

Spatial chromatic variance tutorial walk-through

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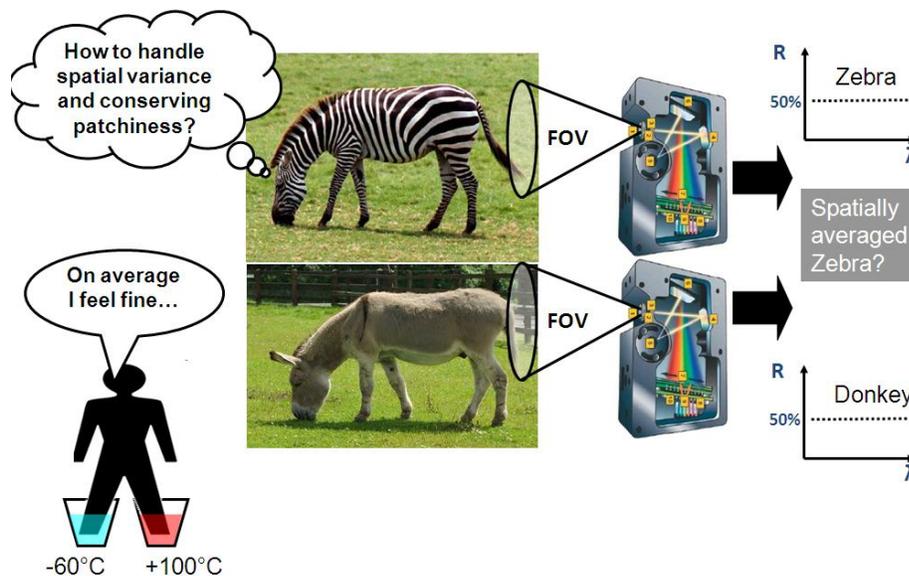
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Introduction

This tutorial and software package demonstrates the concept of multidimensional chromatic distribution and examples on how to use such. Multi-dimensional chromatic distributions can be produced from widely available RGB color imagers, and is a straightforward way to capture arbitrary chromatic distributions and compare them in-between samples. The concept can be expanded to cover multispectral images[1]. The figure below illustrates why variance matters and one example where spatial chromatic variance is needed to identify the species. More considerations can be found in the authors reference[2] and in the included power point presentation.

Sometimes high spectral resolution doesn't help



Dewlaps

The example pictures in this tutorial were kindly provided by Yoel Stuart from his work at Jonathan Loses lab, Harvard University, Cambridge, USA. The anoles lizards were collected throughout the Caribe. The lizard possesses colorful dewlaps which they can display at will, only a few varieties are included in this tutorial. The dewlaps are colored by a number of pigments in all colors, and display a number of

different types of patchiness, see figure below. The dewlaps are thought to play a role in sexual interplay and to have evolved[3, 4] and differentiated e.g. due to sexual selection and local adaptation[5, 6].

