MANGA-SPECIFIC FEATURES AND LATENT STYLE MODEL FOR MANGA STYLE ANALYSIS

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Outline

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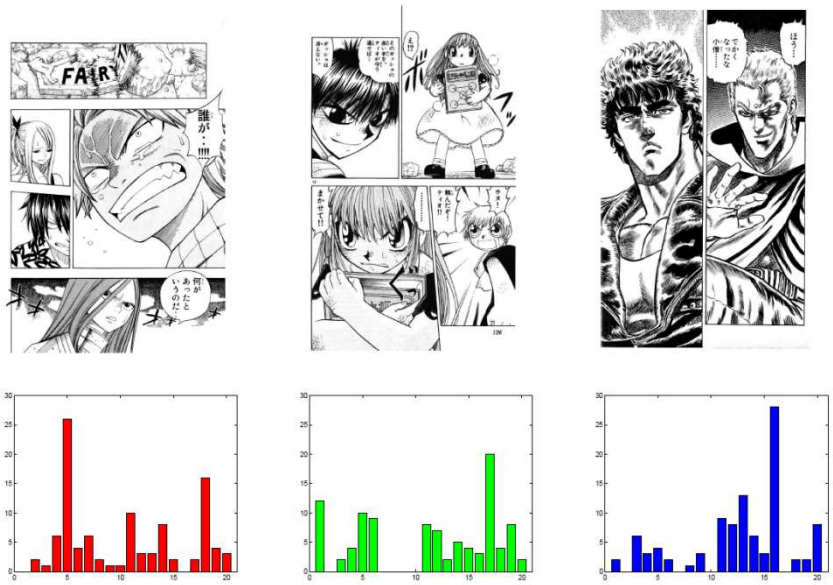
- Manga Features
- Style Model
- Applications
  - Style-based Artist Retrieval
  - Style-based Art Movement Retrieval
  - Style-based Artwork Period Retrieval
- Conclusion

Introduction

- Motivation: Many mangas (Japanese comics) are published every year, building a big market and conveying knowledge and culture
- Goal: Novel access scenarios based on *manga styles*
  - Manga styles can be described in a style space constituted by style elements, such as line drawing, screentone, and panel arrangement

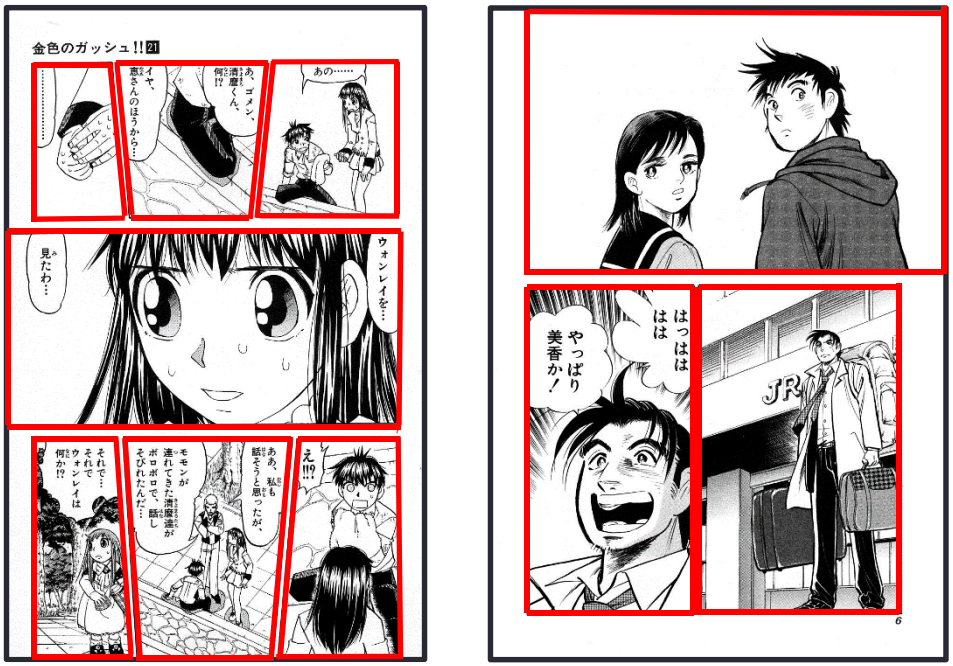


Introduction

- Contributions
  - *Manga-specific features*: line features, screentone primitive, panel arrangement features
  - *Latent style model*: describe manga pages as documents, adopt the latent Dirichlet allocation to discover style elements
  - *Applications*: style-based artist retrieval, style-based art movement retrieval, artwork period retrieval

