

### A77 **SkullProfiler: A Simple New Capability for the Quantitative Estimation of Ancestry and Sex From Lateral Skull Photographs**

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The goal of this presentation is to introduce attendees to the R capability SkullProfiler for quantitative estimation of ancestry and sex using outlines of skulls or crania extracted from photographs in norma lateralis.

This presentation will impact the forensic science community by providing a new and freely available computer capability for ancestry and sex estimation that is user-intuitive, field-friendly, accurate, and fast to implement.

SkullProfiler is designed to analyze left lateral skull or cranial photographs of unknown cases, taken with a specifically standardized protocol using a full-frame camera fitted with a 100mm macro lens and subject-to-camera distance of 1.2m. The photograph is imported into R using the SkullProfiler code, which then undertakes a series of semi-automated steps. First, outline coordinates are extracted from the case photograph and Elliptical Fourier Analysis (EFA) is conducted using 40 harmonics.

Group assignment for the unknown case is then achieved using linear discriminant function analysis of a truncated set of Principal Component (PC) scores. Mahalanobis square distances, posterior probabilities, and Chi-square typicality probabilities are reported for the unknown relative to samples selected from an inbuilt reference database. This database comprises skulls (>18 years of age) of known sex from the following collections: the Hamann-Todd Human Osteological Collection, William M. Bass Donated Skeletal Collection, Robert J. Terry Anatomical Skeletal Collection, Khon Kaen Osteological Collection, and Chiba Bone Collection. Groups for analysis are defined as United States Black female ( $n=87$ ) and male ( $n=109$ ), Japanese male ( $n=59$ ), Thai female ( $n=39$ ) and male ( $n=47$ ), and United States White female ( $n=97$ ) and male ( $n=134$ ).

Five-fold cross validation results are provided in the data outputs to assist users in gauging classification accuracy. Tests using all seven reference samples produced cross-validated accuracies of 73%. This increased to 78% accuracy for reference samples of United States Black and White females and males only.

Tests using an out-of-group sample of nine individuals from the Defense POW/MIA Accounting Agency (DPAA) Laboratory, and all seven reference groups, yielded eight of the nine skulls correctly classifying as White male for both skull and cranial outline data (89%). All nine skulls were correctly classified in a four-way comparison of ancestry when sex was specified ahead of analysis — as would be possible in cases possessing infracranial elements, in which sex could be independently estimated from pelvis.

Both the cross validation and out-of-group validation test results indicated that SkullProfiler can successfully use lateral skull and cranial outlines to correctly estimate an individual's ancestry and sex with high degrees of accuracy, and at rates comparable to other computerized capabilities using linear measurements (namely FORDISC®). The reliance on a single, easy-to-take photograph, portable computer, and semi-automated segmentation program in SkullProfiler increases speed and flexibility of the method. This holds advantages for field use, where robust field assessments of basic bioprofile data can confirm or decline requirements for repatriation of skeletal remains. This becomes paramount in instances with large distances, expenses, and administrative bureaucracy, where unnecessary or incorrect repatriations are better avoided. SkullProfiler and supporting documentation is currently available for free download at [CRANIOFACIALidentification.com](http://CRANIOFACIALidentification.com).

**Forensic Anthropology, Elliptical Fourier, Biological Profile**