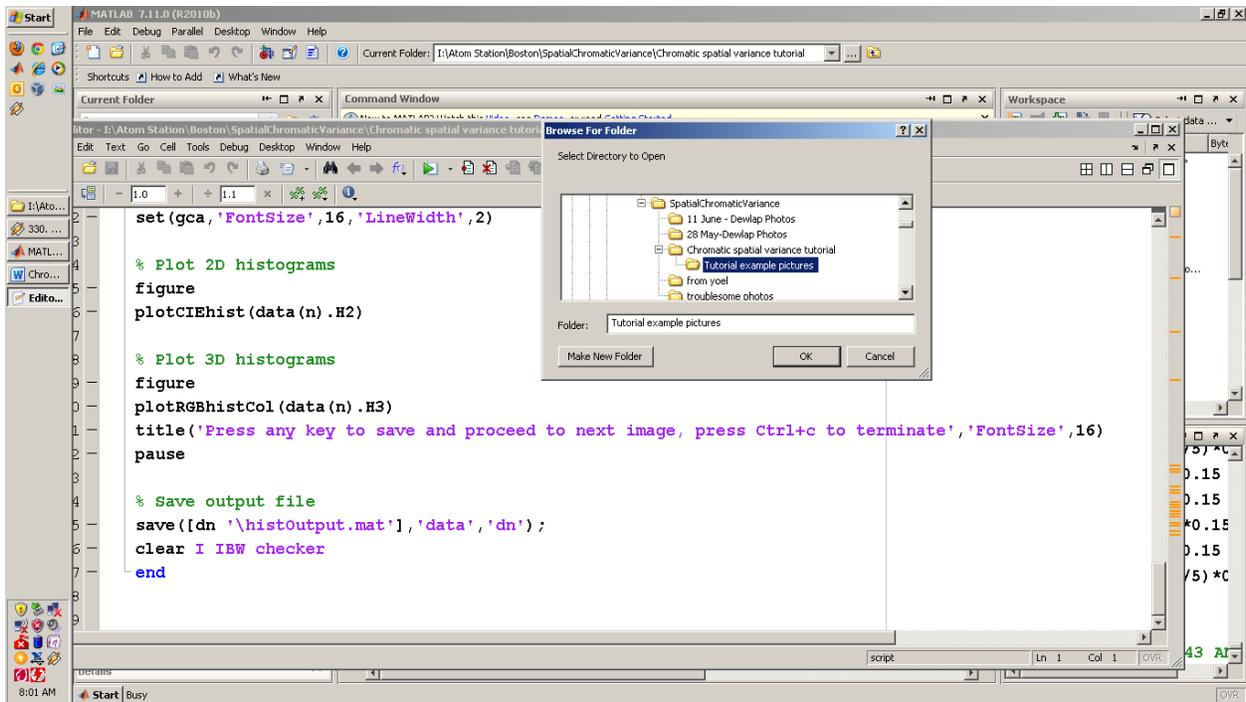


Walkthrough

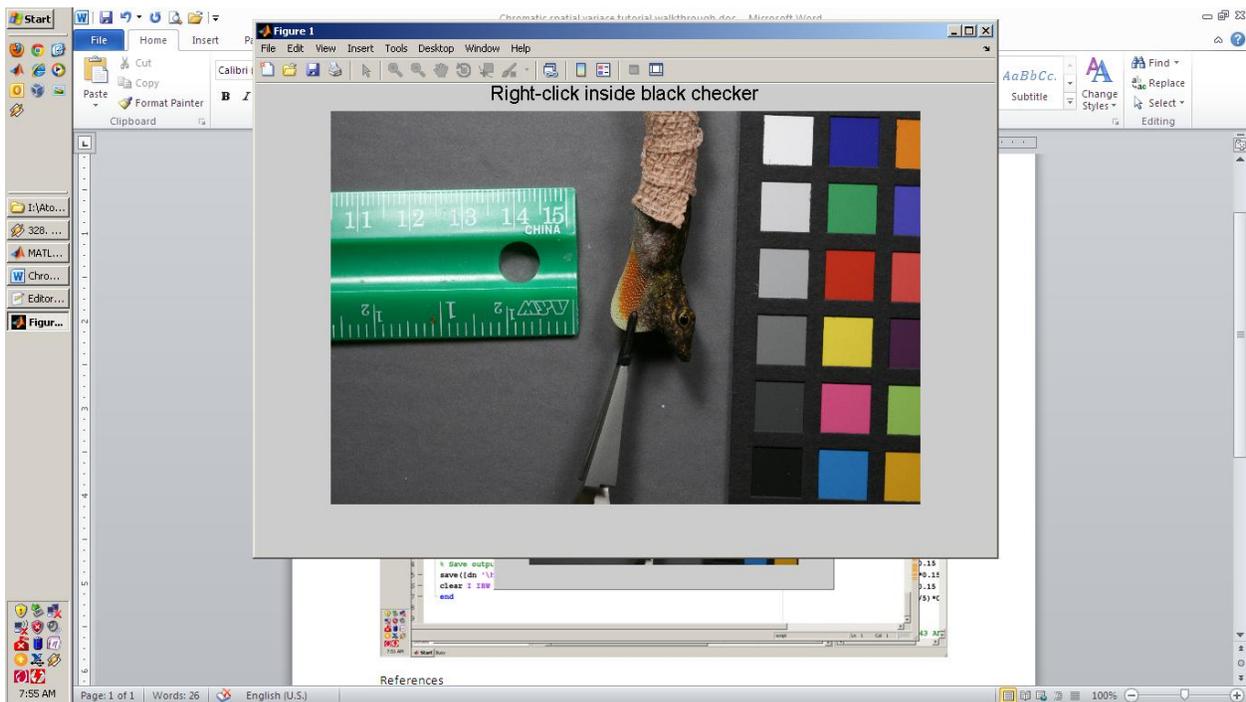
Following are step by step instructions how to use the included Matlab scripts. Thus the package requires Matlab. Further the scripts utilizes the Matlab image processing toolbox. The scripts could be adapted to work on Octave but it is not ensured.

Run the script histBatch.m

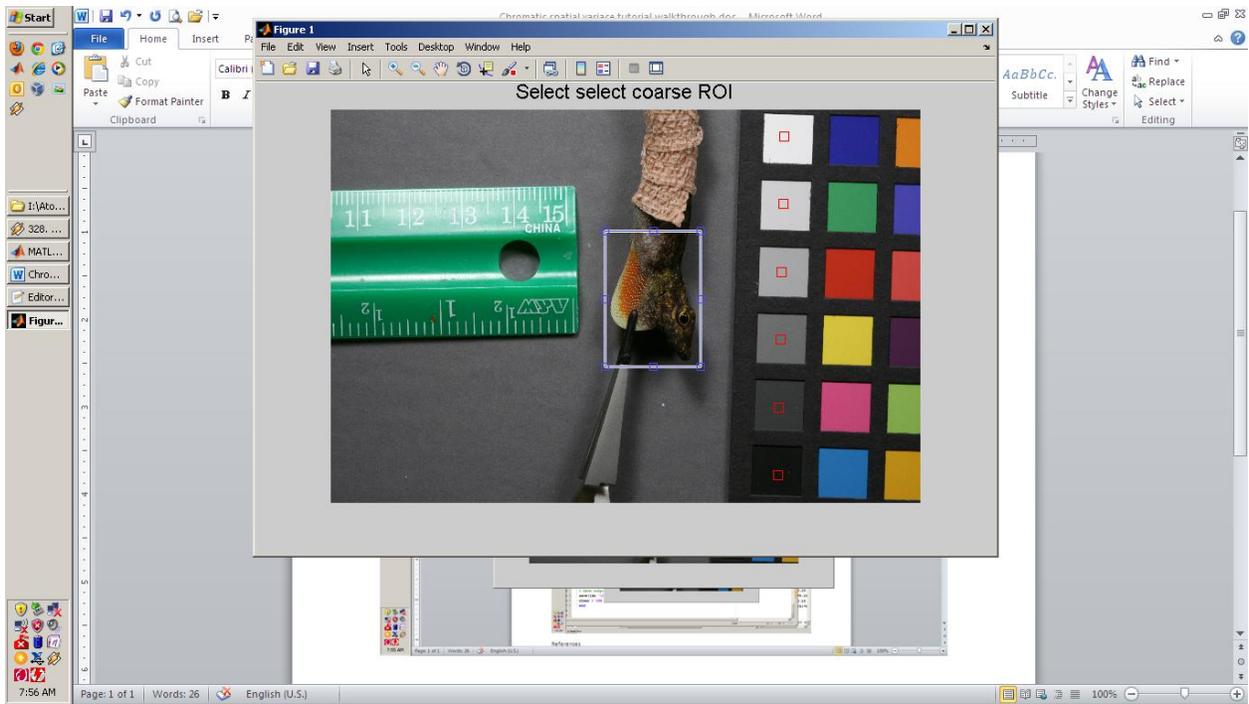
Select the folder tutorial example pictures



