Estimating Painting Date Based on Image Features

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***Abstract*—The abstract goes here.**

I. Introduction

II. Background

III. Methodology

Leave-one-out cross validation was used on the results of feature-based classifiers, a list of actual years against the classified years was then produced. Pearson product-moment correlation coefficient was applied to these lists to give a performance measure of each classifier.

For exemplar-based classifiers the result of the classification was a new point in space, the statistically-chosen exemplar, which was then compared to an existing point in space, the artistically-chosen exemplar. The performance measure applied to each classifier was the squared error of the distance from the statistically-chosen exemplar to the artistically-chosen exemplar.

IV. Classification

A. Feature-based Classification

The digital analysis of paintings is quite a wide area to look into; there are many feature spaces which can be used; from colour-space, edge detection, texture analysis and brush-stroke recognition.

Initially we focused on simple colour-space analysis; taking the mean RGB across each painting and running it through a simple classification algorithm, k-nearest neighbour. Other colour models, such as HSV, were also used to compare and contrast against RGB. Manhattan distance was the primary distance measure used for this feature space.

Colour histograms of the paintings were also produced as a more accurate measurement of colour space. We continued to use k-nearest neighbour, but with different methods of calculating distance between each point in feature space; namely chi squared.

As a lot of Kyffin Williams' paintings are highly textural, edge detection and texture analysis were thought to be good techniques to explore.

Edge detection involved applying one of the various edge detection algorithms available, applying it to each painting. The distance measure is base on the number and strength of edges in the painting.

Texture analysis is a continuation of edge detection. Instead of just taking the strength and number of edges; it creates a histogram of orientated gradients[1] begin to build up a more faithful representation of the texture of a painting. To begin with steerable filters at 0, $\frac{\pi}{4}$, $\frac{\pi}{2}$ and $\frac{3\pi}{4}$ were applied to the image to bin by those orientations.

Gabor filters were also used with a greater range of angles to produce a more accurate representation of the texture of the painting.

Another method for producing histograms of orientated gradients is to apply two discrete derivative masks to the image to get the gradient of x and y and then to work out the gradient direction at each point. This can then have a histogram created from it to provide a different representation of the texture of the image.

B. Exemplar-based Classification

The data on artistically-chosen exemplars opened up the options for different methods of classification. Rather than using a k-nearest neighbour algorithm to classify each point in the feature space we could just take the year of the nearest exemplar to that point and use that for classification.

This then raised the question as to what the digitally-chosen exemplars would be. Statistically exemplars would be the centroid of a group of paintings in feature space; a relatively simple operation to perform digitally.

C. Comparing Artistic and Statistical Exemplars

The same distance measure used to run k-nearest neighbour on the feature-based classifiers was used to generate the error between the statistical and artistic exemplars.

V. Results

VI. Conclusion

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[1] N. Dalal and B. Triggs, "Histograms of oriented gradients for human detection," in *Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on*, ser. CVPR '05, vol. 1. Washington, DC, USA: IEEE, Jun. 2005, pp. 886–893 vol. 1. [Online]. Available: http://dx.doi.org/10.1109/cvpr.2005.177