

Playing cards object detection model

Developing a model that can detect multiple cards and identify their suit and rank.

by Teodor Kostadinov, 4MI0600097,
Faculty of Mathematics and Informatics, Sofia University

Business idea

Developing an application that can:

- assist during a game of Blackjack, Bridge, Belot, Poker, etc.

Business idea

To create the application a model recognizing the playing cards is required.
A **fast implementation** of the required model is needed as soon as possible to develop the business!

Problem #1

Since the business **is just starting**, no senior Data science team members are currently available.

There is no advanced knowledge on the topic, **nor time** to develop a model from scratch.

Solution to Problem #1

Use a popular **pretrained model** and a **library** that allows easy access to ease the implementation.

In our case:

- YOLOv8 model
- Pyhton ultralytics library

Problem #2

There is **no public dataset** available.*

There is no time to create a big dataset, with well-designed examples for training, nor time to label them.

Finding a dataset

A person, facing the same problem, has created a synthetic dataset with over 20,000 images. [Link](#) to dataset in kaggle

First I took 20-30 second videos of all 52 cards under variable light temperature and brightness. The images were processed with open-cv. The DTD dataset (<https://www.robots.ox.ac.uk/~vgg/data/dtd/>) was used to simulate backgrounds of various textures for our dataset.

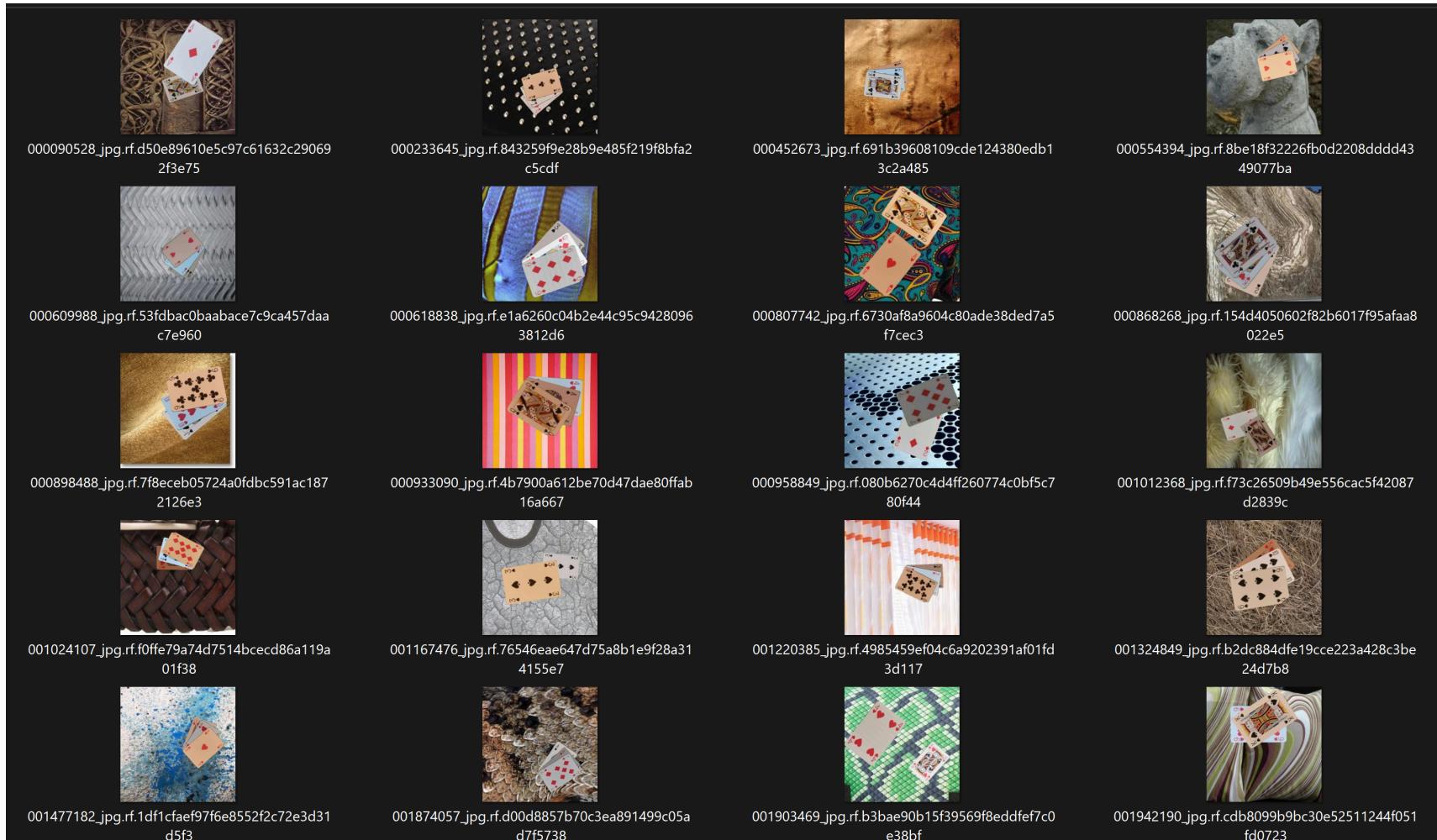
Examples of the images

A set of 1, 2 or 3 cards together placed on different backgrounds.



Examples of the images

Since the dataset is generated programmatically, there are obvious patterns.

