Deep Learning Approach for Frog Egg Quantification

Fall 2023-Prof. Peter Wolenski DeVision team-Ang'el Wilson, Finn Phayer, Monika Pandey, Gowri Priya Sunkara, Iswarya Sitiraju, Ibraheem M Al Jabea.

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Prediction and Results from Summer 2023

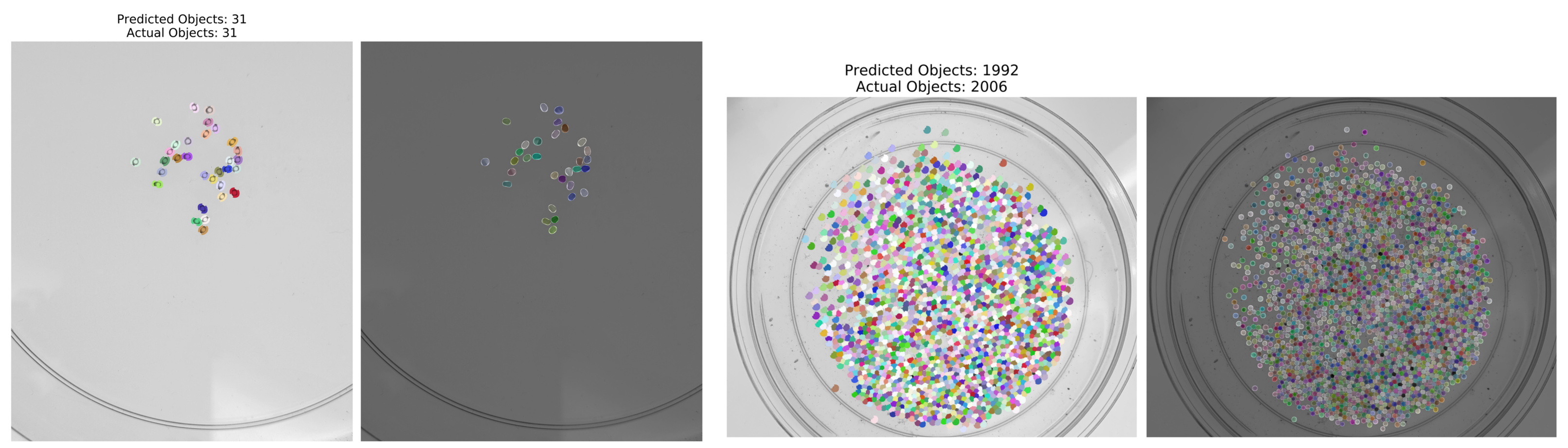


Figure 1. Prdeiction of eggs count with 98 percent based on stardist algorithm

During Summer 2023, the Devision team created a Stardist-based algorithm to train and test a dataset comprising 180 images, achieving a commendable 98 percent accuracy in predictions. The entire process is conducted using the high-performance computing system "Chaos." The preprocessing phase, involving the annotation of the 180 images using Image J software, proved to be time-consuming.

As we transitioned into Fall 2023, our objective was to reduce the amount of data required to attain a comparable prediction percentage to that achieved with the summer dataset of 180 images. Our aim was to demonstrate that a substantial number of annotations are not necessarily essential for achieving a reliable prediction.

