default colour specified in the • **Plot Options Menu**.

◇ **Display Variable Axes** : Alters the • **MDS Configuration Plot**.

FEATURE- In the case where a  $\mathbf{Z}:n \times m$  matrix was uploaded via \* **Load Dataset**, this feature will be available. Selection will display the  $m$  variable axes through the origin of the configuration. Each axis is assigned its own colour. Menu item is also a checkbox and indicates activation with a checkmark. De-selection removes variable axes.

◇ **Remove Axes of Variable(s)** : Opens the **Variable Axes Removal Options** window.

MENU- The menu provides ability to determine which subset of variable axes are displayed.

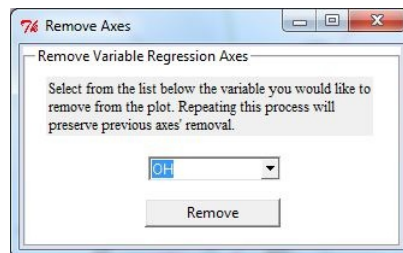


Figure 12: Variable Axes Removal Options

### Options for **Variable Axes Removal Options**

**Variable Selection** : Selection by drop down menu.

FEATURE- The variable selected will be removed from display from the • **MDS Configuration Plot**. All removed variables are listed in the ◇ **Removed Axes** table of the • **Information Table**.

**Remove** : Selection Button.

FEATURE- Selection will perform the removal of the selected variable.

◇ **Pop-out Plot** : Opens an external plotting window.

FEATURE- The ● **MDS Configuration Plot** will be popped out for external viewing in an external *tcltk* window. This second plot will display all visual aspects of the original version in the **Main Plotting Area** and reflect changes as they are made, but will lack the full extent of the capabilities itself.

◇ **Copy Plot to Clipboard** : Utilises native operating system clipboard capabilities.

FEATURE- The ● **MDS Configuration Plot** figure is copied from the MDS-GUI to the computers clipboard where it may be pasted and utilised externally.

◇ **Plot Options** : Opens the ● **Plot Options Menu** menu.

● **Secondary Plot Menu** : Menu accessed via right clicking when the mouse is hovering over any of the plots housed in the **Secondary Plotting Area** area. All menus are similar with only slight differences. For demonstration purposes, only the menu corresponding to the ● **Shepard Plot** will be described. Similar menus apply to the ● **Stress Plot**, ● **Stress Plot2** and ● **Scree Plot**.

MENU- The secondary plot menu provide functions relating to the ● **Shepard Plot**. The features utilised will alter the Shepard Plot itself and in some cases the ● **MDS Configuration Plot** as well.

◇ **Label Specific Point** : Opens the **Shepard Point Label**.

MENU- The menu provides option to label a specific point from the Shepard Plot. Visually selecting a desired point is impossible since by default the Shepard Plot does not print point labels due to the inevitable large number of points.

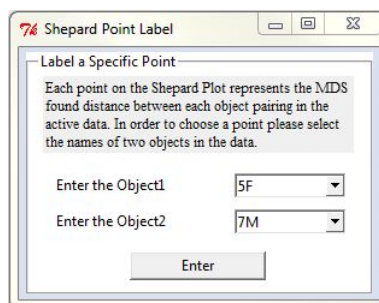


Figure 13: Shepard Point Label

#### Options for **Shepard Point Label**

**Enter Object1** : Selection is via dropdown list of object names.

FEATURE- Selects the first object name index to be labeled.

**Enter Object2** : Selection is via dropdown list of object names.

FEATURE- Selects the second object name index to be labeled.

**Enter** : Selection Button

FEATURE- Upon selection, the Shepard point relating to the object pairing defined above will be labled. This highlights the point on the • **Shepard Plot** and draws the corresponding line in the same colour between the defined objects on the • **MDS Configuration Plot**.

◇ **Clear Added Labels** : Alters the • **Shepard Plot** and the • **MDS Configuration Plot**.

FEATURE- Upon selection, all Shepard point labels that have been added will be cleared from the plot and all other plot features will be reverted to their original settings. In addition, the lines corresponding object pairing lines will be removed from the configuration plot.

◇ **Pop-Out Enlarged Plot** : Opens an external plotting window.

FEATURE- The • **Shepard Plot** will be popped out for external viewing in an external *tcltk* window. This second plot will display all visual aspects of the original version in the **Secondary Plotting Area** and reflect changes as they are made, but will lack the full extent of the capabilities itself.

◇ **Copy Shepard Plot to Clipboard** : Utilises native operating system clipboard capabilities.

