Law Enforcement Use of Probabilistic Genotyping, Forensic DNA Phenotyping, and Forensic Investigative Genetic Genealogy Technologies

A Workshop

March 13 and 14, 2024
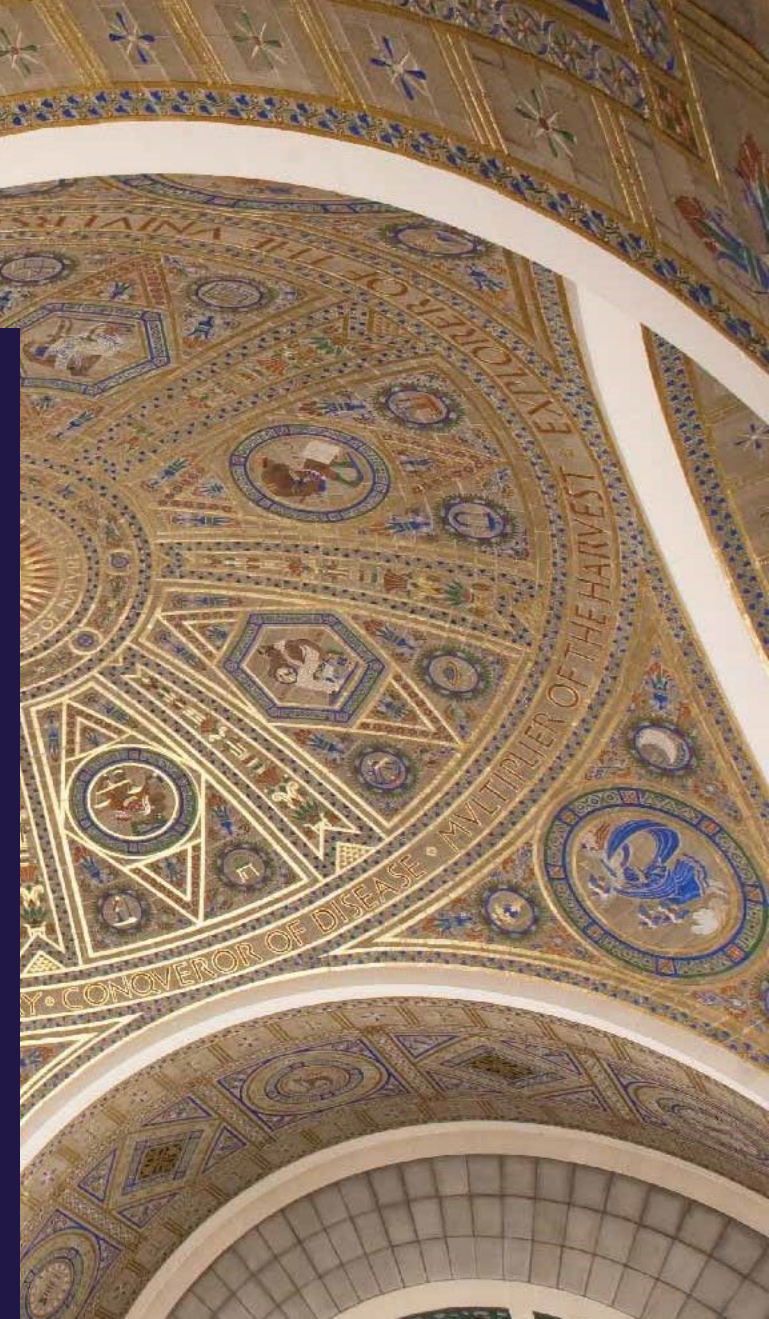
NATIONAL ACADEMIES

Sciences
Engineering
Medicine

Probabilistic Genotyping Software

- **What is it?** Probabilistic genotyping software (PGS) helps police compare DNA found at crime scenes with potential suspects, even when the DNA is limited in quantity, damaged, or mixed from different people.

Probabilistic Genotyping Software

- **What is it?** Probabilistic genotyping software (PGS) helps police compare DNA found at crime scenes with potential suspects, even when the DNA is limited in quantity, damaged, or mixed from different people.

- **How does it work?** Forensic investigations start by collecting genetic material from both the evidence and potential suspects, analyzing them separately to create genetic profiles. Forensic analysts use PGS to compare these profiles, by calculating the probability of the evidence given the suspect is a contributor versus an unknown person is a contributor.

NATIONAL ACADEMIES *Sciences Engineering Medicine*

Probabilistic Genotyping Software

- **What is it?** Probabilistic genotyping software (PGS) helps police compare DNA found at crime scenes with potential suspects, even when the DNA is limited in quantity, damaged, or mixed from different people.

- **How does it work?** Forensic investigations start by collecting genetic material from both the evidence and potential suspects, analyzing them separately to create genetic profiles. Forensic analysts use PGS to compare these profiles, by calculating the probability of the evidence given the suspect is a contributor versus an unknown person is a contributor.

- **Who is involved in its use?** The software used in PGS is typically provided by external vendors and internally validated by individual labs for use.

NATIONAL ACADEMIES *Sciences Engineering Medicine*

Probabilistic Genotyping Software

- **What is it?** Probabilistic genotyping software (PGS) helps police compare DNA found at crime scenes with potential suspects, even when the DNA is limited in quantity, damaged, or mixed from different people.

- **How does it work?** Forensic investigations start by collecting genetic material from both the evidence and potential suspects, analyzing them separately to create genetic profiles. Forensic analysts use PGS to compare these profiles, by calculating the probability of the evidence given the suspect is a contributor versus an unknown person is a contributor.

- **Who is involved in its use?** The software used in PGS is typically provided by external vendors and internally validated by individual labs for use.

