A100 Ancestry Estimation Using Cranial and Postcranial Macromorphoscopic Traits

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Learning Overview: After attending this presentation, attendees will understand how combined datasets, specifically cranial and postcranial macromorphoscopic traits, can be applied to ancestry classifications.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by highlighting the utility of a multiple dataset approach to ancestry estimation. Additionally, this presentation will demonstrate the importance of multivariate statistical frameworks and machine learning models to improve accuracy and validity for traditional forensic anthropological methods.

To examine the utility of combining cranial and postcranial macromorphoscopic traits, a variety of classification models were employed to estimate ancestry. The samples represent American Black (n=20) and American White (n=20) individuals from the Robert J. Terry Skeletal Collection and include females (n=21) and males (n=19) ranging in age from 24 to 80 years. Classification models using up to 8 cranial and 23 postcranial macromorphoscopic traits were performed. The classification models include: stepwise Quadratic Discriminant Analysis (QDA), artificial neural Network (aNN), Random Forest Model (RFM), and Supported Vector Machine (SVM).

Polychoric correlation was computed to assess the relationship between all variables. Overall, there was a moderately strong negative significant relationship between cranial and postcranial traits, indicating models assuming trait independence should be applied cautiously. Nasal Aperture Width (NAW) and the Left Third Trochanter (LTT), for example, were significantly negatively correlated (r=-0.34, n=40, p=0.03), suggesting increases in NAW correspond to decreases in the incidence of LTT. Post-bregmatic depression was negatively correlated with all postcranial traits, except for the Left Anterior and Middle Calcaneal Facets (LAMCF) (r=0.225, n=40, p=0.04), suggesting post-bregmatic depression corresponds to overall decreases in the presentation of LAMCF and increases in all other postcranial traits.

The data was divided into training and test sets, uniformly within groups using 70% of the sample for training and validation and the remainder as a hold-out test set. The results of the classification models were appealing and suggest further work is necessary. Variable importance models using the Gini index suggest both variable types are important in classification. Inferior Nasal Aperture (INA) and Spinous Process Bifurcation of the Third Cervical Vertebrae (C3SPB) were nearly equally important in all models. In fact, the stepwise QDA models using only these two variables correctly classified 90% of the sample (k=3; AB=91%; AW=89%), a slight improvement over previous classification models utilizing a combined craniometric and cranial morphoscopic approach (AB=79.4%; AW=87.1%).[1] The aNN model correctly classified 95% of the holdout sample. The SVM correctly classified 97.5%, showing great promise for future work using larger sample sizes.

These models maximize classifications of ancestry by including postcranial morphology. Previous research on the utility of postcranial non-metric traits hinted at their utility in ancestry estimation methods; however, until recently, very little quantification of these traits in modern human skeletal samples has been conducted. The morphology of the postcranial skeleton is often considered too plastic to be of use in ancestry estimation; the reason may be little more than the reliance on older beliefs with no testing or verification. However, these traits show great promise in ancestry estimation, both alone and in combination with cranial macromorphoscopic traits. However, the key is robust classification models appropriate for categorical data.

Reference(s):

1. Hefner, J.T., Spradley, M.K., Anderson, B. 2014. Ancestry Assessment Using Random Forest Modeling. *Journal of Forensic Science.* 49 (3): 583-589.

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