Bonaparte
Disaster Victim Identification System

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1 Introduction

Society is increasingly aware of the possibility of a mass disaster. Recent examples are the 9/11 World Trade Center attacks, the 2004 Boxing Day tsunami and various plane crashes. Recently the Netherlands Forensic Institute was confronted with the task identifying the victims of the Afriqiyah Airways flight 8U771 crash in Tripoli, Libya. In such events the recovery and identification of the remains of the victims is of great importance, both for humanitarian and legal reasons. Disaster victim identification (DVI), the identification of victims of a mass disaster, is greatly facilitated by the advent of modern DNA technology. In forensic laboratories, DNA profiles can be recorded from small samples of body remains which may otherwise be unidentifiable. The identification task is the match of the unidentified victim with a reported missing person. This is often complicated by the fact that the match has to be made in an indirect way. This is the case when there is no reliable reference material of the missing person. In such a case, DNA profiles can be taken from relatives. Since their profiles are statistically related to the profile of the missing person (first degree family members share about 50% of their DNA) an indirect match can be made. In cases with one victim, identification is a reasonable straightforward task for forensic researchers. In the case of a few victims, the puzzle to match the victims and the missing persons is often still doable by hand, using a spread sheet, or with software tools available on the internet [1]. However, large scale DVI is infeasible this way and an automated software system is indispensable for forensic institutes that need to be prepared for DVI.

2 Bayesian Networks

Bonaparte is developed as such a system. The development is in collaboration with Netherlands Forensic Institute (NFI), and as such it is aimed to be used by forensic specialists (e.g. forensic laboratories, medical research universities, etc). The computational engine of Bonaparte uses automatically generated Bayesian networks and Bayesian inference methods, enabling to correctly do kinship analysis on the basis of DNA profiles combined with pedigree information. Bayesian networks are very well suited to model the statistical relations of genetic material of relatives in a pedigree [2]. (according to the Mendelian inheritance laws). They can directly be applied in kinship analysis with any type of pedigree of relatives of the missing persons.

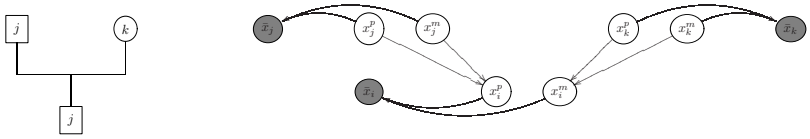

Figure 1: A basic pedigree with father, mother, and child. Squares represent males, circles represent females. Right: corresponding Bayesian network. Grey nodes are observables. x_j^p and x_j^m represents paternal and maternal allele of individual j.

An additional advantage of a Bayesian network approach is that it makes the analysis tool more transparent

and flexible, allowing to incorporate other factors that play a role such as measurement error probability, missing data, statistics of more advanced genetic markers etc. Bonaparte computes the probabilities using the Junction Tree Algorithm.

3 Bonaparte

Bonaparte is built as a client-server system, the core and database run on one or more servers and clients connect to these servers from their workstations using a regular web browser. Bonaparte is designed to handle large scale events, with thousands of victims and missing persons. Special care has been taken to design a graphical user interface that presents the overwhelming amounts of data (1K victims and 1K pedigrees results in 1M matches) in a manageable manner to the researchers. The use of xml data interfaces ensures that Bonaparte can be easily connected to the existing infrastructure (existing databases, reporting infrastructure, user management).

4 Tripoli Disaster

Bonaparte has recently been deployed at the Netherlands Forensic Institute to identify the victims of the flight 8U771 crash. The deployment received a lot of media attention in the Netherlands see for example the NFI press release [3] and the national tv news [4]. The system has successfully identified all victims. Deployment of Bonaparte has shortened the actual matching process from several weeks (or even months) to several minutes/hours.

5 Demonstration

Although an actual Bonaparte system runs on multiple Unix machines, a small scale version can run on a fairly standard laptop. It can even run over the internet via the Bonaparte website at http://www.bonaparte-dvi.com. We intend to demonstrate how the Bonaparte system can shorten the time it takes to complete the identification process in large scale DVI incidents.

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