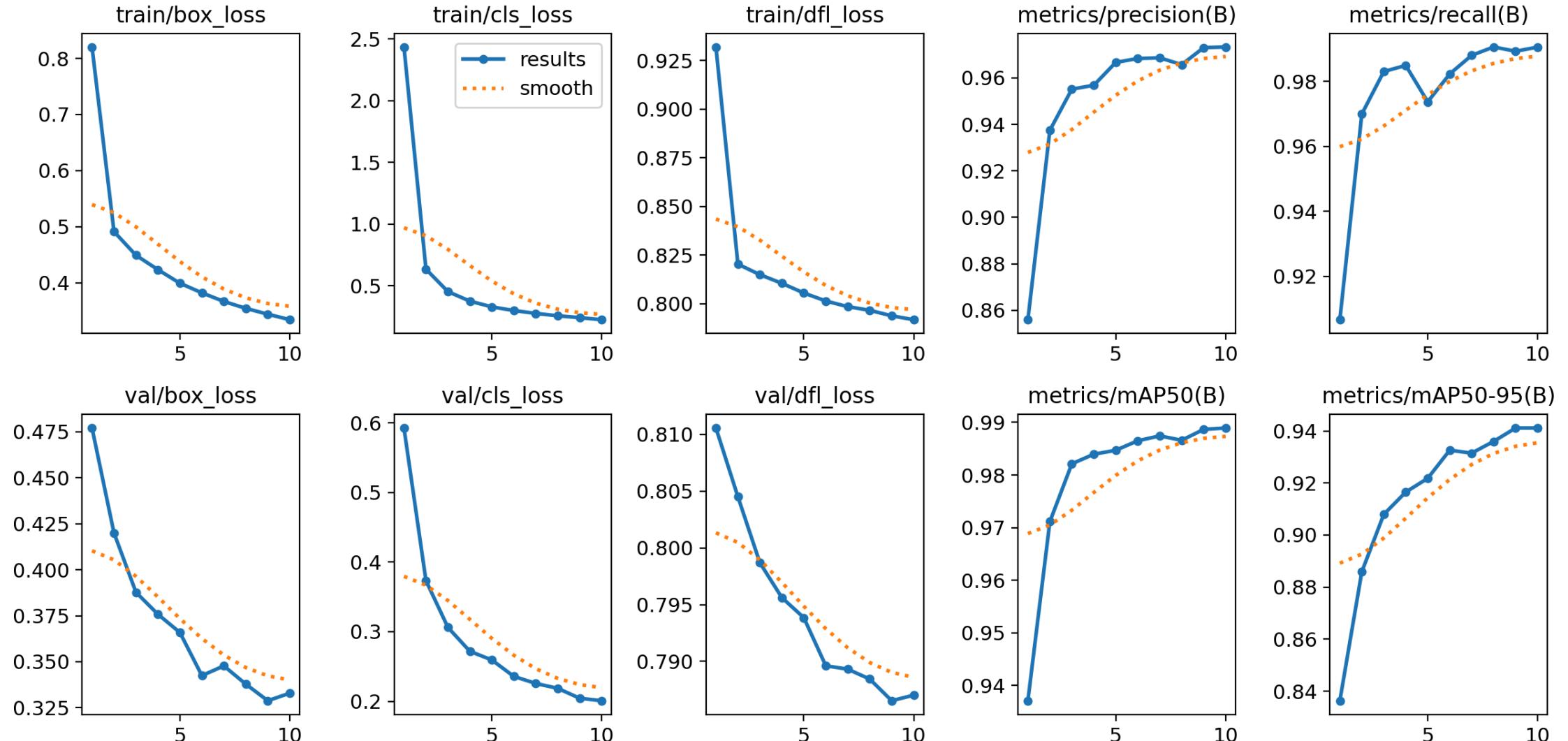


Our YOLOv8_syntethic model

- Trained on YOLOv8 medium using 10 epochs
- Trained with 20 000 images split 70/20/10 and 52 classes.
- 2 hours training time on NVIDIA RTX A2000 8GB Laptop GPU.
- Can detect each card from the test set with ~99% accuracy.

Our YOLOv8_synthetic model statistics

The results are impressive on paper:



Our YOLOv8_synthetic in practice

Working pretty good on similar style pictures:



Our YOLOv8_synthetic in practice



Our YOLOv8_synthetic in practice



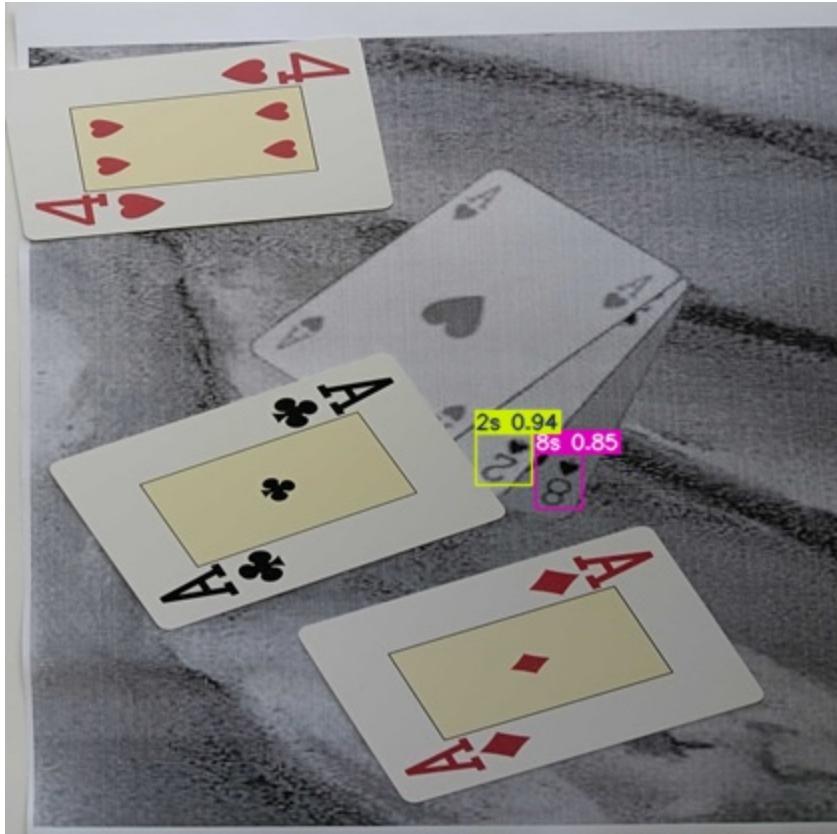
Our YOLOv8_synthetic in practice

When the images differ from the synthetic format the results drop as well:



Our YOLOv8_synthetic in practice

It can also detect printings of a train data but not other types of cards:



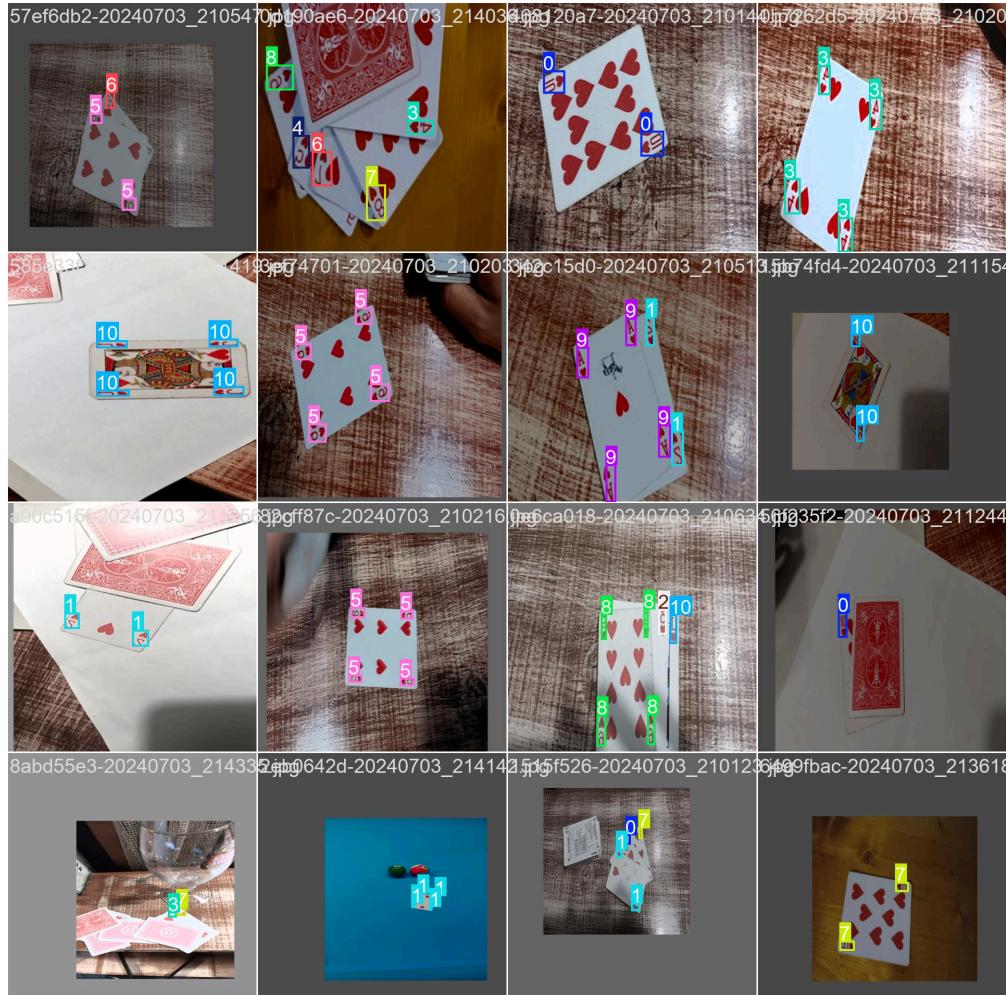
Creating own small dataset

The dataset is created with "real" life examples of cards.

