

Faster R-CNN as an Application for Object Detection of Scattered LEGO Pieces

1 Problem

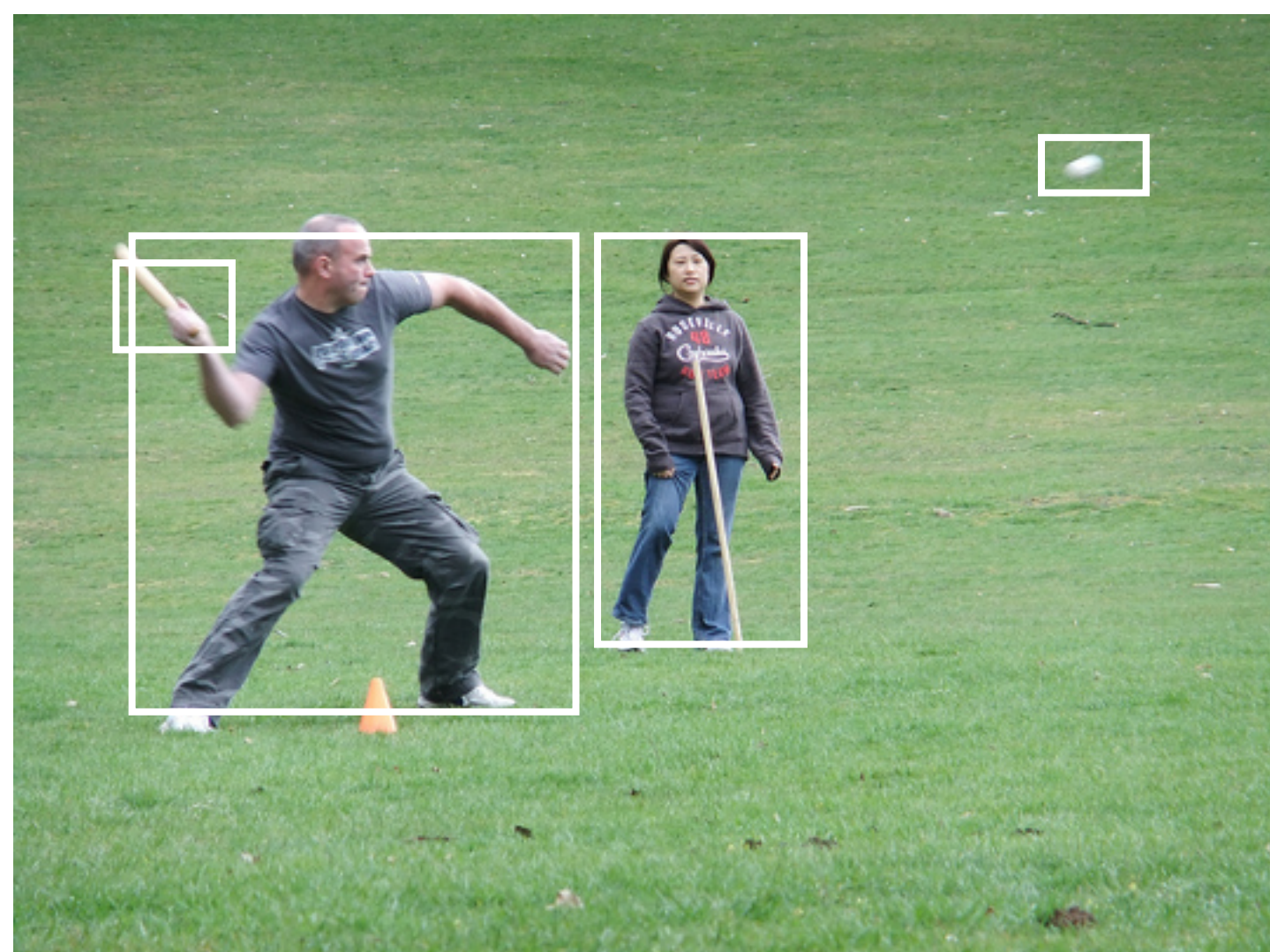


Figure 1: Detection on the COCO dataset [1].

VS



Figure 2: Detection on small, cluttered and rotated objects.

Goal: investigate and improve the performance of Faster R-CNN, optimized for Figure 1, on Figure 2.

