Motivation

It takes some time for a human being to conceive the differences between two of the most well-known impressionist painters: Claude Monet and Edouard Manet. Although quite cultivated the French beau monde of the nineteenth century had a struggle with this problem as well. Claude Monet made his debut at the salon in Paris in 1865 where, at the same time, already well-known Edouard Manet presented his famous painting “Olympia”. Manet was very surprised and furious when visitors came to him to appraise “his” outstanding marinas, he was convinced: some no-name artist used the similar name to steal his fame. The confusion was overcame and one and a half centuries later the people came up with the following memes: “Monet is spots. Manet is people.”

Dataset

- The data was obtained from “Painter by numbers” Kaggle competition web-site [1] and containing Wikiart dataset [2]
- After filtering we get 7,264 color images in .png format and two classes:
  - 4,898 paintings by Claude Monet (3,899 Train + 1,000 Test)
  - 2,043 paintings by Edouard Manet (1,822 Train + 221 Test)

References


Data preprocessing

Problem: all paintings have different resolution (height and width can vary from 400 to 7500 pixels) To homogenize the data the Python Imaging Library (PIL) is used:

Step 1 Crop image to be a square with a side equal to the shorter one of the initial rectangle.
Step 2 Resized image to be 300 * 300 pixels.
Step 3 Use 8-bit RGB color representation is used to encode the color of each pixel.

Data format:
- 3-dimensional matrix 300 * 300 * 3
- each element is a number from 0 to 255

For some methods is used:
Step 4 Flatten 3-dimensional matrix to a vector of length \(2.7 \times 10^5\)

Problem: The number of features \((2.7 \times 10^5) \approx\) sample size \((726)"

Questions: is there any set of essential distinctive features for the paintings?

Solutions: ICA and PCA

Classification with CNN

Loss: binary cross-entropy
Parameters = 3,089, batch size = 10, epochs = 50

Results

- SVM is biased and KNN is very biased towards Monet
- CNN improves accuracy and accuracy by 10%
- CNN have balanced TP and TN

Best performance:
- TP = 0.98 (KNN)
- TN = 0.74 (CNN)
- Acc = 0.86 (CNN)
- auroc = 0.85 (CNN)

Classification with PCA + KNN

KNN Parameters:
- the number of neighbors \(n_{\text{neighbors}} = (2, 3, ..., 19, 20)\)
- weights = \(\text{uniform} + \text{all neighbors are weighted equally}$
- distance = \text{inverse Euclidian distance from the neighbor to the point}

Classification with PCA + SVM

Kernels and parameters:
1. Linear \(K(x, y) = < x, y >$
   - misclassification vs. decision boundary simplicity
   \(C = (0.001, 0.01, 0.1, 1, 10, 100, 1000)\)
2. Poly \(K(x, y) = < (\alpha x), y > + c^2\)
   - \(\alpha = (0.001, 0.01, 0.1, 1, 10, 100, 1000)\)
   - \(c = (0, 1, 2, ..., 10)\)
3. Rbf \(K(x, y) = \exp(-|x - y|^2)\)
   - \(C = (0.001, 0.01, 0.1, 1, 10, 100, 1000)\)
   - \(\gamma = 10^{-5}, 10^{-4}, ..., 10^0\)

Principal Component Analysis

Independent Component Analysis

Problem: the number of features \((2.7 \times 10^5) \approx\) sample size \((726)"

Questions: is there any set of essential distinctive features for the paintings?

Solutions: ICA and PCA

80% of variance explained by 127 components

The image reconstruction from 127 PC

The first 16 PCA components

The first 16 ICA components

The dataset projection onto the first 3 PC

The dataset projection onto the first 3 IC (Monet, Manet)