J25 Writer Classification of Handwritten Characters Using a Neural Network

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Learning Overview: After attending this presentation, attendees will understand the results of writer classification using a neural network and the necessity of the future research on a neural network using various data.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by showing the validity and the problems of the application of a neural network to handwriting identification.

Machine image recognition technique along with deep learning has been advancing rapidly, and its application to forensic document examination has also been expected. A writer classification experiment using a neural network, which was conducted as one of the feasible studies, is reported in this presentation.

Writer classification using the neural network LeNet was conducted. Samples used for the experiment were 26 uppercase Latin alphabetical letters, 26 lowercase letters, 26 Hiragana characters, and 26 Kanji characters, written five times respectively by ten people. Each letter and character was originally written in a 1cm x 1cm square box in handprint. Then, an 8-bit grayscale image of each sample was obtained under conditions in which the image size was 32 pixels x 32 pixels with a resolution of 85 dots per inch (dpi).

Writer classification using LeNet was conducted on the following four categories: uppercase Latin alphabetical letters, lowercase letters, Hiragana characters, and Kanji characters. Image data were divided into two groups: training data and validation data. Four out of five samples per letter or character were used for training and the remaining one was used for validation. Thus, there were 1,040 samples (26 characters x 4 samples per character x 10 writers) used for training and 260 samples (26 characters x 1 sample per character x 10 writers) used for validation per category. Training was done under conditions in which the batch size was 64 and epoch was 50. After training was completed, validation samples were classified into any of ten writers respectively, and the accuracy ratio was calculated on four categories.

The accuracy ratio was 0.7615 for uppercase letters, 0.6500 for lowercase letters, 0.7500 for Hiragana characters, and 0.7769 for Kanji characters, which was higher than expected. The average accuracy ratio of respective letter or character (training samples: 4, validation samples: 1, batch size: 8, epoch: 50, trials: 104 (26 letters or characters x 4 categories)) was 0.5897, and the expected accuracy ratio of each of the four categories was around 0.7000 before the experiment. These results may show the importance of the number of samples in the application of the neural network. Recall ratio per writer varied the largest in lowercase letters (0.0769–0.9230), which explained the reason of the lower accuracy ratio. In these classification experiments, feature extraction of individuality from each writer's handwriting was conducted on all the training samples, and this means a writer's features extracted were expected to be common to all letters or characters used. Thinking that the comparison of documents in forensic document examination is performed on the same letters or words and that forensic document examiners have knowledge and experience with the feature extraction from one's handwriting, these results are interesting. The results may suggest that a person writes various letters and characters in a constant and unique manner.

Two writers showed a high recall ratio (over 0.9000) in all four categories, and their handwriting samples were unique in size, shading, or the location of the handwriting in the box, which may be the primary features for the neural network classification in this experiment. Forensic document examiners do give weight to these features, but they give more weight to graphic features of a handwriting, such as slope, angularity, relative relationship between strokes in writer classification, or identification tasks.

Several findings on the application of a neural network to writer classification were obtained from these experiments. More experiments, such as classification using samples of the same graphic form with augmented samples, using image data with higher resolution, or using more complicated algorithm, will be necessary for the future study.

Handwriting, Writer Classification, Neural Network

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