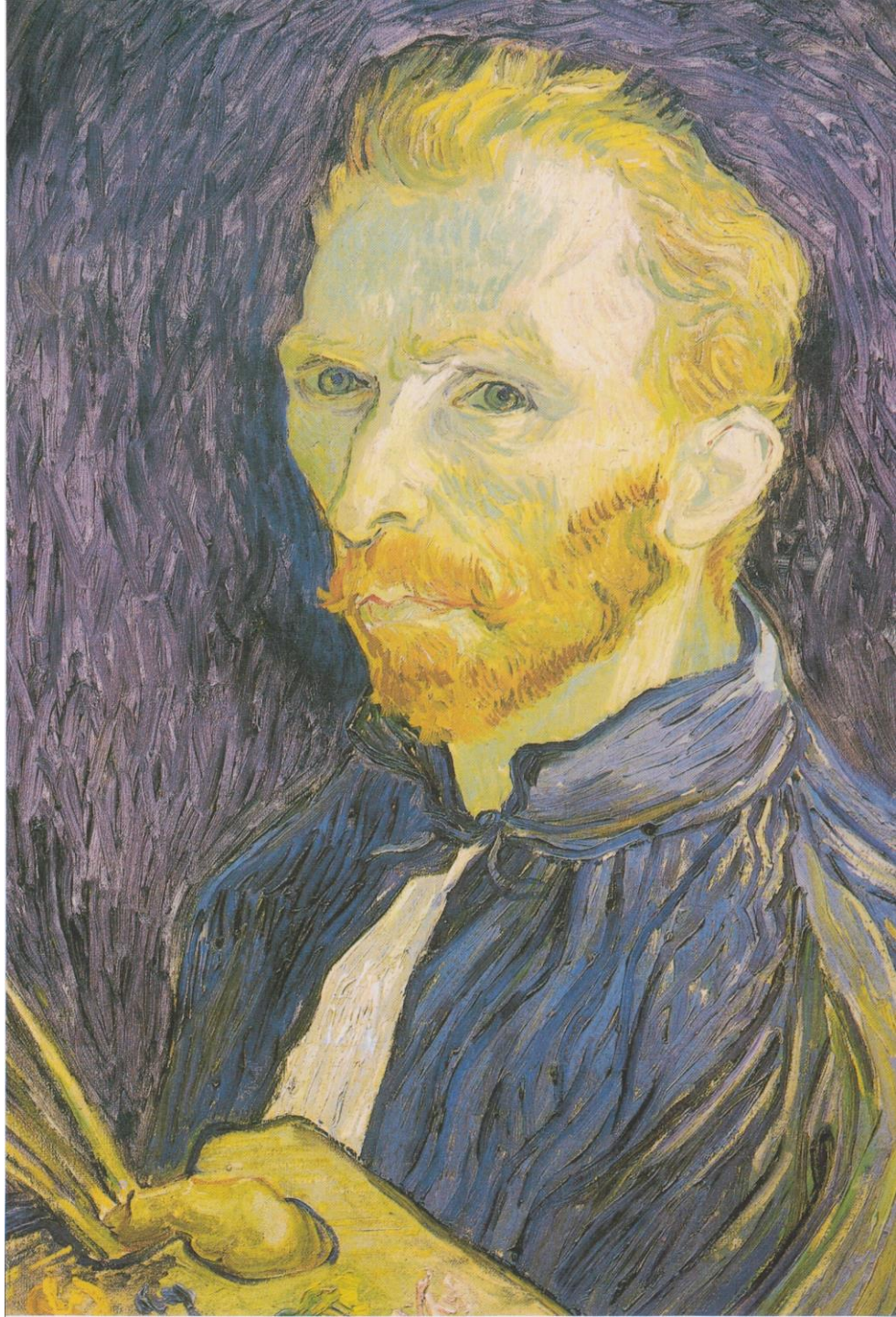
An Automatic Method of Identifying Vincent Van Gogh's Paintings

Anze Xie (Andy)



Research question:

How can we determine whether a given painting is created by Vincent Van Gogh without any fine-art knowledge?

Overschie in the Moonlight (1871)

Johan Barthold Jongkind

Fishing Boats on the Beach at Les Saintes-Maries-de-la-Mer(1888)

Vincent Van Gogh

Motivation

- The authorship of a piece of fine-art painting can affect its art value, history value and market value [1].
- Common methods used by art specialists, such as UV light, X-rays are invasive and may cause potential damage.
- Large amount of paintings in online database need be to classified
- An automatic author identifying method can help to address such problems

Current state-of-the-art

- Li et al. developed a novel algorithm for extracting brush strokes from van Gogh's paintings and conducted statistical analysis to distinguish van Gogh's works of different periods[2].

- Liao et al. proposed a cluster multiple kernel learning algorithm to recognize authors of oil paintings based on color, texture and spatial layout[3].

Current state-of-the-art

- Folego et al. applied a Convolutional Neural Network to extract discriminative visual patterns of an artist directly from images[4].

- Khan et al. built a database of paintings of 91 artists and classified their works[5].