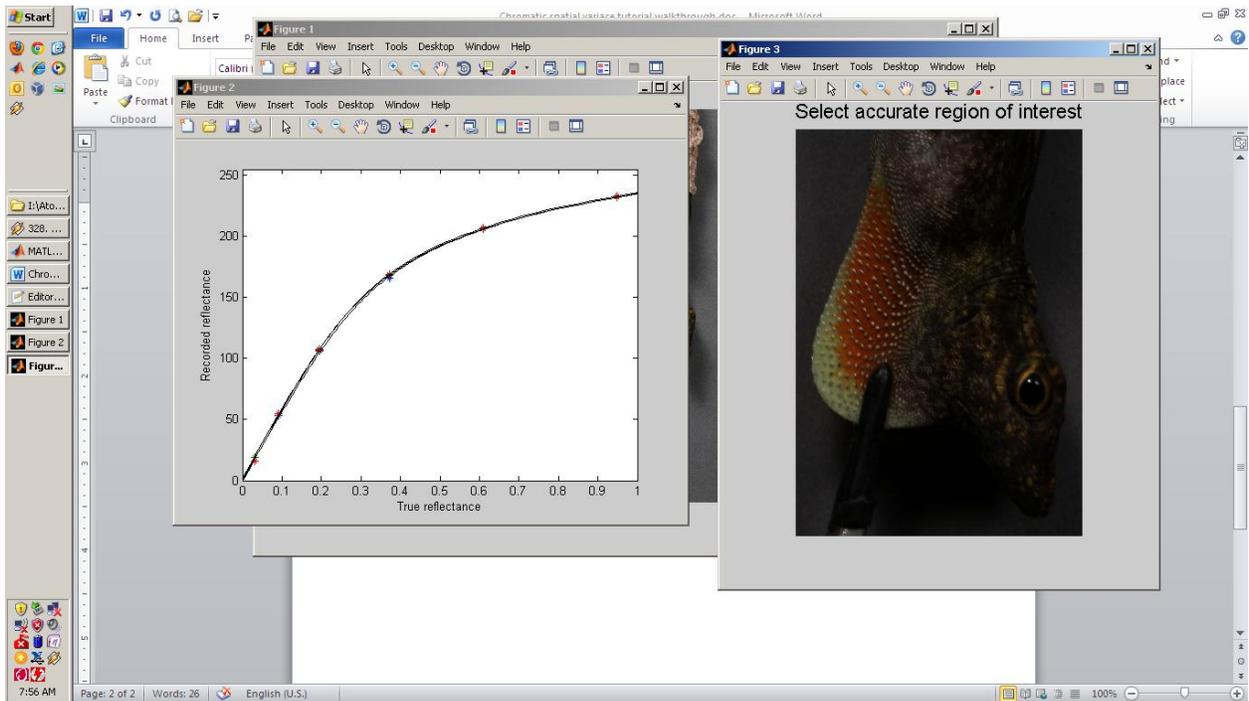
Right click in the centres of the prompted reflectance reference squares



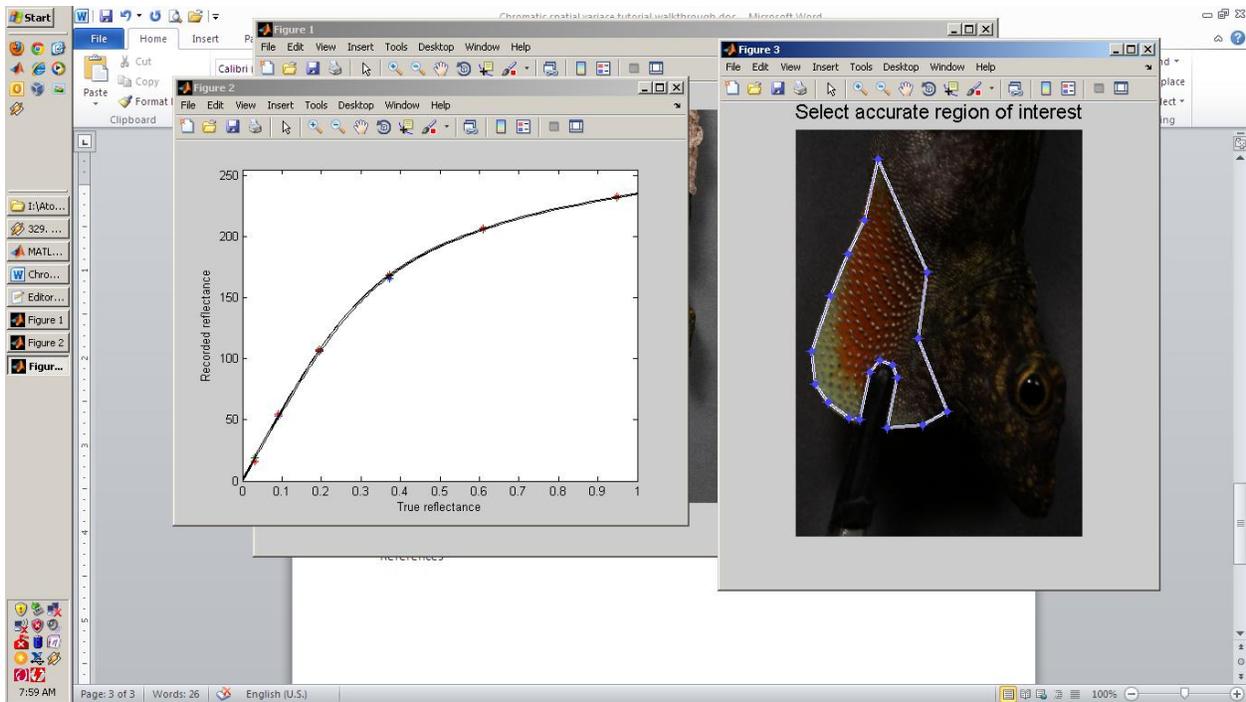
Select the region of interest for zoom in



