Determining soybean plant stand count across different fields using the YOLO network

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Accurate detection of soybean plant stand from aerial images collected by an Unmanned Aerial System (UAS) is of great value to farmers, breeders, and scientists for planning and developing decision support systems. In addition, it is important for deep learning detection models to maintain performance when making inferences on new datasets from similar distributions to which the network is trained and tested. This is, however, not the case, as the detection model performance drops and fails to generalize soybean images from different fields. In-field variations due to illumination changes, the size of individual soybean plants in the early season, weed pressure, and dead plant foliage make soybean detection accuracy change from one field to another, resulting in poor generalization. This study evaluates the generalization ability of YOLOv7 architecture which is trained using large dataset from a soybean field to produce a baseline model and resulting model is tested on different soybean fields. The generalization ability of the baseline model is compared with the resulting models obtained by training consolidated imagery dataset from different soybean fields. In addition, a two-stage finetuning methodology is developed where the baseline model is further finetuned using imagery dataset which covers a fraction of the area from a different field. To verify the results, generalization accuracy is tested on three different soybean fields with different in-field variations over three seasons (2020-2022). The baseline model has poor generalization on unseen fields and while the resulting model from data consolidation improved the generalization ability over the baseline model, the two-stage finetuning process had the best generalization accuracy on new soybean fields while minimizing dependence on images from the new field. The study shows that the two-stage finetuning approach is vital in maintaining soybean detection model accuracy over different fields while reducing the reliance on a large dataset in training a generalizable model.