My approach

1. Image transformation (add random noise and flip)
2. Crop each image and break into small patches
3. Extract features from patches by transfer learning of VGG-19
4. Generate support vector classifier models using patches from training set
5. Apply patches from test set to SVC model generated
6. Compute each patch’s score (distance to separating hyperplane)
7. Fuse the scores and give final response

Method of fusing scores

- Max number of votes(number of patches with positive/negative distance)
- Mean patch distance to separating hyperplane
- Total patch distance to separating hyperplane
- The farthest patch distance to separating hyperplane
- The median of patch distance to separating hyperplane

Dataset description

Class	Training paintings	Training patches	Test paintings	Test patches
van Gogh	23	78754	9	2648
non-van Gogh	42	17222	11	3114
Total	67	25076	20	5762

Results

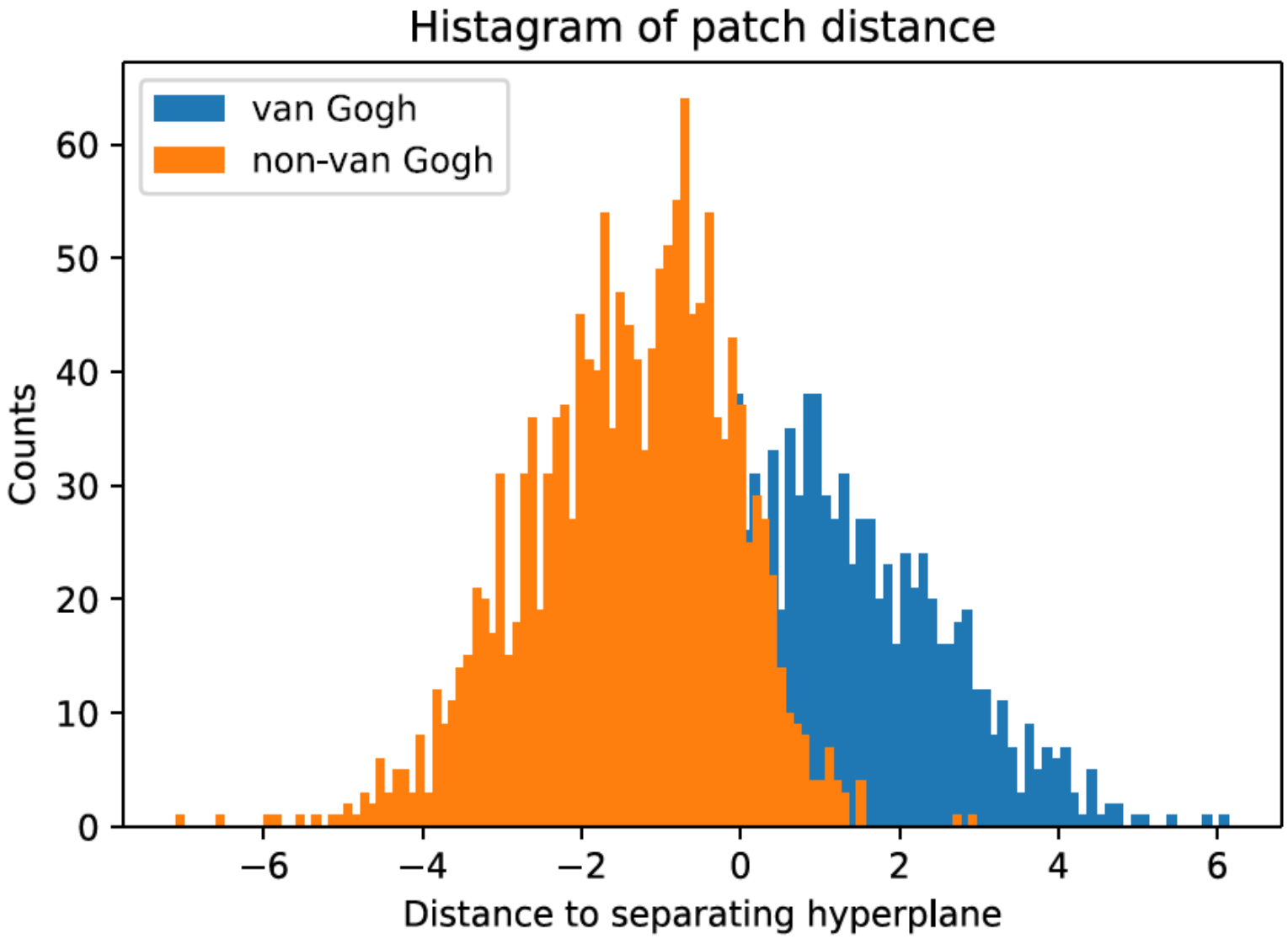
Positive: van Gogh's painting
Negative: non-van Gogh's painting

	Correct prediction	False positive	False negative	Correctness rate	F1-scroe
Max vote	16	4	0	80%	0.889
Mean distance	17	3	0	85%	0.919
Sum distance	17	3	0	85%	0.919
Max distance	16	4	0	80%	0.889
Median distance	16	4	0	80%	0.889

$$F_1 = \frac{TP}{TP + 0.5\,(FP + FN)}$$

TP = number of true positive
FP = number of false positive
FN = number of false negative

Two-sample t-test



Van Gogh patch distances:
Mean = 0.4418
Var = 2.9938

Non-van Gogh distances:
Mean = -1.4115
Var = 1.6251

Null hypothesis:

$$Mean_{van\ Gogh} = Mean_{non-van\ Gogh}$$

Alternative hypothesis:

$$Mean_{van\ Gogh} \neq Mean_{non-van\ Gogh}$$

t-statistic = 32.238
p-value = 1.123e-189

Discussion and Comparison

- F1-score is about the same level as the F1-score (0.932) of Folego et al.’s method (trained with 264 images)
- Less sample images are required
- May be effective on smaller image size

Application on identifying other artist's paintings

- Same method is applied to identify Pablo Picasso's paintings
- F1-score: 0.84

Possible future work

- Apply this method to other artists' paintings
- Extend this method to a multi-class classification method
- Combine features extracted from CNN with other features such as complementary color, brush strokes to get more precise outcome

References

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[3]. Liao, Z., Gao., Zhou, T., Fan, X., Zhang, Y., & Wu, J. (2019). An oil painters recognition method based on cluster multiple kernel learning algorithm. *IEEE Access, 7,* 26842-26854. doi:10.1109/ACCESS.2019.2899389

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Thank you!