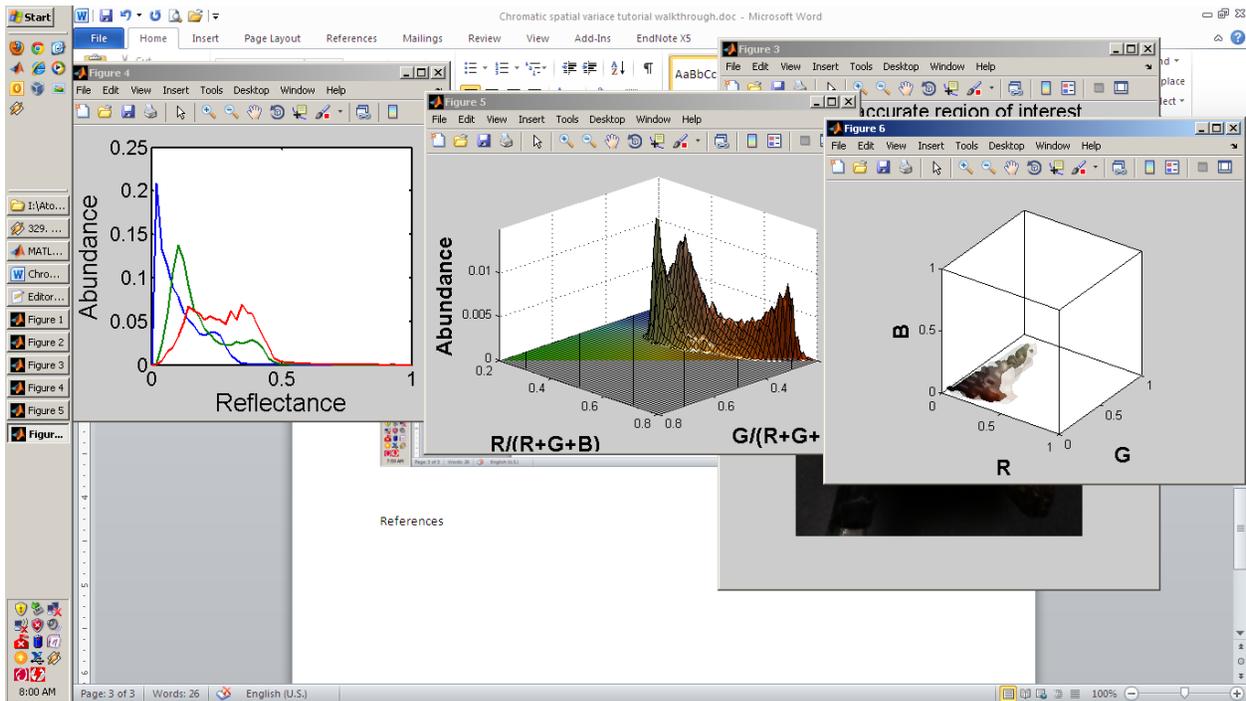
The image is not linearized to correct for camera response and digital image maltreatment.



Now carefully select the region of pixels which colors would be subjected to the analysis.



After each file, the distributions are showed.



Continue for all photos in the folder. Histograms are stored in the file histOutput.mat in the tutorial picture folder.

The distribution can be inspected at later stage by loading that file and using the plot functions:

```
plot3x1Dhist(data(n).H1)
```

plotCIEhist(data(n).H2)

plotRGBhistCol(data(n).H3)

Also, run the script animateHist.m to produce animated rotating 2D and 3D distributions of the chromatic probability distributions. Do not minimize script during execution.

animateHist.m

The animated histograms are stored as GIF files, which can be conveniently inserted in e.g. power point.

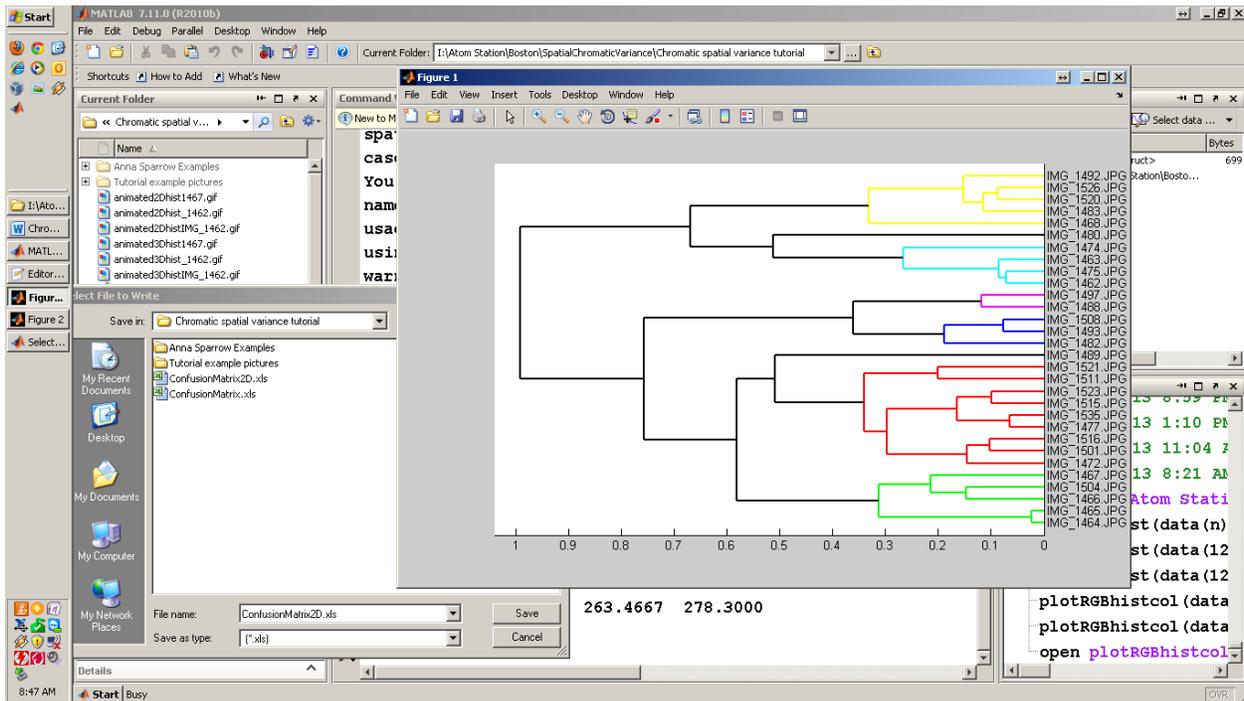
Histogram distributions can be comparing in terms of their respective similarity or correlation. By doing so hierarchical cluster analysis (HCA) can be performed. The similarity can be represented either in form a dendrogram or as a confusion matrix. The performance will depend whether 1D, 2D or 3D histograms are used. Use these scripts to compare the results.

