Create Your Own Chinese Calligraphy Artwork

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Motivation

Chinese calligraphy has been an integral part of Chinese culture since four thousand years ago. In this project, we propose a platform that enables users to create their own Chinese calligraphy artworks without holding the brush or even having any knowledge about Chinese calligraphy. The platform takes in regular handwritten Chinese characters and generates personalized Chinese calligraphy artwork for the user. Unlike existing work that focus on handwritten Chinese character recognition, our work aims to extract, cluster, and recognize strokes from handwritten Chinese characters using neural network algorithms.

Algorithm Workflow

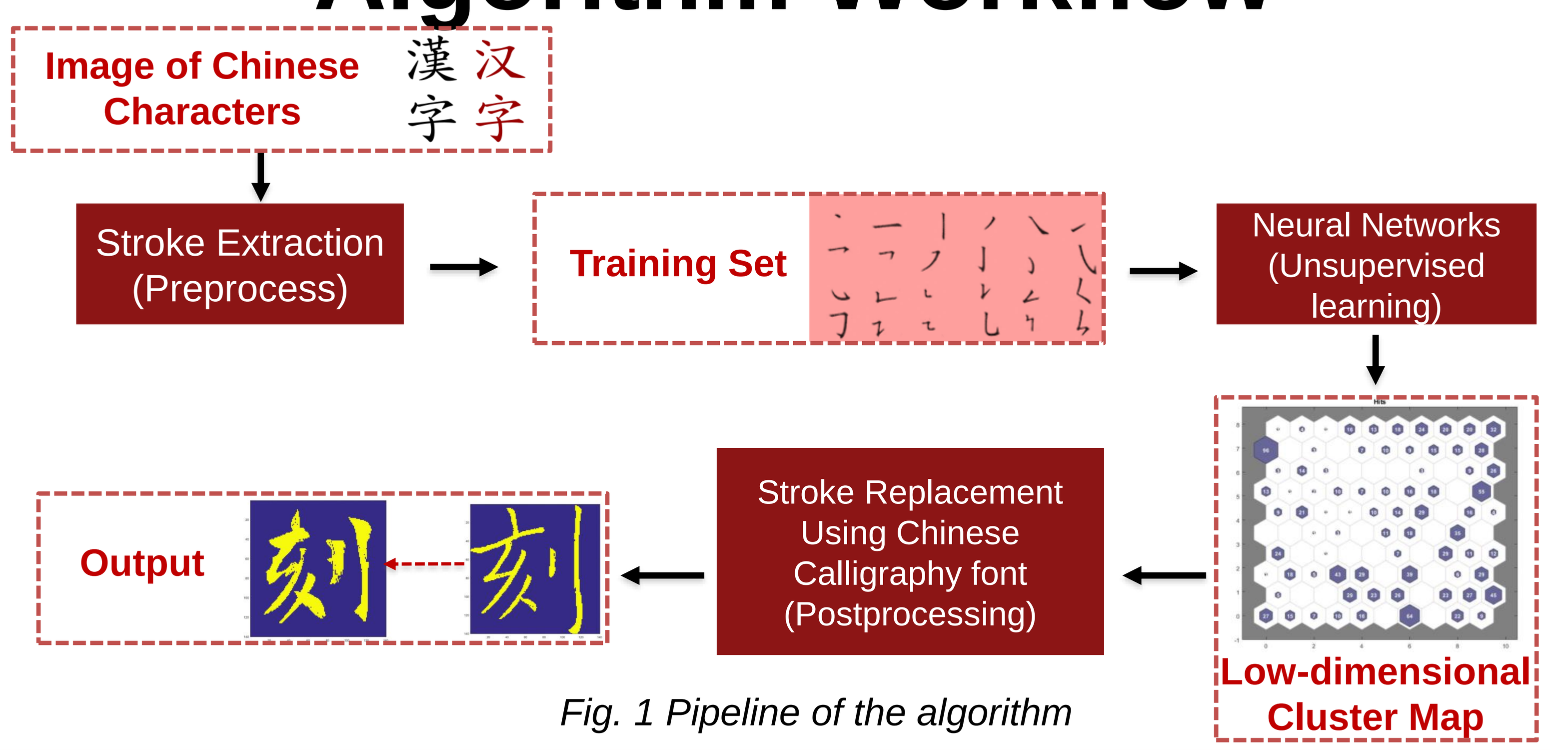

Fig. 1 Pipeline of the algorithm

Stroke Extraction: Dataset

- **Point to Boundary Orientation Distance (PBOD)**
  PBOD map is computed to distinguish edges, body parts, and singular regions of a character. PBOD is the orientation distance between the pixel and the boundary point along different directions.
- **Boundary-Boundary Orientation Distance (BBOD)**
  BBOD refers to the distance between the two stroke boundary points intersected by a line passing through a certain pixel.