Since 52 classes of cards require a lot of data - the classes were **cut to 13** (Hearts only).

Our real dataset examples

Captured and labeled 100 photos with different configurations of cards.

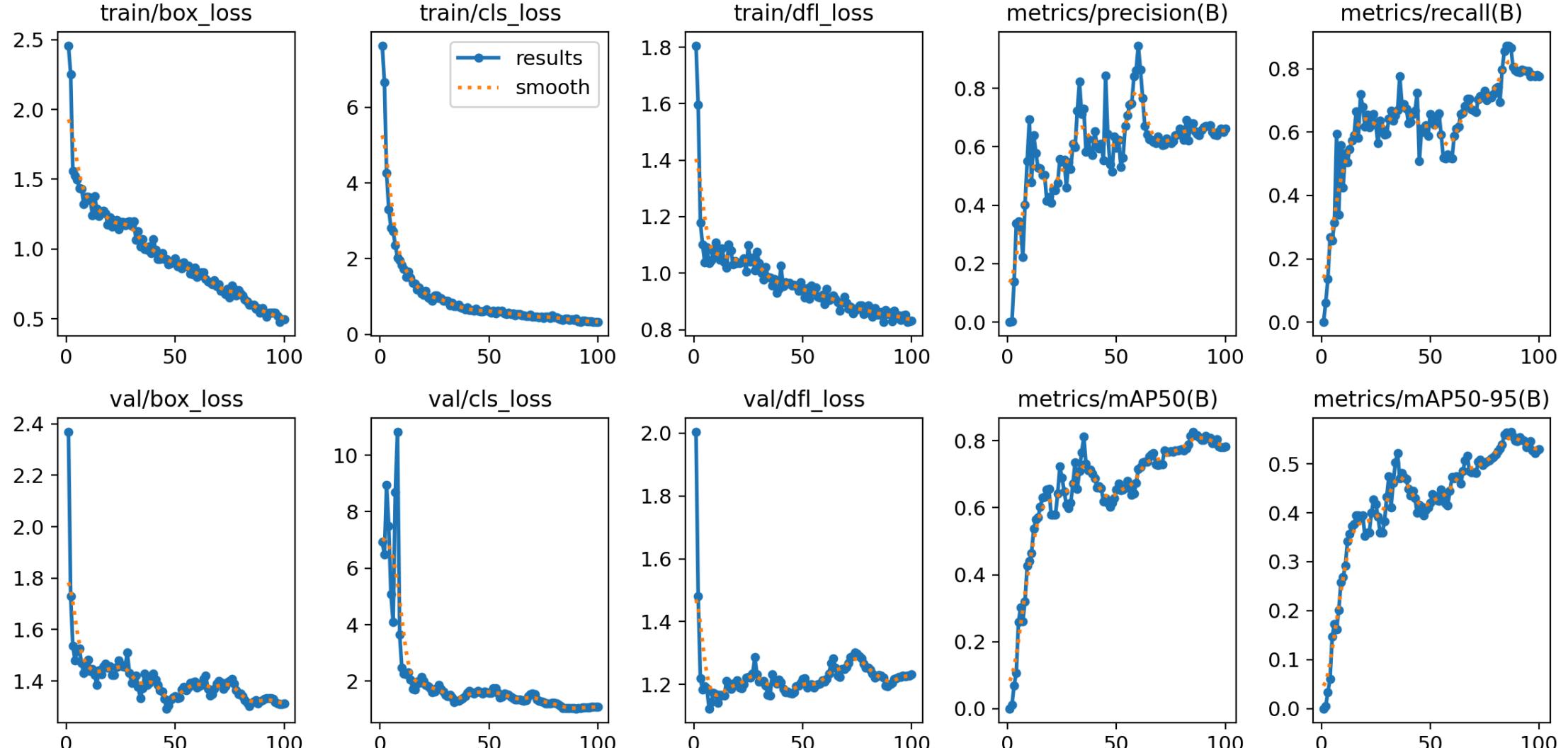


Our YOLOv8_real model

- Trained on YOLOv8 medium using 100 epochs
- Trained with 100 images split 70/20/10 and 13 classes.
- 20 minutes training time on NVIDIA RTX A2000 8GB Laptop GPU.
- Results are not quite impressive but this is expected as the low number of data entries.

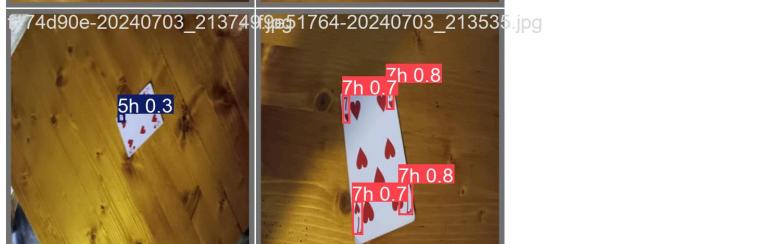
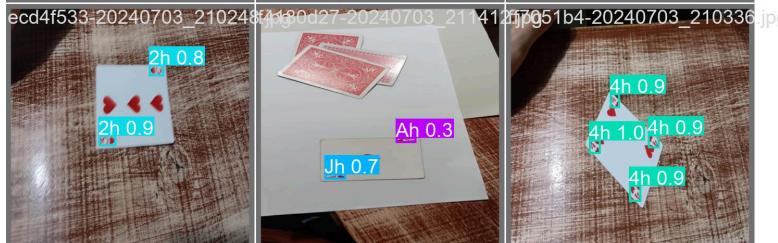
Our YOLOv8_real model statistics

The results are impressive on paper:



Our YOLOv8_real on test set

The test set is not perfect, there are a handful of mistakes.



Our YOLOv8_real in practice

It is doing ok on images with Hearts, but not as good as YOLOv8_synthetic



Our YOLOv8_real in practice



Our YOLOv8_real in practice

However, it does confuse other suits for Hearts.



