

Chinese Calligraphy Brushstroke Analysis: Mi Fu's Style Compared

1 山水野

William Meng EE 292F May 17, 2021

Historical Context

Four Treasures of the Study

争 bǐ Brush









5 Standard Styles







Clerical Script



Cursive Script



Running Script



Regular Script

Image by Xintong Chen

5 Standard Styles





Image by Xintong Chen

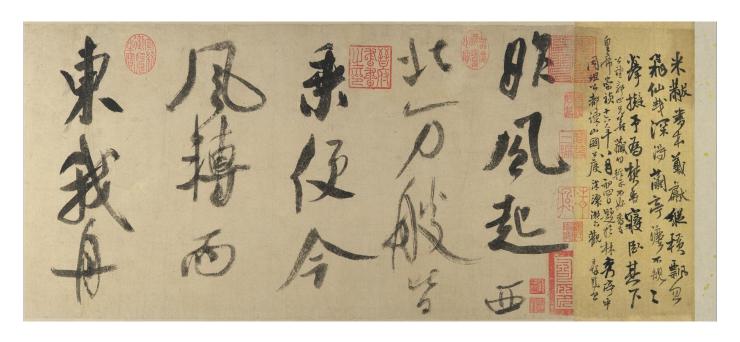
Wang XiZhi (303–361)

Most renowned calligrapher in Chinese history!



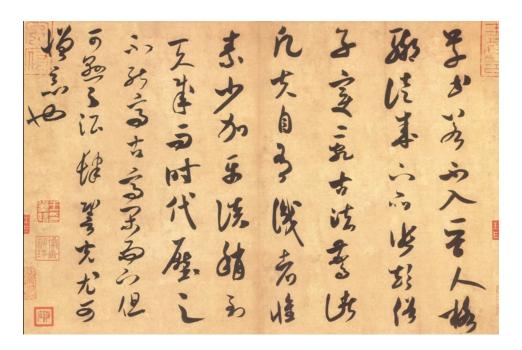
On the Seventeenth Day by Wang XiZhi (The Met)

Mi Fu (1051-1107)



Poem Written in a Boat on the Wu River by Mi Fu, ca. 1095 ($\underline{\text{The}}$ $\underline{\text{Met}}$)

Mi Fu (1051-1107)



On Cursive Calligraphy by Mi Fu, ca. 1097 (China Online Museum)

Su Shi (1037–1101)



Inscription of Hanshi by Su Shi (Paris Galerie d'Art de l'Extrême-Orient)

Emperor Huizong (1082–1135)



Finches and bamboo by Emperor Huizong (The Met)

Methods

Data Collection

Screenshots (by-hand) of individual characters in each scroll



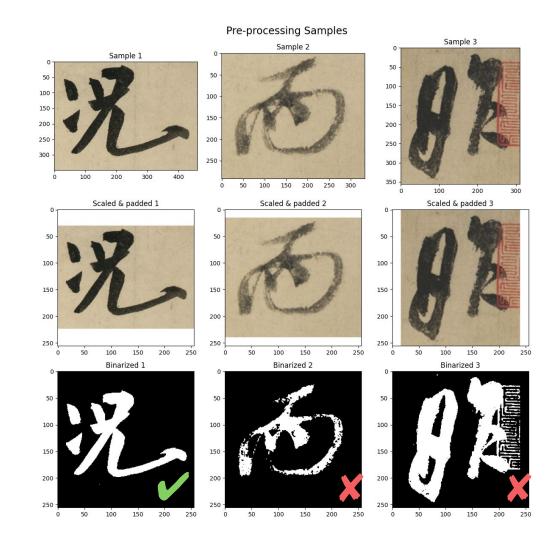
Pre-processing

Left: high-contrast solid character, no occlusions. Easiest to pre-process.

Middle: low-contrast porous character. Requires inpainting.

Right: Occlusion by red stone seal. Requires color segmentation and inpainting.

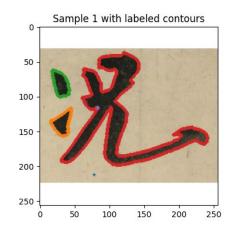
For simplicity, we only use characters like the one on the left for the contour analysis.