Performance Analysis of StarDist Architecture on Dataset 180 with IOU > 0.5

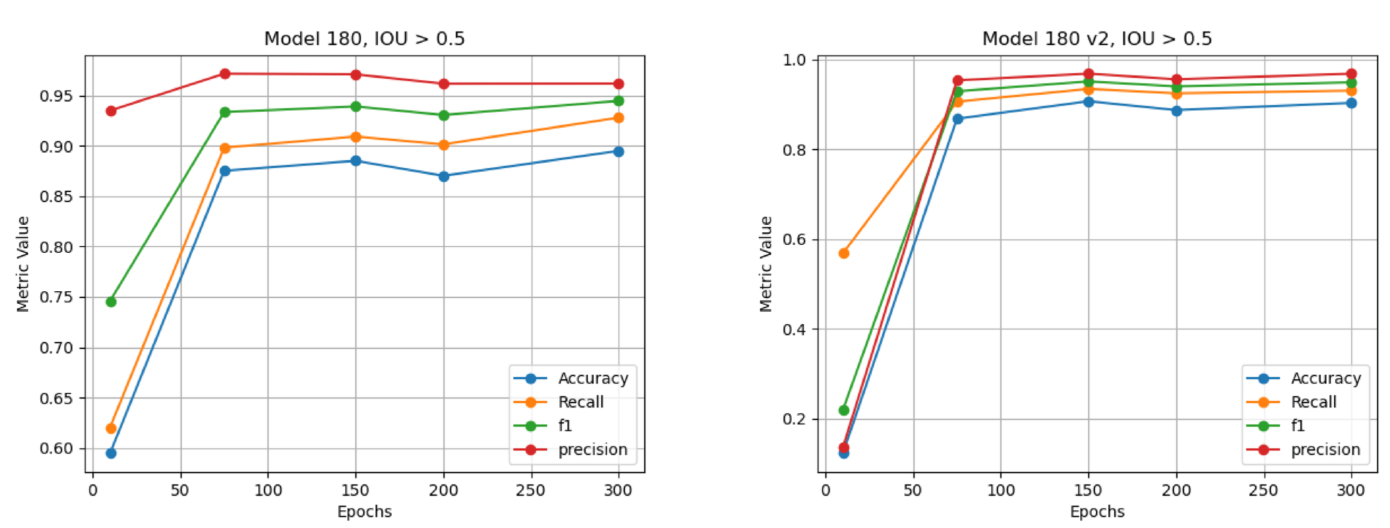


Figure 2. Illustration of Dataset 180 with v1 and v2 with reference to accuracy,recall,f1 score and precision

The graph depicts the variations in f1 score, accuracy, recall, and precision with respect to the Epoch during the training of StarDist architecture on Dataset 180, comprising 180 images and corresponding masks. The dataset was split into an 80-20 ratio for training and testing, and the models were evaluated using an Intersection over Union (IOU) threshold greater than 0.5. The experiment involved testing different Epochs with two model versions, namely Version 1 and Version 2(picking a random number of images from the dataset). Both graphs exhibit a notable increase in accuracy after 50 epochs for both Version 1 and Version 2 models, indicating the significance of extended training iterations in enhancing model performance on object detection and recognition tasks.

Accuracy Heat Map

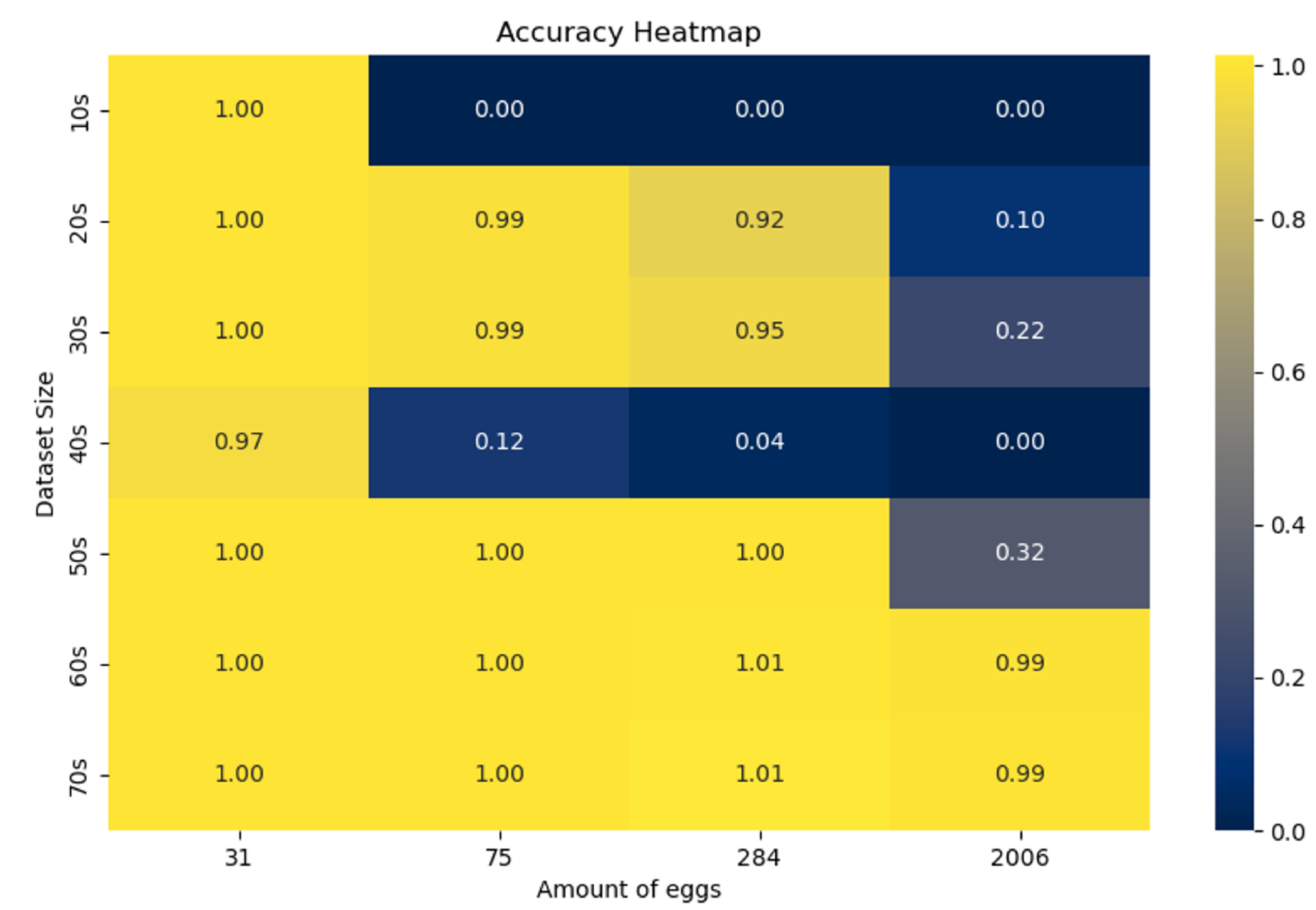


Figure 3. The Heat map illustrating the Accuracy with respect to the number of eggs in the dataset

