H88 Genes, Nerves, and Bones: Neural Networks, Genetic Algorithms, and Forensic Anthropology

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Attendees will be provided with an overview of neural networks and genetic algorithms including a discussion of their strengths and weaknesses for forensic applications. Although forensic anthropological aspects will be emphasized, all attendees will leave with the basic information needed to begin exploration and implementation of neural network modeling and analysis of forensic data they encounter.

The presentation will encourage the forensic community to explore, exploit, and adopt neural networks and genetic algorithms in their area of interest. These approaches provide a powerful new tool that forensic scientists can use to improve modeling and to enhance their understanding of the large complex data sets and databases common to forensic science.

Multivariate statistical techniques are firmly entrenched in forensic anthropology, most visibly in the widely used FORDISC program. Neural networks, which are flexible, robust, and distribution-independent, can significantly enhance and supplement such traditional statistical methods. A comprehensive empirical approach to network modeling avoids the "black box" stigma often associated with nets, and can lead to valuable insights, particularly in revealing and studying complex, multivariate relationships among input variables. Additionally, the increasing reliance of the business community on data mining has led to the availability of affordable, PC-based neural network software which is often integrated into larger statistical packages. Numerous network architectures, including supervised and unsupervised algorithms, increases their utility as modeling and data analysis tools. They complement statistical methods, and when used in concert, nets and statistics provide a more complete understanding of anthropological data sets, as well as of other databases used in forensic science. Finally, the coupling of networks to genetic algorithms has dramatically improved network optimization, training, and variable selection procedures. As a result, neural networks have become a viable tool for forensic anthropology as well as forensic science generally. This presentation will focus on the anthropological data the Howells database, including crania from all over the world. Incorporated in this collection is data from Terry/Todd 19th century anatomical collections, recent American Whites, Blacks and Hispanics from the Forensic Data Bank (FDB). The FDB is perhaps the most familiar collection to forensic practitioners.

Prior to the mid 1980s, forensic identification criteria were based almost exclusively on the large anatomical collections (Terry and Hamann-Todd) containing individuals with mainly 19th century birth dates. Since modern documented skeletal collections are few in number, the FDB was conceived and launched in 1986 with a grant from the National Institutes of Justice as a way to obtain data from modern individuals. The FDB contains extensive demographic information for many cases, including place of birth, medical history, occupation, stature, and weight. The skeletal information in the database includes cranial and postcranial metrics, suture closure information, various aging criteria scores, and other information. Statistical analysis of this database has demonstrated that the American population has changed dramatically, presumably from the unparalleled environmental changes that have occurred over the past 100 years. Therefore, predictive models, both statistical and neural network created from the FDB typically aim to determine the ageat-death, sex, and status of the remains as historical (ca. 100 years old or more) or forensic. Such tasks are addressed by FORDISC; parallel neural network/genetic algorithm models were created for comparison here, using cranial measurement variables and the larger Howells/FDB collection.

This presentation will present a non-mathematical overview of neural networks and genetic algorithms which will lead into a review of findings from on-going work using different neural network topologies. The creation and characterization of the network models will be explained, as well as methods used to elucidate information and hidden structure from the underlying database of cranial measurements. Genetic algorithm approaches to determine variable importance and sensitivity will also be discussed. Comparison of performance and finding from statistical techniques will be shown to illustrate how the two techniques can work in concert. A short overview of available and affordably software packages will also be provided. It is hoped that this presentation will facilitate wider adoption of neural networks in the forensic anthropological community as well as the forensic community at large.

Forensic Anthropolgy, Neural Networks, Forensic Data Bank