

Application of neural networks to image recognition of wheat rust diseases

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Rust diseases of cereals are caused by pathogenic fungi and can significantly reduce plant productivity. The disease is difficult to control on a large scale, so one of the most relevant approaches is crop monitoring, which helps to identify the disease at an early stage and make efforts to prevent its spread. In this work, we present a deep learning algorithm that uses a digital image of wheat plants to determine whether they are affected by a disease and, if so, what type: leaf rust, stem rust or yellow rust. The data set for training our model includes 1375 images of 4 classes. Examples of images of each class:



Healthy (255 images)



Leaf rust (373 images)



Stem rust (547 images)



Yellow rust (202 images)

Methods

We used the EfficientNet B5 architecture neural network with initial weights from ImageNet (efficientnet_pytorch) and catalyst Catalyst framework with the specified parameters:

Stratified split on train (80%) and test (20%)

CrossEntropyLoss with LabelSmoothing 0.1%.

Batch size: 8

Epochs: 50

Upsampling

Image size: 512x512

Optimizer: AdamW, weight_decay 1e-3

LR: 8e-4

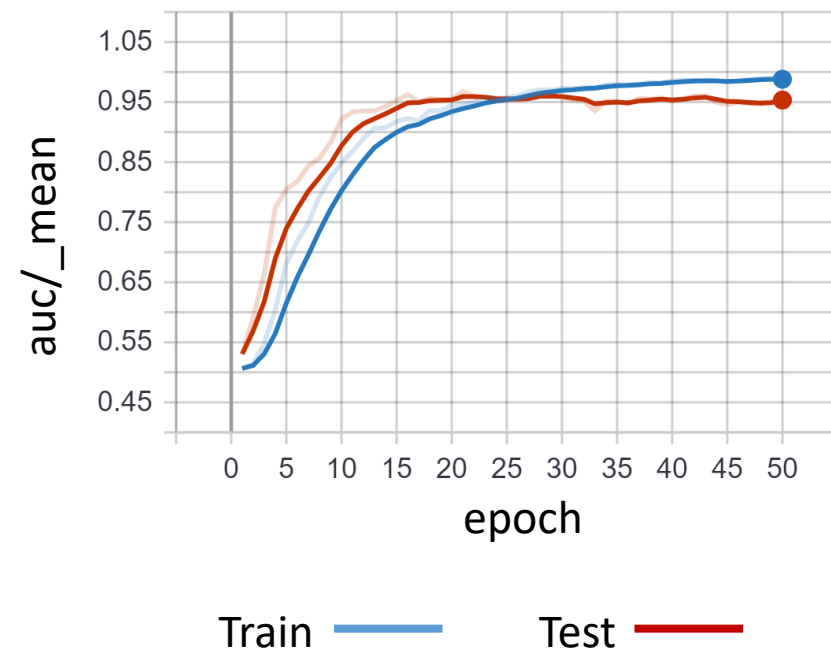
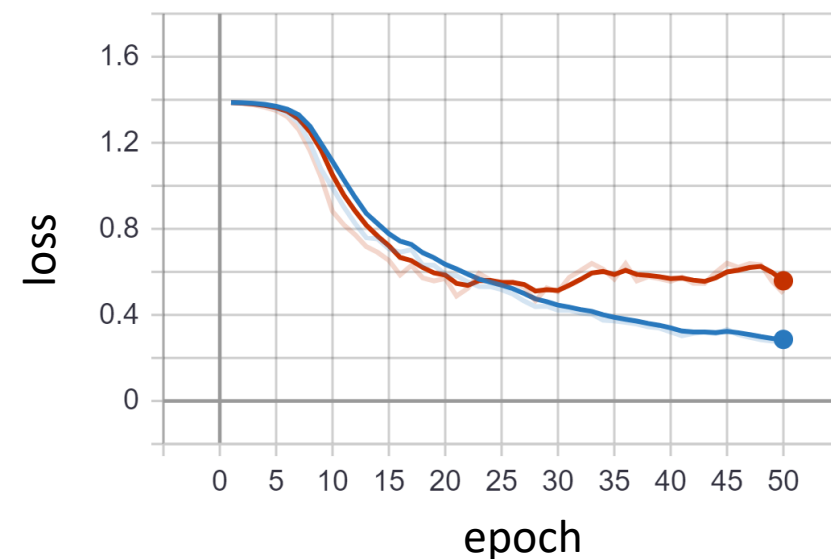
Scheduler: Cosine schedule with warmup

Augmentations: RandomResizedCrop, HorizontalFlip, VerticalFlip, ShiftScaleRotate, IAASharpen, Blur, ElasticTransform, IAAPiecewiseAffine from albumentations lib.

