Application of Prototypical Networks and Few-Shot Learning for Art Analysis and Classification

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Overview

Objective: Apply few-shot learning to remedy the problem of heavy-tailed class distribution for artwork labels.

Motivation: Artwork databases are heavily oriented towards European and North-American art which in turn are used to train models by the ML community. Thus finding better ways to efficiently label artwork and make use of the information contained in different databases can greatly improve the diversity, quality and quantity of datasets.

Method: Prototypical Networks for few-shot learning on Web Gallery of Art and WikiArt images.

Result: Few-shot learning techniques show promising results for heavy-tailed art labels distributions and further research is encouraged.

Related Work

Strezoski et al. (2017) has been working on a **multi-task deep learning algorithm** to analyse artworks in his OmniArt project. He has collected artworks from several databases and his Omniart model effectively tries to define the type, material, time period and artist attrition. While he does well on the first few categories, he only reaches 64% accuracy for artist classification which is arguably still good for 374 different artists. He faces a problem many others will face when the number of labels becomes too large and not enough examples are available.

Similarly, Belhi et. al. train multi-task culture heritage annotators which are **conditioned on the type** of the asset. Thus paintings are annotated with classifiers trained solely on paintings. However, they face a similar issue to Strezoski et al. (2017).

References:

Belhi A, Bouras A, Foufou S. Towards a hierarchical multitask classification framework for cultural heritage. In2018 IEEE/ACS 15th International Conference on Computer Systems and Applications (AICCSA) 2018 Oct 28 (pp. 1-7). IEEE.

Snell J, Swersky K, Zemel R. Prototypical networks for few-shot learning. Advances in neural information processing systems. 2017;30.

Strezoski G, Worring M. Omniart: multi-task deep learning for artistic data analysis. arXiv preprint arXiv:1708.00684. 2017 Aug 2.

Method

Prototypical networks with few shot learning (Snell et al. 2017) creates a mapping of the input which are averaged into "prototypes" each representing a different class. A new observation is classified by its closest distance to a prototype. This makes it highly applicable to problems with heavy-tailed class distributions. In these experiments, convolutional layers are used to generate one dimensional vector representations of the artworks and consequently compute the prototypes. As can be seen on the right figures, the algorithms can generate a mappings in different locations dependent on the class label.

Data

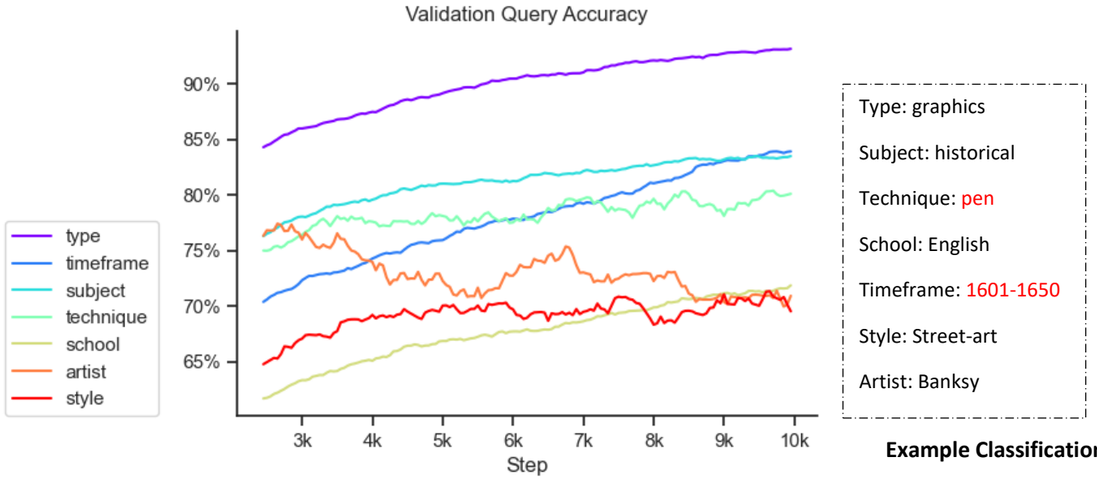
		Number of different labels						
	Count	**Type**	**Timeframe**	**Subject**	**Technique**	**School**	**Artist**	**Style**
Web Gallery of Art	51,396	12	24	9	3,914	26	4,288	16
WikiArt	19,375	-	29	-	-	-	2,744	157

