IMP: Regress6

Integrated Morphometrics Package Thin Plate Spline Regression Tool

Introduction

Regress6 is part of a suite of software (IMP) meant for use in morphometric analysis of 2D landmark data. If you have not already used CoordGen at some point, you should read the manual for that piece of software before proceeding.

This program takes in data files in x1y1x2y2...CS format and carries out the following set of operations:

1.) Computes partial warp scores. This may be done using a reference formed over an average over some portion of the input data set, or by using a reference specified by the user and loaded as an x1y1x2y2...CS data file.

2.) Regresses the partial warp and uniform deformation scores on the centroid size (CS) or on the natural log (ln) of centroid size (LCS). The deformation from the smallest specimen to the largest specimen is then plotted, starting from the reference form. This plot can be shown using deformation grids, quiver plots, vectors on the reference form or contour plots. The deformation may be shown using Partial Procrustes superimpositioning, Sliding Baseline Registration or Bookstein Shape Coordinate form. The Wilk's Lambda value for the regression is computed as a test of significance of the regression.

3.) The program will also show what each principle warp looks like, in several formats.

4.) A plot of the Procrustes distance from the reference for each specimen may be plotted vs. CS or LCS. This forms a quick check for allometry. A file listing this Procrustes distance and CS or LCS may also be produced, so that one may calculate a correlation coefficient or regression slope as desired.

Operation of Regress6 will be discussed on a button by button basis.
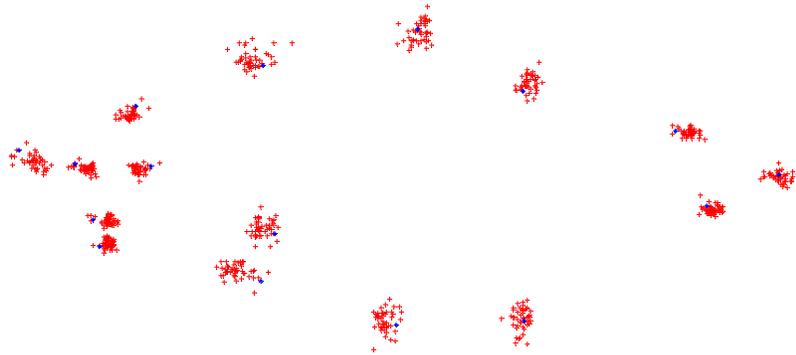
The example image above from Regress6 shows the Partial Procrustes Coordinates of 46 specimens of *Serrasalmus elongatus* a species of piranha. The size (and) age vary greatly for this data set. The image below shows the change in shape predicted from the smallest to the largest, base on a regression of shape on the ln of centroid size and presented as a defomation grid. Rao's F-score was 16.49 (based on Wilk's Lambda=0.0355) with df1=28, df2=17, yielding p=1 x10^{-7}.

1.1
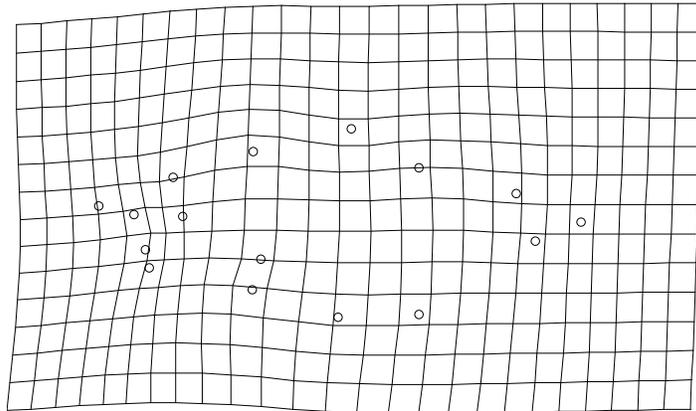
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Using Regress6

Set Superposition Type

This set of button is used to set the form of superposition used in the display of deformations. Currently deformations may be displayed in Procrustes Superposition, SBR or Bookstein Coordinates (BC). Note that all Partial Warp scores and Uniform components are based on Procrustes Superposition in Principal Axis Orientation (see Bookstein's chapter in the White Book). The deformations displayed using SBR or BC use the same scores as the Procrustes superposition does when drawing the images.

You must chose one of these superposition types before proceeding, but you can go back once the partial warp scores are calculated and change the superposition used in drawing the images. You are encouraged to do this.

Baseline Endpoints

These are the landmarks used as the baseline endpoints used in BC or SBR registrations. They may be changed while the program is running, so that the deformation based on a different choice of baseline may be seen.

Regression Variable

These buttons allow you to regress the PW scores and Uniform components on either the centroid size or natural log of centroid size. See the discussion at the end of this manual on how to regress on other variables. You must chose one of these prior to proceeding.

Load Data

This button allows you to load data in x1y1x2y2..CS format. When the data is loaded, the filename, number of specimens and number of landmarks will be displayed. The data will be plotted in the display window. Note that input data can be in Procrustes, SBR or BC registration. Data must be loaded before proceeding.

Load Reference

This button loads a reference form in x1y1x2y2...CS format. References may be generated using CoordGen. The reference can be in any registration form, although Procrustes is using in the PW and Uniform calculation.

N Smallest as Reference

This button forms a reference using the N smallest specimens in the data set. There is a small edit box (labeled N) just below this button that will let you specify the value of N. The default choice is to use the smallest 3 specimens. You can also set N to be equal to the number of specimens in the data set, to form a reference from the average of all points in the data set. You must either load a reference or calculate one before proceeding.

Save Reference

This will save the reference used in x1y1x2y2....CS format. This is useful if you have calculated a reference in this program.

Compute Partial Warp Scores

This button carries out the computation of partial warp scores and regresses these scores on CS or LCS.