FEATURE- The • **Shepard Plot** figure is copied from the MDS-GUI to the computers clipboard where it may be pasted and utilised externally.

◇ **Shepard Plot Options** : Opens the relevant • **Plot Options Menu**.

• **General Settings** : The menu is recalled from the \* **General Settings** option of the ◇ **General** menu.

MENU-Controls various technical aspects of the MDS-GUI. The four tabs of the menu are the ◇ **General Tab**, ◇ **Convergence Tab**, ◇ **Graphical Tab** and ◇ **Visualisation Tab**.

◇ **General Tab** : First tab of • **General Settings** window.

MENU-The first tab of the menu contains *Computation Options* and *Windows Options*. By default, the MDS-GUI will calculate all five major processes automatically, these being: the • **MDS Configuration Plot**, the • **Shepard Plot**, the • **Scree Plot**, and (when applicable) the • **Stress Plot** and • **Stress Plot2**. In *Computation Options* the option is available to deactivate any of these computations for all subsequent use. This option is expected to be exercised when data is sizable and all computations have proven to be excessively time consuming.

### Options for **General Tab of General Settings**

**Compute MDS Point Configuration** : First option of Computation Options frame. Selection is made with checkbox.

FEATURE- When deselected, MDS processes will not compute or display the • **MDS Configuration Plot**. Default is on.

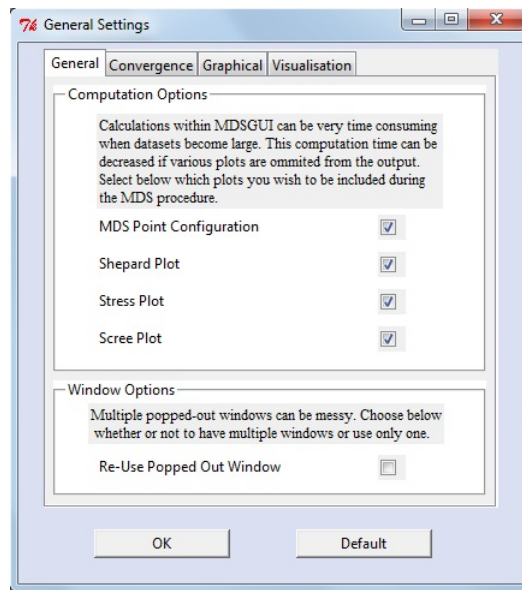


Figure 14: General Tab of General Settings

**Compute Shepard Plot** : Second option of Computation Options frame. Selection is made with checkbox.

FEATURE- When deselected, MDS processes will not compute or display the **Shepard Plot**. Default is on.

**Compute Stress Plots** : Third option of Computation Options frame. Selection is made with checkbox.

FEATURE- When deselected, MDS processes will not compute or display the **Stress Plot** or **Stress Plot2**. Default is on.

**Compute Scree Plot** : Fourth option of Computation Options frame. Selection is made with checkbox.

FEATURE- When deselected, MDS processes will not compute or display the **Scree Plot**. Default is on.

**Re-use Popped Out Window** First option of Windows Options frame. Selection is made with checkbox.

FEATURE- When selected, only one popped out plot can be visible at a time. Creating a new popped out plot will destroy the old and keep the new. When deselected, numerous popped out plots may exist. Default is off.

◇ **Convergence Tab** : Second tab of **General Settings** window.

MENU-The *Convergence* tab contains options relating to the allocation of computational resources dedicated to the MDS procedures.

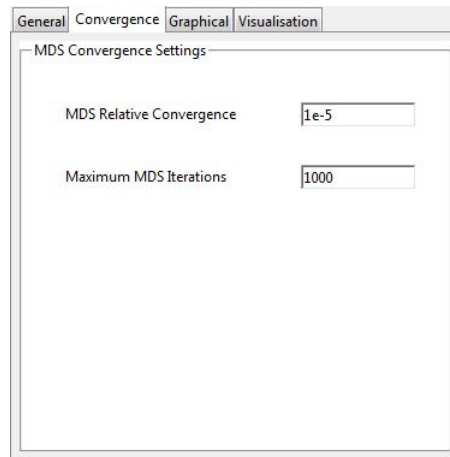


Figure 15: Convergence Tab of General Settings

### Options for **Convergence Tab of General Settings**

**MDS Relative Convergence** : Numerical text input required.

FEATURE– When numeric figure is  $\in [0 : 1]$ , the MDS procedure will converge when the difference between stress values between iterations is less than or equal to the input amount.