Notes:

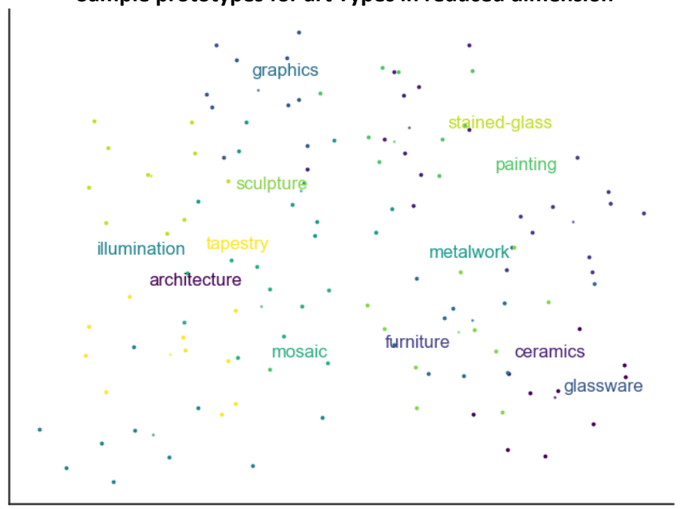
- WikiArt was scraped because the Web Gallery of Art did not contain many different styles and only art prior to the 1900s.
- For technique the 100 most common labels are selected and only sculptures, paintings and graphics techniques are classified due to unclean, irregular or insufficient labelling.
- The style classifier is conditioned on the timeframe. The artist classifier is conditioned on style.
- All images are resized and cropped to have a dimension of (224,224,3).

Results

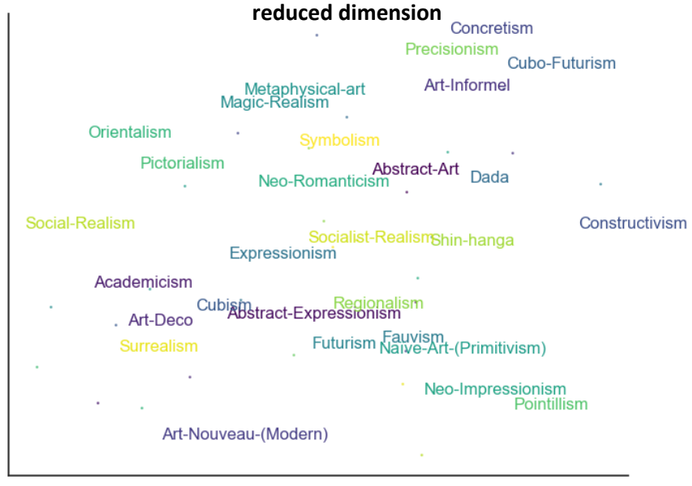
- The majority of the best models were obtained using **2-way 5-shot models** with 5 convolutional layers and 32 channels.
- The **more labels** a category has the **less well** the model performs.
- Artist classifier performs slightly **better** than the model of Strezoski et al. (2017) even thought there **20x more artists**.
- The models generate **interesting mappings** (see right Figure) and can be **applied to new data** (see example image).



Sample prototypes for art Types in reduced dimension



Sample prototypes for art Styles between 1901 and 1950 in reduced dimension



Type: graphics

Subject: historical

Technique: pen

School: English

Timeframe: 1601-1650

Style: Street-art

Artist: Banksy

Credits: Ed Ram/ Getty Images

Example Classification: recently discovered Banksy artwork in Ukraine