dataHCA1.m

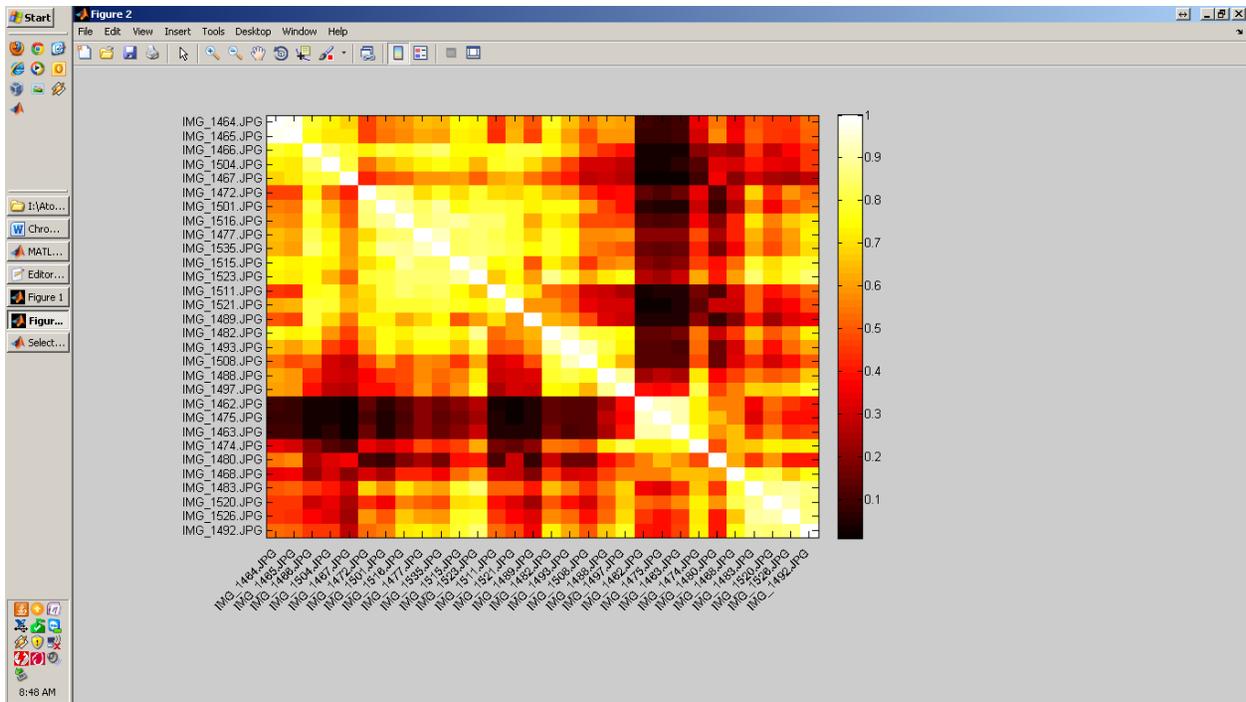
dataHCA2.m

dataHCA3.m

A dendrogram sorts the images according to the similarity of the histograms



The confusion matrix shows which individuals are easiest confused by others.