**Maximum MDS Iterations** : Numerical text input required.

FEATURE–This input number must be greater than zero. Defines after how many iterations the MDS process should stop if convergence has not yet been met.

◇ **Graphical Tab** : Third tab of **General Settings** window.

MENU–The *Graphical* tab, relates to default options of the visual MDS outputs. *Graphical Settings* is used in conjunction with the settings in **Plot Options Menu**. *Point Label Settings* controls point labels manually added by the user to any relevant plot.

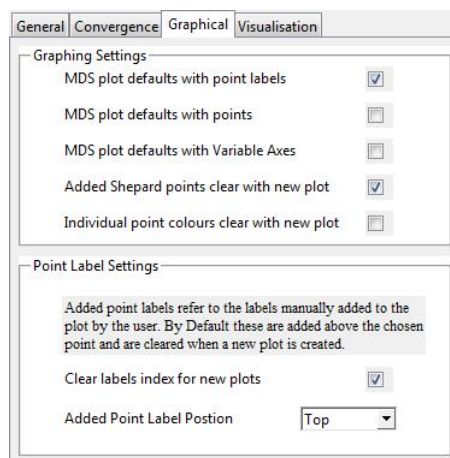


Figure 16: Graphical Tab of General Settings

### Options for **Graphical Tab of General Settings**

**MDS plot defaults with point labels** : Selection is by checkbox.

FEATURE- New • **MDS Configuration Plot** will by default have labels.

**MDS plot defaults with points** : Selection is by checkbox.

FEATURE- New • **MDS Configuration Plot** will by default show points.

**MDS plot defaults with Variable Axes** : Selection is by checkbox.

FEATURE- New • **MDS Configuration Plot** will by default display all  $m$  variable axes.

**Added Shepard Points clear with new plot** : Selection is by checkbox.

FEATURE- New • **MDS Configuration Plot** and • **Shepard Plot** will by default show no prior labeled Shepard points.

**Individual point colours clear with new plot** : Selection is by checkbox.

FEATURE- New • **MDS Configuration Plot** will by default not carry through manual object colour changes (excluding category related colours).

**Clear labels index for new plots** : Selection is by checkbox.

FEATURE- New • **MDS Configuration Plot** will by default not show previously labeled points.

**Added Point Label Position** : Selection is by dropdown menu.

FEATURE- All point labels on all • **MDS Configuration Plot** and • **Shepard Plot** will have their labels in this position relative to the point. Options are 'Top', 'Bottom', 'Left' or 'Right'. Default is 'Top'.

◇ **Visualisation Tab** : Fourth tab of • **General Settings** window.

MENU- The *Visualisation* tab specifies the elements of the MDS procedures that should have its iterative nature depicted visually. This should not be confused with the *Computation Options* elements in the *General* tab. The outputs that have been unchecked will still be processed (provided they have not been deactivated), but will not have their respective plots updated after each iteration. In this case, the final result is plotted upon process completion.

### Options for **Visualisation Tab of General Settings**

**Update MDS Configuration** : Selection is by checkbox.

FEATURE- If selected, the • **MDS Configuration Plot** is updated after every iteration of the active MDS process.

**Update Shepard Plot** : Selection is by checkbox.

FEATURE- If selected, the • **Shepard Plot** is updated after every iteration of the active MDS process.

**Update Stress Plots** : Selection is by checkbox.

FEATURE- If selected, the • **Stress Plot** and • **Stress Plot2** are updated after every iteration

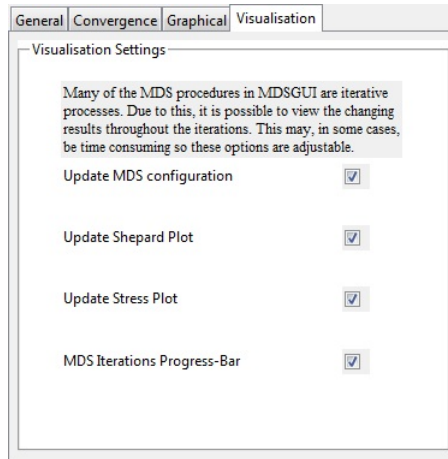


Figure 17: Visualisation Tab of General Settings

of the active MDS process.

**Update iterations Progress-Bar** : Selection is by checkbox.

FEATURE– If Selected, the Progress-Bar shown at the leftmost side of the **Information Panel** progresses throughout every iteration of the active MDS process and in the construction of the **Scree Plot**.

• **Data Options Menu** : The menu is recalled from the \* **Data Options** option from the **Data** menu.

