Practical work 2

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Option: 2

Title of the work: Image Classification using Convolutional Neural Networks

Used algorithm(s): Convolutional Neural Networks (CNN)

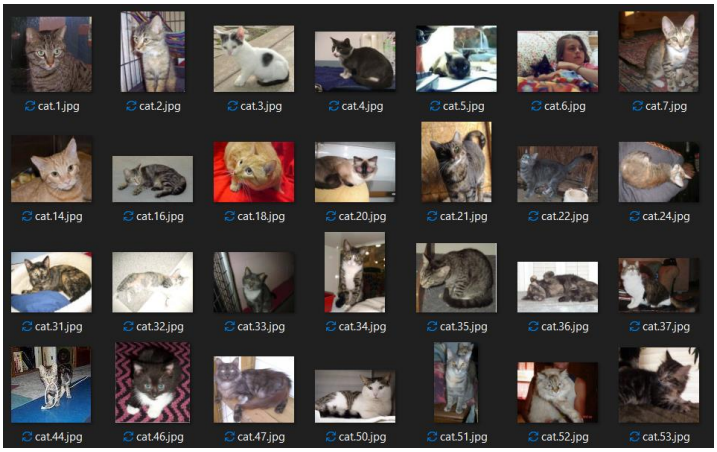
1 DESCRIPTION OF THE WORK

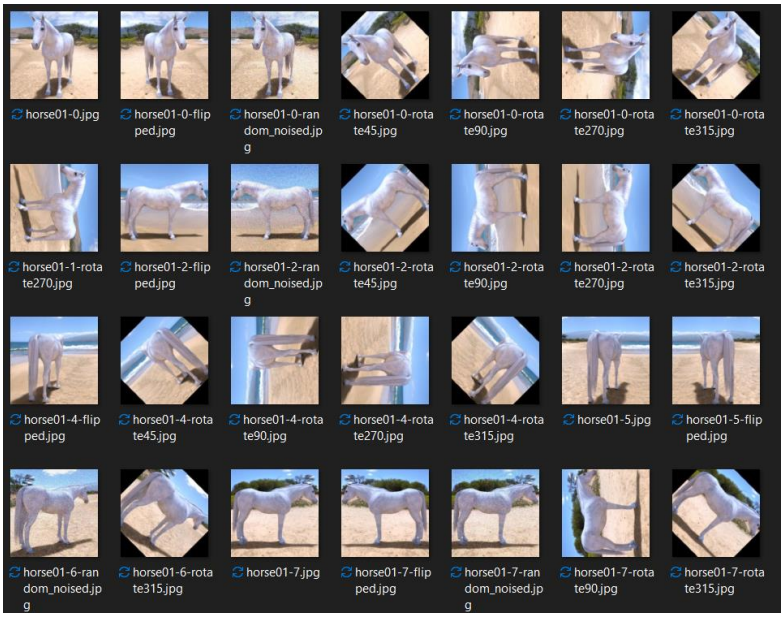
The goal of this work is to classify images into three categories: cats, dogs, and horses. The dataset consists of 12500 images of cats, 12500 images of dogs, and 3500 images of horses. The images are used to train a Convolutional Neural Network (CNN) model, which is then used to predict the class of new, unseen images.

2 DATA PREPARATION FOR THE TRAINING AND THE STRUCTURE OF THE CNN

The dataset consists of images of cats, dogs, and horses. The images are labeled according to their respective classes. The dataset is divided into training and testing sets, with 80% of the images used for training and 20% used for testing. The images are resized to a uniform size of 200x200 pixels and the pixel values are normalized to the range [0,1].

Training data samples:





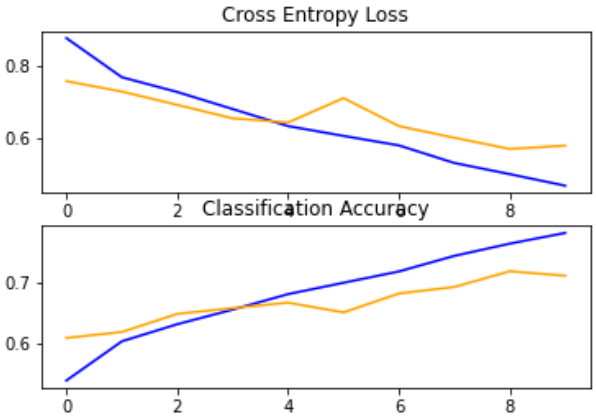
The Convolutional Neural Network (CNN) used for this task has the following structure

1. A Convolutional layer with 32 filters, a kernel size of 3x3, 'relu' activation, and 'he_uniform' kernel initializer. The padding is set to 'same', which means the output has the same width and height as the original input.
2. A MaxPooling layer with a pool size of 2x2. This layer reduces the spatial dimensions (width, height) of the input volume.
3. A Flatten layer which flattens the tensor output from the previous layer.
4. A Dense (fully connected) layer with 128 neurons and 'relu' activation.
5. An output Dense layer with 3 neurons, one for each class (dogs, cats, horses). The activation function is 'softmax', which makes the output sum up to 1 so the output can be interpreted as probabilities. The class with the highest probability is chosen as the output prediction.

The model is compiled with the SGD optimizer with a learning rate of 0.001 and momentum of 0.9. The loss function is 'categorical_crossentropy', which is suitable for multi-class classification problems.

3 Neural Networks Training

The CNN model is trained using the Stochastic Gradient Descent (SGD) optimizer, with a learning rate of 0.001 and momentum of 0.9. The 'categorical_crossentropy' loss function is used, which is appropriate for multi-class classification problems. The model is trained for 10 epochs.



The training process is visualized through plots showing the change in loss and accuracy over the epochs for both the training and validation sets. The 'Cross Entropy Loss' plot shows a decrease in loss over the epochs, indicating the model's learning progress. The 'Classification Accuracy' plot shows an increase in accuracy over the epochs, indicating the model's improving performance in correctly classifying the images.

4 RELEVANT METRICS FOR THE CASES:

The primary metric used to evaluate the model's performance is accuracy, which is the proportion of correct predictions out of total predictions. The model achieved an accuracy of 0.7936.

5 CONCLUSIONS OF THE RESULTS:

The model is validated using the test data. The prediction results reveal some errors, particularly in distinguishing between the three classes. Prior to adding horses to the dataset, the model demonstrated higher accuracy in predicting whether an image was a cat or a dog.

To enhance the model's performance, more data, particularly images of horses, could be added to balance the dataset. Additionally, data augmentation techniques could be employed to increase the diversity of the training data, potentially improving the model's ability to generalize.