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Classification of interior architectural styles using deep neural networks

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Abstract

This paper presents a study on the automatic classification of interior architectural styles using deep neural networks. Both CNNs and visual transformers were used as models for classification and were finetuned on the annotated dataset. Our findings demonstrate the potential of deep learning for automating interior style classification and advancing the field of interior architecture

Introduction

Automatic interior architectural style classification has practical application in advertising and marketing of interior design services. With the assist of modern deep neural networks, we aim to automate the process of classifying interior design styles.

Deep learning algorithms can analyze large sets of images and learn to recognize patterns and features that are characteristic of different styles. This allows them to classify new images with high accuracy and make predictions about the style of an interior design.

Data

Collecting the data was challenging, as there are no publicly available datasets. Most of the available images do not represent a specific design style, which makes the task even more difficult. The data was entirely collected by us by internet scrapping, it was then labelled with assist of a interior design professional. Dataset consists of around 10000 images in RGB format of size 720x720 px, with balanced eight classes. The classes were chosen based on their popularity in internet searches and with the advice of an expert mentioned prior.

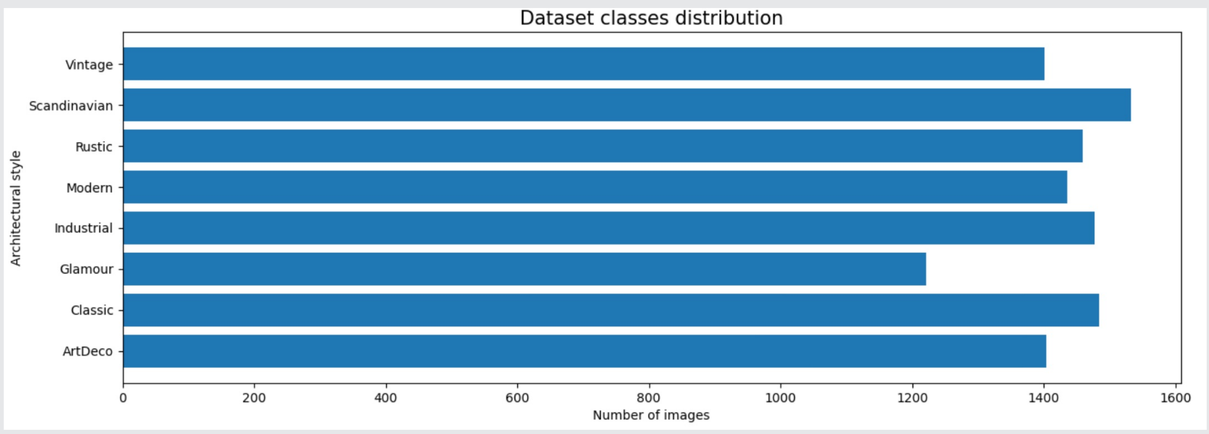


Figure: Class Distribution

Model

Both convolutional neural networks (CNNs) and visual transformers as classification models were used. Our approach involves fine-tuning pretrained architectures on our annotated dataset. For CNNs, we utilized popular models such as VGG16, VGG19, ResNet34. For the visual transformers - VIT-b-16. [2] In total 70 experiments were performed with various hyperparameters. An offline augmentation was applied prior to training, and the images were resized to 256x256 px size.