Our YOLOv8_real in practice

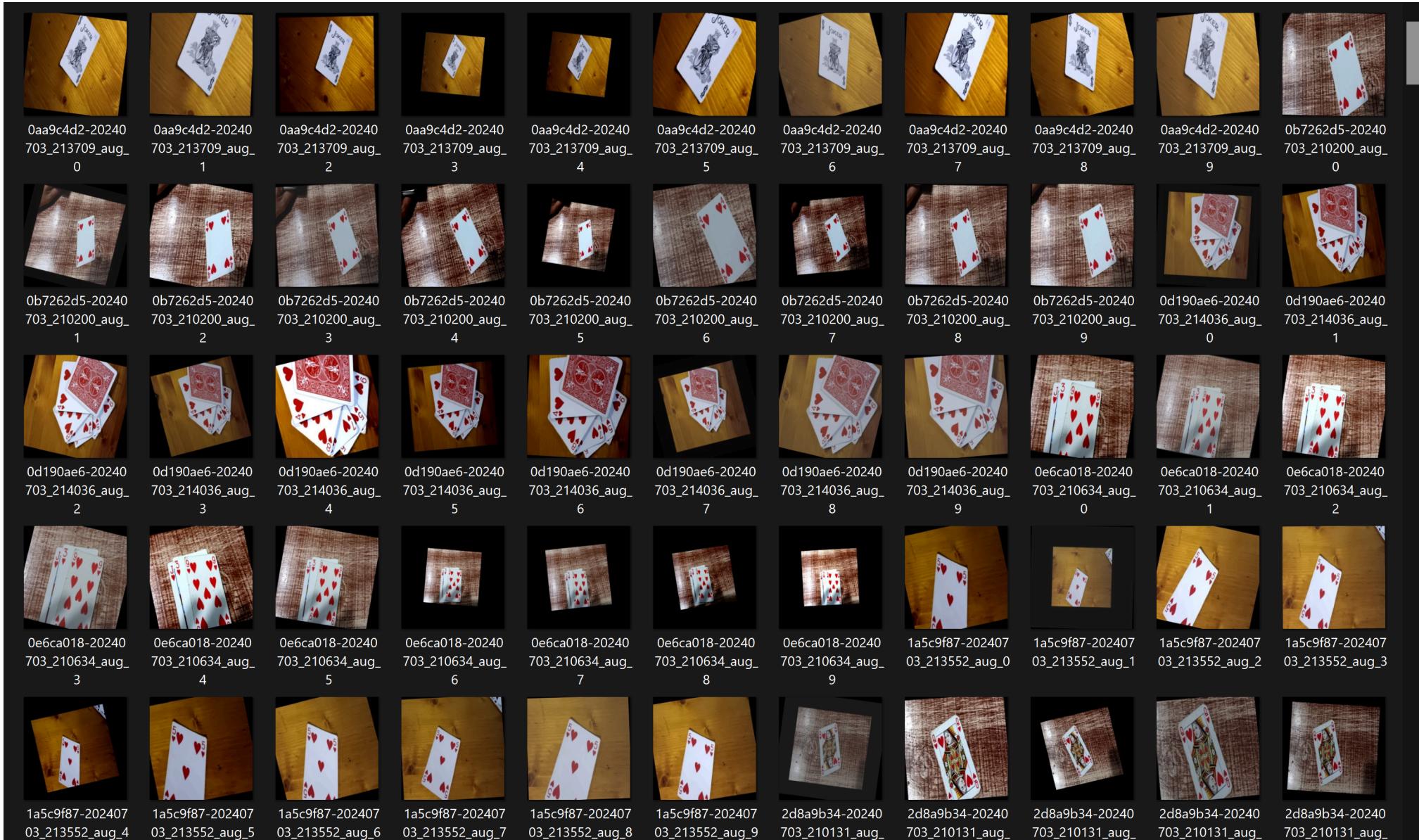


Augmented dataset workaround

Developed a Python script that **transforms the images** in a dataset, effectively multiplying the dataset.

The library used to transform the marked bounding boxes in the original dataset correctly to the augmented one is: *[imgaug](#)*

Augmented dataset example

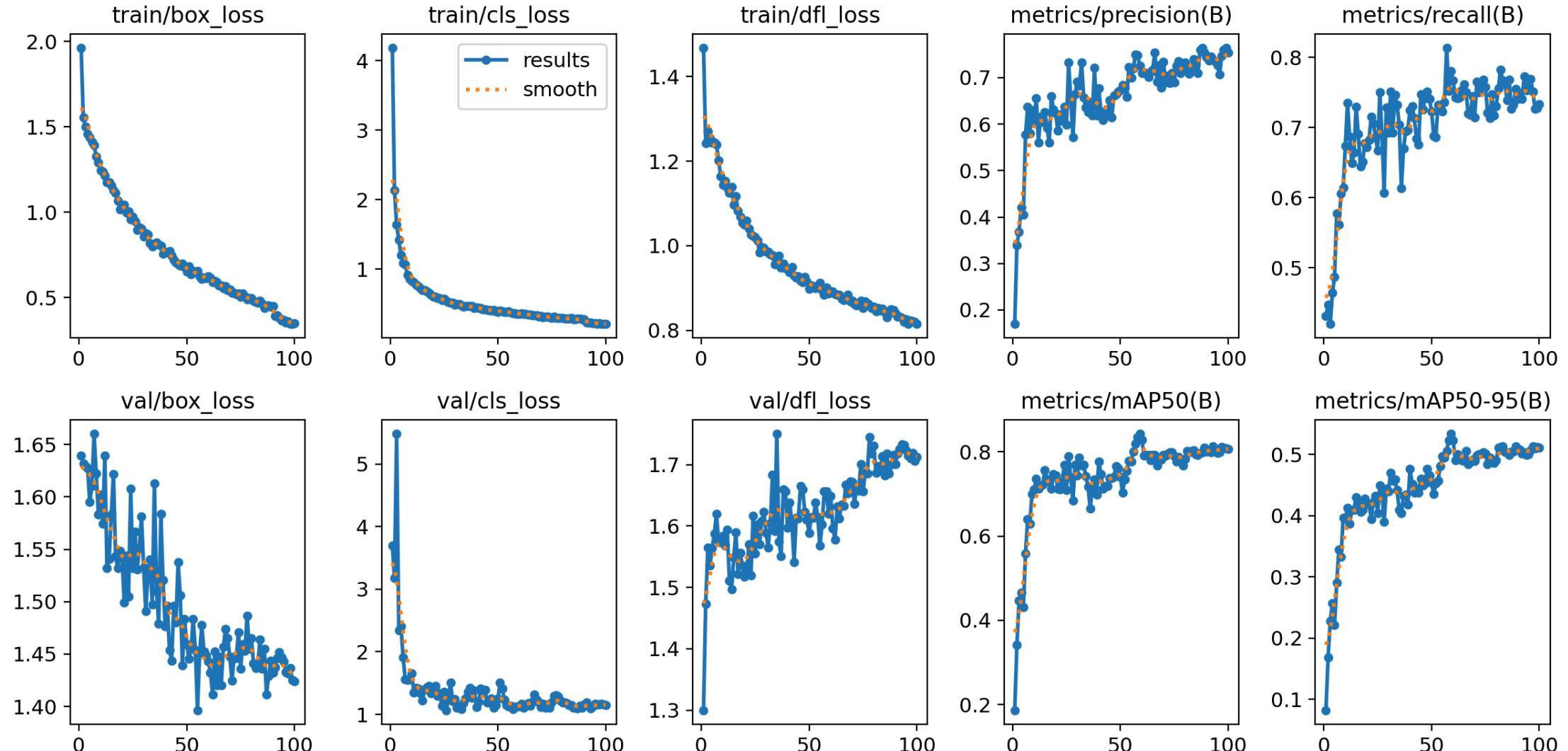


Our YOLOv8_aug model

- Trained on YOLOv8 medium using 100 epochs
- Trained with **1000 images** split 70/20/10 and 13 classes.
- **40 minutes training time** on NVIDIA RTX A2000 8GB Laptop GPU.
- Results are questionable - similar to the model without augmentation.

