Multi-Class Quantification of Frog Embryos

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Introduction

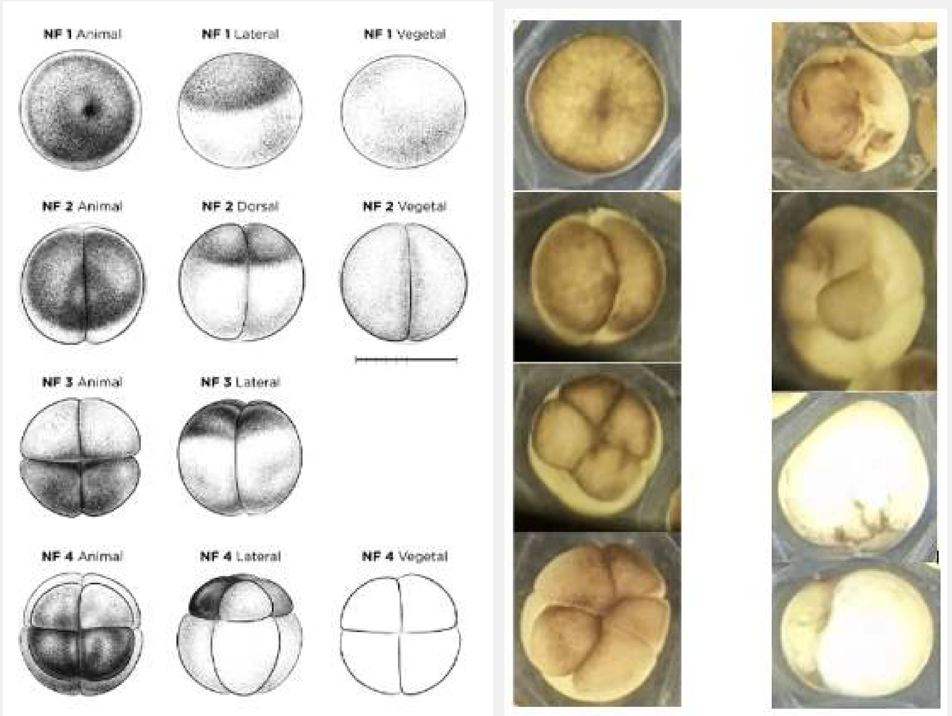

Figure 1. Xenopus illustrations © Natalya Zahn (2022

We utilize a multi-class machine learning algorithm based on [2] and [3] to accurately count Xenopus laevis embryos [1] at various developmental stages within a Petri dish, as requested by the Aquatic Germplasm Genetic Research Center (AGGRC). These embryos undergo divisions into blastomeres across distinct developmental stages, denoted by NF after Nieuwkoop and Faber in 1994.

Objectives

We aim to provide AGGRC researchers with a straightforward and reliable application for efficient multiclass predictions of embryos into viable and non-viable classes.