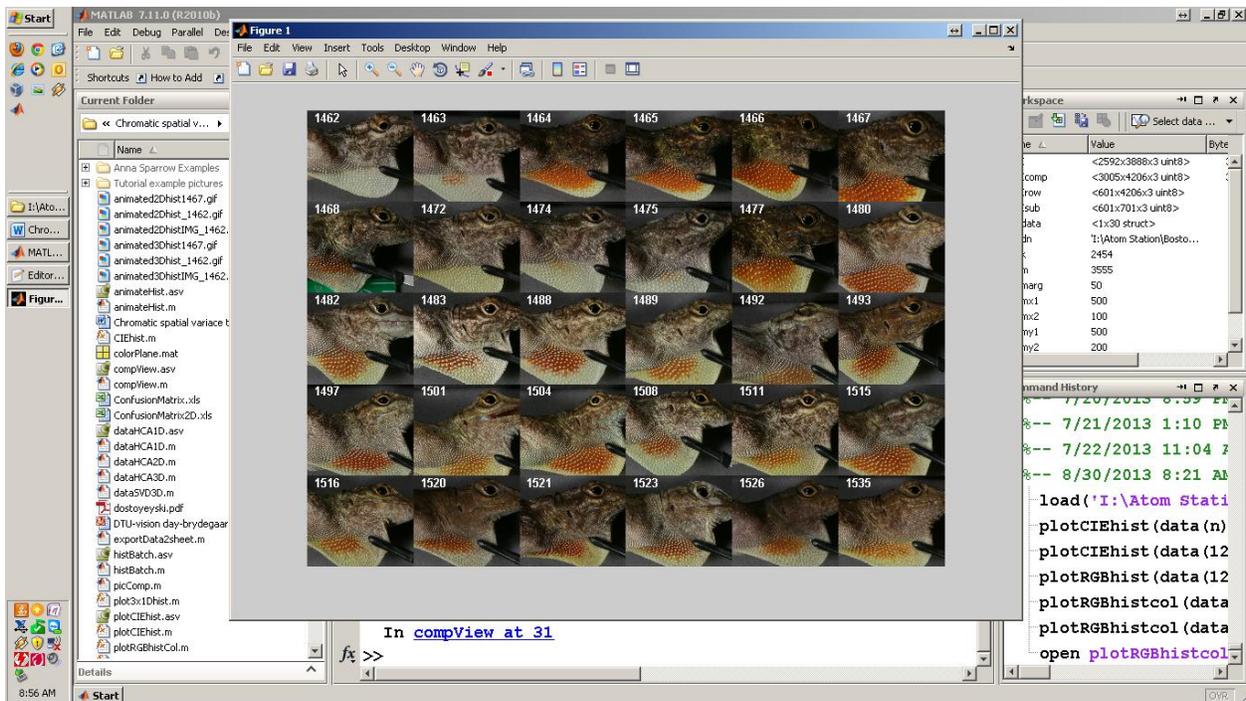
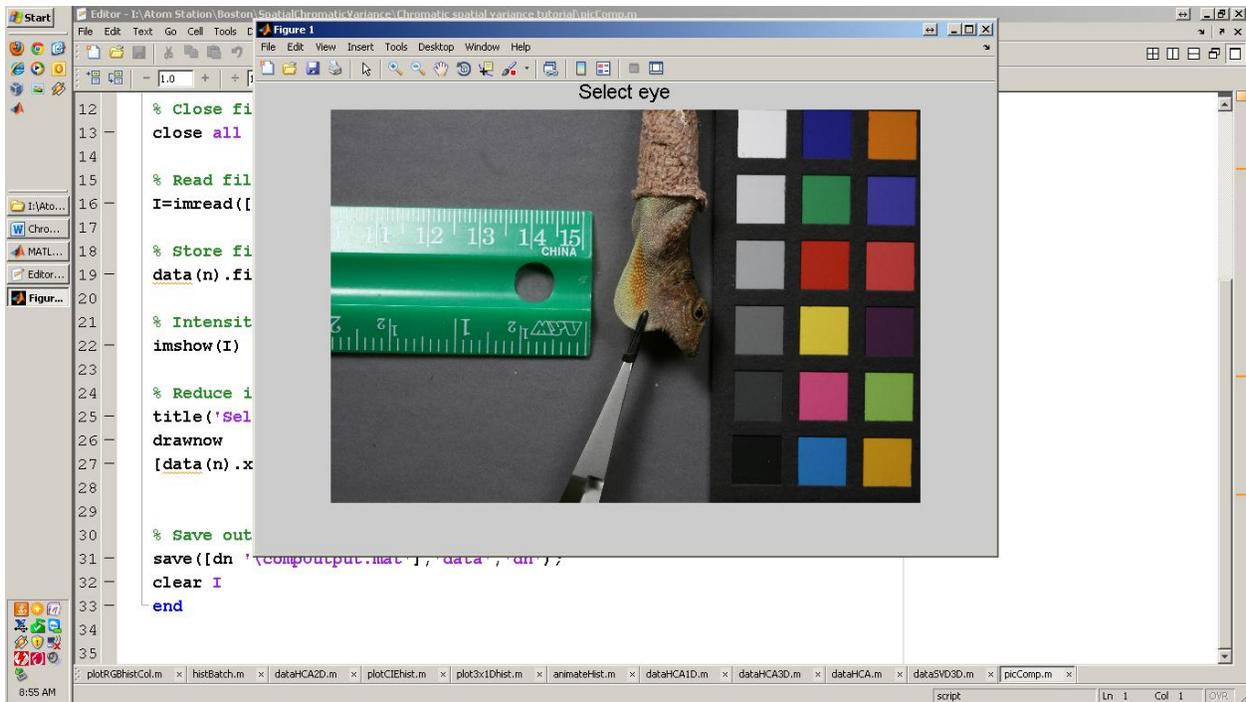


