

A BRIEF STUDY ON THE APPLICATIONS OF MATHEMATICS IN FORENSIC SCIENCE

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Abstract: Forensic science is the application of science to criminal and civil laws, mainly deals with the application of the knowledge and methodology of various disciplines of science to legal matters. Mathematics is fundamental to all kinds of science and forensic science is no exception. Some of the interesting applications of Mathematics to forensic science is highlighted.

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1. Introduction

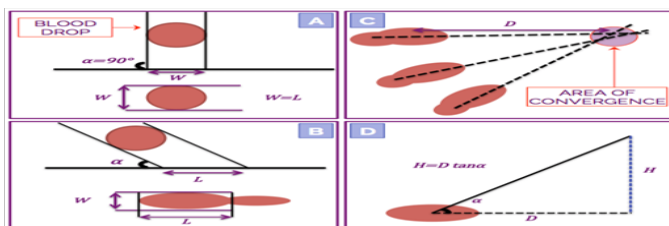
Forensic science is that piece without which the puzzle of a criminal investigation is incomplete. Without the application of forensic science, criminals can never be convicted unless an eyewitness is present. Thus in a world devoid of forensic science, murderers, thieves, drug traffickers and rapists would be roaming scot-free. Certain attributes of a crime scene reveal information about the event. Thanks to mathematical models, we are able to estimate the time at which a crime was committed, identify the suspects fingerprints and analyse the pattern of bloodstains and bone fractures to reconstruct the crime scene. We will show some of the most common and simplest examples of the applications of mathematics in forensic science.

2. Proportions

Forensic scientists use not only measurements, but proportions in their analyses. If a human leg bone is discovered in an unmarked grave, for example, forensic scientists use math equations to determine what proportion, or percentage, of a persons overall height the leg bone would be. Once they know that, they can determine how tall the person was and whether it was a child or adult. Proportions are one way math is involved in forensic science.

3. Trigonometry

Trigonometry, the study and measurement of triangles, is another common use of math in forensic science. Blood spatter analysts, for example, use trigonometry in their study of how blood from a human injury splatters on a wall or other surface. They draw lines from the victims body to the blood spatter, then use angles and distances to calculate the third point of the triangle: the person who struck the victim, where the attacker was standing, how hard he must have hit the victim and more. In the figure above, we show the general procedure used by forensic scientists to make a blood pattern analysis: in case A, the drop of blood hits the surface at an angle of $\alpha = 90^\circ$ giving a shape that is a circle of diameter W ; and in case B, the blood drop strikes the floor with $\alpha \neq 90$ giving a shape that is a teardrop made up of an ellipse (diameter W and length of splatter L) and an extension resulting from the droplets momentum. For each droplet, the forensic scientist measures W and L to determine the angle of impact α ($\sin \alpha = W/L$), then extends the long axis of the ellipses (the dashed lines in figure C), to find the area of convergence: the zone where all the lines intersect. Once they locate this area, they measure the distance D between an individual bloodstain and the area of convergence. Finally, using simple trigonometry (see figure D) they can determine the point of origin H of the blood spatter ($H = D \tan \alpha$). The value of H must then coincide for all the drops of blood.



4. Probabilities

Probability is a measurement of the likelihood that a specific event will occur under certain conditions. Forensic scientists often use probabilities to explain how likely it is that their findings are correct. For example, a forensic biologist who has

compared a suspect's DNA to DNA from a fluid sample found at a crime scene will tell the jury the probability, or likelihood, that the DNA samples are from the same person: perhaps the probability the two samples did not come from the same person is 1 in 100 billion. Explaining findings to juries using probabilities is a common way math is applied to forensic science

5. Statistics

Statistics plays a crucial role in obtaining, interpreting and reporting results. Sampling, statistical quality control, chemo metrics, biometrics, design of experiments, and the Bayesian framework for interpreting evidence are areas of statistics that are of key importance to many forensic scientists. The role of statistics is becoming increasingly important as forensic reports are currently scrutinised by courts and accreditation bodies. Statistics and forensic science have a lot to offer to each other.

6. Algebra

Algebra is needed in forensics to calculate the method of killing a victim- e.g. a blood splatter's pattern can indicate if the victim was assaulted with a stab, a slice, a chop, etc. Algebra can also help to reconstruct a crime scene. It can also help in a car crash, where authorities can find the location of the cars before they collided, how they collided, and at the speed they were going at. Ballistics (the motion of a bullet/ weapon) also needs algebra to know where the assaulter was standing. Also, DNA analysis and the time of the crime (body temperature) both need algebra. Algebra is used to find the crime rates of a particular area, so that police forces will know where to beef up authorities.

7. Conclusion

Mathematics is the Queen of all science, and whether a forensic scientist specializes in biology, chemistry, computers or any other scientific branch, mathematics will be central to the crime-solving job. As new scientific discoveries are constantly being made, mathematics will take on even larger roles in forensic science. In the future, forensic scientists in any discipline will need an increasingly strong educational background in mathematics.

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