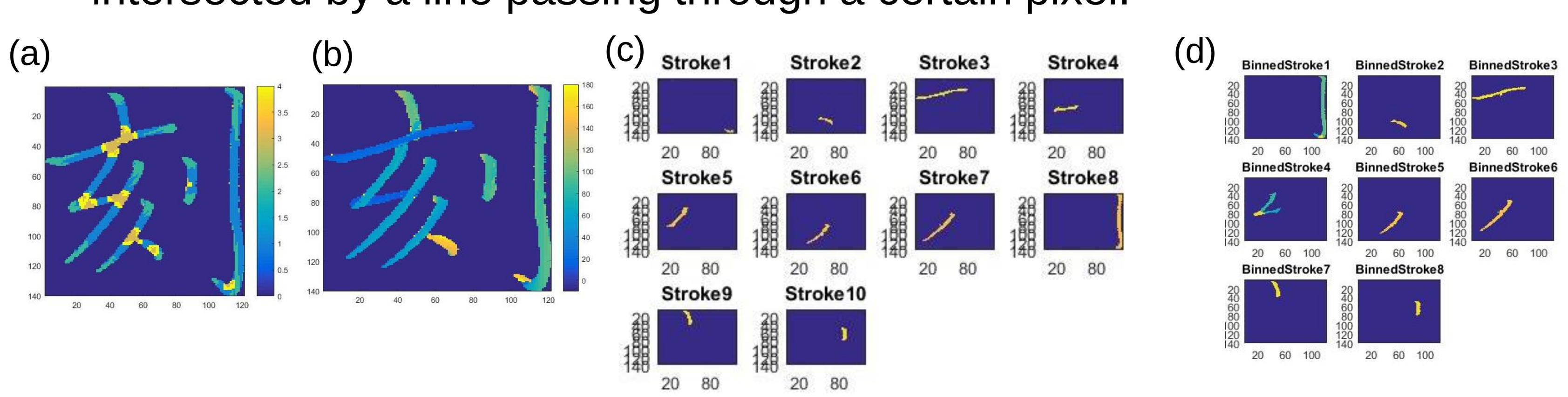

Fig. 2 Extracting strokes from "刻". (a) PBOD map. (b) BBOD map. (c) Sub-strokes extracted as an intermediate result. (d) Connecting the substrokes and making legitimate strokes as training data.

Neural Networks

- **Autoencoder neural network**
  The encoder maps the input to a hidden representation with lower dimensions. The decoder then reconstructs the original input using representation found in Encoder. In our model, an input image with 19600 dimensions is represented in a space with 400 dimensions.

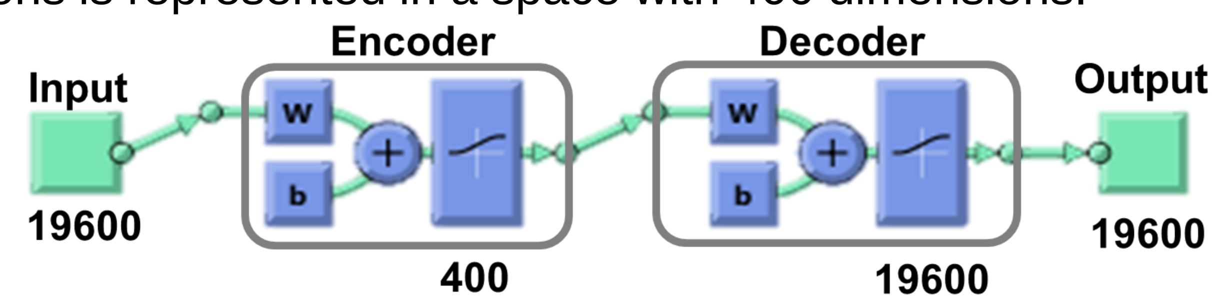

Fig. 3 Autoencoder neural network

Cost function is the error between the input x and its reconstructed output $\hat{x}$.
Sparsity Regularization enforces a constraint on the sparsity of the output from the hidden layer. One such sparsity regularization term is the K-L divergence:

