Project ID: 19

NERD'S GALLERY:
COMMUNITIY DETECTION ON PAINTINGS

Jiang Shuyu Liu Ziqian Zhang Ming Zhang Jiacan

NUS National University of Singapore

Introduction

- **Objective:** In this project, we aim to identify styles of different paintings with community detection(CD) algorithms , compare various CD algorithms' performance and take insights into the relationships of genres.
- **Dataset:** We have paintings of 12 styles , and each style contains 20 paintings.
- **Algorithms:** Girvan-Newman, Markov Clustering and Clique Percolation Method.

Details of Data & Methods Used

- **Data:** Each painting is a RGB image labeled with a certain style(abstract art, naive art, etc.).
- **Feature vector**: We use pre-trained CNN to get feature vectors. Feature vectors' size is (12, 1), and the i^{th} value indicates the probability of belonging to the i^{th} style.
- **Dissimilarity matrix**: For each pair of paintings, we compute the Euler distance of their feature vectors as their dissimilarities, set a threshold manually and remove all values that are greater than the threshold.
- **Graph**: We use NetworkX to generate graphs. We compare algorithms' performance on both weighted graphs and unweighted graphs.

Workflow

Project Proposal	Decide our project theme and gather dataset
Compute Dissimilarity	Calculate the dissimilarity matrix
Form Graph	Construct graphs for paintings
Community Detection	Detect communities using GN ,CPM and MCL

Comparison of CD Algorithms

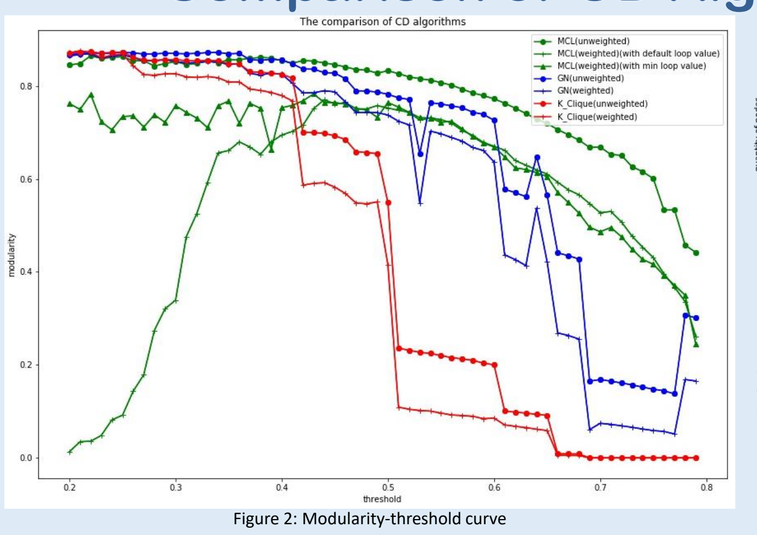


Figure 2: Modularity-threshold curve

- All three algorithms perform better on unweighted graphs than weighted graphs.(see figure 2)
- Markov Clustering is more stable than Girvan-Newman and K-Clique, and there are more fluctuations on GN's curve.(see figure 2)
- Modularity is not a good measurement when the threshold is very low, because we cut off so many edges that only few core communities can survive.
- MCL tends to divide communities strictly and generate many single-node communities, especially on weighted graphs(see figure 3.[1,2,3]). That's why the modularity is low on the MCL(weighted) curve even though the threshold is very low(see figure 3.4).
- We find that if we set the self-loop value to be the minimum in dissimilarity matrix, then MCL performs similarly on weighted graphs like other algorithms.

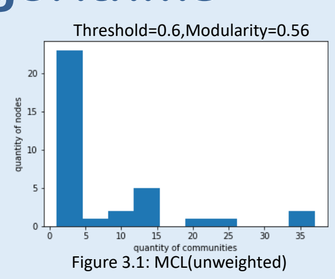


Figure 3.1: MCL(unweighted)

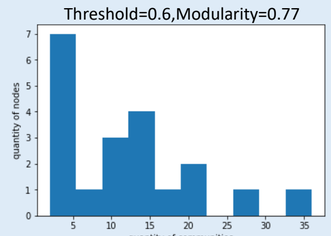


Figure 3.2: MCL(weighted)

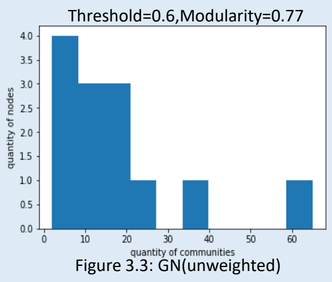


Figure 3.3: GN(unweighted)

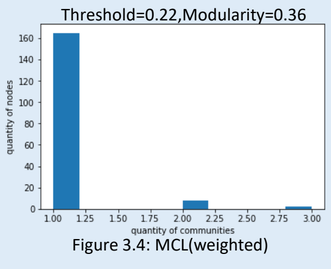


Figure 3.4: MCL(weighted)