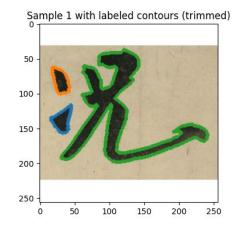


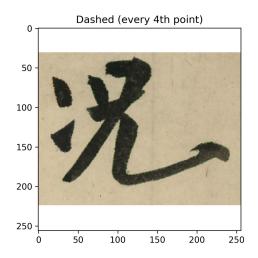
Contour Angle Analysis

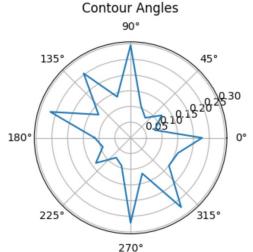
Procedure for each image:

- Extract contours with cv2.findContours()
- 2. Remove contours with 10 or fewer points
- 3. Keep every *n*th point in each contour to get dashed contour
- 4. Calculate angle between each pair of adjacent points as a sequence
- 5. Compute normalized histogram, with 20 bins, of sequence of angles

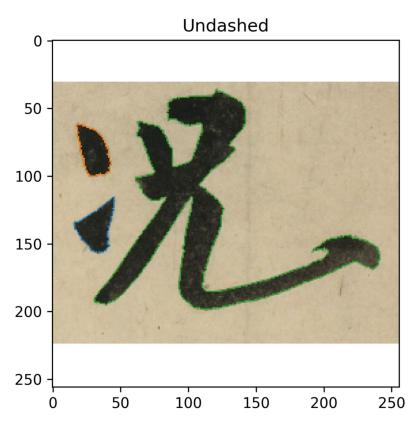


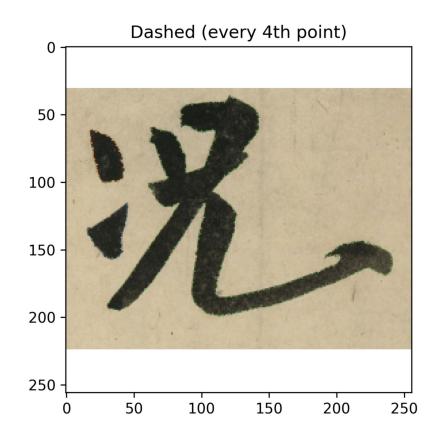






Why dashed contours?

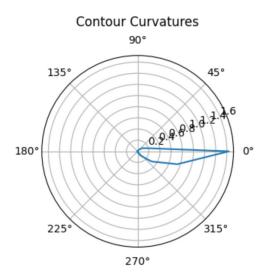




Other Features

"Curvature" = difference between subsequent angles

Also histogram into 20 bins for each image



(Normalized) Mass = %-age of image occupied

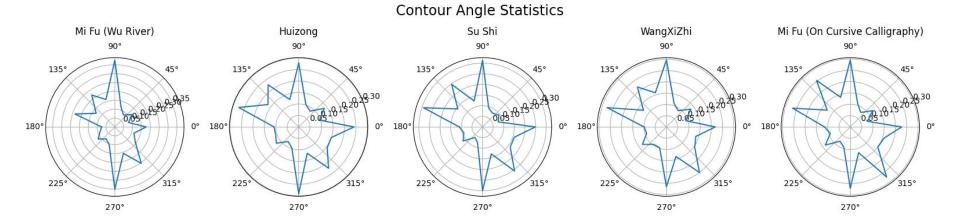
Center of Mass = average x value occupied, average y value occupied

Mass Variance = variance of x values occupied, variance of y values occupied

All together: **46-dim feature vector**

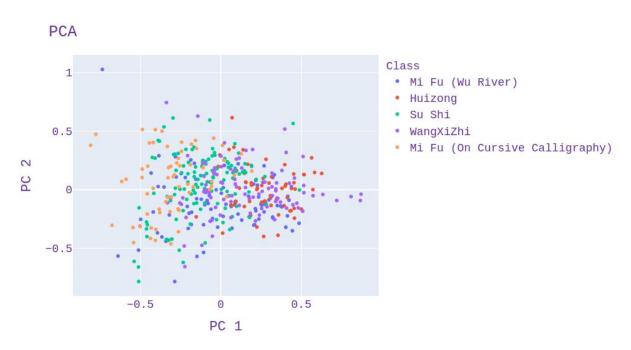
Results

Comparison of contour angle statistics

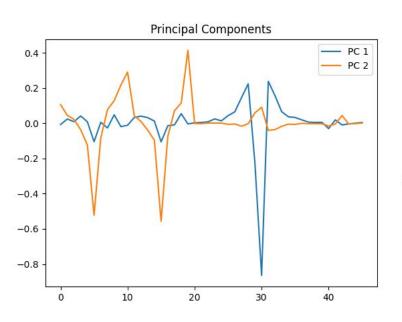


Principal Component Analysis (PCA)