$$\Omega_{sparsity} = \sum_{i=1}^{D^{(1)}} KL(\rho \| \hat{\rho}_i) = \sum_{i=1}^{D^{(1)}} \rho \log\left(\frac{\rho}{\hat{\rho}_i}\right) + (1-\rho)\log\left(\frac{1-\rho}{1-\hat{\rho}_i}\right)$$

- **Self-organizing map (SOM)**
  SOM learns to clusters the input data. In our model, 100 clusters were produced for the 400-dimension reconstructed image generated by the Decoder.

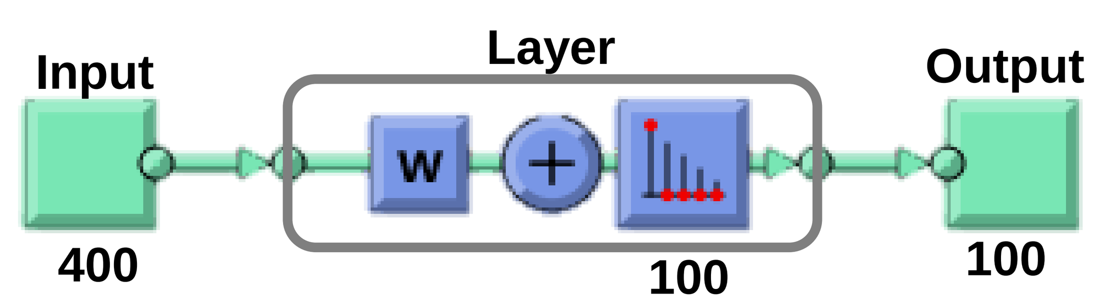

Fig. 4 Cluster with SOM neural network

Training Results

- **Autoencoder**

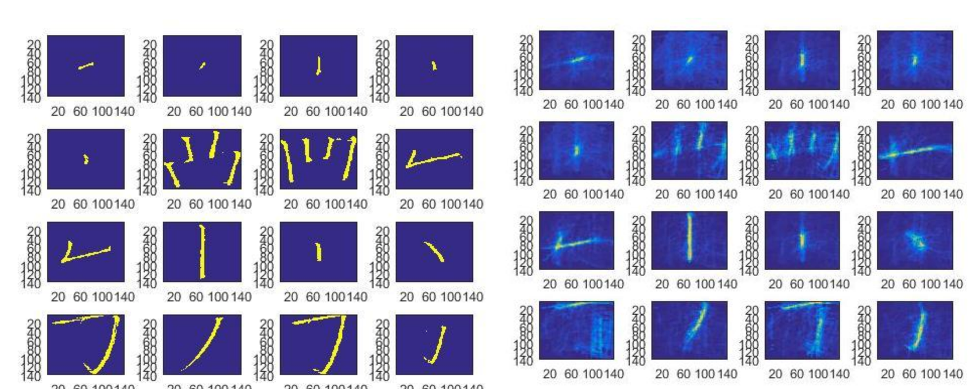

Fig. 5 Input (left) and output (right) of autoencoder

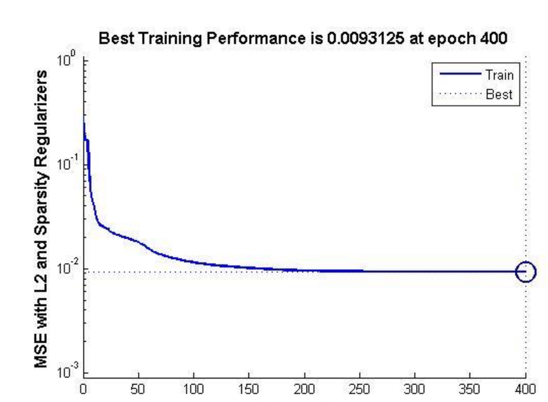

Fig. 6 Training performance of autoencoder

The input and output of the autoencoder look similar in Figure 5, which suggests good performance of the autoencoder.
Fig.6 shows that training error decreases to 0.01 at 200 epochs using L2 and Sparsity regularizations. Dimension reduction and feature extraction of the input data are very nicely done by autoencoder.