Preprocessing

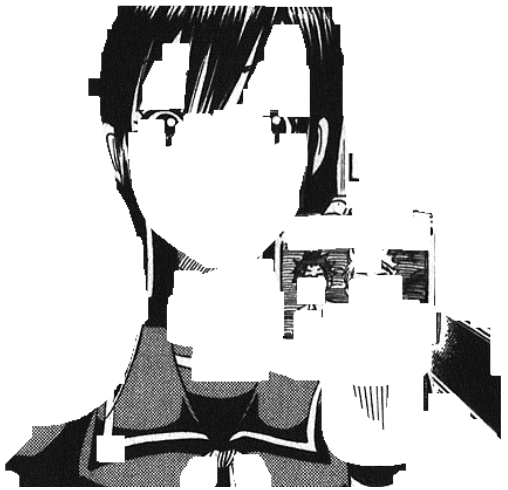
- Panel segmentation
  - We adopt the panel extraction method implemented by Pang et al. to segment panels from manga pages



Pang, X., Cao, Y., Lau, R. W., & Chan, A. B. (2014, November). A Robust Panel Extraction Method for Manga. In *Proceedings of the ACM International Conference on Multimedia* (pp. 1125-1128).

Screentone Features

- Screentone is a technique to apply texture or shade to objects or scene.
- Different artists have different habits in using screentone
- Screentone detection
  - 1. Binarize each pixel by checking intensity
  - 2. Pixels with lower intensity values are applied the erosion and dilation operations
  - 3. Extract patches from the screentone areas

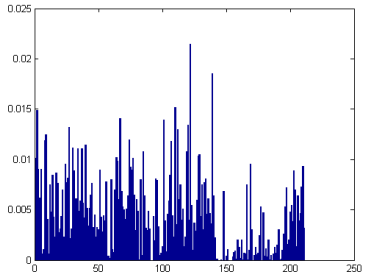


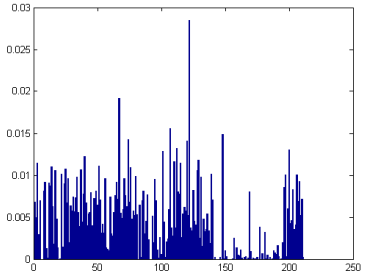
Screentone Features

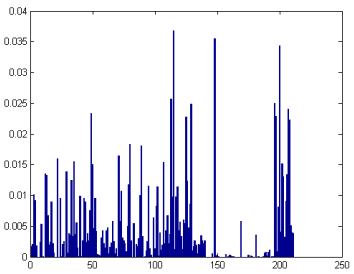
- Screentone features
  - 1. s_1: The ratio of screentone area to the whole panel area
  - 2. s_2: bag of screentone primitives
    - Apply the Gabor wavelet transform (4 orientations, 3 scales) to each screentone patch
    - Average and standard deviation of transform coefficients in each frequency band are concatenated as patch's texture feature vector
    - Apply the affinity propagation algorithm to cluster feature vectors (codebook construction)
    - Quantization each screentone patch into one of the primitives
    - A manga page can then be represented as the bag of screentone primitives

Cluster1 Cluster2 Cluster3 Cluster4

Screentone Features







Top row: sample manga pages from three different artists.
Bottom row: the BoP distributions corresponding to these artists.