The scripts

picComp.m

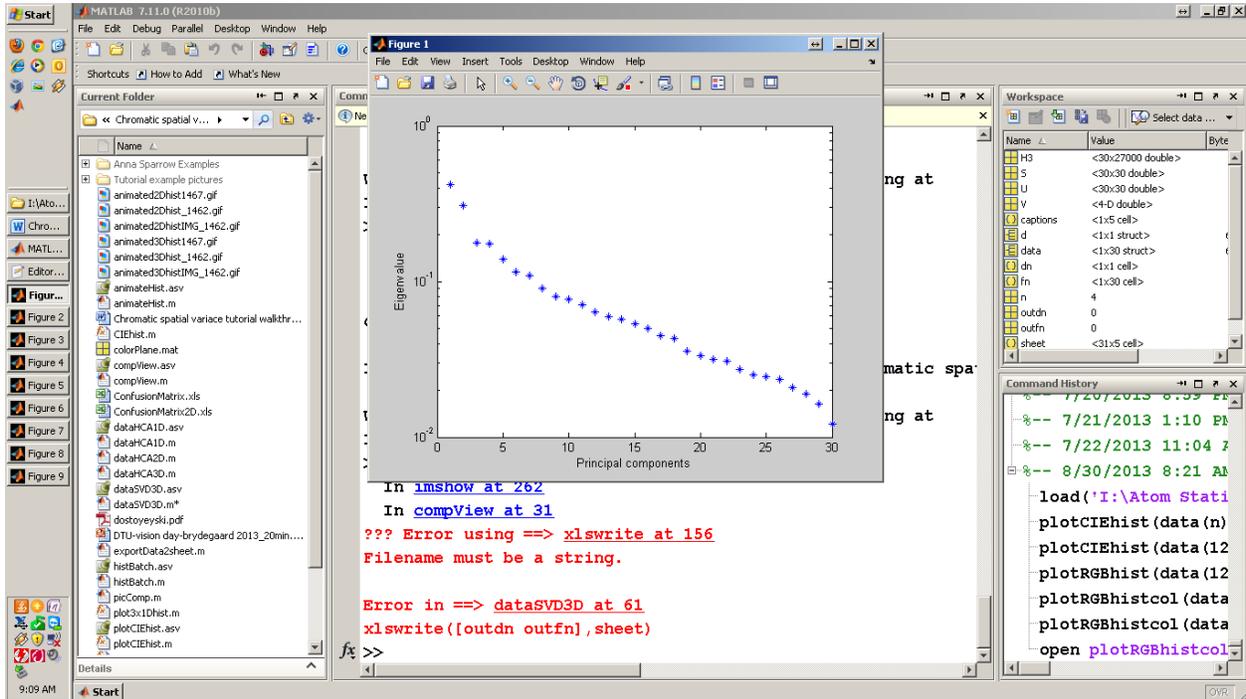
compView.m

Composes images into one large image for visual inspection

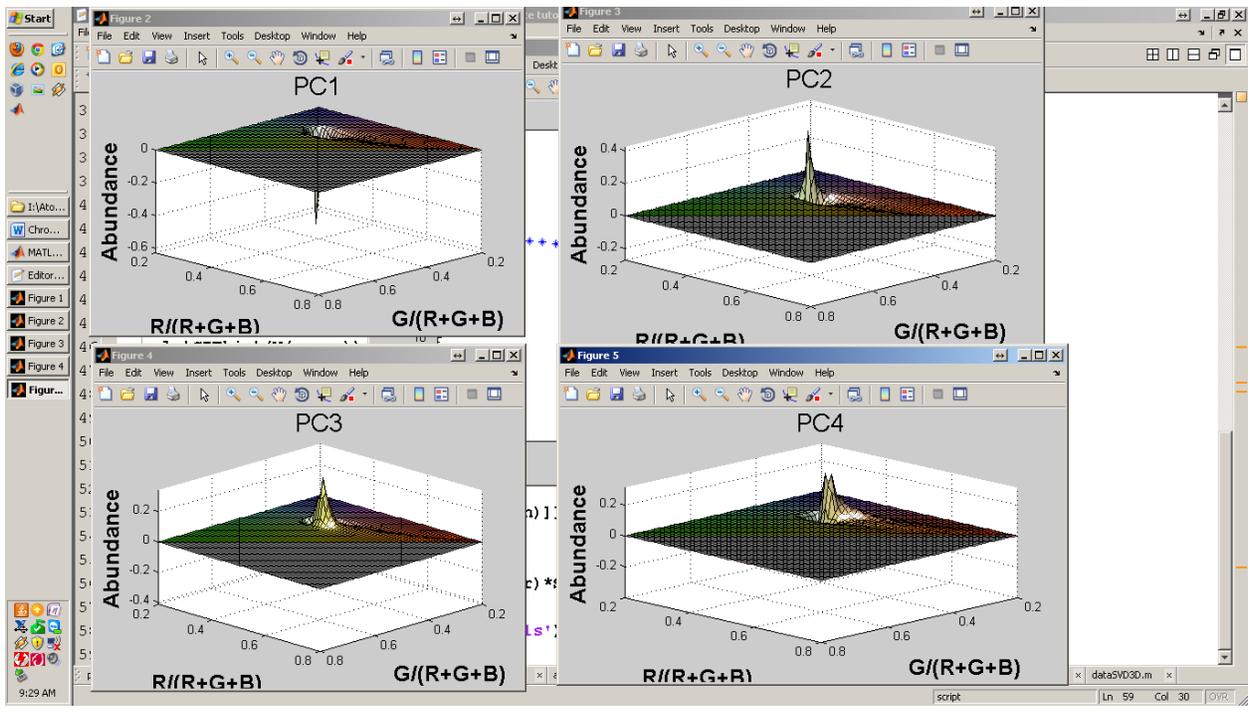
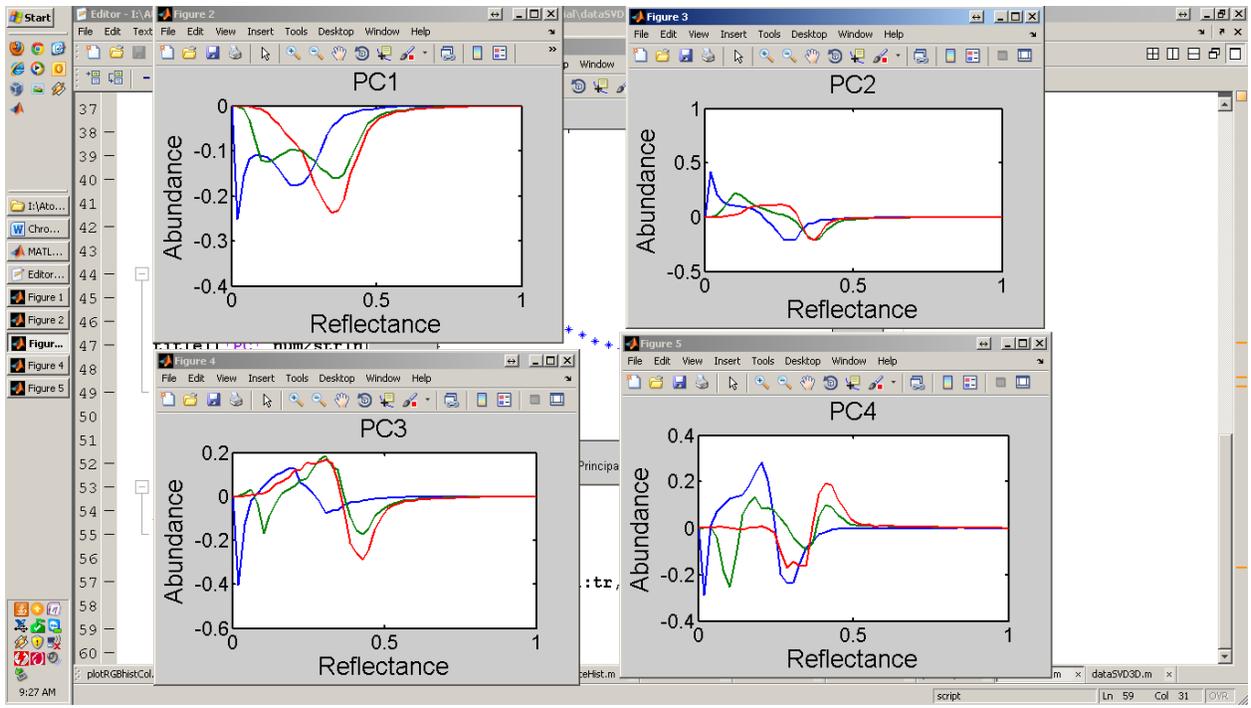


