**CoRA: Commingled Remains and Analytics – An Open Community Ecosystem**

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**DESCRIPTION**

Countries are founded on morals and ideas for the future. Sometimes, these conflict and wars breakout and soldiers are lost in the process. On the battlefield often retrieving deceased bodies was the last priority on the list. This meant that bodies were often not organized when located. Bones eventually became intermingled due to improper storage. When bones are recovered the additional job of anthropologists is to sort and identify who the bones belong to. This job is not an easy one to accomplish and can take years to complete. Some bones are incomplete or even missing from sets and often bones are similar. DNA testing helps but can take a long time to complete. Being able to bury the bones of a family member can mean a lot to the family. The burial or cremation of the body of a family member can bring closure even after many years.

Knowing the important and meaning to families, sorting with accuracy and speed is essential. Currently anthropologists at the organization DPAA (Defense POW/MIA Accounting Agency) mainly use individual excel sheets to store information. This is not a great system when trying to collaborate with a team. A new government project has started that plans to make better use of computing power to help these anthropologists sort through the many bones they have recovered. This project involves the creation of a web application for storing the bone data that is collected throughout the sorting process. This project will help anthropologists communicate and find data more easily.

**PROBLEM DEFINITION & TERMINOLOGY**

The process of recovering, managing, analyzing, and ultimately identifying individuals out of a set of commingled remains is a complex one. In order to perform proper data analysis techniques the remains have to be first all stored in an environment with consistent terminology and recording procedures.

The workflow of doing this today is stalling the process of identifying an individual and can be improved significantly. Currently, an analyst would record and input data into an Excel spreadsheet. This causes problems with consistency, as each analyst might have their own nomenclature that they use. Also, the bones are not in one convenient database so they cannot be compared easily.

Terminology: POW/MIA - Prisoner of War/Missing in Action

Commingled: to become blended

Nomenclature: the devising or choosing of names for things, especially in a science or other discipline

**PROPOSED SOLUTION**

Our proposed solution is the web application CoRA, or Commingled Remains and Analytics. In CoRA we have a database designed for the entry of skeletal remains and their appropriate associations. As you can see in Figure B, we hope to expand the application to accommodate for different roles in the organizations, such as a DNA analyst or a dental expert. This will involve creating modules for each, and customizing the screens for each role’s needs. There will also be permissions for each role, adding extra security to CoRA. Along with this we have an administration component that will be the place for the most elevated permissions to be executed. Overall, this will streamline the inventory process of commingled remains.

Another main component of the solution will be data exploration, discovery, and visualization. As anthropologists inventory the remains and build up the database we will be working on analyzing the data. This will move us closer to the ultimate goal of identifying the remains and bringing closure to a family. Figure C illustrates some of the data analysis techniques we will be utilizing like machine learning and AI algorithms. We will be focusing on using graph theory for analytics. This is a powerful mathematical tool for modeling objects and the relationships between them. A graph G = (V,E), where V is the set of nodes and E is the set of edges, can be seen in Figure D where the bones are matched to the nodes and the P value obtained from statistical tests are the edges. The purpose of this is to graph similar bones that are possible pair matches to a individual to eventually come to an identification.

**IMPLEMENTATION AND RESULTS**

We are currently building out the inventory component of CoRA. This has to be done so that data can be entered and then analysis can be performed. Figure E is an example of a screen that a DNA analyst may see when recording information to create a DNA profile for a skeletal element.

The database that’s been implemented is built around skeletal elements. As you can see in Figure F, a skeletal element has multiple associations such as DNA, methods, measurements, and zones. Other major tables in CoRA include organizations, projects, users, roles, and permissions. These support the structure of inventorying bones. For example, a user belongs to an organization and is assigned to a project and has a role. Any skeletal element they inventory will then be stored with the appropriate project id. As CoRA grows this concept will become more important as organizations are added and more users are contributing to the database.

**CONCLUSIONS**

Our application is striving to assist the DPAA - and potentially future organizations - that work to identify commingled human remains. This will bring a larger impact to the families that are wanting closure when it comes to their missing loved ones. The CoRA inventory application and data analytics process will work together to reach the ultimate goal of human identification more efficiently.