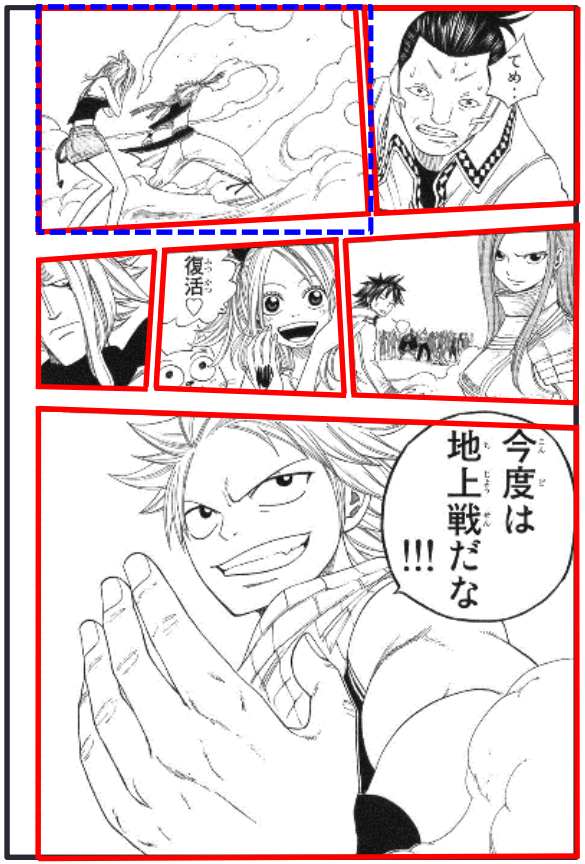
Panel Features

- How several images are placed inside a page also presents artistic styles.

From bounding box of each panel, we extract features to describe characteristics of layout.

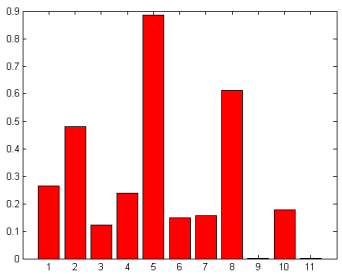
1) p_1: average panel height (derived from bounding boxes)
2) p_2: average panel width
3) p_3: standard deviation of p_1
4) p_4: standard deviation of p_2

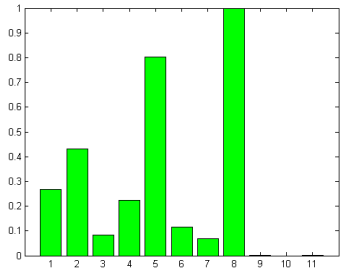
Panel Features

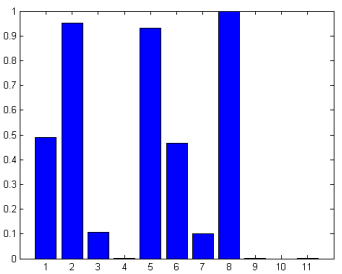


5) p_5: the ratio of total panel area to the whole page
6) p_6: average panel area
7) p_7: standard deviation of p_6
8) p_8: average slope of vertical panel boundaries
9) p_9: average slope of horizontal panel boundaries
10) p_{10}: standard deviation of p_8
11) p_{11}: standard deviation of p_9

Panel Features



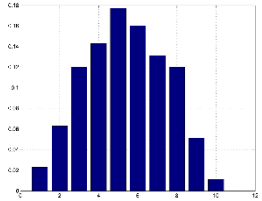


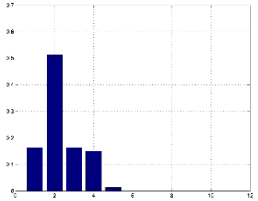


Top row: sample manga pages from three different artists.
Bottom row: panel feature distributions corresponding to these pages.

All Features

- The proposed screentone features and panel features are concatenated with line features proposed in [5] to form a feature vector describing a manga page.
- The line features are used to describe a character's face. We detect the largest and frontal face in a manga page to extract line features.



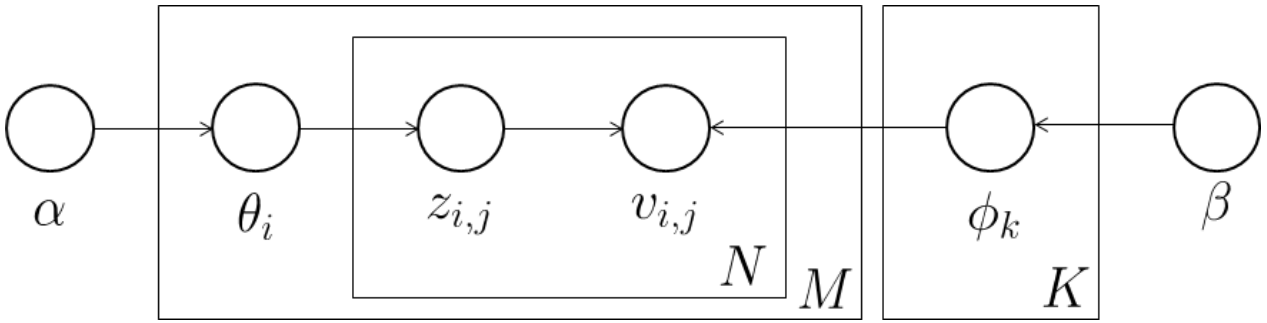
[5] Chu, W. T., & Chao, Y. C. (2014, November). Line-Based Drawing Style Description for Manga Classification. In Proceedings of the ACM International Conference on Multimedia (pp. 781-784).