MENU– The menu is similar to the **New Active Dataset**, with the difference that this menu may be called at any point and have the settings changed. The displayed tab is associated with an uploaded  $\mathbf{Z}:n \times m$  matrix or  $\Delta : n \times n$  matrix.

### Options for **Data Options Menu**

**Transpose Active Data** : Selection by checkbox.

FEATURE– Applicable when uploaded data has variables as rows and objects as columns. Selection transposes data such that rows are objects and variables as columns.

**Enter New Name of Dataset** : Required Text Entry.

FEATURE– Name of data can be changed at any point. Result is reflected in the **Information Panel** and future exported documents and **MDS Configuration Plot**.

**Change Name** : Selection Button.

FEATURE– Selection will only change name of data and nothing else.

**Scale Your Active Data** : Selection by checkbox.

FEATURE– Selection will scale data such that all columns range from zero to one.

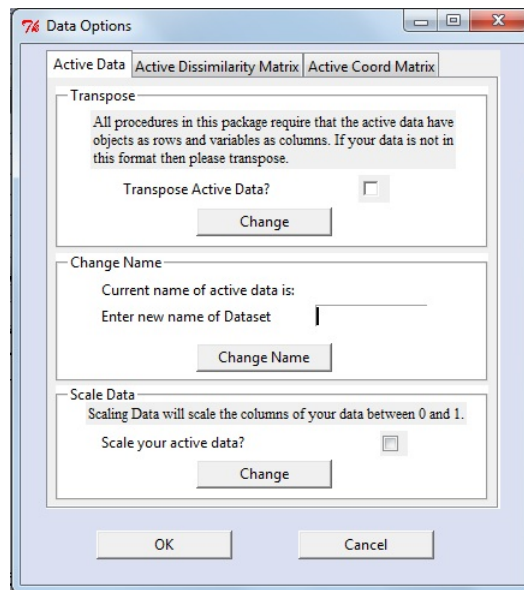


Figure 18: Data Options Menu

**Change** : Selection button.

FEATURE– Makes all specified changes.

- **MDS Options Menu** : The menu is recalled from the \* **MDS Options** option of the ◇ **Multivariate Tools** menu.

MENU– The purpose of menu is to provide key adjustments to the MDS procedure that effect the output in a substantial way. The three tabs of the menu are the ◇ **Dimensions Tab**, the ◇ **Starting Configuration Tab** and the ◇ **Stress Tab**.

- ◇ **Dimensions Tab** : The first tab of the • **MDS Options Menu**.

MENU–The tab adjusts the user defined  $p$  for all subsequent MDS procedures. When a new dataset is added, the selection is populated with the entries being 1,2,..., $n-1$ .

#### Options for **Dimensions Tab**

**Choice of dimension** : Selection by drop down list of numbers.

FEATURE– All subsequent procedures will be performed in  $p$  dimensions. If  $p = 1$  is chosen, a warning box will be displayed urging the user against it.

**Change** : Selection Button.

FEATURE– Activates the chosen  $p$  value. The result is indicated in the **Information Panel**.

- ◇ **Starting Configuration Tab** : The second tab of the • **MDS Options Menu**.

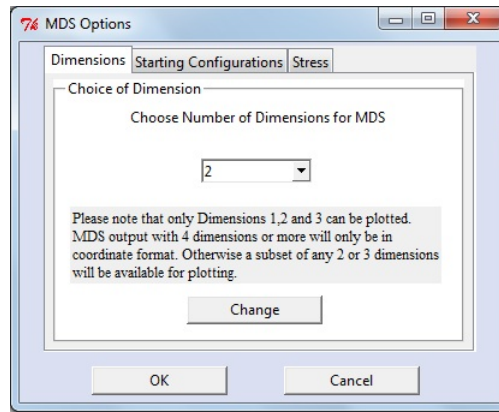


Figure 19: Dimensions Tab

**MENU**–The *Starting Configurations* tab provides the user the option to change what starting configuration is used in the MDS procedures (where starting configuration is relevant). Three options are provided, being: the  $n \times p$  result of Classical Scaling on data; a random configuration, where the  $n \times p$  matrix is uniformly distributed and doubly centered around the origin; and finally a configuration in any of the five main plotting tabs may be set as the starting configuration for all subsequent procedures. Therefore, the user may use, say, the result of a Sammon Mapping procedure as the starting configuration for a SMACOF procedure.

