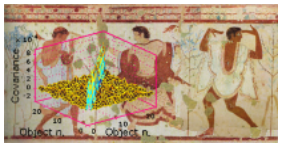

# Pattern Recognition of Morphological Measurements on Modern and Ancient Humans

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## Abstract

Chemometrics pattern recognition approaches are applied to morphological measurements of human skeletal remains. These include modern, archaeological, and fossil individuals. Data matrices can be obtained whose columns represent measurements on vertebrae, obtained using digital image processing using a Microtomography Scanner (microCT). Approaches such as principal components analysis, principal co-ordinates analysis, clustering and factor analysis can be employed to separate individuals and species and contribute to our understanding of which features are significant in the differentiation of individuals and our fossil heritage.

## Introduction

Palaeopathology and palaeoanthropology has traditionally relied on the observation of external skeletal morphology. Recent advances in microCT technology have made it possible to examine the internal architecture of bone non-invasively, and opened up new possibilities for understanding the relationships between skeletal ontogeny, bone health, and biomechanics. However, the relative novelty of the technology and the sheer size of the data sets produced by such scanning projects has rendered these data difficult to manage. The current project aims to address these issues through a comparative analysis of microCT scans of 40 adult human vertebral specimens (modern human cadaveric specimens, modern human archaeological specimens and fossil australopithecine specimens). Regions of interest of cancellous bone will be investigated through the measurement of microarchitectural parameters, and this suite of characters will then be compared across all specimens. The relationships between the parameters will be analysed. This should provide new information on the variance of microarchitecture in the normal human spine, the impact of osteoporosis, and the closeness of the likeness between australopithecine morphology and that of modern humans.

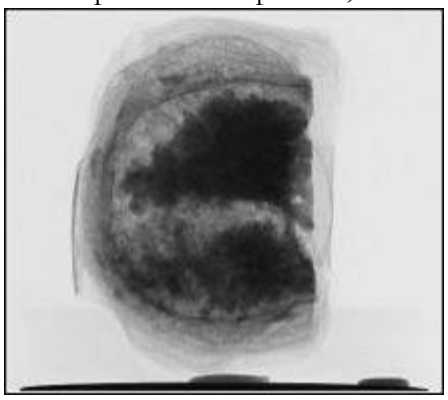

Figure 1: A microCT scan image of a human cadaver vertabra sample

## Materials & Methods

In this study, 40 specimens are used to describe the microarchitecture of the vertebral body from the thoracic or lumbar regions of the spine. Figure 1 shows an example microCT scan image of a human cadaver vertebral sample. Each specimen was scanned using a microCT scanner (microCT 1172 from Skyscan, Kontich, Belgium) at 80kV, 124uA, with a reconstructed image pixel size of 35microns. The specimens fall into 3 categories: modern specimens from cadavers; fossil specimens from extinct hominins; dry specimens from archaeological skeletons. In addition, each of the samples can be categorised by age, gender and the vertebral position (eg L1 = the first lumbar vertebra). After scanning and reconstruction each specimen is described by a stack of 8 bit image

files (CT scans). The images were cropped to an approximate volume of interest before being imported into Matlab.

## Results

A total of 40 images (25 modern human specimens; 12 fossil specimens; 3 archaeological specimens) were investigated. The images were cropped into cubes of the size of 201 × 201 × 201 pixels (0.35 μm/pixel) and subjected to analysis for micro-architectural parameters (12 in total) with CT-An. A table of dimension (12 × 40) was produced with the rows corresponding to the micro-architectural parameters and the columns represent the samples. The data matrix was standardised and subjected to PCA yielding score plots in Figure 2. There appears to be a fairly good separation between the specimens from the three different categories. Fisher weight was employed to find the best discriminating variables; bone surface, bone surface density and number of objects are ranked the highest. Fossil specimens demonstrate relatively higher values for these parameters (particularly the number of objects) indicating the diagenesis processes undergone by the specimens. The number of objects increases with the time a specimen has been buried; an increasing trend is well observed from modern human to archaeological specimens and fossil specimens.

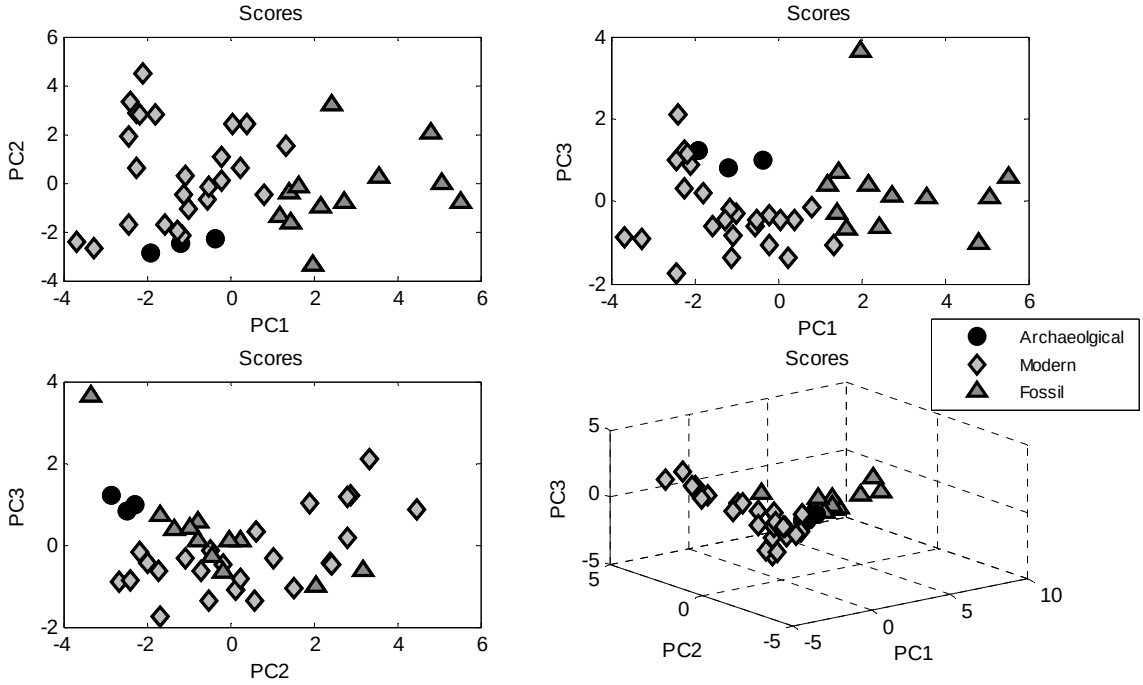


Figure 2: The score plots of micro-architectural parameters and 40 samples

## Conclusions

In a study, it was reported that three-dimensional architecture parameters could be used to reconstruct the behaviour of the extinct taxa and its relationship to locomotor behavioral differences across different primate taxa[2]. Integrating chemometric approaches contributes to our understanding of which features are significant in the differentiation of individuals and our fossil heritage.

## Reference

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2) M. R. Timothy, A. K. Richard, Femoral head trabecular bone structure in two omomyid primates, J. Hum. Evol., 43(2) (2002) 241-263