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## Two-Stage Deep Learning Approach to the Classification of Fine Art Paintings

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**ABSTRACT** Due to the digitization of art collections and art galleries became widely available online. This paper presents a multi-stage machine learning approach aiming to improve the accuracy of fine art painting classification. The proposed approach divides the input image into patches and trains a deep neural network to classify each patch individually. The probability vectors given by the first-stage network are fused in the decision-making process to classify the analyzed input image. The key factor in this approach is the fact that the second stage is trained on the patches extracted from the analyzed input image. This way, the second stage is able to learn the features of the input image during the first stage. The proposed approach is evaluated using VGG-16, VGG-19, GoogLeNet, ResNet-50, and ResNet-101 as first-stage deep neural networks and VGG-16, VGG-19, GoogLeNet, ResNet-50, and ResNet-101 as second-stage deep neural networks. The results indicate that the proposed approach outperforms the state-of-the-art techniques.

**INDEX TERMS** Fine art style recognition, transfer learning, digital humanities.

### I. INTRODUCTION

This paper presents a multi-stage machine learning approach to the problem of semantic categorization of fine art paintings. The proposed approach