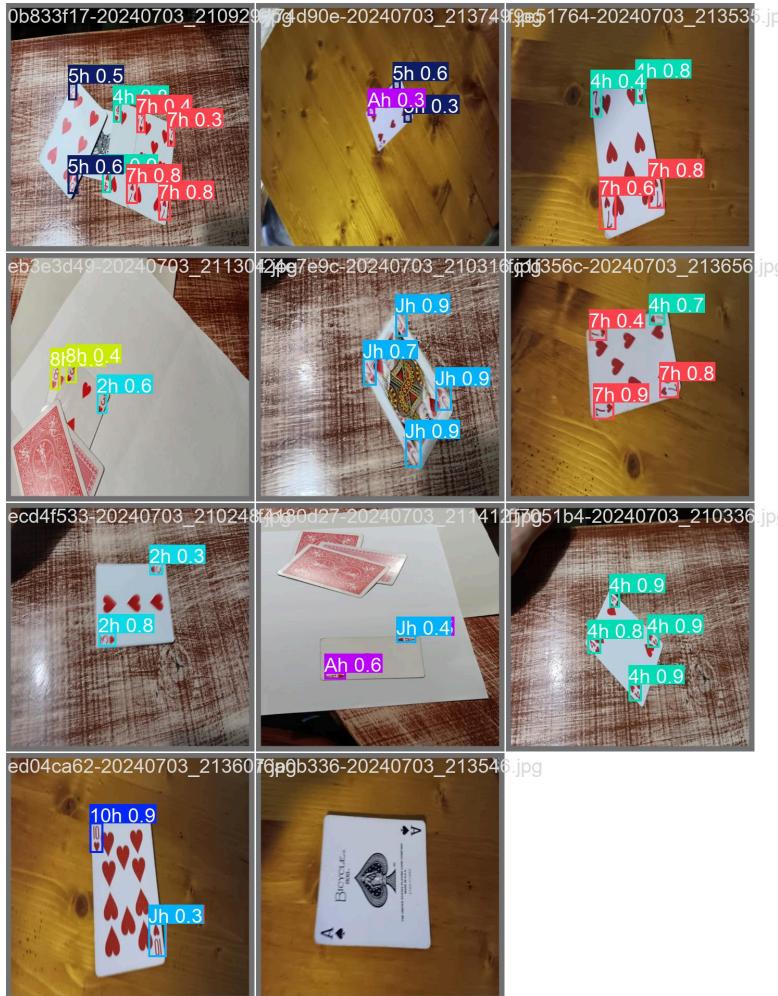
Our YOLOv8_aug model statistics

Observing similar mAP50 and mAP50-95 percents as YOLOv8_real.



Our YOLOv8_aug on test set

It is still making similar mistakes to the previous model:



Our YOLOv8_aug in practice

It still does not detect the Ace, loses the King though.



Combining the datasets

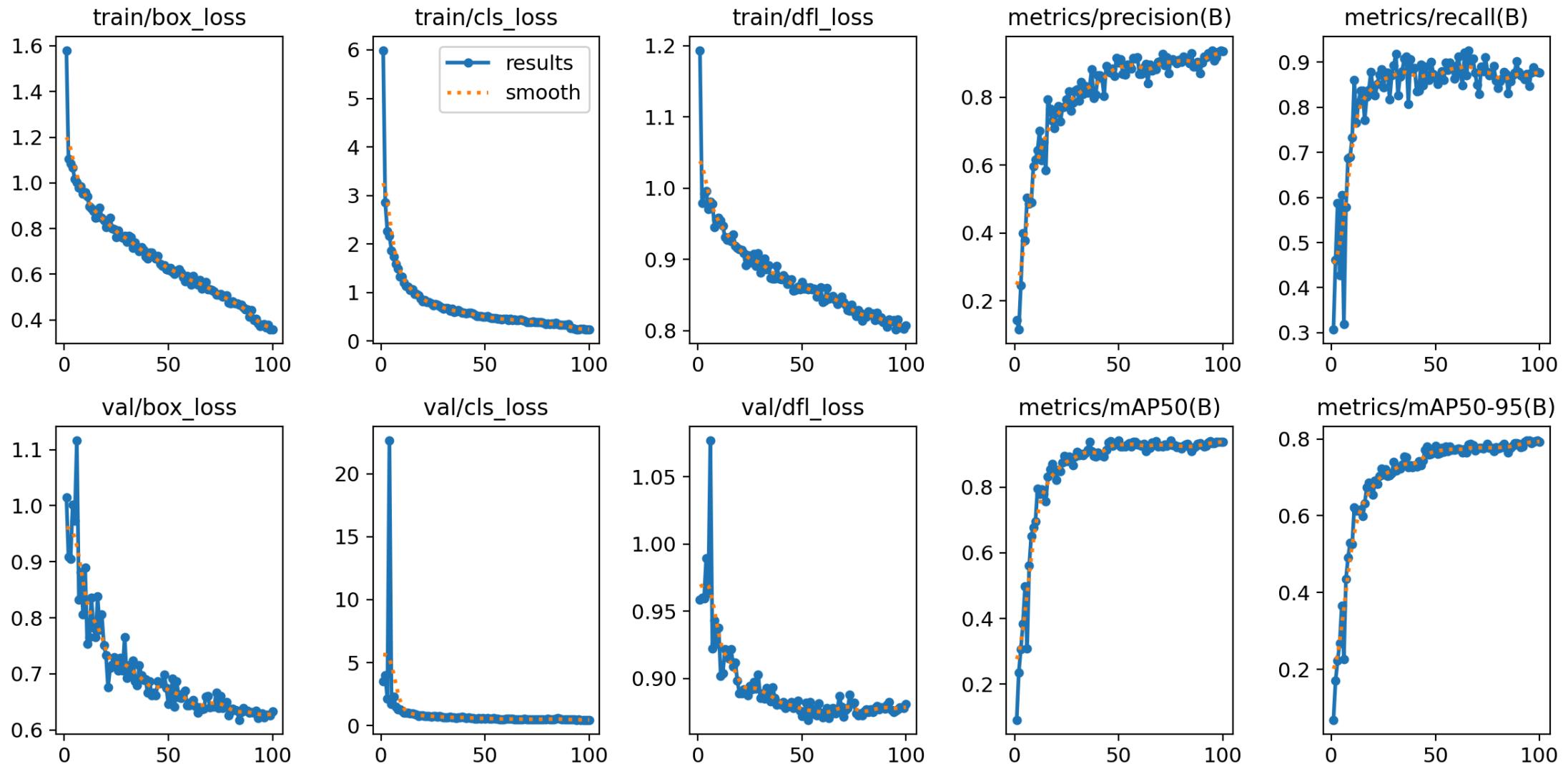
Combined the synthetic and "real" datasets, taking all **100 images** from the "real" dataset and **10 times more** from the synthetic one.

