Project Summary: Fine-Tuning a YOLOv8 Model for Military Aircraft Detection

Through a methodical process of data preparation, automated hyperparameter tuning, and targeted training, the final model achieved an exceptional **Mean Average Precision (mAP) of 95%**, demonstrating its accuracy and reliability. The initial phase involved preparing an unlabeled dataset of cropped aircraft images from Kaggle. To overcome the challenge of manual annotation, a script was developed to automatically label each image, leveraging the fact that each image contained only a single, centered aircraft. This prepared dataset was then split into 80% for training and 20% for validation.

Hyperparameter Tuning Analysis

To ensure optimal performance, I conducted an automated hyperparameter tuning process using YOLOv8's built-in tuner. This process systematically tests different combinations of model settings to find the configuration best suited for the dataset. Due to computational constraints, the tuning was focused on **5 iterations each with 5 epochs**, which took approximately **70 minutes** to complete. The tuner's objective was to maximize the "fitness" score, a composite metric reflecting overall model accuracy. The analysis revealed that the default hyperparameters provided the best performance in the first iteration, achieving a **fitness score of 0.20721**. This indicated that the baseline settings were already well-suited for this specific dataset, providing a strong foundation for the final training.

Final Optimized Hyperparameters

The following hyperparameters, identified during the tuning phase, were used for the final 20-epoch training run, which was completed in approximately 55 minutes.

Learning Rate (lr0)	0.01	**Weight Decay**	0.0005
Final Learning Rate (lrf)	0.01	**Warmup Epochs**	3
Momentum	0.937	**Warmup Momentum**	0.8
Box Loss Gain	7.5	**Class Loss Gain**	0.5
DFL Loss Gain	1.5	**Mosaic Augmentation**	1
Horizontal Flip (fliplr)	0.5		

Sample hyperparameter tuning according to accuracy metrics per iteration: