Testing the YOLOv5 Object Detection

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Introduction

The purpose of this research is to conduct a performance evaluation of the YOLOv5 model by Ultraalytics. Experimenting with different computer architectures with a mineral dataset, the YOLOv5 model will be under a series of testing, analysis and training to gain a better understanding of how YOLOv5 behaves under different circumstances.

By evaluating the performance and behavior of the YOLOv5 model with a mineral dataset, the hope is that there's a clear performance or behavioral differences with a range of computer architectures.

Methodology

There will be set of parameters in place to study the YOLOv5's behavior. As explain earlier, the YOLOv5 will be training with a mineral dataset designed for the model to be familiar with the minerals inside the dataset. That will be the one of the parameters that will be utilized..

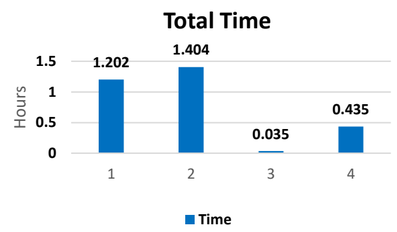
Another parameter will be CPU testing. Each CPU will be widely speculated to have its own behavior based on its architecture that'll affect the YOLOv5 model differently from each other. Therefore, training YOLOv5 will also acquire not only the CPU behavior, but also a computer system's behavior when training the YOLOv5 model.

* → IMG = 480, Batch = 12. See *Analysis and Conclusion* for more

Testbench and Results

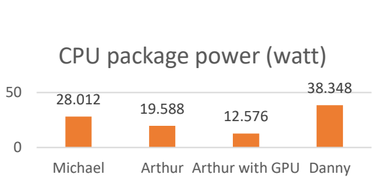
Group Member	CPU	Memory	GPU1	GPU2
Michael	Intel Core i7-1260P	16GB (DDR4)	Intel Iris Xe Graphics	N/A
Nicholas	Intel Core i5-8265U	8GB (DDR4)	Intel UHD Graphics 620	N/A
Danny	Intel Core i7-8750H	32GB (DDR4, 2667Mhz)	Intel UHD Graphics 630	NVIDIA GeForce GTX 1050Ti (4GB)
Arthur	AMD Ryzen 9 5900HS	16GB (DDR4, 3200Mhz)	AMD Ryzen Graphics	NVIDIA GeForce RTX 3060 (6GB)

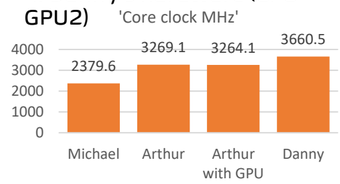
Control Parameters	Number/Name	Definition
Epoch	10	Total number of training samples in a batch.
Img	640	Image Size
Batch	16	Number of Images per batch.
YOLO Model	YOLOv5s.pt	Size of the YOLOv5 model. (Second smallest)



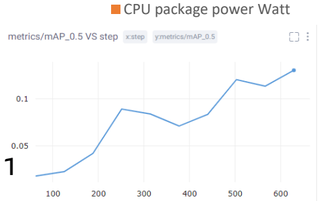
CPU Behavior

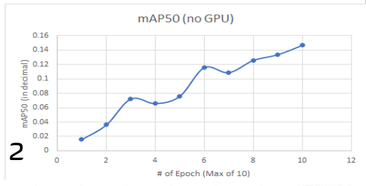
1: Michael's hardware (CPU Only)
2: Arthur's hardware (CPU Only)
3. Arthur's hardware (CPU + GPU2)
4. Danny's hardware (CPU + GPU2)

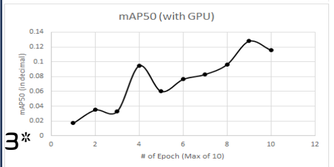


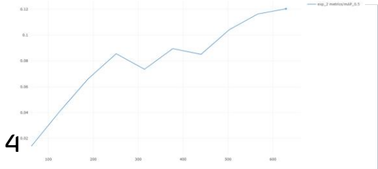


mAP50









Analyze and Conclusion

Based on the charts on the charts for CPU behavior, it's clear that adding a discrete GPU (graphics processing unit) will significantly decrease the time needed to train the YOLOv5 model with the mineral dataset. For example, when Arthur's system included its discrete GPU to train the YOLOv5 engine, it was calculated to be approximately 40 times faster than the CPU alone.

There were also concerns regarding the results of mAP-50 (mean average precision > 0.5). While there was consistent improvement on the 10th epoch compared to the 1st epoch, the overall values were well-below YOLOv5's typical values. This either suggest that more epochs were required to meet YOLOv5's typtical values or the mineral dataset didn't have enough data to sufficiently train with.

Lastly, in some cases, there were hardware limitations. There was a consistent error message that stated that the system didn't enough about video memory or physical memory to support YOLOv5 given the control parameters in *Testbench and Results.*

In conclusion, the YOLOv5 model has already shown its potential to be an efficient and powerful tool for object detection. Given the results, there was always improvement from the 1st epoch to the 10th. However, the lack of accuracy overall implies that the number of epochs required to train a YOLOv5 model must be significantly higher.

Reference

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[2] "Train Custom Data," Ultralytics YOLOv8 Docs, https://docs.ultralytics.com/yolov5/tutorials/train_custom_data/#12-create-labels (accessed Nov. 28, 2023).
[3] J. Solawetz, "What is Yolov5? A guide for beginners.," Roboflow Blog, https://blog.roboflow.com/yolov5-improvements-and-evaluation/ (accessed Nov. 18, 2023).
[4] W. by: E. Zvornicanin, "What is Yolo Algorithm?," Baeldung on Computer Science, https://www.baeldung.com/cs/yolo-algorithm#:~:text=3.-,You%20Only%20Look%20Once%20(YOLO),main%20reason%20for%20its%20popularity. (accessed Nov. 16, 2023).