DATING *Giacomo Leopardi's* TEXTS (BY HANDWRITING RECOGNITION) USING CONVOLUTIONAL NEURAL NETWORKS

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ABSTRACT

We present a Convolutional neural network model that is able to date Zibaldone, a diary of Giacomo Leopardi, from 1817 to 1820. The model was trained on many different works and manuscripts of Giacomo that were all labeled from 1817 to 1820. Of the data-set we used 60% for the training the model, 20% for validation, and 20% for testing. The pre-processing of the data we did included first cropping out most of the backgrounds of all the images, which we did manually. We then wrote code that slices the images into 48 x 48 pixel squares. Then, we manually went through all the images and discarded the ones that were not suitable. The remaining 48x48 pixel images were used to train the model and date Zibaldone. The model had an accuracy of 87.28% and dated Zibaldone as most likely being written in 1819.

1 Introduction and Related Work

In the past decade, there has been lots of progress in the area of handwriting recognition, such as OCR which revolutionized the logistic and transportation industry. OCR also is widely used in healthcare for scanning ID Cards, insurance forms, and doctor's notes. This is one example of someone using a OCR to digitize some manuscript documents. [1] Deep learning has also been useful in extracting handwriting from images using convolutional neural networks (CNN).

Using a CNN, many people have made handwriting recognition models that can accurately differentiate who the author of a written text is. Here are some examples of people using a CNNs for Author Identification. [2] [3] The problem is that there are not many models that are widely known and popular for dating handwriting. In order to tackle this issue, we used a data-set of Giacomo Leopardi's works to train our model to identify writing from Giacomo and be able to accurately date the writing between the years 1817 through 1820.

2 Methodology

2.1 Dataset

The dataset that we used consisted of many manuscripts and different works of Giacomo and they were all grouped based on what year they were written from 1817 to 1820.

2.2 Pre-processing

We first pre-processed the data to exclude the empty space and keep only his handwriting by manually going through each image and cropping out the background. After this, we used OpenCV to make all the images gray-scale so that the different background colors of the manuscripts do not have an effect on the model. We then run all the images through code that will slice all the images into 48 x 48 pixel smaller images. After this, we have to go through each 48

x 48 pixel image to make sure that it is not blank. We delete the blank ones, because even though we cropped out the background some images still had some blank space that got cut into 48 x 48 pixel images.

One problem we ran into during the pre-processing state is how to slice the images into the smaller images of size 48x48. The reason there was a problem with this is that some of the images had a size that was not an integer multiple of 48. We tried out three different ways of slicing up the images to combat this problem. The first was to have a margin around the image that would not be included in the sliced images. The second was to resize the images so that they were integer multiplies of 48. The final was to include margins in between each smaller image. We went with the last method because there were some issues with the first two. The issue with the first method was that a lot of data was lost in the margins. The problem with the second was that some of the data was scaled so much that they no longer looked like coherent text.

2.3 Model

Our convolutional neural network (used widely with image recognition) uses 60% of the data for training , 20% for validation and 20% for testing. The features go through three convolutional layers, where the data goes through Convolution2D, a ReLU activation function and MaxPooling2D. After this produces a 3D convolutional layer, it is flattened into 1 dimension of the same size. This then goes through 3 dropout and linear layers, with the last activation function being softmax. The loss is categorical cross-entropy with Adam as the optimizer.

Layer (type)	Output Shape	Param #
zero_padding2d_9 (ZeroPaddin	(None, 49, 49, 1)	0
conv1 (Conv2D)	(None, 24, 24, 32)	320
activation_54 (Activation)	(None, 24, 24, 32)	0
pool1 (MaxPooling2D)	(None, 12, 12, 32)	0
conv2 (Conv2D)	(None, 12, 12, 64)	18496
activation_55 (Activation)	(None, 12, 12, 64)	0
pool2 (MaxPooling2D)	(None, 6, 6, 64)	0
conv3 (Conv2D)	(None, 6, 6, 128)	73856
activation_56 (Activation)	(None, 6, 6, 128)	0
pool3 (MaxPooling2D)	(None, 3, 3, 128)	0
flatten_9 (Flatten)	(None, 1152)	0
dropout_27 (Dropout)	(None, 1152)	0
dense1 (Dense)	(None, 512)	590336
activation_57 (Activation)	(None, 512)	0
dropout_28 (Dropout)	(None, 512)	0
dense2 (Dense)	(None, 256)	131328
activation_58 (Activation)	(None, 256)	0
dropout_29 (Dropout)	(None, 256)	0
output (Dense)	(None, 4)	1028
activation_59 (Activation)	(None, 4)	0

Total params: 815,364
Trainable params: 815,364
Non-trainable params: 0

Figure 1: Model Architecture

3 Results

The best model that was made had a validation accuracy of 87.28%. This was the model we used to date Zibaldone.

According to the data, it is highly likely that Zibaldone was written in 1819

Table 1: Results

# of Epochs	Epoch	Loss	Accuracy
100	100th(Last)	0.5101	85.20%
100	70th (best)	0.3987	87.28%

Table 2: Zibaldone results

1817	1818	1819	1820
0.05957469%	39.74149766%	44.99961147%	15.19931619%

4 Conclusion and Future Work

In the future, if we had access to more manuscripts, we could have used polynomial regression instead of a softmax to make our predictions more precise and predict exactly what day Leopard wrote something.

5 Division of Labor

We divided the work as follows:

- Model - Pradyun Solai
- Paper - Aadhavan Raja Nainar
- Poster - Nakul Solai

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