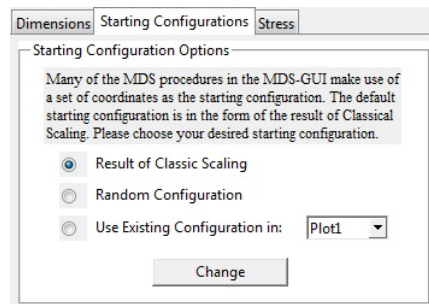


Figure 20: Starting Configurations Tab

### Options for **Starting Configurations Tab**

**Result of Classical Scaling** : Selection is by radiobutton.

**FEATURE**– All MDS procedures requiring a starting configuration will now use the result of `cmdscale` with  $\Delta$  as input.

**Random Configuration** : Selection is by radiobutton.

**FEATURE**– All MDS procedures requiring a starting configuration will use an  $\mathbf{X}:n \times p$  that is randomised using the uniform distribution.

**Use Existing Configuration in** : Selection is by radiobutton and drop down menu of **Plotting Tabs** options.

**FEATURE**– All MDS procedures requiring a starting configuration will use the  $\mathbf{X}:n \times p$  from

the • **MDS Configuration Plot** from the selected plotting area.

**Change** : Selection Button.

FEATURE– Selection will change the starting configuration as specified.

◇ **Stress Tab** : The third tab of the • **MDS Options Menu**.

MENU–The final tab of *MDS Options* is called *Stress* and controls the measure of stress used to assess the goodness-of-fit of all configurations. It should be noted that this does not affect the loss function used within each MDS functions, as each method is usually defined by their specific loss function. The stress method chosen here simply defines how the accuracy of the final configurations are measured, in order to compare accuracy of configurations in absolute terms, as they need to be compared on an identical scale.

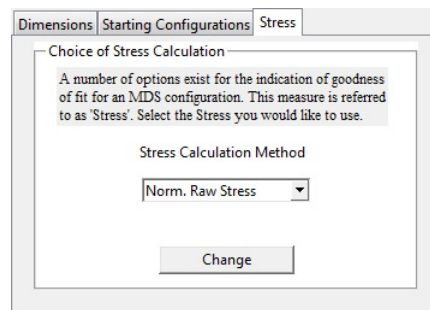


Figure 21: Stress Tab

### Options for **Stress Tab**

**Stress Calculation Method** : Selection by drop down menu.

FEATURE– Result will adjust the stress value shown in the ◇ **MDS Configurations** table of the • **Information Table**, and the stress values in the • **Stress Plot**, • **Stress Plot2** and • **Scree Plot**. Options for this include: Normalised Raw Stress, STRESS1, STRESS2 and Pearson's Correlation Coefficient.

**Change** : Selection Button.

FEATURE–Selection will change the stress calculation method as specified.

• **Plot Options Menu** : The menu is recalled from the ◇ **Plot Options** option of the • **Main Plot Menu** menu.

MENU– Each plotting area found in the MDS-GUI has a Plot Options menu, which may be accessed via a right click of the plot and selecting the *Plot Options* option. These areas include: • **MDS Configuration Plot**, • **Shepard Plot**, • **Stress Plot**, • **Stress Plot2**, • **Scree Plot**, • **Zoomed Plot**, • **RGL 3D Plot**, • **Static 3D Plot** and • **Procrustes Analysis Plot**. Each of these menu's are set out in a similar way with only slight

differences depending on the nature of the plot itself. The menu associated with the • **MDS Configuration Plot** will be used for demonstrative purposes. Four tabs exist on the majority of the menus.

◇ **General Tab** : First tab of the • **Plot Options Menu**.

MENU- The *General* tab of the plot menu deals with overall settings of the plotting area.

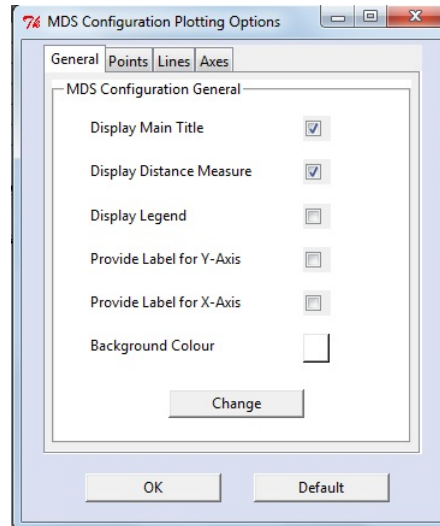


Figure 22: Plot Options: General Tab

#### Options for **Plot Options: General Tab**

**Display Main Title** : Selection by checkbox.

FEATURE- When active, the • **MDS Configuration Plot** displays a title at the top center, indicating the type of MDS performed and the name of the data.