Display Regression (Deformation)

This button displays the deformation from the smallest (lowest CS or LCS) to the largest specimen predicted by the regression model. This deformation can be rescaled by using the exaggeration box in the lower right hand corner. The actual deformation is multiplied by this factor when drawing the plot.

There are a number of different display formats possible, these are chosen using the Deformation Display Format window. The reference form is shown on each diagram. The available formats are:

Deformation Grid- a grid showing the deformation from a square grid pattern.

   The deformation of the grid is drawn to scale of the reference.

Quiver Plot- this graph shows the relative deformations at all points in the

diagram using a set of arrows. Note that these are relative deformations, the largest arrow is the largest deformation, but is not scaled to the reference.

Vectors on Smallest- This actually shows the deformation as vectors located at

each landmark on the reference. The deformation shown is the predicted difference from the smallest specimen to the largest (this is the deformation shown in all of these plots).

Contour X Components, Contour Y Components- These are contour plots, as

used in topographic maps. The contour plots show only the X or Y components at one time.

Quiver X components, Quiver Y components-These are the same as the Quiver

Plot above, but showing only the X or Y components.

Contour Abs(X), Contour Abs(y)- This are contour plots of the absolute value of

the deformations in the x and y directions.

Buttons that control the plot options

Color Scheme- These options alter the color used in the contour plots.

Image Brightness, Up and Down-These adjust the brightness levels in the contour

plots.

Add Colorbar- Adds a scale bar along one side of the diagram, showing the

coding used in the color scheme.

Clear Axis- This button turns off the axis along the plot. An option to restore the

axis is in the Axis Controls menu.

Clear image and remove colorbar-Use this button to clear the image and remove

the colorbar. Use the Display Regression button to replot the data.

Display Distance vs CS or LCS-

This option plots the Procrustes Distance of each specimen from the reference as a function of the centroid size or log centroid size. This is helpful for determining if there is allometry in the data set.

Plot Principal Warps

This button plots the Principle warp corresponding to the number chosen using the slider in the upper right hand corner of the screen. There is a Principal Warp Display format box immediately above it as well.

This feature is less than ideal at the moment, it will eventually be updated and improved.

Copy Figure to Clipboard

This option copies the image onscreen to the Windows clipboard. From there, it may be pasted into a variety of different software packages. MS Word seems to work well for this. This is the best way to print images from this software, copying them into another program first.

Save Principle Warp Image/ Save Deformation Image

These options save the current deformation image or the current Principle Warp image, the files are in bitmap format. This is less than ideal, the Copy Figure to Clipboard is a better option.

Clear Data and Reset

Clears the existing data and resets the software. Faster than exiting and restarting the program.

Exit

Exits program

Save Partial Warp Scores

Saves the partial warp scores in x1y1x2y2...CS format, highest numbered partial warp scores first PW13x,PW13y,PW12x.....PW1x,PW1y,CS, where higher numbered warps are of higher bending energy.

Note that the specimen order is preserved, it is the same as the input file.

Save Regression Information

This writes an output file with the following information:

Save Growth Vector (x1y1... format)

This button saves the normalized growth vector (the regression coefficients of each warp component on CS or LCS) in x1 y1...format. These may be loaded into VecDisplay12 to display the growth vectors produced by two different groups of organisms. Note that in order to do this, it is necessary to compute partial warp scores based on the same reference form.

Growth vectors may also be obtained by loading the PW scores into VecCompare.

Pull Down Menus

Display Format

Controls various aspects of the plot produced, to allow for better user control of images.

Set Line Weight-this option allows increases or decreases in line weight, the changes

appear in both the current graph and the next one plotted.

Set Line Color - this alters the color used in the next plot. To get the change to take

place, one must choice a color, then use the Display Regression button to redraw the plot.

Set Plot Density- sets the plot density to be used in deformation grids, quiver plots and

contour maps, takes effect on the next graph plotted.

Arrowheads- indicates whether or not to use arrowheads in the Vectors on Landmarks

plot or not. Takes effect on the next plot.

Fill or Empty symbols-Alters the current graph only.

Alter Symbol size- increase or decrease the size of the symbols used in the plot.

Axis Controls

Remove Axis/Restore Axis- Removes the axis from the image, or replaces it as needs be.

Add Colorbar- this is a bar that shows the scale implied by the color coding in the

contour plots.

Clear Image and colorbar- clears off the current image and removes the colorbar. This is

the only way to get rid of the colorbar once it is on screen.

File Menu

The file menu duplicates many of the onscreen file saving options. It does have separate
save options for the:

1.) Normalized growth vector- outputs the normalized form of the growth vector

in x1y1x2y2....CS format. It may be loaded directly into VecDisplay6.

2.) Deformation vector-this is the vector deformation from the smallest sample in the set to the largest. Allows comparison of actual deformations, rather than normalized growth vectors. It will load directly into VecDisplay6.

Regression Statistics

There are regression statistics available for the univariate regression of Partial Procrustes distance from the reference as a function of the independent regression variable, and for the multivariate regression of the Partial Warp plus uniform component scores on the independent regression variable. They are both accessed through the Regression Statistics menu bar.

The univariate statistics yields a regression slope and intercept, with a confidence interval for the slope. The correlation coefficient is also calculated, as is the Z-score of the correlation coefficient (using the statistic $1/2\ln(r+1/r-1)$ with variance n-3) and the p-value corresponding to the correlation coefficient. The menu option for is **Procrustes Distance vs. CS/LCS**

The multivariate statistics option computes the Wilk's Lambda score, Rao's F, the number of degrees of freedom for Rao's F and the p-value resulting from the F-test. The menu option is PW+Uniform vs CS/LCS.