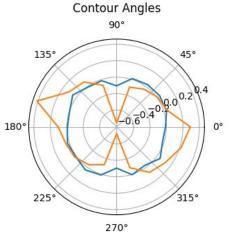
Visualize high-dimensional data in fewer dimensions!

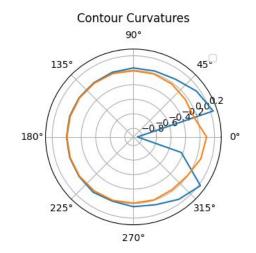


Principal Components

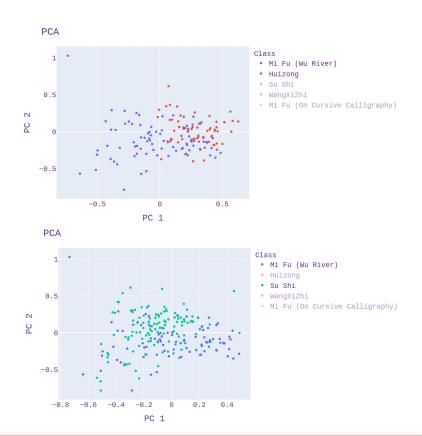


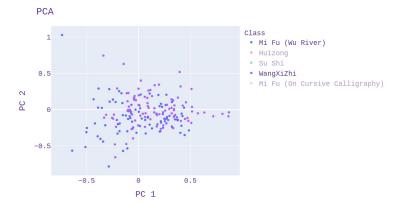
Principal Components

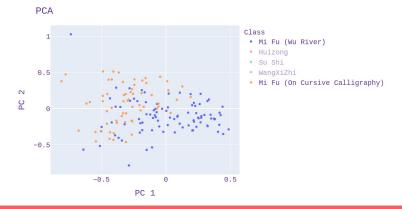




Comparisons

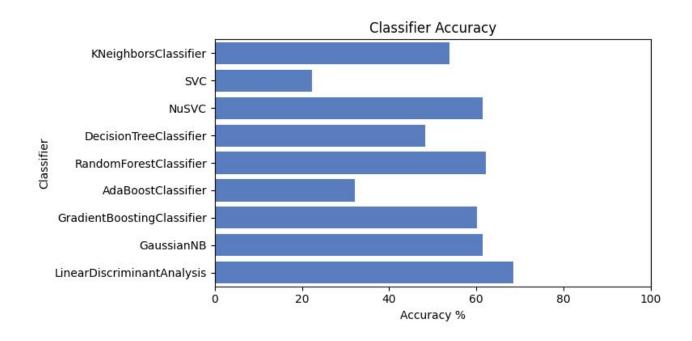






Classification

A few generic classifiers...



Discussion

Further Work

- Use a deep neural network instead of simple statistical analysis
 - The neural network may be able to understand higher-level features of the artist's style (eg. how they draw a specific type of stroke), much like an art connoisseur, rather than looking only at low-level features (eg. what are the most frequent angles overall).
- Automated character segmentation
 - Taking screenshots of each character got boring pretty quickly :/
- More sophisticated preprocessing
 - DEPICT algorithm to remove red ink stone seals
 - Remove background noise
 - Cleanly separate characters which have overlapping bounding boxes
- Porosity analysis

References

- Sun, Yuandong, et al. "<u>A Robot for Classifying Chinese Calligraphic Types and Styles</u>." IEEE International Conference on Robotics and Automation, 2013.
- Yujiro, Nakata. "Calligraphic Style and Poetry Handscrolls: On Mi Fu's Sailing on the Wu River." Words and Images: Chinese Poetry, Calligraphy, and Painting, edited by Murck, Alfreda, and Wen C. Fong, Metropolitan Museum of Art, 1991, 91-105.
- Images of artwork from their respective owners (see links inline).

Thank you!

Please contact wlmeng@stanford.edu with any questions or feedback.