**Display Distance Measure**: Selection by checkbox.

FEATURE- When active, the • **MDS Configuration Plot** displays (at the top left) the current distance metric used to calculate  $\Delta$ , as selected in \* **Dissimilarity Matrix Calculation**.

**Provide Label for Y-Axis** : Selection by checkbox.

FEATURE- When selected, a small dialog box appears prompting user to name the axis. The result is added vertically along the Y-Axis.

**Provide Label for X-Axis** : Selection by checkbox.

FEATURE- When selected, a small dialog box appears prompting user to name the axis. The result is added horizontally along the X-Axis.

**Background Colour** : Selection by clicking coloured box, calling native operating system colour selection window.

FEATURE- Selection will cause the entire backdrop of the • **MDS Configuration Plot** to change to the desired colour.

**Change** : Selection Button.

FEATURE- Makes all specified changes.

◇ **Points Tab** : Second tab of the • **Plot Options Menu**.

MENU– The visual effects of the  $n$  points making up the configuration are controlled by the *Points* tab.

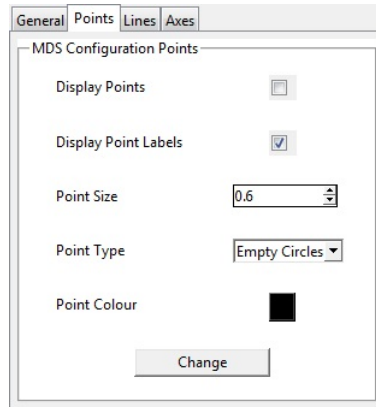


Figure 23: Plot Options: Points Tab

#### Options for **Plot Options: Points Tab**

**Display Points** : Selection by checkbox.

FEATURE– When selected each of the  $n$  objects in the • **MDS Configuration Plot** will display a specified symbol at the corresponding exact coordinates of the **X** matrix.

**Display Point Labels** : Selection by checkbox.

FEATURE– When selected each of the  $n$  objects in the • **MDS Configuration Plot** will display the object name. If points are also activated, the label will be at the position specified in the ◇ **Graphical Tab** of • **General Settings**. If points are not activated, the label is displayed at the exact coordinates.

**Point Size** : Selection by scrollbox.

FEATURE– Adjusts the ‘cex’ par function.

**Point Type** : Selection by dropdown menu.

FEATURE– Adjusts the ‘pty’ par function for points (if selected). Options include, ‘Solid Dot’, ‘Empty Dot’, ‘Solid Block’, ‘Empty Block’, ‘Solid Triangle’, ‘Empty Triangle’ and ‘Cross’.

**Point Colour** : Selection by clicking coloured box, calling native operating system colour selection window.

FEATURE– All objects will be changed to the specified colour.

**Change** : Selection Button.

FEATURE– Makes all specified changes.

◇ **Lines Tab** : Third tab of the • **Plot Options Menu**.

MENU– The lines tab controls the various forms of line additions that may be added to the configu-

ration plot.

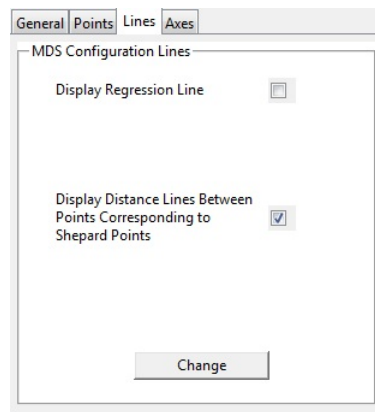


Figure 24: Plot Options: Lines Tab

### Options for **Plot Options: Lines Tab**

**Display Regression Line** : Selection by checkbox.

FEATURE– Refers to the variable axes regression lines. Toggles their display on and off. Seen as an alternative to the **Display Variable Axes** option of the **Main Plot Menu**.

**Display Distance Lines Between Points Corresponding to Shepard Points** : Selection by checkbox.

FEATURE– Toggles on and off the display of lines between objects that correspond to the labeled points on the **Shepard Plot**

**Change** : Selection Button.

FEATURE– Makes all specified changes.

◇ **Axes Tab** : Fourth tab of the **Plot Options Menu**.

MENU– The measurement indicators on the axes of the plotting area for the configuration are usually regarded as irrelevant. This is due to the fact that only the relative distances between points is useful which may be observed visually. This being said, the option to add the numerical axes measures is available to the user if that output is desirable to them.

### Options for **Plot Options: Axes Tab**

**Display Axes Measures** : Selection by checkbox.

FEATURE– When selected, the numerical points along both axes are displayed on the **MDS Configuration Plot**.