The above heatmap displays the accuracy of each model in relation to different prediction images. The color gradient indicates, with yellow representing close to 100 percent and darker shades indicating lower accuracy. The left side of the image represents egg count ranges, bottom are the four images used (31, 75, 284, 2006 eggs) for predictions. The 60's and the 70's datasets were the top performers.

Bar graph representing the Number of eggs versus Number of images used for Accuracy

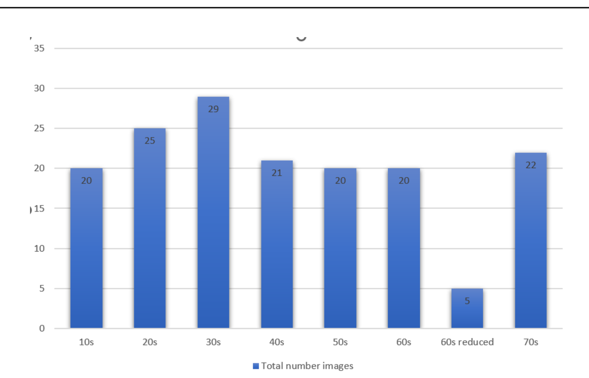


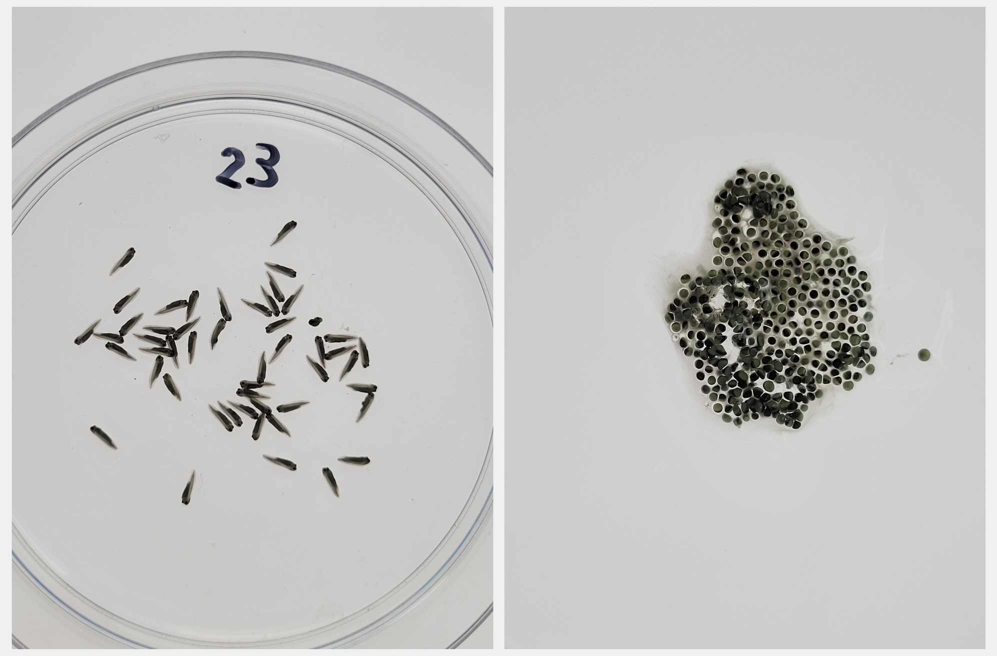
Figure 4. Number of eggs versus Number images from the Dataset used for the accuracy

The summer dataset featured images with egg counts ranging from 10 to 300. Training, spanning 100 epochs, concentrated on the 10-70 egg count range using a dataset over a range of 20 images. Insufficient datasets were augmented by rotating images.

Results

The outcomes were unexpectedly impressive. Despite working with a dataset comprising only 5 images, we achieved a remarkable 93 percent accuracy for the image containing 2006 eggs and a flawless 100 percent accuracy for the remaining three images. While these results exceed the 5 percent deviation threshold specified by the lab, there is room for enhancing accuracy further by considering additional training on a slightly expanded dataset using the 60s configuration.

Future Work



In the future, to advance the field of egg counting, we intend to extend our focus to the classification of fertilized and unfertilized eggs using a star dist-based model—an approach that captures the distinctive features of each category. Beyond mere classification, our ambition extends to creating a three-dimensional (3D) model, building upon the foundation of the star dist 2D model. Additionally, we aim to develop an algorithm based on a Classification Neural Network, leveraging a labeled dataset. Moreover, we plan to work in clustered environments. To achieve this, we intend to assess the performance of our model by introducing more noise and incorporating poor and unclear images.

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References

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