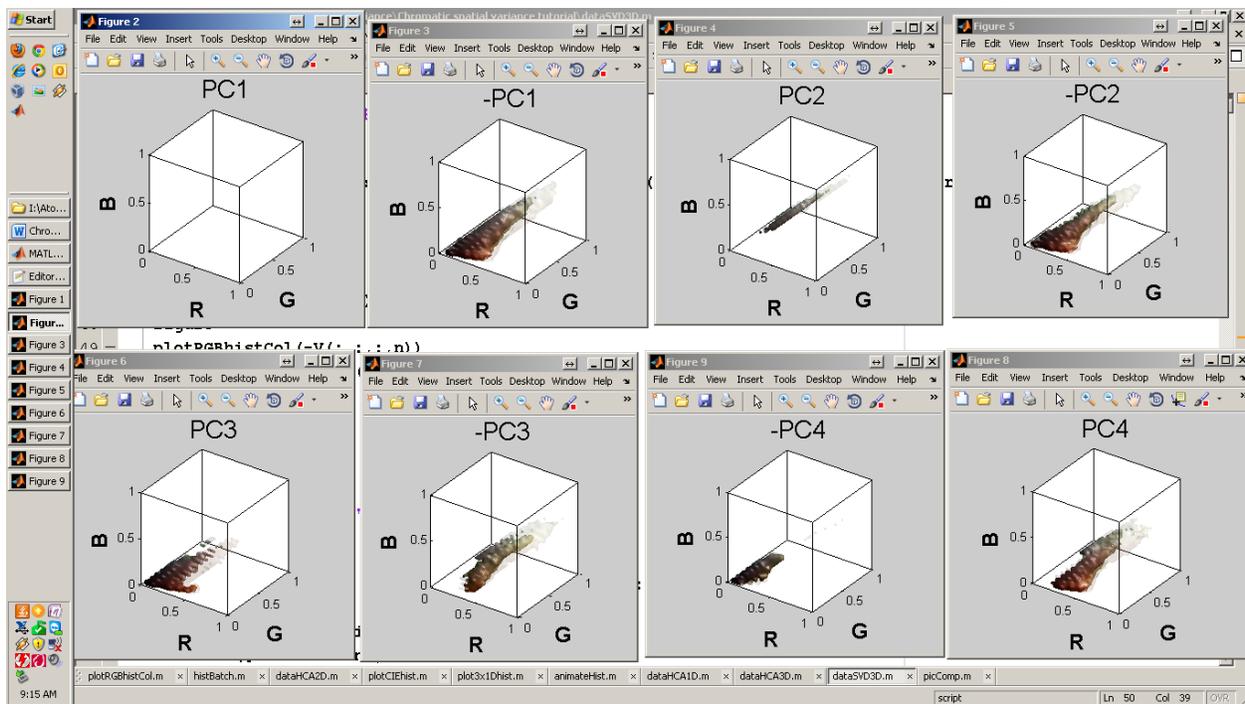
The chromatic distribution in the 1D, 2D and 3D histograms can vary their shape in a number of ways. Singular Value Decomposition (SVD) is a data reduction tool, which can describe whole distributino using a truncated set of parameters, or principal components. The method is employed in the scripts:

dataSVD1D.m
 dataSVD2D.m
 dataSVD3D.m



After inspected the decay of the eigenvalue, one can decide on a truncation value, and adjust the variable `tr` in the scripts. The reduced parameters or loadings are exported to excell sheets. Examples of SVD base sets are show below.





References

- [1] S. Kucheryavskiy, "A new approach for discrimination of objects on hyperspectral images," *Chemometrics and Intelligent Laboratory Systems*, vol. 120, pp. 126-135, 2013.
- [2] M. Brydegaard, A. Runemark, and R. Bro, "Chemometric approach to chromatic spatial variance. Case study: patchiness of the Skyros wall lizard," *J. Chemometrics*, pp. n/a-n/a, 2012.
- [3] K. E. Nicholson, L. J. Harmon, and J. B. Losos, "Evolution of *Anolis* Lizard Dewlap Diversity," *PLoS ONE*, vol. 2, p. e274, 2007.
- [4] Y. E. Stuart, J. B. Losos, and A. C. Algar, "The island-mainland species turnover relationship," *Proceedings of the Royal Society B: Biological Sciences*, vol. 279, pp. 4071-4077, October 7, 2012.
- [5] A. Runemark, M. Brydegaard, and E. I. Svensson, "Predation release facilitates island gigantism in lizards and increases population divergence in phenotypic traits," *to appear*, 2012.
- [6] A. Runemark, B. Hansson, P. Pafilis, E. Valakos, and E. Svensson, "Island biology and morphological divergence of the Skyros wall lizard *Podarcis gaigeae*: a combined role for local selection and genetic drift on color morph frequency divergence?," *BMC Evolutionary Biology*, vol. 10, p. 269, 2010.