C1 Convolutional Neural Networks for the Automatic Classification of Shoe Print Features

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Learning Overview: After attending this presentation, attendees will be familiar with the ways that Convolutional Neural Networks (CNNs) can be trained and implemented to classify forensic pattern evidence, specifically with shoe print features.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by introducing a powerful machine learning method to automatically classify shoe prints with the goal of improving the reliability of pattern evidence analysis. Results of this research can improve the speed of shoe print database searches and provide valuable information about the relative frequency of specific characteristics found on shoe prints.

The improvement of modern computing has led to the widespread implementation of machine learning, in which computers "learn" about data without being explicitly programmed. CNNs are a form of deep learning that mimics the human brain by using complex networks of hidden layers to learn patterns and make decisions about the contents of an image. For example, we may see an image that contains features such as "eyes" and "nose" and conclude that the image contains a "face." Similarly, CNNs learn and combine local patterns in a set of training images to learn to detect the presence of a desired set of features in new images.

In forensic applications, images of shoe prints are well-suited to classification using CNNs. Shoe prints often contain distinct and well-defined shapes, such as circles and triangles, as well as text and textures that can be easily classified by a CNN. Once the shapes contained in a print are detected and classified, the resulting labels can be combined to determine the shoe's category (e.g., athletic, formal) and brand. This automatic classification can be used to speed up database searches for a given shoe print and can also be used to determine the relative frequency with which certain characteristics appear in shoes that are commonly worn within specific populations. Development of a model that can automatically identify class characteristics of shoes and prints will provide a valuable tool for examiners to use when searching for candidate shoe models which may match a questioned print. In addition, various statistical methods for assessing class characteristic frequency within a population depend on being able to automatically identify class characteristics, allowing for large amounts of data collection. CNNs for class characteristics represent an important first step toward greater statistical quantification of class characteristic frequency within a local population.

Using approximately 2,000 images of shoe soles of various types, brands, and sizes, the presented model can successfully identify several different class characteristics with accuracy above 95%.

Machine Learning, Shoe Print, Pattern Evidence