Shape analysis in R: GM library in the light of recent methodological developments

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Introduction. Lately, geometric morphometrics (GM) has focused considerable methodological ingenuity on data from landmarks, curves and surfaces in-between landmark points. Here we discuss not the algebra of these so-called (semi)landmark methods, an algebra that is nearing consensus at the present time, but rather their scientific yield for the kinds of questions (paleo)anthropologists ask. Some of typical investigative designs ask questions about size and shape in a context of species differences and sexual dimorphism, or questions about integration and modularity. Recently few image/statistical softwares have been developed to help to answer some of these questions but researchers have to combine them to get the answers they are searching for. Some of the methods are not covered yet.

2D example. We recruited 20 young women (aged between 19 and 31) who reported to have a regular menstrual cycle and did not take any hormonal contraceptives (Oberzaucher et al., 2008). We took standardized facial photographs neutral expression, eye height, facial ornaments and hair removed from the face, no make-up, 5m distance from the camera, evenly lighted daily for 30 days. In a forced choice task, 50 male and 50 female subjects were presented with two photographs of each participant one taken in the ovulatory and one taken in the luteal phase. The task was to pick out the more attractive, healthy, sexy, and likeable, of the two. We cut skin patches sized 150×150 pixels from the cheek and subjected them to the same forced choice task with slightly modified adjectives. We measured the facial photographs by setting 72 anthropological landmarks and semilandmarks. We analysed the texture of the skin patches calculating co-occurrence parameters, such as homogeneity, energy, entropy, contrast and correlation. The colour information was calculated in an RGB-space in terms of hue, saturation and intensity.

3D example. Our example re-uses part of a Vienna data set of 372 skulls from various collections (include Zoological Dpt. of the Natural History Museum, Vienna, Austria; Dpt. of Anthropology, University of Zurich-Irchel, Switzerland; Royal Museum of Central Africa, Tervuren, Belgium; Dpt. of Anatomy and Human Genetics, Frankfurt/Main, Germany): data from 32 landmark points and 7 ridge curves totalling 161 semilandmarks. The landmark points on both sides of every cranium and 161 semilandmarks on the left side of every cranium were digitalized using a MicroScribe 3DX (Mitteroecker et al., 2004). The right side semilandmarks were calculated by TPS based on the set of all landmarks and left side semilandmarks.

Conclusion. Up-coming GM library includes the methods as Generalized Procrustes Analysis, affine and non-affine component, unwarping, missing value estimation, Multivariate Multiple Linear Regression Model of shape on size, Relative Warp Analysis, shape-space PCA, form-space PCA, size-adjusted PCA, 2-block PLS (two shape blocks, one shape block and one block of external variables), sliding of semilandmarks on open and closed curves and surfaces, analysis of asymmetry, statistical inference (Katina, 2008). The GM library has practical implications for (paleo)anthropologist and also researchers from the other fields.

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