Latent Style Model

- We develop a style model based on LDA
- Each manga page is described by a feature vector.
- Use PCA to reduce dimensionality from 314 into 20, and employ the K-means clustering algorithm to construct the visual vocabulary.
- Each manga page, therefore, can be represented as a visual word through quantizing the corresponding feature vector.

Latent Style Model

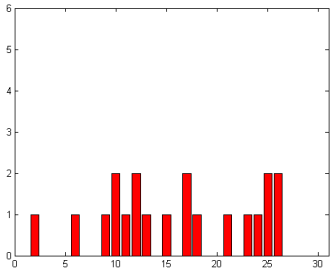
- View several manga pages of the same artist as a document, view each manga page as a word, and view the discovered latent topics as style elements.
- A document d_i is represented as a bag of N_i visual words, denoted by $d_i = \{v_1, v_2, ..., v_{N_i}\}$
- Documents are assumed to be characterized by K style elements. The latent style model assumes the generative process for a corpus consisting of M documents each of lengths (number of words) N_i.

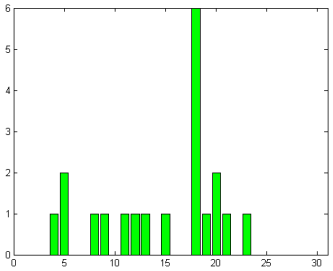


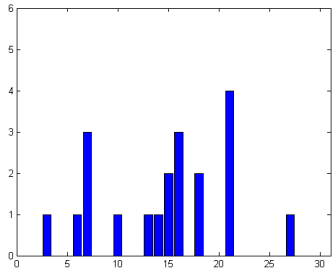
Latent Style Model

- Given a set of documents $D = \{d_1, d_2, ..., d_M\}$ with the observed visual words, we can efficiently learn the model by the Gibbs sampling algorithm.
- Style probabilities of a document can be estimated, which enable us to represent a document as a distribution of style elements.

Style Element Distribution



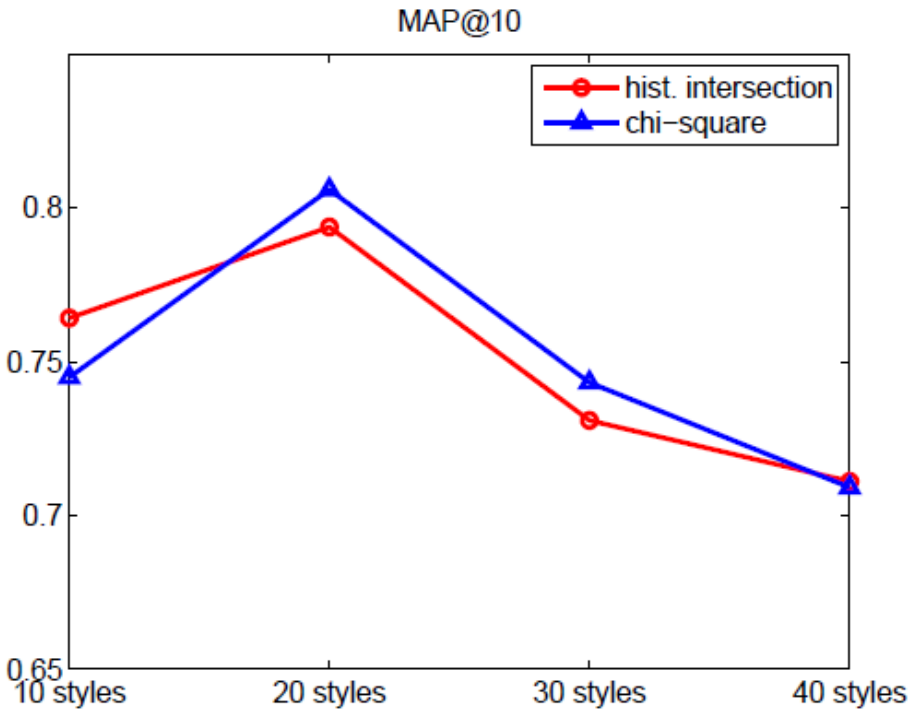




Top: sample manga pages from three different documents.
Bottom: style element distributions corresponding to these documents.