Results & Analysis

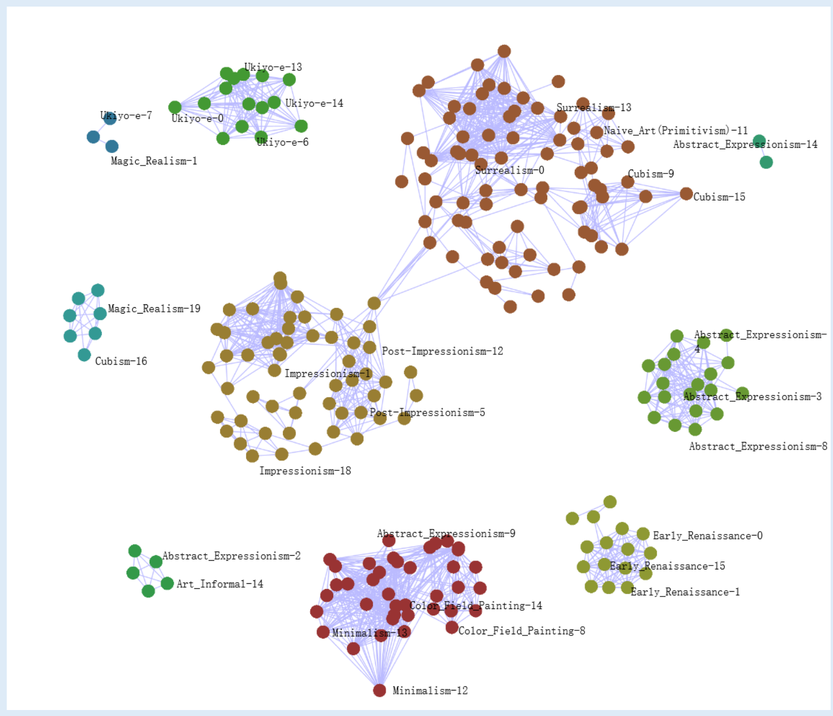


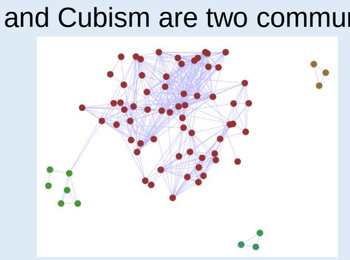
Figure1: Community Detection using Girvan-Newman Algorithm

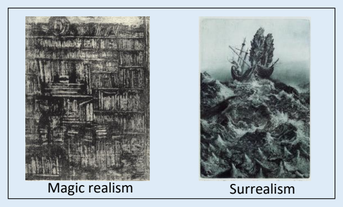
■ Results

- Some communities are closed to others, and some are far from others. It shows that some painting styles are seperated while some are intertwined.
- We have detected the unique or intertwined ones from figure 1.
  Unique: *Early Renaissance, Ukiyo-e*
  Intertwined: *<Cubism, Magic Realism, Naive Art, Surrealism>, and <Abstract Expressionism, Color Field Painting, Minimalism> and <Abstract Expressionism, Art Informal> and <Impressionism, Post-Impressionism*

■ Analysis of intertwined styles

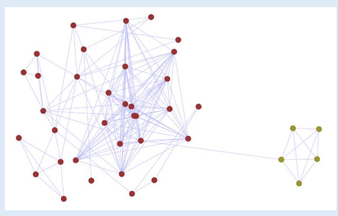
- CNN recognition accuracy is **81.25%** for the 4 painting styles: Cubism, Magic Realism, Naive Art, and Surrealism.
- Naive Art and Cubism are two communities, however, they have many connections.

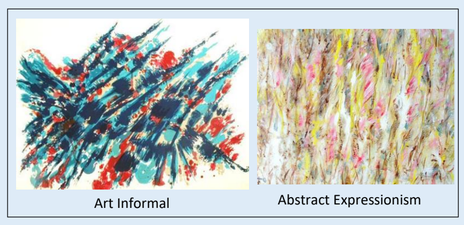




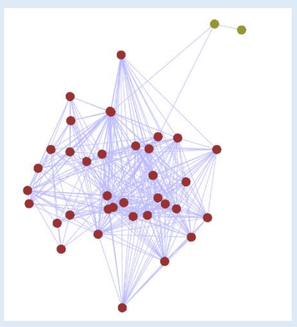
- Color Field painting and Minimalism are different styles while they have something in common with Abstract Expressionism.

- Abstract Expressionism and Art Informal have strong connections. The CNN recognition accuracy is **82.5%**.





- Impressionism and Post-Impressionism also have strong connections.



■ Findings

- Color Field painting and Minimalism are developed from Abstract Expressionism which can be validated on Wikipedia and can support our results.
- Abstract Expressionism and Art Informal are connected tightly in the communities. Actually they are called equally by artists.(*ideelart.com*)

Conclusions & Lessons

Conclusions

- Most of the relationships we find by the communities can be validated by the painting's style development history and real genres. It shows the results of our analysis are good and reasonable.
- The deep learning tool is helpful to do further work, whereas the CNN's recognition accuracy of styles should be improved.

Lessons

- Our project can be used in painting art research.
- Teamwork is very important, and everyone's work is an indispensable part.