Developed a script the **relabels** all 52 classes **to the 13** from the "real" one, dropping all classes that are not Hearts.

Our YOLOv8_comb model

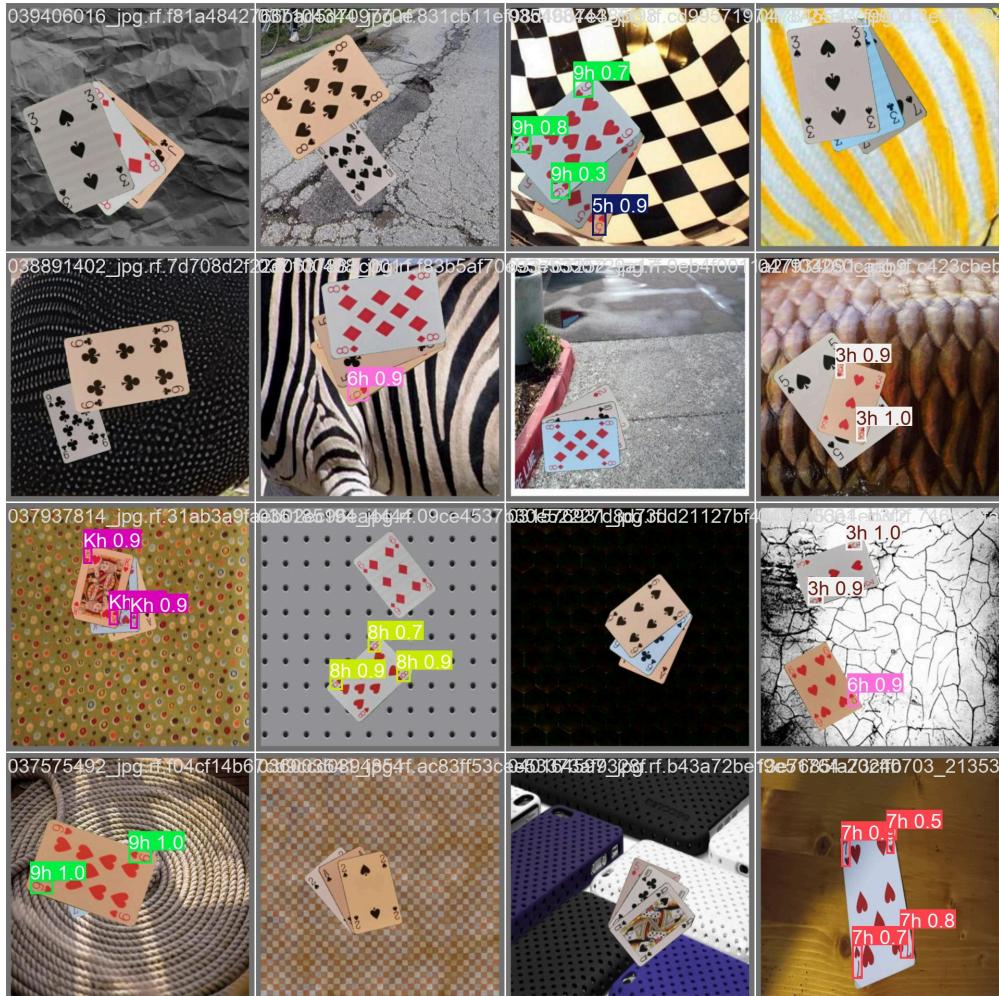
- Trained on YOLOv8 medium using 100 epochs
- Trained with 1100 images split 70/20/10 and 13 classes.
- 50 minutes training time on NVIDIA RTX A2000 8GB Laptop GPU.
- Results are worse than the synthetic model.

Our YOLOv8_comb model statistics



Our YOLOv8_comb on test set

It is doing fine on the test set, detecting only Hearts.



Our YOLOv8_comb in practice

Doing similarly to the other models in some situations.



Our YOLOv8_comb in practice

The model managed to detect the Ace, but not the King:



Our YOLOv8_comb in practice

There are definite examples that the model is not better than the others.



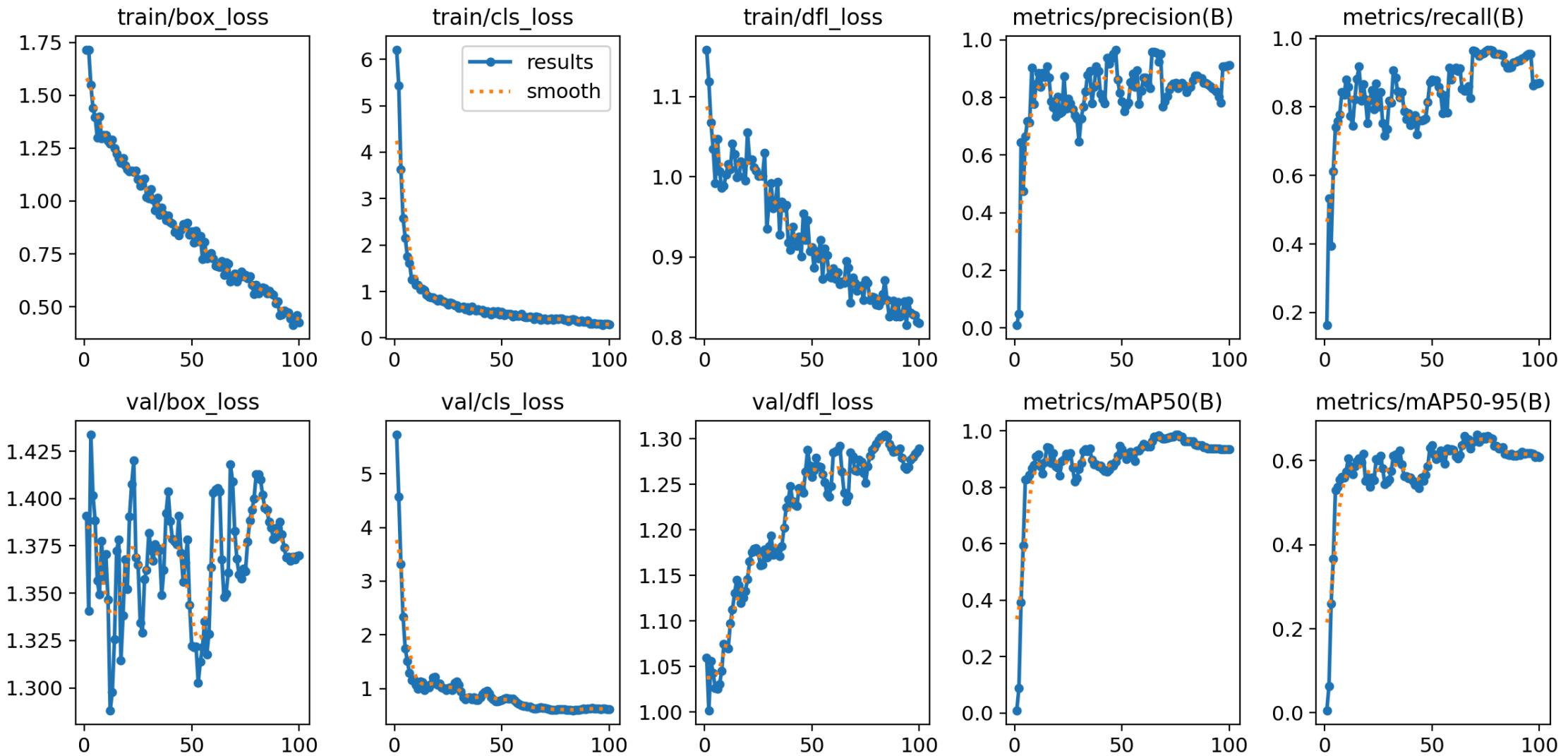
Retraining the synthetic YOLOv8_synth model