- **Scale of use**: Widely adopted. Over 100 law enforcement and/or state laboratories in the US use PGS.

Forensic DNA Phenotyping

- **What is it?** Forensic DNA phenotyping helps predict physical characteristics from DNA samples, typically used for investigative lead generation.

National Academies
Sciences
Engineering
Medicine

Forensic DNA Phenotyping

- **What is it?** Forensic DNA phenotyping helps predict physical characteristics from DNA samples, typically used for investigative lead generation.

- **How does it work?** Forensic DNA Phenotyping makes use of genetic variations linked to specific traits. Then, predictive modeling is applied, using statistical techniques to predict characteristics like eye color, hair type, and skin color from DNA samples.

NATIONAL ACADEMIES *Sciences Engineering Medicine*

Forensic DNA Phenotyping

- **What is it?** Forensic DNA phenotyping helps predict physical characteristics from DNA samples, typically used for investigative lead generation.

- **How does it work?** Forensic DNA Phenotyping makes use of genetic variations linked to specific traits. Then, predictive modeling is applied, using statistical techniques to predict characteristics like eye color, hair type, and skin color from DNA samples.

- **Who is involved in its use?** Generally requires law enforcement agencies to contract with external vendors or private consultants.

Forensic DNA Phenotyping

- **What is it?** Forensic DNA phenotyping helps predict physical characteristics from DNA samples, typically used for investigative lead generation.

- **How does it work?** Forensic DNA Phenotyping makes use of genetic variations linked to specific traits. Then, predictive modeling is applied, using statistical techniques to predict characteristics like eye color, hair type, and skin color from DNA samples.

- **Who is involved in its use?** Generally requires law enforcement agencies to contract with external vendors or private consultants.

- **Scale of Use:** Not widely adopted, some notable cases of use

NATIONAL ACADEMIES *Sciences Engineering Medicine*

Forensic/Investigative Genetic Genealogy

- **What is it?** Forensic/investigative genetic genealogy (FIGG) applies advanced DNA sequencing and traditional genealogical research methods to forensic DNA evidence to identify unknown perpetrators of violent crime and unidentified human remains.

Forensic/Investigative Genetic Genealogy

- **What is it?** Forensic/investigative genetic genealogy (FIGG) applies advanced DNA sequencing and traditional genealogical research methods to forensic DNA evidence to identify unknown perpetrators of violent crime and unidentified human remains.

- **How does it work?** FIGG utilizes advanced DNA sequencing to examine genetic material. Once a DNA profile is generated, a genetic genealogist enters it into genealogy databases which use algorithms to identify potential familial relationships between the sample and database users. The genetic genealogist then constructs family trees to identity candidates of the unknown forensic sample.

NATIONAL
ACADEMIES *Sciences Engineering Medicine*

Forensic/Investigative Genetic Genealogy

- **What is it?** Forensic/investigative genetic genealogy (FIGG) applies advanced DNA sequencing and traditional genealogical research methods to forensic DNA evidence to identify unknown perpetrators of violent crime and unidentified human remains.

- **How does it work?** FIGG utilizes advanced DNA sequencing to develop genetic profiles. Once a profile is generated, a genetic genealogist enters it into genealogy databases which use algorithms to identify potential familial relationships between the sample and database users. The genealogist then constructs family trees to identity candidates of the unknown forensic sample.

- **Who is involved in its use?** Since department laboratories do not typically produce DNA profiles suited for use in FIGG, DNA samples may be outsourced to vendor laboratories. For genealogical research, select law enforcement agencies have staff experts while others engage the services of an external vender or private consultant.

NATIONAL ACADEMIES *Sciences Engineering Medicine*

Forensic/Investigative Genetic Genealogy

- **What is it?** Forensic/investigative genetic genealogy (FIGG) applies advanced DNA sequencing and traditional genealogical research methods to forensic DNA evidence to identify unknown perpetrators of violent crime and unidentified human remains.

- **How does it work?** FIGG utilizes advanced DNA sequencing to develop genetic profiles. Once a profile is generated, a genetic genealogist enters it into genealogy databases which use algorithms to identify potential familial relationships between the sample and database users. The genealogist then constructs family trees to identity candidates of the unknown forensic sample.

- **Who is involved in its use?** Since department laboratories do not typically produce DNA profiles suited for use in FIGG, DNA samples may be outsourced to vendor laboratories. For genealogical research, select law enforcement agencies have staff experts while others engage the services of an external vender or private consultant.

- **Scale of use:** Limited but rapidly expanding use and demand

NATIONAL ACADEMIES *Sciences Engineering Medicine*

References

- Gill, P., Benschop, C., Buckleton, J., Bleka, Ø., & Taylor, D. (2021). A Review of Probabilistic Genotyping Systems: EuroForMix, DNAStatistX and STRmix™. Genes, 12(10), 1559. https://doi.org/10.3390/genes12101559

- Glynn, C. L. (2022). Bridging Disciplines to Form a New One: The Emergence of Forensic Genetic Genealogy. Genes, 13(8). https://doi.org/10.3390/genes13081381

- Kayser M. (2015). Forensic DNA Phenotyping: Predicting human appearance from crime scene material for investigative purposes. Forensic science international. Genetics, 18, 33–48. https://doi.org/10.1016/j.fsigen.2015.02.003

- United States Government Accountability Office. (2019, October 3). Science & Tech spotlight: Probabilistic genotyping software. Science & Tech Spotlight: Probabilistic Genotyping Software | U.S. GAO. https://www.gao.gov/products/gao-19-707sp

NATIONAL ACADEMIES
Sciences
Engineering
Medicine