UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

Deep Learning

(Master's degree in Artificial Intelligence)

Lab 1 CNN

Model card

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1. MODEL DETAILS

a. Person or Organization

The responsible individuals of the present project are:

- João Valério (joao.agostinho@estudiantat.upc.edu)
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From the FIB - UPC Universitat Politècnica de Catalunya organization.

b. Date

13.04.2023

c. Version

236 221 parameters

d. Type

Convolutional neural network (CNN).

2. INTENDED USE

The primary purpose of this model is for educational use within the context of a deep learning assignment in the Master in Artificial Intelligence program at UPC. The model was designed to demonstrate the understanding and application of Convolutional Neural Networks (CNNs) and deep learning concepts in the domain of image classification.

This model can serve as a baseline for comparing the performance of different algorithms or more complex models on the same problem, assisting in identifying areas for improvement and potential routes for further research.

Please note that this model is not intended for deployment in real-world applications or for use in critical applications. The model's performance and generalizability have not been rigorously tested, and it may not be suitable for use outside of the educational context.

3. METRICS

During development, the primary metric used was validation accuracy, accompanied by the true positive distribution from the confusion matrix. For the final evaluation of the model, metrics such as accuracy, precision, recall, and F1-score were used and are presented in Chapter 6.

4. THE DATA

The training data used is the low-resolution images from the Museum Art Medium dataset (https://storage.hpai.bsc.es/mame-dataset/MAMe_data_256.zip), which contains 29 classes of materials and techniques. Each class has an equal distribution of 700 examples in the dataset and 150 examples in the validation set.

Additionally, the labels Woven fabric, Glass, and Lithograph have been oversampled by factors of 0.2, 0.3, and 0.2, respectively. This was achieved through data augmentation involving 0-10-degree rotation, 0-0.2 height and shift range, and 0-0.2 zoom.

The test data used follow the distribution in Table 1:

Table 1: Label distribution in the test set.

Label	Distribution	Label	Distribution
Albumen photograph	700	Lithograph	700
Bronze	700	Marble	257
Ceramic	700	Oil on canvas	700
Clay	313	Pen and brown ink	286
Engraving	700	Polychromed wood	375
Etching	700	Porcelain	700
Faience	700	Silk and metal thread	95
Glass	700	Silver	700
Gold	700	Steel	133
Graphite	188	Wood	700
Hand-colored engraving	328	Wood engraving	361
Hand-colored etching	584	Woodblock	700
Iron	265	Woodcut	700
Ivory	572	Woven fabric	700
Limestone	700	-	-

The distribution indicates that the generalizability for labels with low representation such as Faience and Graphite has low confidence.

a. Preprocessing

The data is globally normalized.

b. Limitations

Upon inspecting the dataset, it is observed that objects are centred in the images, unrotated, and presented with good lighting conditions. Consequently, any new, unseen data should adhere to the same conditions for optimal performance. The developers have not conducted an analysis to determine whether the objects accurately represent the art labels, in form of style or techniques. The model supports input images of resolution 256x256.

The tests are performed on predefined validation and test sets. Those might have different characteristics than the training set. Additionally, it is not performed K-fold cross-validation or statistical analysis of the results, so it might be affected by the initialization.

5. MODEL ARCHITECTURE

Following is the representation of layers with output shape and parameters:

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 256, 256, 16)	448
max_pooling2d(MaxPooling2D)	(None, 128, 128, 16)	0
conv2d_1 (Conv2D)	(None, 128, 128, 32)	4640
max_pooling2d_1 (MaxPooling2D)	(None, 64, 64, 32)	0
dropout (Dropout)	(None, 64, 64, 32)	0
conv2d_2 (Conv2D)	(None, 22, 22, 64)	18496
max_pooling2d_2 (MaxPooling2D)	(None, 11, 11, 64)	0
dropout_1 (Dropout)	(None, 11, 11, 64)	0
conv2d_3 (Conv2D)	(None, 4, 4, 128)	73856
max_pooling2d_3 (MaxPooling2D)	(None, 2, 2, 128)	0
dropout_2 (Dropout)	(None, 2, 2, 128)	0
flatten (Flatten)	(None, 512)	0
dense (Dense)	(None, 256)	131328
dense_1 (Dense)	(None, 29)	7453

Total params: 236,221
Trainable params: 236,221
Non-trainable params: 0

6. PERFORMANCE

Table 2 shows the results after applying the model to the test data set.

The overall accuracy is 0.694, while the macro F1 score is 0.679.

Table 2: Test results

Label	Precision	Recall	F1-Score	Support
Albumen photograph	0.95	0.92	0.93	700
Bronze	0.65	0.69	0.67	700
Ceramic	0.79	0.60	0.68	700
Clay	0.66	0.80	0.73	313
Engraving	0.66	0.57	0.61	700
Etching	0.52	0.62	0.56	700
Faience	0.86	0.72	0.78	700
Glass	0.65	0.59	0.62	700
Gold	0.84	0.85	0.84	700
Graphite	0.60	0.91	0.72	188
Hand-colored engravings	0.89	0.96	0.92	328
Hand-colored etching	0.88	0.93	0.90	584
Iron	0.54	0.74	0.63	265
Ivory	0.60	0.57	0.58	572
Limestone	0.64	0.58	0.61	700
Lithograph	0.63	0.66	0.64	700
Marble	0.43	0.57	0.49	257
Oil on canvas	0.78	0.62	0.69	700
Pen and brown ink	0.63	0.72	0.67	286
Polychromed wood	0.48	0.60	0.53	375

Porcelain	0.81	0.73	0.76	700
Silk and metal thread	0.20	0.68	0.31	95
Silver	0.72	0.70	0.71	700
Steel	0.48	0.85	0.62	133
Wood	0.72	0.57	0.63	700
Wood engraving	0.61	0.77	0.68	361
Woodblock	0.87	0.69	0.77	700
Woodcut	0.81	0.80	0.80	700
Woven fabric	0.66	0.57	0.61	700
accuracy			0.694	15657
macro avg	0.67	0.71	0.679	15657
weighted avg	0.71	0.69	0.70	15657

7. ETHICAL CONSIDERATIONS

This CNN model has been developed solely for educational purposes and is intended to be used within the scope for which it was conceived. It is not intended to cause harm or damage to any individual or entity. The model is not to be used for any illegal, unethical, or malicious activities. Any use of this CNN model beyond its intended purpose is strictly prohibited. The developers of this CNN model do not assume any responsibility for any consequences that may arise from the misuse of the model. Users are solely responsible for ensuring that their use of the model complies with all applicable laws and regulations. The developers of this CNN model disclaim any liability for any damages or losses incurred as a result of using the model. Users should exercise caution and use the model responsibly, keeping in mind its intended educational purposes only.