**Axes Colour** : Selection by clicking coloured box, calling native operating system colour selection window.

FEATURE– Selected colour will be reflected on the axes border of the plot as well as the measures if they have been added.

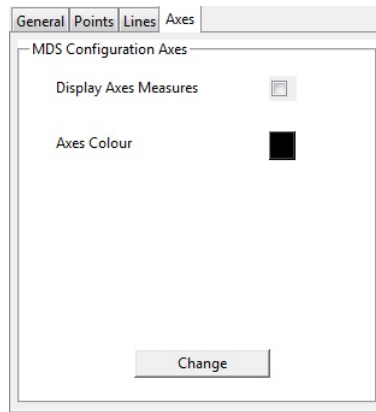


Figure 25: Plot Options: Axes Tab

**Change** : Selection Button.

FEATURE- Makes all specified changes.

## Other Features

- **NotesScript** : The Notes and scripting capabilities of the MDS-GUI are housed in the Notes/Script tab of the **Plotting Tabs**.

MENU- The tab in the secondary plotting area named *Notes/Script* serves two purposes within the MDS-GUI. The first is a note making service available to the user where it acts as a simple text input location. The area comes complete with copy and pasting functionality, either through a right click menu or the keyboard shortcuts Ctrl-C and Ctrl-V. The second feature is the interface that has been customised between the tab and the active *R*-Environment. This link allows the user to treat the area as a scripting location, whereby they may write their *R* code and run it directly from the MDS-GUI to the console.

- ◇ **Run as Code** : Selection Button

FEATURE- Treats all text in the text box as code and runs it through the *R* console.

- ◇ **Save Notes** : Selection Button

FEATURE- Opens the native operating system save file window. Allows user to save contents to a txt file for external use.

- ◇ **Load Notes** : Selection Button

FEATURE- Opens the native operating system load file window. Allows user to load contents of an external txt file.

- **Information Table** : the table section of the MDS-GUI summarises all relevant information of each of the five plotting areas of **Plotting Tabs**. This allows the user to make direct comparisons from a numerical point of view.

- ◇ **MDS Configurations** : Every time an MDS procedure is performed, the information all relevant

information is updated on the table in the row corresponding to the active plotting area.

FEATURE- Informs of the MDS method of each plot.

FEATURE- Informs of the distance metric of each plot.

FEATURE- Informs of the Stress value of each plot.

FEATURE- Informs of the MDS method of each plot.

FEATURE- Informs of the tolerance used for the process shown in each plot.

FEATURE- Informs of the number of iterations used in the MDS process for each plot.

- ◇ **Removed Points** : When objects have been removed from any of the **Plotting Tabs**, the object names are displayed in this table.

FEATURE- The table corresponds to the active plotting tab. Each tab has its own individual table.

FEATURE- Each element of the table will be coloured the same as they were in the • **MDS Configuration Plot**.

FEATURE- Each element of the table may be returned to the • **MDS Configuration Plot** by right clicking the cell and selecting 'Replace Point in Active Cell'.

- ◇ **Removed Axes** : When variable axes have been removed from any of the **Plotting Tabs**, the variable names are displayed in this table.

FEATURE- The table corresponds to the active plotting tab. Each tab has its own individual table.

FEATURE- Each element of the table will be coloured the same as they were in the • **MDS Configuration Plot**.

FEATURE- Each element of the table may be returned to the • **MDS Configuration Plot** by right clicking the cell and selecting 'Replace Point in Active Cell'.

- **Animated Optimisation** : Refers to the ability to see real time changes in the • **MDS Configuration Plot**, • **Shepard Plot**, • **Stress Plot** and • **Stress Plot2** during MDS procedures.

FEATURE- By replotting all plots after every iteration, the illusion is of fluid motion of the points and lines (if computer has sufficient capabilities). The feature works best when datasets are smallest.

FEATURE- The feature may be turned off for every plot individually from the ◇ **Visualisation Tab** of • **General Settings**.

FEATURE- Only the focused tab in the **Secondary Plotting Area** will be updated to avoid unnecessary utilisation of computational power.

FEATURE- All popped out plots will also update.

- ◇ **End Process** : Selection button found at the left most side of the **Information Panel**.

FEATURE- If a process is taking too long, as may be the case when the data is big, the button may be selected to stop the MDS process and return GUI functionality to the user.

- **Keyboard Shortcuts** : The following shortcuts have programmed to the keyboard.

