**Developing machine learning for quality improvement in manufacturing**

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**Introduction**

In this work, a model was developed to solve a binary classification problem. The aim of the work was to develop a model that can efficiently classify images into two categories. The use of machine learning techniques such as convolutional neural networks (CNNs) can solve classification problems with high accuracy. A simple architecture was used to implement the model and tested on a dataset with a limited number of examples. Comparison with the YOLOv8 background model allowed analyzing the effectiveness of the proposed approach.

**Description of the work**

**Task selection and data preparation**

The task was to solve a binary classification problem. For this purpose, a dataset consisting of two categories of images: positive and negative images was selected. The training data contains 1500 positive and 2500 negative images with a size of 640x640 pixels. Due to the imbalance of classes, data augmentation technique was used to improve the generalization ability of the model.

**Model Development**

The model was built based on a convolutional neural network (CNN), which is one of the most common architectures for image processing. A stochastic gradient descent (SGD) with a learning rate of 0.01 and a packet size of 32 was chosen to optimize the training process. Regularization with Dropout was used in the training process to reduce the probability of overtraining.

**Model Training**

The model was trained on 20 epochs, each taking approximately 10 minutes. Improvements in accuracy were observed during training, with the third epoch achieving already 98% accuracy on the training data. However, a stagnant accuracy problem was observed on the validation data, which may indicate insufficient data to generalize the model more accurately.

**Testing and performance evaluation**

The model was tested on a validation dataset. The results obtained showed model accuracy comparable to that of the YOLOv8 background model, indicating a high quality solution to the problem. However, despite the good accuracy, the model showed limited ability to account for complex geometric shapes of objects in the images.

**Analyzing the results**

**Model accuracy:** The accuracy of the model on the training data reached 98%, indicating the good ability of the model to be trained on the provided data. However, the validation accuracy was stable and no significant improvement was observed as the number of epochs increased.

**Data diversity issues:** The limited amount of data and lack of data diversity were the main challenges in training the model. The model performed well for general images but did not account for more complex geometric shapes of objects, which reduces its applicability in more complex scenarios.

**Comparison with YOLOv8:** It is important to note that the accuracy achieved is comparable to that of the YOLOv8 background model, confirming the effectiveness of the chosen approach for this task. However, the use of more sophisticated models such as YOLOv8 may be preferable for more complex and diverse datasets.

**Conclusions and Recommendations**

**High model accuracy:** The developed model demonstrated high accuracy on training data and corresponding accuracy on validation data, which confirms its ability for effective classification. However, additional data and data diversity are needed for more accurate results and to increase the generalization ability of the model.

**Problems with object geometry:** The model is unable to account for complex geometric shapes of objects, which limits its accuracy in the case of complex images. To address this issue, the model architecture should be improved or more sophisticated image processing techniques should be used.

**Recommendations for improvement:** To improve the results, it is recommended to increase the amount of data as well as the variety of data. Using more sophisticated architectures such as pre-trained models can significantly improve accuracy. Methods for balancing classes and improving the generalization ability of the model are also worth investigating.

**Conclusion**

This work has successfully developed a model for binary image classification, which has shown good results on training and validation data. Despite the gains in accuracy, the identified problems with insufficient data set and data diversity require further refinement of the model. In the future, it is planned to expand the data set and use more complex architectures to solve the problem.