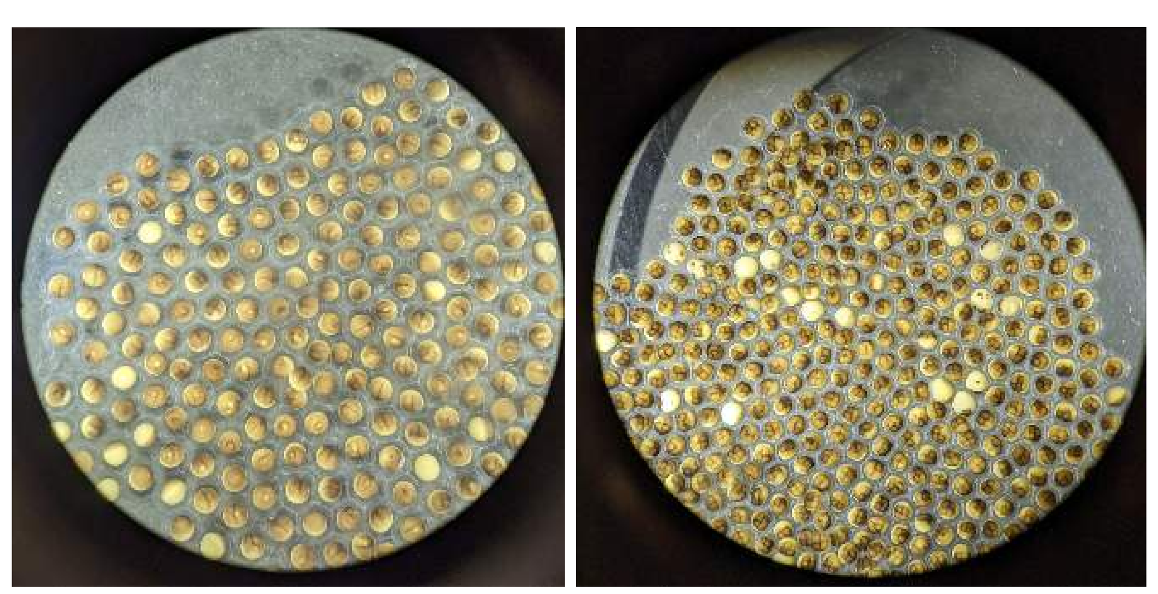

Figure 2. Frog Embryos in Petri Dish

Architechture-Stardist and Multi Class

StarDist ([2], [3]) can classify each found object instance into a fixed number of different object classes (e.g. cell types, phenotypes, etc.).

The dataset provided by AGGRC has been preprocessed, with developmental stages annotated using LabKit in FIJI.

Distance and Probability Loss

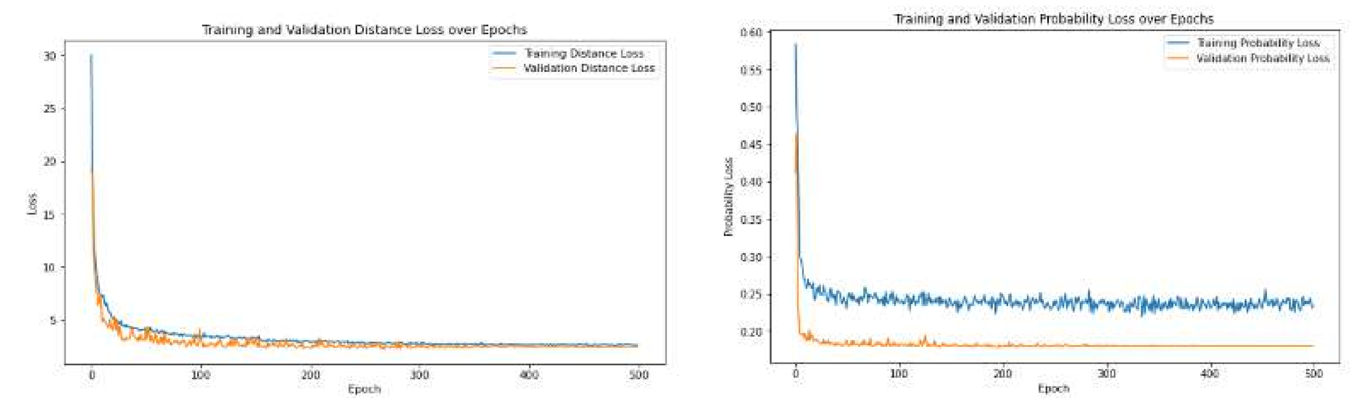

Figure 3. Distance and Probability Loss

The first graph illustrates that both training and validation losses began at 30 and dropped to 5 by epoch 50. The second graph depicts the probability loss, with both training and validation losses starting at 0.6 and decreasing to 0.2 by epoch 10. The dataset was split into an 80-20 ratio for training and testing. This indicates improved model performance and learning capability, leading to more accurate predictions.

Metrics of F1 score, Precision, Accuracy and Recall over Epochs

Figure 4. Illustration of the metrics-F1 score, Precision, Accuracy, and Recall on Epochs 50 to 250

The graph depicts the variations in f1 score, accuracy, recall, and precision for varying epochs during the training of U-Net CNN architecture and StarDist. The models were evaluated using an Intersection over Union (IoU) threshold equal to 0.5.