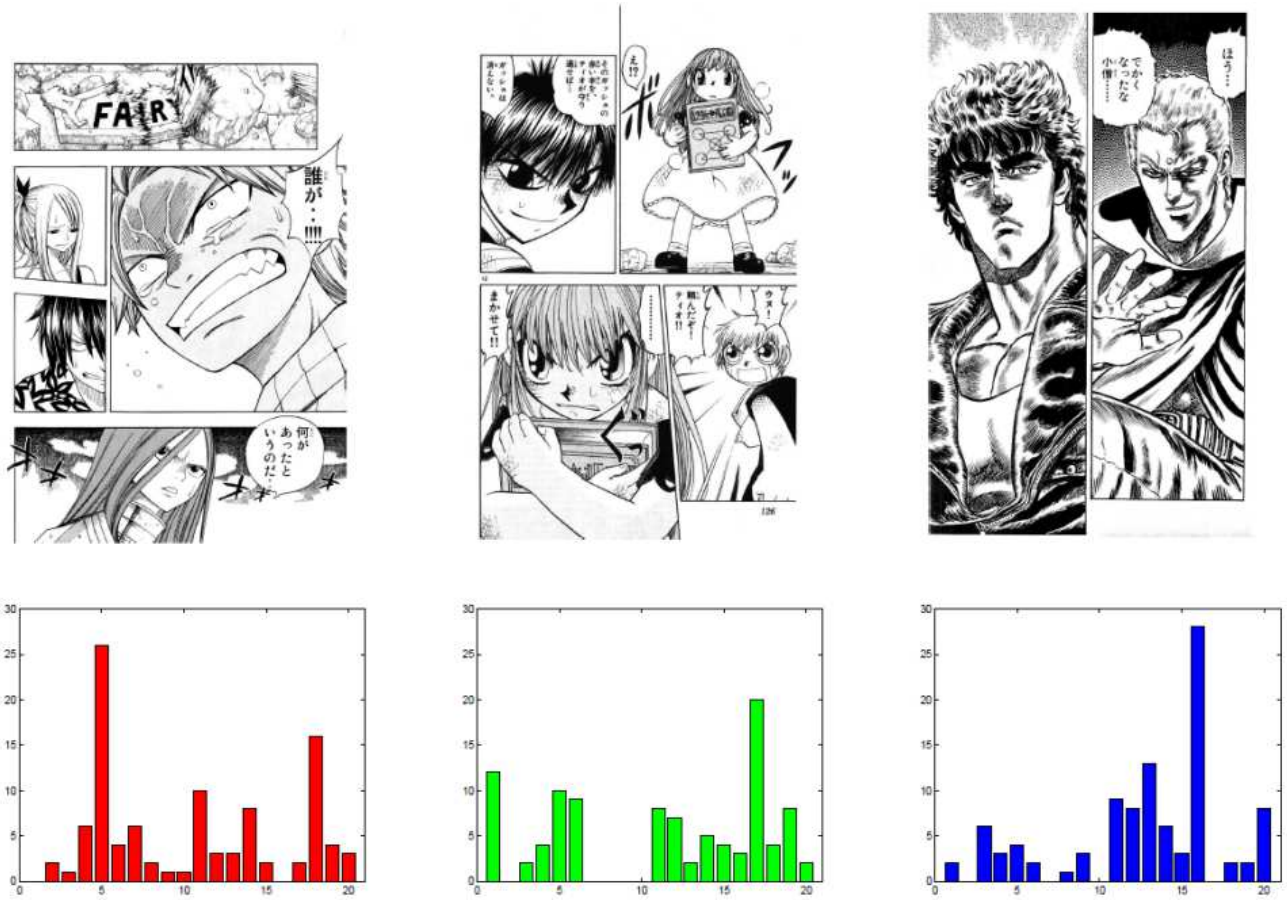
Style-Based Artist Retrieval

- The manga collection of the same artist is randomly divided into subsets, each of which consist of 20 manga pages. Each subset is viewed as a manga document.
- The proposed style model is used to discover style elements of an artist.
- Given a query document, find documents there were produced by the same artist who produced the query.
- MAP@10=0.806