Clustering Results

- **Self-organizing map (SOM)**

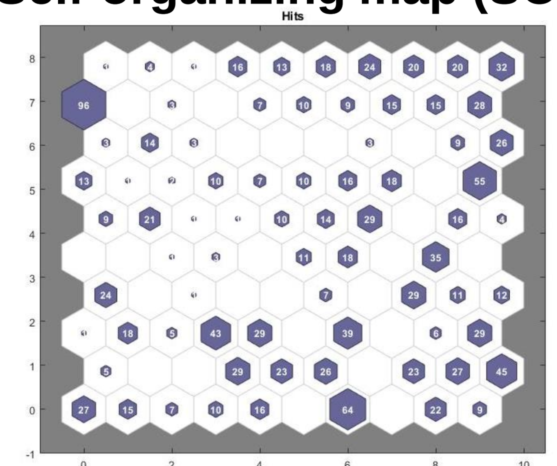

Fig. 7 Clustering result by SOM neural network. 100 neurons were chosen.

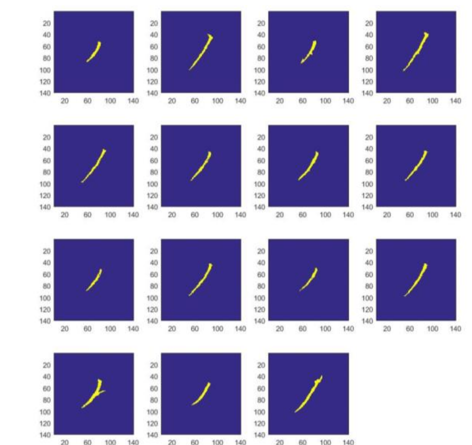

Fig. 8 A display of the elements in one cluster

Although there are only 31 basic strokes in Chinese characters, we set the number of neuron to be 100 in order to capture more characteristics of different types of Calligraphy. Figure 8 shows an example of a cluster identified in our model..

Applications

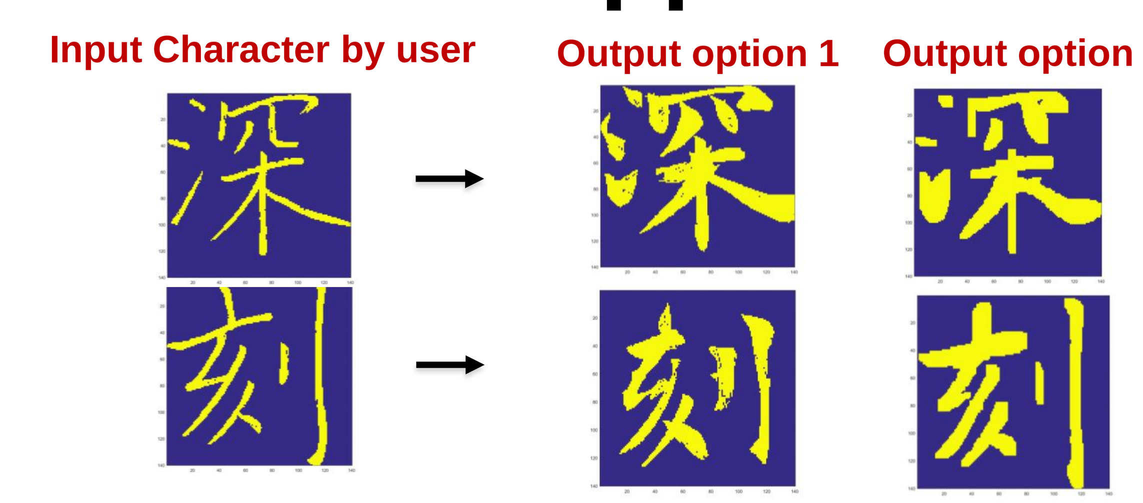

Fig. 9 An example usage of our algorithm

Our platform will output a few characters with different calligraphy font. Users are able to choose the artwork they like the most.

References

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