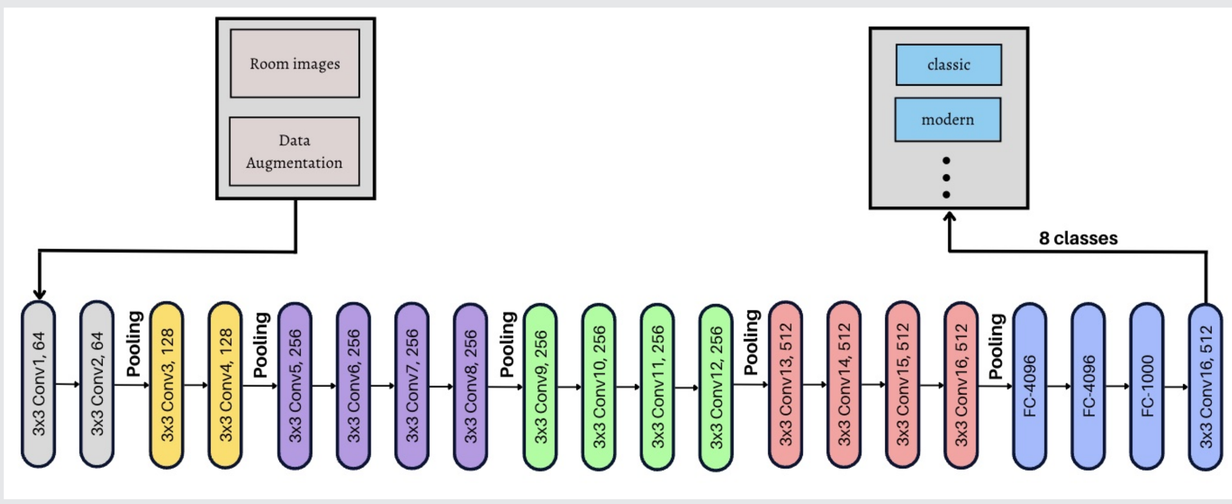


Figure: VGG19 Model Architecture

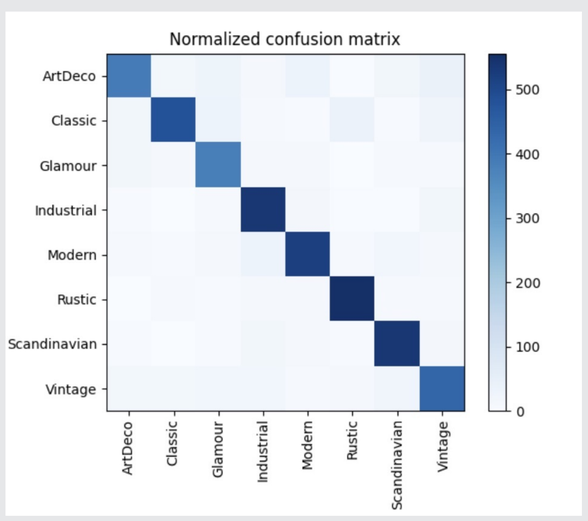
Results

Table: Various Model Evaluation Metrics

Model Type	Accuracy	Precision	Recall	F-score	Loss*
VGG16	0.8290	0.8308	0.8290	0.8291	0.7417
VGG19	**0.8407**	**0.8422**	**0.8407**	**0.8399**	**0.7327**
ResNet34	0.4568	0.4825	0.4568	0.4527	1.5111
ViT-B-16	0.5386	0.5037	0.5386	0.5006	1.3865

*Binary Cross Entropy Loss

Best model achieved high metrics proving its effectiveness in classification. The use of Class Activation Maps makes the model fairly explainable, providing insight into how the model makes its predictions. Furthermore, the model has demonstrated its ability to work effectively on different types of images, including both taken by amateurs and professionals.



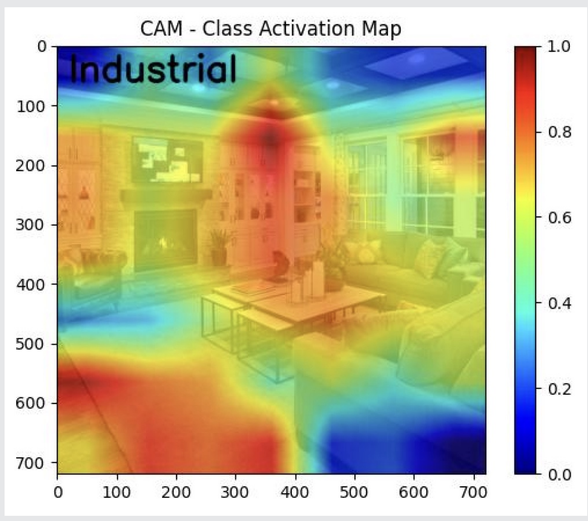


Figure: Left: Confusion Matrix, Right: Sample Class Activation Map

Application

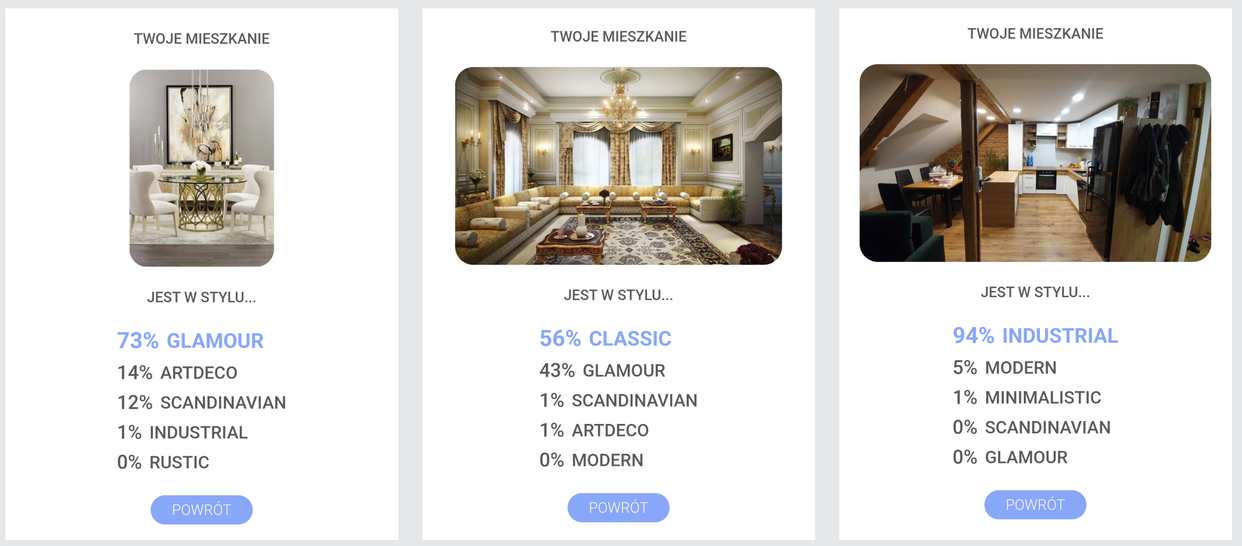


Figure: Screenshots of hosted application

References

1. Kim, J. and Lee, J.-K. Stochastic detection of interior design styles using a deep-learning model for reference images. volume 10. 2020. doi:10.3390/app10207299.

2. Yoshimura, Z. W. C. R., B. Cai. Deep learning architect: Classification for architectural design through the eye of artificial intelligence.CUPUM 2019,53:249–265, 2019. doi:10.1007/978-3-030-19424-6_14.

Source code

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Demo application