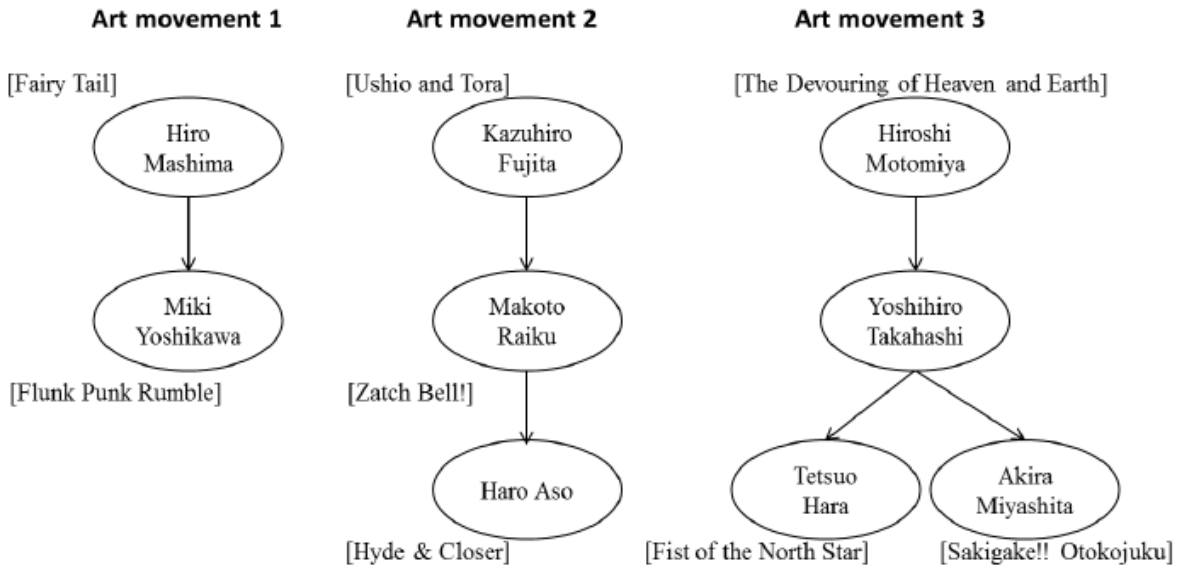
Style-Based Artist Retrieval

- Sample manga pages produced by three different artists.



