Automated Data Labeling for Object Detection via Iterative Instance Segmentation

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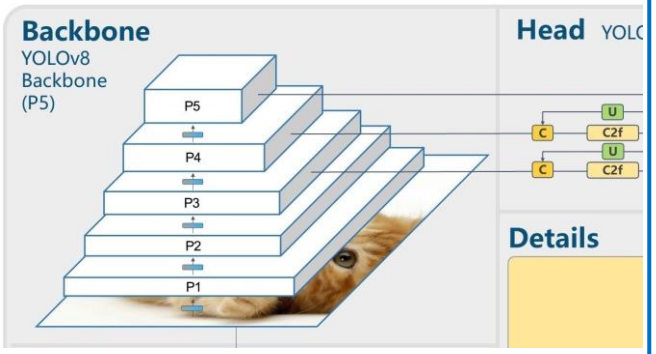
Purpose

- **Data Labeling.** Data labeling presents a significant challenge in computer vision, particularly with complex tasks like image segmentation.
- **Labor Efficiency.** These tasks demand substantial time and human labor to annotate large datasets, which is essential for building robust models.
- **Automated Labeling Algorithm.** The aim of our research is to propose an automated labeling system.
- Integrates with state-of-the-art object detection models to achieve both efficiency and notable improvements in performance.

YOLOv8 Architecture

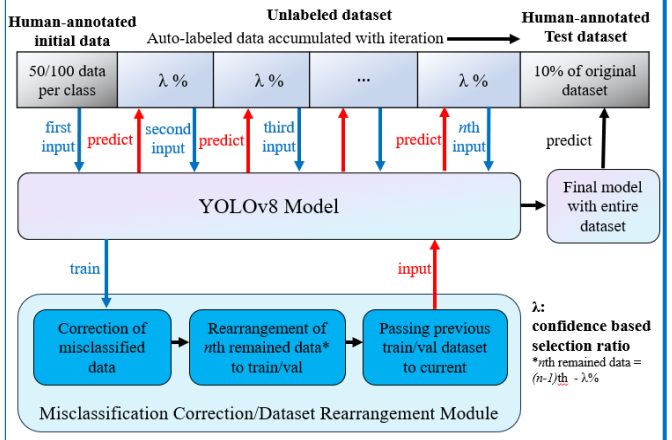


- Latest version in the "You Only Look Once" (YOLO) model series.
- Unique in predicting all objects in an image with one forward pass.
- Classification tasks into regression for bounding box coordinates.
- Enhancements in architecture and user experience from its YOLOv5 base.
- Known for its accuracy and speed, marking it as the state-of-the-art object detection model.

Contribution

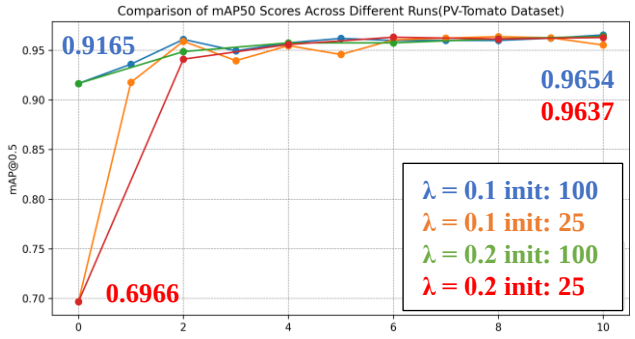
- Utilizes dataset over 20,000 plant samples from the Plant Village dataset.
- Applies YOLOv8 object detection model with instance segmentation techniques to enhance the performance of the auto-labeling system.
- Adopts active learning and semi-supervised learning approaches.
- Contributes by enabling the full annotation of the dataset with minimal human intervention and boosting the model's accuracy.

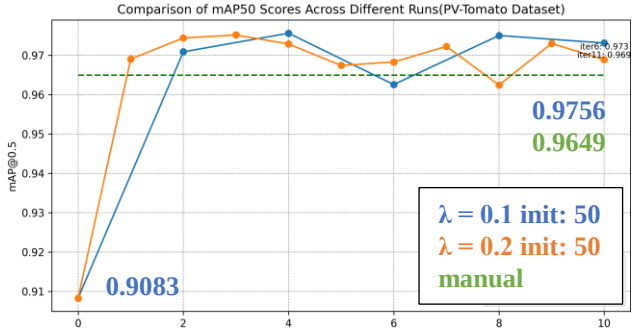
YOLOv8-ADL (Methodology)



- Initializes with manually labeled training dataset for the first weights.
- Performs inference on unlabeled data.
- Processes through a correction and uncertainity-based selection algorithm to select a portion of the data to be newly labeled and add them to training dataset.
- Repeats until the finally trained model tested on labeled test dataset.

Results





Tomato Dataset.

- Conducts tests on a larger dataset to assess the effects of varying lambda values.
- Compares environments with different volume of initial training data.
- Notes that the disparity in the initial data diminishes as iterations progress.
- Bases evaluation on mean Average Precision at 50% (mAP@50).

Apple Dataset.

- Comparison of the model's performance using auto data labeling (ADL) algorithm with the original model trained on a manually labeled dataset.
- Results demonstrate that our algorithm is not only more efficient in terms of human labor but also superior in object detection performance.

Conclusion

Model Name	mAP on PV-Tomato Dataset
Faster_RCNN	0.625
YOLOv2	0.704
SSD	0.569
YOLOv3	0.731
Mask RCNN	0.882
YOLOv8-ADL(100 images per class, λ=0.1)	**0.9654**

- Demonstrates the effectiveness of the auto-labeling system.
- Showcases how the integration of the proposed algorithm with advanced object detection model can become a powerful tool.
- Surpasses both its original model and previously existing models

Future Direction

- Overcome the limitation of solely relying on the Plant Village dataset and YOLOv8 model.
- Expand beyond using only results and research from existing records; implement these as well.
- Continue advancements with new models, such as transformers, and explore additional datasets like skin cancer datasets.