Measuring YOLOv8 Performance on Diverse Object Detection Datasets
– Executive Summary –

This study evaluates the object detection performance of YOLOv8 (state-of-the-art in this field) across three distinct datasets: **SkyFusion** (tiny aerial objects), **Traffic Signs** (road signs), and **Multilabel Fruits** (agricultural objects). The analysis highlights the model's strengths in balanced and well-defined datasets and its challenges with small objects and imbalanced classes.

Key Findings

- **SkyFusion**: Moderate results due to challenges with small objects and severe class imbalance. Precision (0.686), recall (0.588), and mAP50+90 (0.342) were hindered by underrepresented classes like "ship."
- **Traffic Signs**: The best performance among datasets, with high precision (0.972), recall (0.899), and mAP50 (0.965). Balanced classes and distinct object features suited YOLOv8 well.
- **Multilabel Fruits**: Lower precision (0.598) and recall (0.450) due to imbalances and variable object sizes. Dominant classes like "Orange" performed better, but rare classes like "Pineapple" struggled.

Observations

- **Strengths**: Exceptional speed and accuracy in datasets with centralized, average-sized objects and balanced class distributions (e.g., Traffic Signs).
- **Weaknesses**: Struggles with tiny objects, visually similar categories, and datasets with severe imbalance (e.g., SkyFusion, Multilabel Fruits).

Recommendations

1. **Data Augmentation**: Address class imbalance and enhance rare class detection using techniques like oversampling or synthetic data creation.
2. **Feature Extraction**: Improve detection of small or occluded objects.
3. **Targeted Training**: Implement specialized training strategies to adapt YOLOv8 to complex datasets.

Conclusion

YOLOv8 is highly effective in balanced, well-structured datasets, demonstrating strong potential for real-world applications like autonomous driving and agriculture. However, targeted enhancements are necessary to improve its performance in diverse and challenging scenarios.