Ground Truth

Figure 5. Ground Truth of viable and non-viable embryos

Multi-Class Prediction

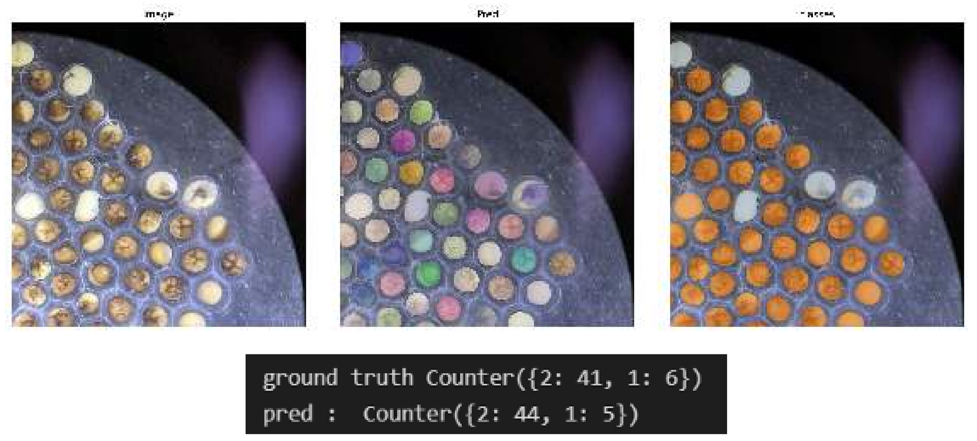

Figure 6. Predictions of viable and non-viable embryos.

Future work

- In future work, we aim to expand our classification algorithm to encompass the initial stages of development in frog embryos. To facilitate classification, we categorize the embryo dataset into four developmental stages:
  - NF 1 (0 divisions), NF 2 (2 divisions), NF 3 (4 divisions), NF 4 (8 divisions)
- StarDist has been shown to be effective with objects with similar shapes but varying textures. We want to verify if StarDist can distinguish between different shapes which is more relevant for frog embryos.

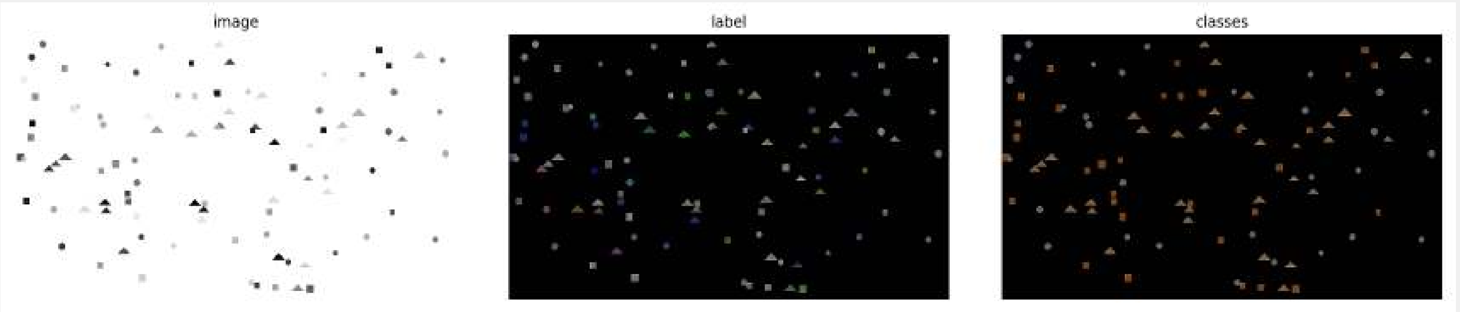

Figure 7. Ground truth for circles, squares and triangles.

Acknowledgements

- We would like to thank Prof. Peter Wolenski and Dr. Nadejda Drenska for guiding and supporting us.
- We would like to thank Aquatic Germplasm And Genetic Resources Center for providing us with the data and making this project possible.
- We would like to acknowledge the Department of Mathematics for foreseeing the utility of "Chaos" and the subsequent purchase.
- We want to acknowledge and thank Nikkos Svoboda, Computer Analyst for introducing and making us familiar with the workings of the high-performance computing system "Chaos".

References

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