- ◇ **1:** Focuses Plot1 of the **Plotting Tabs**

- ◇ **2:** Focuses Plot2 of the **Plotting Tabs**

- ◇ **3:** Focuses Plot3 of the **Plotting Tabs**

- ◇ **4:** Focuses Plot4 of the **Plotting Tabs**
- ◇ **5:** Focuses Plot5 of the **Plotting Tabs**
- ◇ **←:** Adjusts the displayed axes of the active **MDS Configuration Plot** to the left (configuration moves right).
- ◇ **→:** Adjusts the displayed axes of the active **MDS Configuration Plot** to the right (configuration moves left).
- ◇ **↑:** Adjusts the displayed axes of the active **MDS Configuration Plot** upwards (configuration moves down).
- ◇ **↓:** Adjusts the displayed axes of the active **MDS Configuration Plot** downwards (configuration moves up).
- ◇ **+**: Zooms in the active **MDS Configuration Plot** around the center of the displayed axes.
- ◇ **-**: Zooms out the active **MDS Configuration Plot** around the center of the displayed axes.
- ◇ **c**: Returns the axes of the active **MDS Configuration Plot** to its original orientation.
- ◇ **w**: Applicable only to the **Static 3D Plot**. Rotates plotting area around its horizontal axes leftwards.
- ◇ **s**: Applicable only to the **Static 3D Plot**. Rotates plotting area around its horizontal axes rightwards.
- ◇ **a**: Applicable only to the **Static 3D Plot**. Extends horizontal axes outwards.
- ◇ **d**: Applicable only to the **Static 3D Plot**. Reduces horizontal axes inwards.
- ◇ **C**: Applicable only to the **Static 3D Plot**. Returns plot to its original orientation.
- ◇ **Ctrl-C**: Applicable only to **NotesScript**. Copies all highlighted text to clipboard.
- ◇ **Ctrl-V**: Applicable only to **NotesScript**. Pastes text from clipboard to text area.
- ◇ **Ctrl-L**: Performs the **\* Load Dataset** operations.

## Known Issues

List Still being compiled.

# Bibliography

- Adler, D. and Murdoch, D. (2011). *rgl: 3D visualization device system (OpenGL)*. R package version 0.92.798.  
**URL:** <http://CRAN.R-project.org/package=rgl>
- Borg, I. and Groenen, P. F. (2005). *Modern Multidimensional Scaling: Theory and Applications Second Edition*, Springer, New York.
- Canty, A. and Ripley, B. (2010). *boot: Bootstrap R(S-Plus) functions*. R package version 1.2-43.
- Cox, T. F. and Cox, M. A. (2001). *Multidimensional Scaling: Second Edition*, Chapman and Hal, Boca Raton.
- de Leeuw, J. and Mair, P. (2009). Gifi methods for optimal scaling in R: The package homals, *Journal of Statistical Software* **31**(4): 1–20.  
**URL:** <http://www.jstatsoft.org/v31/i04/>
- Grosjean, P. (2011). *SciViews-R: A GUI API for R*, UMONS, Mons, Belgium.  
**URL:** <http://www.sciviews.org/SciViews-R>
- Husson, F., Le, S. and Cadoret, M. (2011). *SensomineR: Sensory data analysis with R*. R package version 1.14.  
**URL:** <http://CRAN.R-project.org/package=SensomineR>
- Leisch, F. (2002). Sweave: Dynamic generation of statistical reports using literate data analysis, in W. Härdle and B. Rönz (eds), *Compstat 2002 — Proceedings in Computational Statistics*, Physica Verlag, Heidelberg, pp. 575–580.  
**URL:** <http://www.stat.uni-muenchen.de/leisch/Sweave>
- LeRoux, N. J. (2012). Smacof R code for metric and non-metric algorithms. Personal Communication.
- Ligges, U. and Mächler, M. (2003). Scatterplot3d - an r package for visualizing multivariate data, *Journal of Statistical Software* **8**(11): 1–20.  
**URL:** <http://www.jstatsoft.org>
- Neuwirth, E. (2011). *RColorBrewer: ColorBrewer palettes*. R package version 1.0-5.  
**URL:** <http://CRAN.R-project.org/package=RColorBrewer>
- R Development Core Team (2011). *R: A Language and Environment for Statistical Computing*, R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0.  
**URL:** <http://www.R-project.org/>

Tierney, L. (2011). *tkrplot: TK Rplot*. R package version 0.0-20.

**URL:** <http://CRAN.R-project.org/package=tkrplot>

Venables, W. N. and Ripley, B. D. (2002). *Modern Applied Statistics with S*, fourth edn, Springer, New York.  
ISBN 0-387-95457-0.

**URL:** <http://www.stats.ox.ac.uk/pub/MASS4>