TTA: HorizontalFlip, VerticalFlip

Main metric: "auc/_mean"

Learning curves shown on the right.



Results

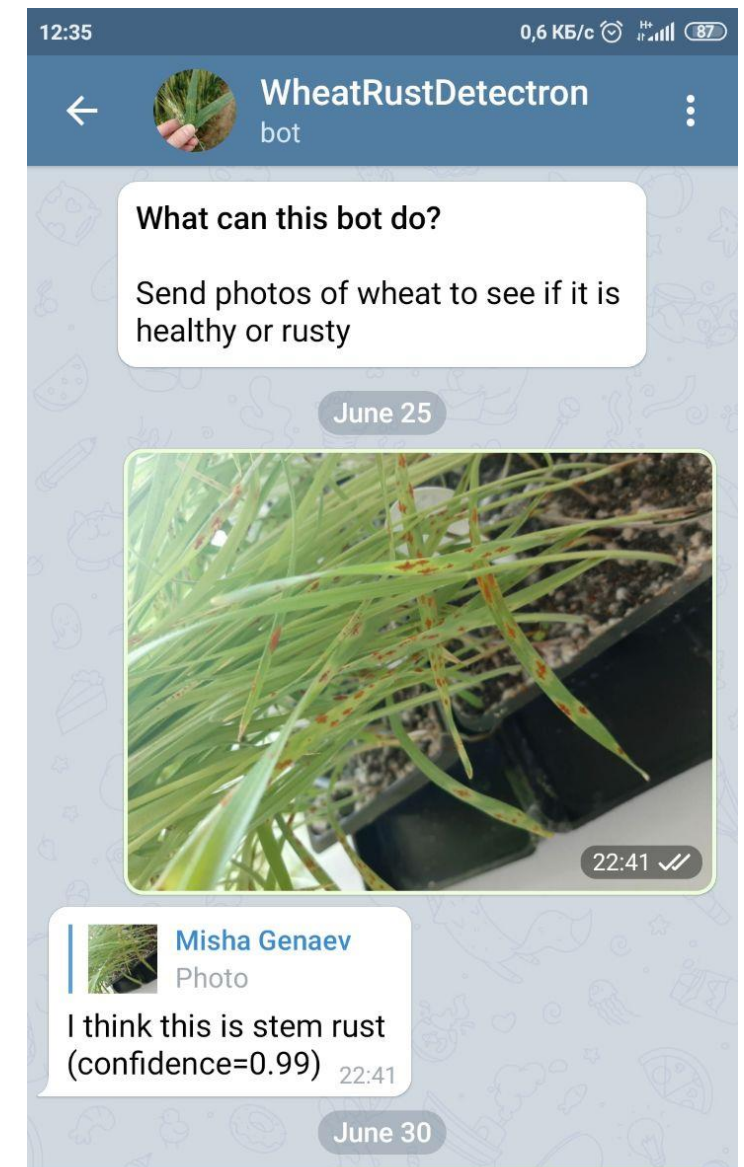
Estimates of the accuracy of the resulting model are presented in the table:

Metric	Value
auc/healthy	0.974
auc/leaf_rust	0.941
auc/stem_rust	0.961
auc/yellow_rust	0.958
auc/mean	0.958



To demonstrate the operation of our model, we created a Telegram bot. You can contact the bot named [@wheat_rust_bot](#) using the mobile or desktop Telegram application. You can send the bot a photograph of a wheat plant and receive a prediction of the disease to which the plant is susceptible.

An example of obtaining a prediction from a Telegram mobile application is shown on the right.



Telegram bot [@wheat_rust_bot](#) for identifying rust of wheat based on image analysis