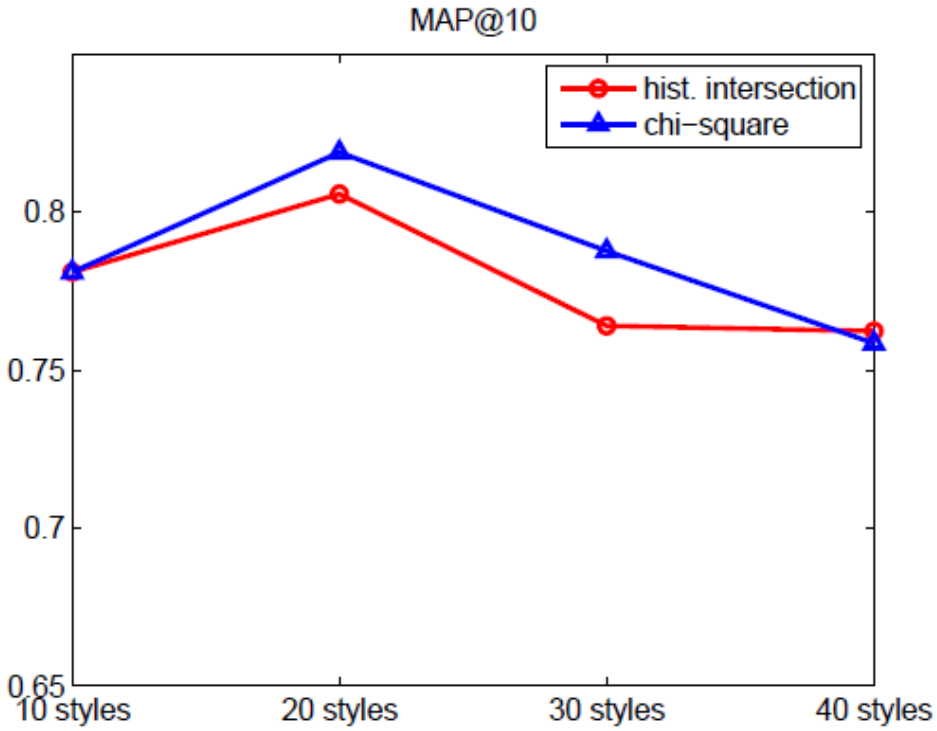
Style-Based Art Movement Retrieval

- An art movement is a tendency or style in art with a specific common philosophy or goal, followed by a group of artists.
- Styles of mangas produced by artists coming from the same studio are correlated.
- Our dataset: 8 artists belonging to 3 art movements



Style-Based Art Movement Retrieval

- View 20 manga pages as a manga document. Learn style elements distribution of each art movement.
- Given a query, find manga documents produced by the artists of the same movement.
- MAP@10=0.854



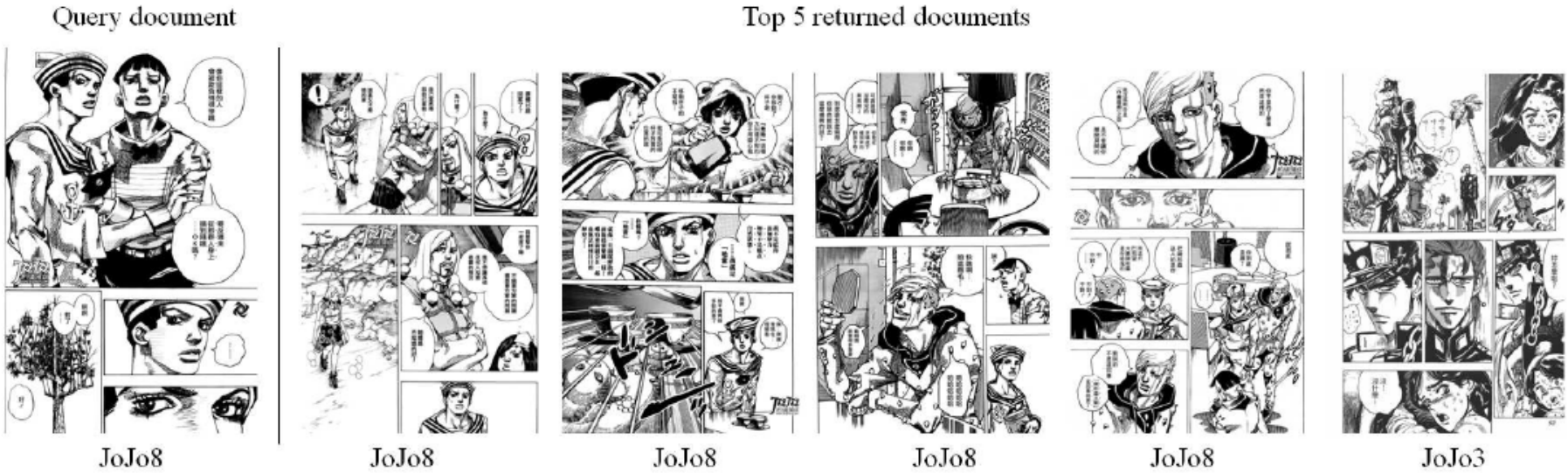
Style-Based Artwork Period Retrieval

- Some popular mangas had been published for more than twenty years.
- Since the first volume published in 1987, *JoJo's Bizarre Adventure* has been published for three decades. There are eight parts consisting of more than 110 volumes.

Fig. 7: Left to right: sample manga pages from *JoJo's Bizarre Adventure* Part 1 (1987–1988), Part 3 (1989–1992), and Part 8 (2011–).

Style-Based Artwork Period Retrieval

- Given a query manga document from JoJo8, for example, we would like to retrieve documents that are also from JoJo8.
- MAP@10=0.73
- Sample results



Conclusion

- Feature design: screentone features and panel features
- Style model construction: Based on LDA, implicit style elements are discovered.
- Novel applications at the style level
  - Artist retrieval
  - Art movement retrieval
  - Artwork period retrieval
- Future works
  - Large-scale experiments
  - More innovative ways to access mangas

QUESTIONS?

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