CSIC 5011 Final Project – Visualize Different Painting through Manifold Learning

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Background and Aim

- The art paintings are not easy to distinguish who painted.
- To classify them, textures of paints have to be extracted
- This work try to visualize through manifold learning techniques: ISOMAP, Spectral Embedding, t-SNE

Dataset

- Raphael Paintings and some other paintings.
- Totally 28 images.
- From Prof. Wang Yang

References

[1] H. Liu, et al, Geometric tight frame based stylometry for art authentication of van Gogh paintings, Applied and Computational Harmonic Analysis, 2016

[2]http://scikit-learn.org/stable/modules/generated/sklearn.manifold.spectral_embedding.html#sklearn.manifold.spectral_embedding

[3]http://scikit-learn.org/stable/modules/generated/sklearn.manifold.Isomap.html#sklearn.manifold.Isomap

[4]http://scikit-learn.org/stable/modules/generated/sklearn.manifold.TSNE.html#sklearn.manifold.TSNE

Methodology:

- 1. convolve images with 18 filters to be 18 images mentioned in [1]:

3.1. Geometric tight frame. The geometric tight frame we use has 18 filters $\tau_0, \tau_1, \cdots, \tau_{17}$:

$$\tau_0 = \frac{1}{16}\begin{bmatrix}1&2&1\\2&4&2\\1&2&1\end{bmatrix},\quad \tau_1 = \frac{1}{16}\begin{bmatrix}1&0&-1\\2&0&-2\\1&0&-1\end{bmatrix},\quad \tau_2 = \frac{1}{16}\begin{bmatrix}1&2&1\\0&0&0\\-1&-2&-1\end{bmatrix},$$

$$\tau_3 = \frac{\sqrt{2}}{16}\begin{bmatrix}1&1&0\\1&0&-1\\0&-1&-1\end{bmatrix},\quad \tau_4 = \frac{\sqrt{2}}{16}\begin{bmatrix}0&1&1\\-1&0&1\\-1&-1&0\end{bmatrix},\quad \tau_5 = \frac{\sqrt{7}}{24}\begin{bmatrix}1&0&-1\\0&0&0\\-1&0&1\end{bmatrix},$$

$$\tau_6 = \frac{1}{48}\begin{bmatrix}-1&2&-1\\-2&4&-2\\-1&2&-1\end{bmatrix},\quad \tau_7 = \frac{1}{48}\begin{bmatrix}-1&-2&-1\\2&4&2\\-1&-2&-1\end{bmatrix},\quad \tau_8 = \frac{1}{12}\begin{bmatrix}0&0&-1\\0&2&0\\-1&0&0\end{bmatrix},$$

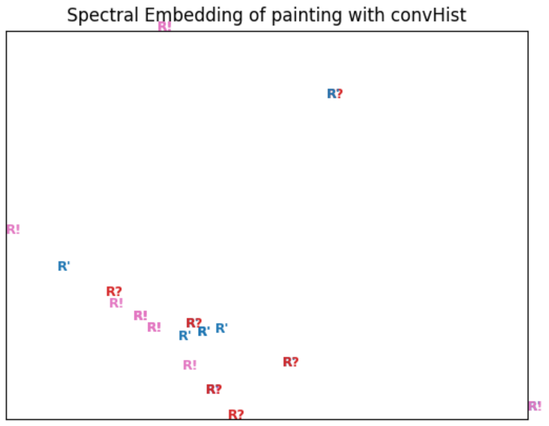
$$\tau_9 = \frac{1}{12}\begin{bmatrix}-1&0&0\\0&2&0\\0&0&-1\end{bmatrix},\quad \tau_{10} = \frac{\sqrt{2}}{12}\begin{bmatrix}0&1&0\\-1&0&-1\\0&1&0\end{bmatrix},\quad \tau_{11} = \frac{\sqrt{2}}{16}\begin{bmatrix}-1&0&1\\2&0&-2\\-1&0&1\end{bmatrix},$$

$$\tau_{12} = \frac{\sqrt{2}}{16}\begin{bmatrix}-1&2&-1\\0&0&0\\1&-2&1\end{bmatrix},\quad \tau_{13} = \frac{1}{48}\begin{bmatrix}1&-2&1\\-2&4&-2\\1&-2&1\end{bmatrix},\quad \tau_{14} = \frac{\sqrt{2}}{12}\begin{bmatrix}0&0&0\\-1&2&-1\\0&0&0\end{bmatrix},$$

$$\tau_{15} = \frac{\sqrt{2}}{24}\begin{bmatrix}-1&2&-1\\0&0&0\\-1&2&-1\end{bmatrix},\quad \tau_{16} = \frac{\sqrt{2}}{12}\begin{bmatrix}0&-1&0\\0&2&0\\0&-1&0\end{bmatrix},\quad \tau_{17} = \frac{\sqrt{2}}{24}\begin{bmatrix}-1&0&-1\\2&0&2\\-1&0&-1\end{bmatrix},$$

- 2. Construct histogram of each image convolved with different filter (with same bins)
- 3. Concatenate histograms of each image to be a feature vector.
- 4. Use those feature vectors to reconstruct 2d map.

Spectral Embedding[2]:



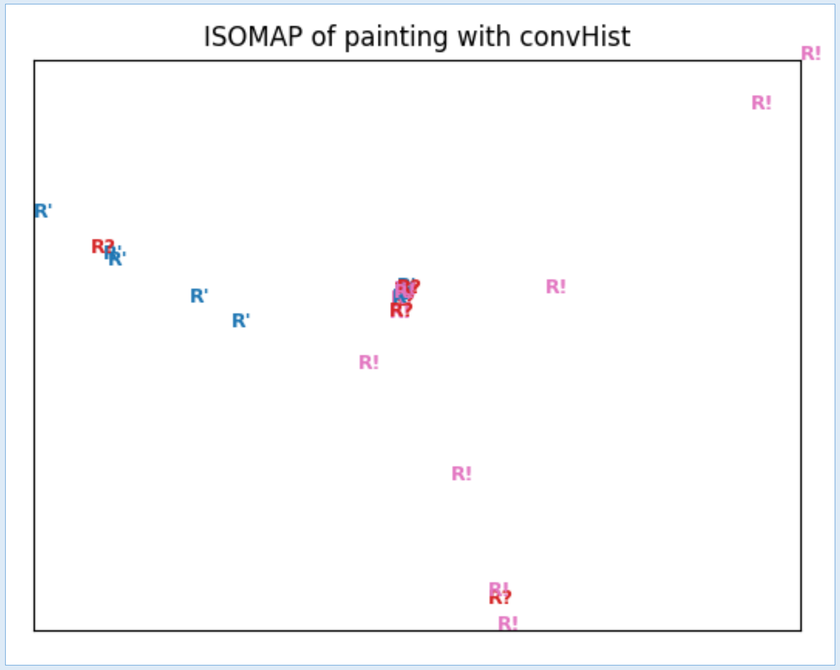
Label:

- R! : Raphael's Paint
- R? : We don't know
- R' : Not Raphael's Paint

Result:

- This texture descriptor didn't work well
- t-SNE cannot form cluster.
- But in ISOMAP, data looks better to be separate by SVM or ther classification techniques.

ISOMAP[3]:



t-SNE[4]: