Monet is spot, Manet is people

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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 beaumonde 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 overcome and one and a half centuries later the people came up with the following memes: "Monet is spots, Manet is people."

Edouard Manet, "Le Dejeuner sur l'herbe"
(English: The Luncheon on the Grass)

Claude Monet, "Le Dejeuner sur l'herbe"
(English: Dinner on the Grass)

Dataset

- The data was obtained from "Painter by numbers" Kaggle competition web-site [1] and containing Wikiart dataset [2]
- After filtering we get 726 color images in .png format and two classes:
  - 498 paintings by Claude Monet (389 Train +100 Test)
  - 228 paintings by Edouard Manet (182 Train +46 Test)

References

[1] https:/www.kaggle.com/c/painter-by-numbers/data
[2] https:/www.wikiart.com

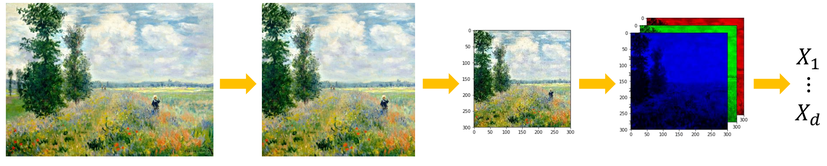
Data preprocessing

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 $300 \times 300 \times 3$
- each element is a number from 0 to 255

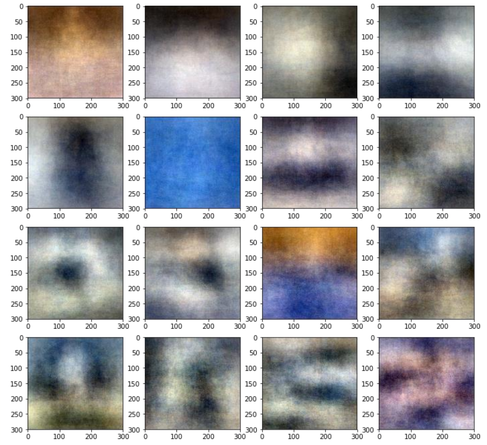
For some methods is used:
Step 4 Flatten 3-dimentional matrix to a vector of length 2.7×10^5



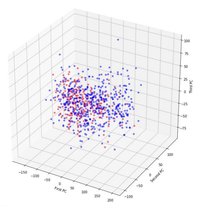
Dimension reduction

Problem: The number of features (2.7×10^5) $\gg$ sample size (726)
Question: Is there any set of essential distinctive features for the paintings?
Solution: ICA and PCA

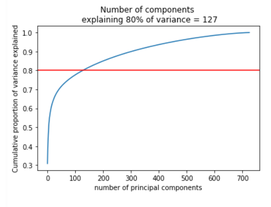
Principal Component Analysis



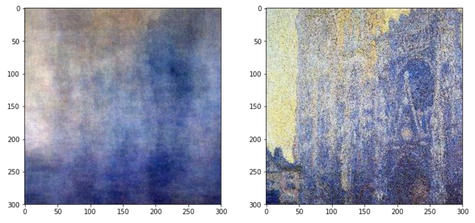
The first 16 PCA components



The dataset projection onto the first 3 PC

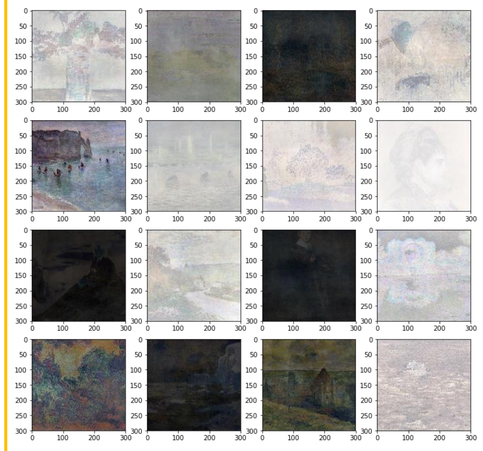


80% of variance explained by 127 components

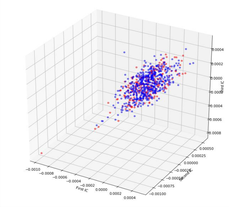


The image reconstruction from 127 PC

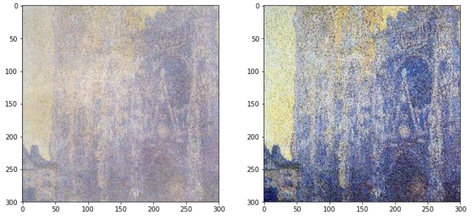
Independent Component Analysis



The first 16 ICA components



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



The image reconstruction from 127 IC

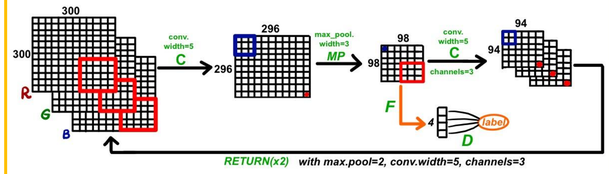
Classification PCA + KNN

KNN Parameters:
- the number of neighbors $n\_neighbors = \{2, 3, \dots 19, 20\}$
- $weights = \{'uniform', 'distance'\}$
  - $uniform$ = all neighbors are weighted equally
  - $distance$ = inverse Euclidian distance from the neighbor to the point

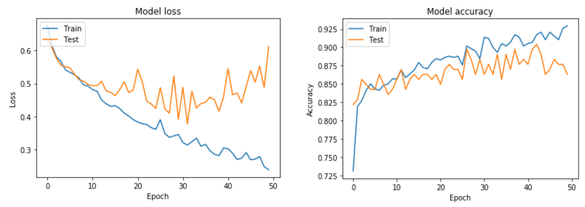
Classification with PCA + SVM

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

Classification with CNN

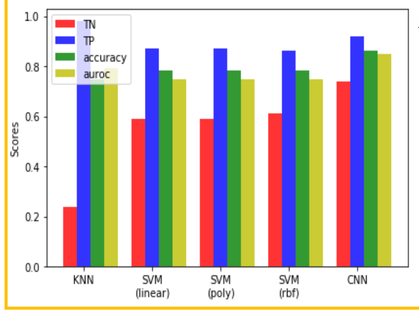


Loss: binary cross-entropy
#parameters = 389 , batch size = 10, epochs = 50



Results

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



Best performance:

- $\mathrm{TN} = 0.74$(CNN)
- $\mathrm{TP} = 0.98$(KNN)
- $\mathrm{acc} = 0.86$(CNN)
- $\mathrm{auroc} = 0.85$(CNN)