Using the well-performing YOLOv8_synth as **base model** to fine-tune the model on the Hearts dataset with **13 classes**.

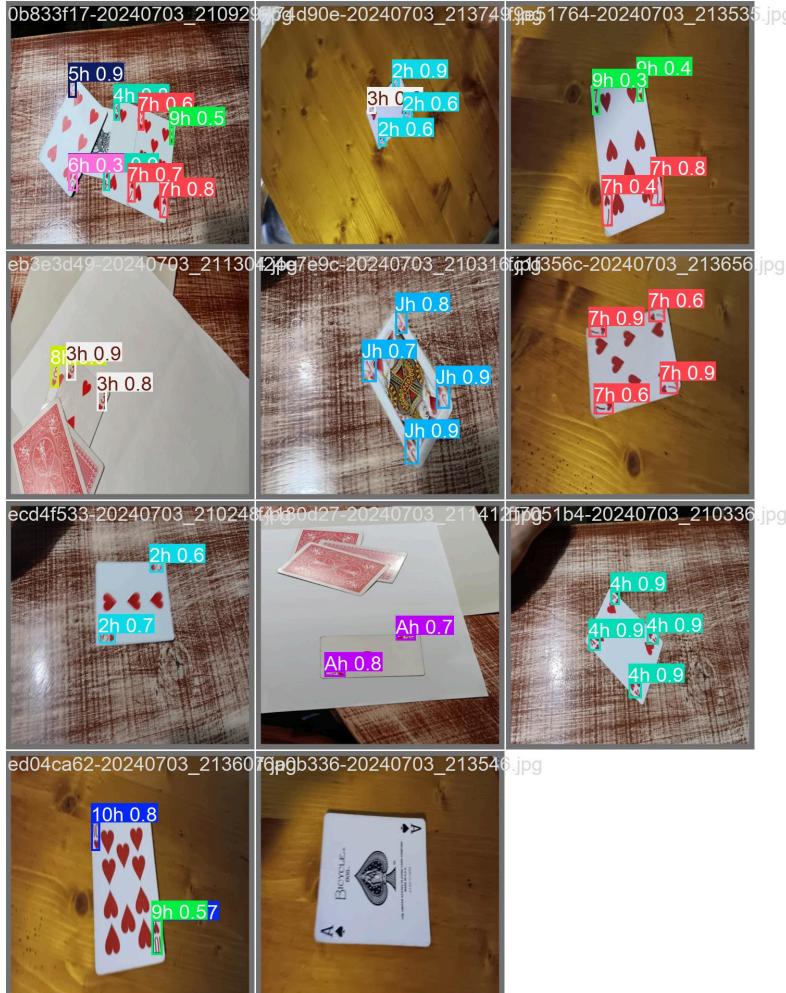
Our YOLOv8_tuned model

- Trained on YOLOv8 medium using 100 epochs
- Pretrained with 20 000 images and 52 classes.
- Fine-tuned with 100 images split 70/20/10 and 13 classes.
- 10 minutes training time on NVIDIA RTX A2000 8GB Laptop GPU.

Our YOLOv8_tuned model statistics



Our YOLOv8_tuned on test set



Our YOLOv8_tuned in practice

The model finally detects the Ace of hearts, but still mistakes other suits for Hearts.



Our YOLOv8_tuned in practice

An improvement on the total number of Hearts recognized when the cards are stacked.



Our YOLOv8_tuned in practice

Good recognition between red and black cards.



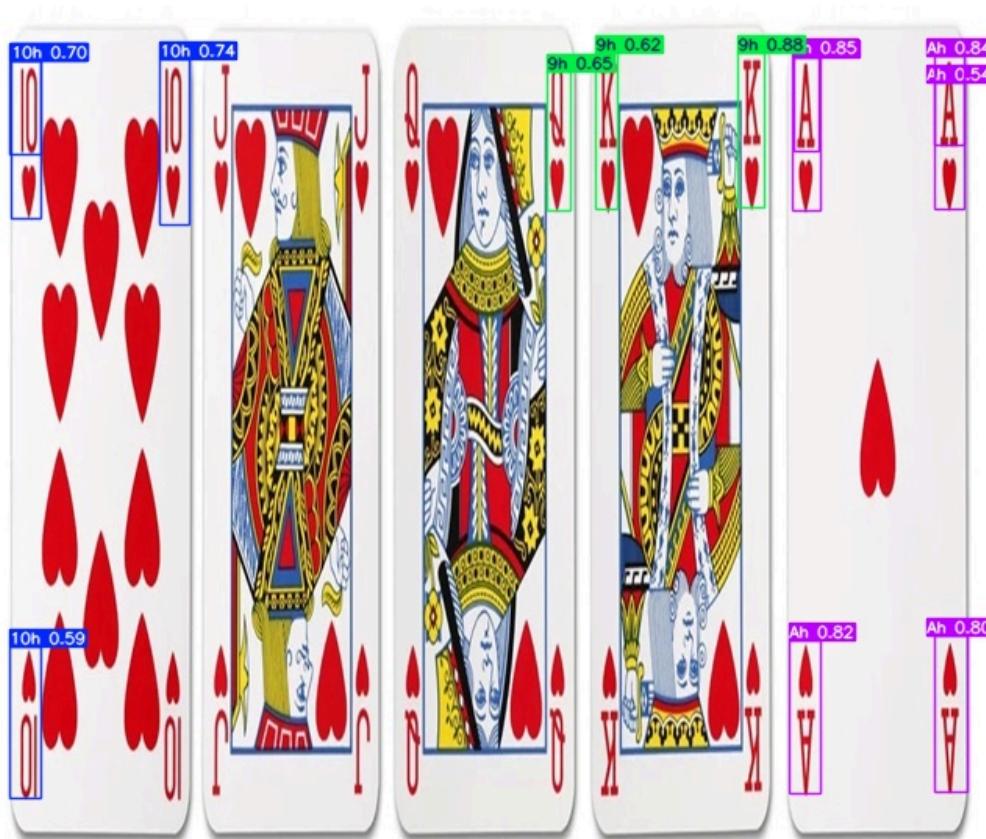
Our YOLOv8_tuned in practice

Example of **similar** recognition compared to the base synthetic model:



Our YOLOv8_tuned in practice

Example of worse recognition than the base synthetic model:



Live Demo

Conclusion

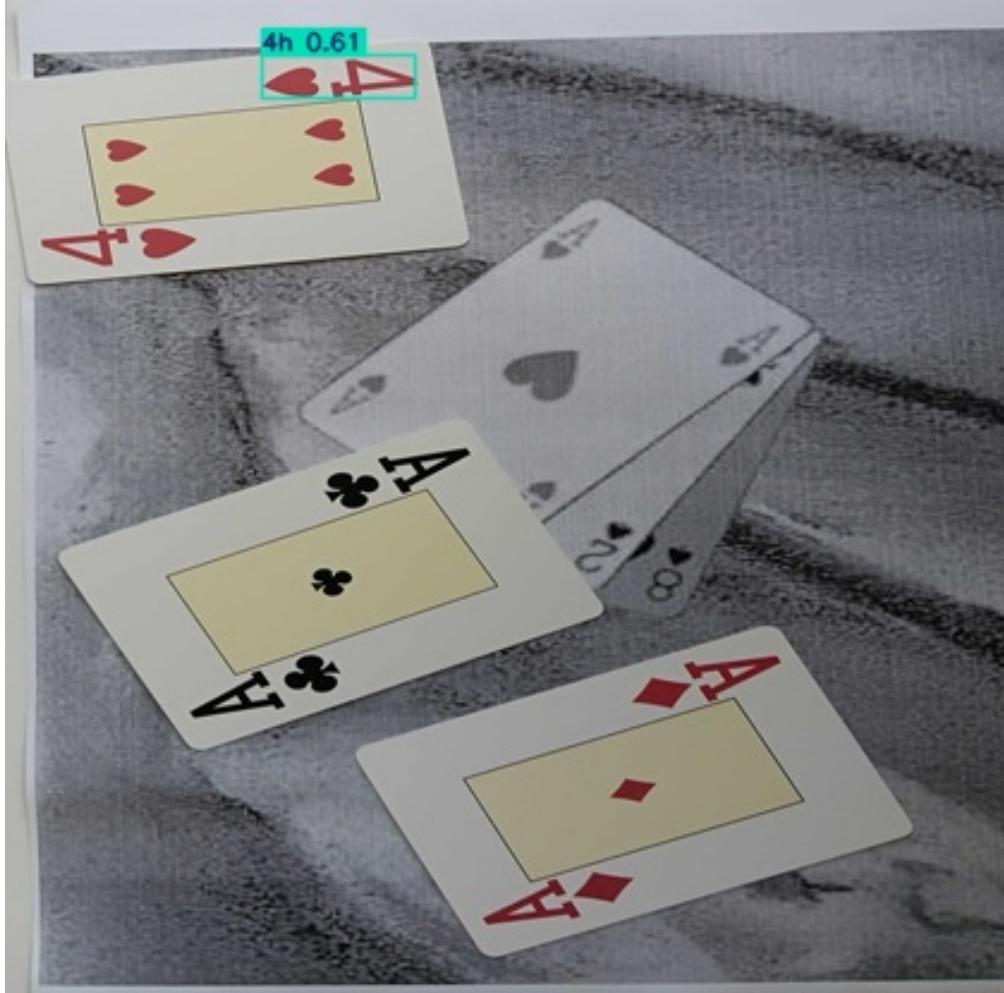
More data, better results!

Conclusion

- Fine-tuning a synthetic model seems like the most promising option if a good amount of data is available for fine-tuning.
- Combining two datasets should be tested with a more even distribution between the datasets, or a bigger amount of data in general.

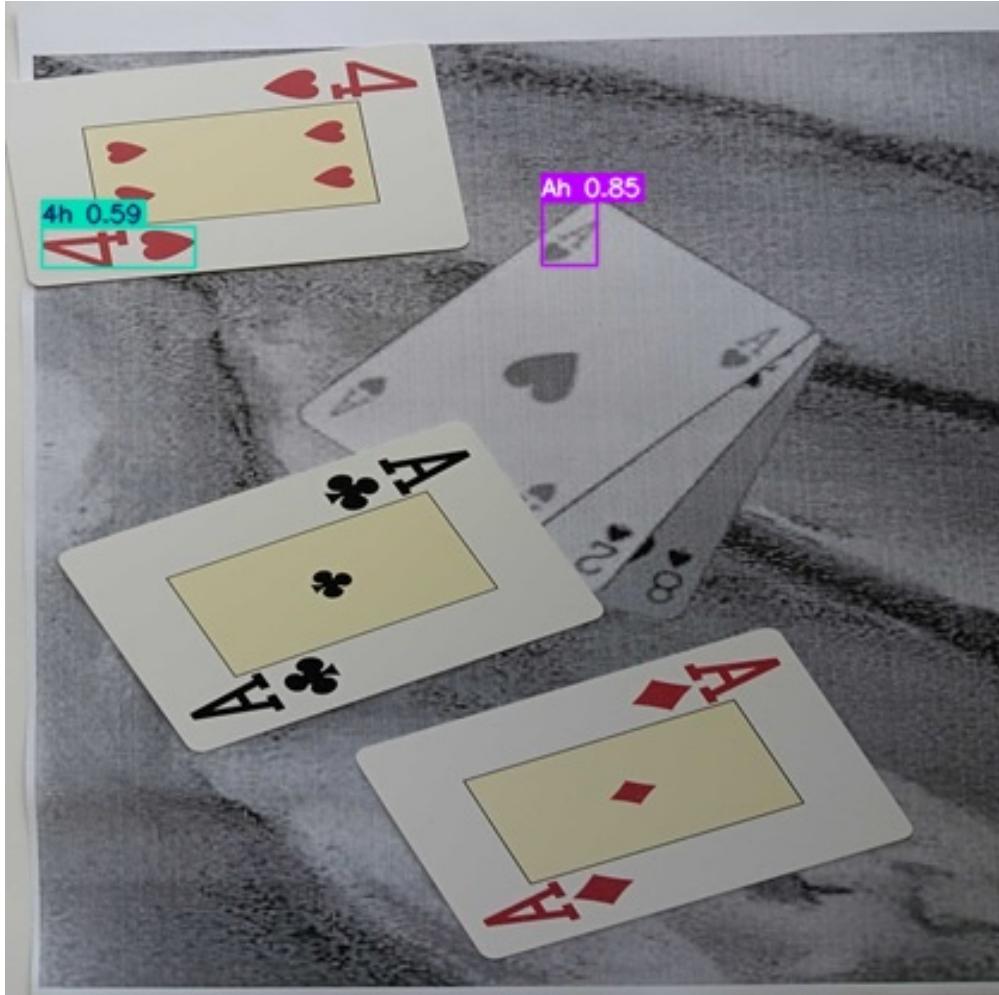
Positive examples

YOLOv8_comb manages to find the Heart:



Positive examples

YOLOv8_tuned manages to find the Heart and the printed Ace of Hearts:



Thank you for the attention!