2 Definitions

- ▶ **True Positives (TP):** number of objects correctly identified by the model
- ▶ **False Negatives (FN):** number of objects not detected by the model
- ▶ **False Positives (FP):** number of non-object items incorrectly detected as objects by the model
- ▶ **Precision:** $TP / (TP + FP)$
- ▶ **Recall:** $TP / (TP + FN)$
- ▶ **F1 Score:** $2 * Precision * Recall / (Precision + Recall)$
- ▶ **Anchor box:** box with a certain size and aspect ratio
- ▶ **Regional Proposal Network (RPN):** layer in the Faster R-CNN model that uses different anchor boxes to decide which regions in the image may contain objects and therefore are relevant to the detector

3 Results

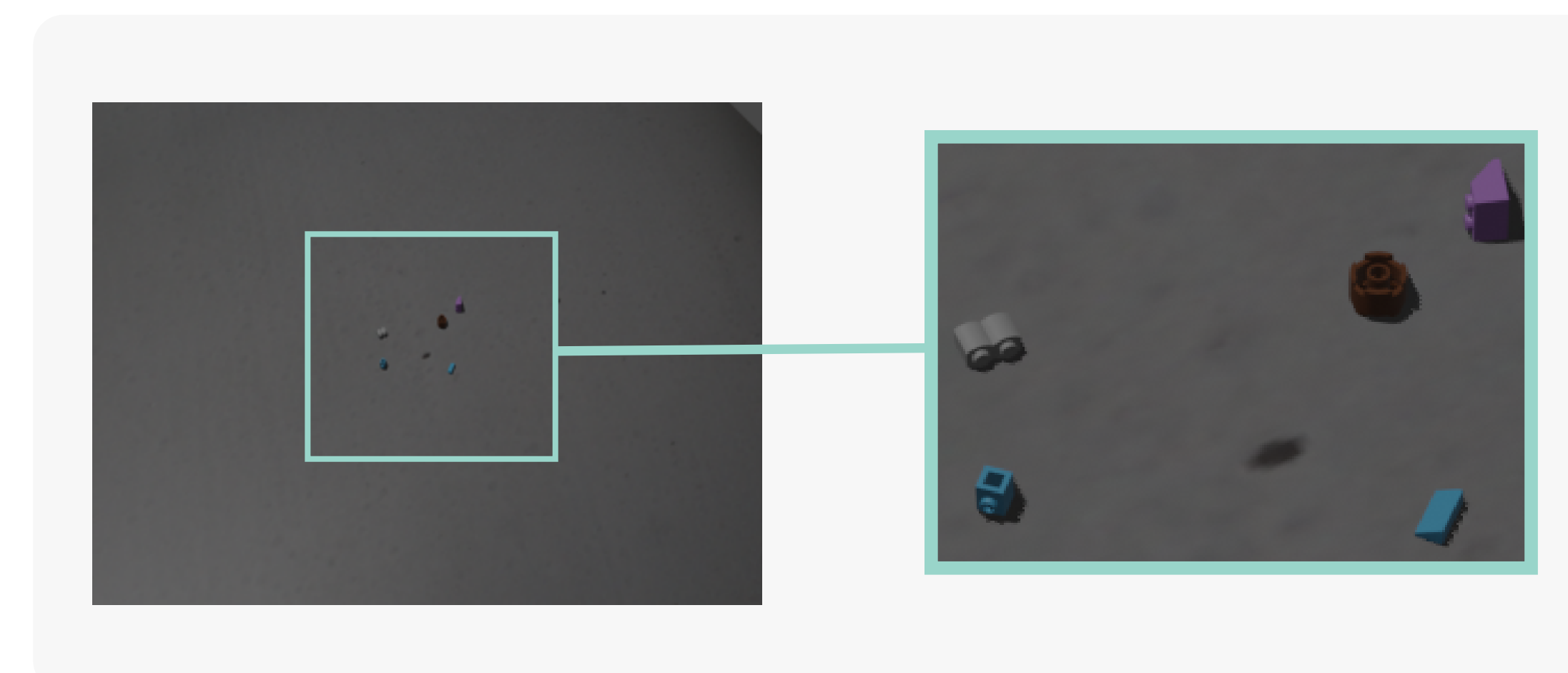
	Data size	Precision	Recall	F1 Score
Rendered	5,000	58.69%	59.82%	59.25%
Rendered-Cropped	5,054	91.94%	96.14%	93.99%
Cut & Paste	10,000	89.38%	96.19%	92.66%
Real	3,062	81.99%	79.33%	80.64%

Table 1: Results for images containing 1-13 bricks showing a 34.74% increase in F1 score after cropping the rendered images. A smaller dataset as well as more complex images for the Real data result in a higher F1 Score for synthetic data than real data.

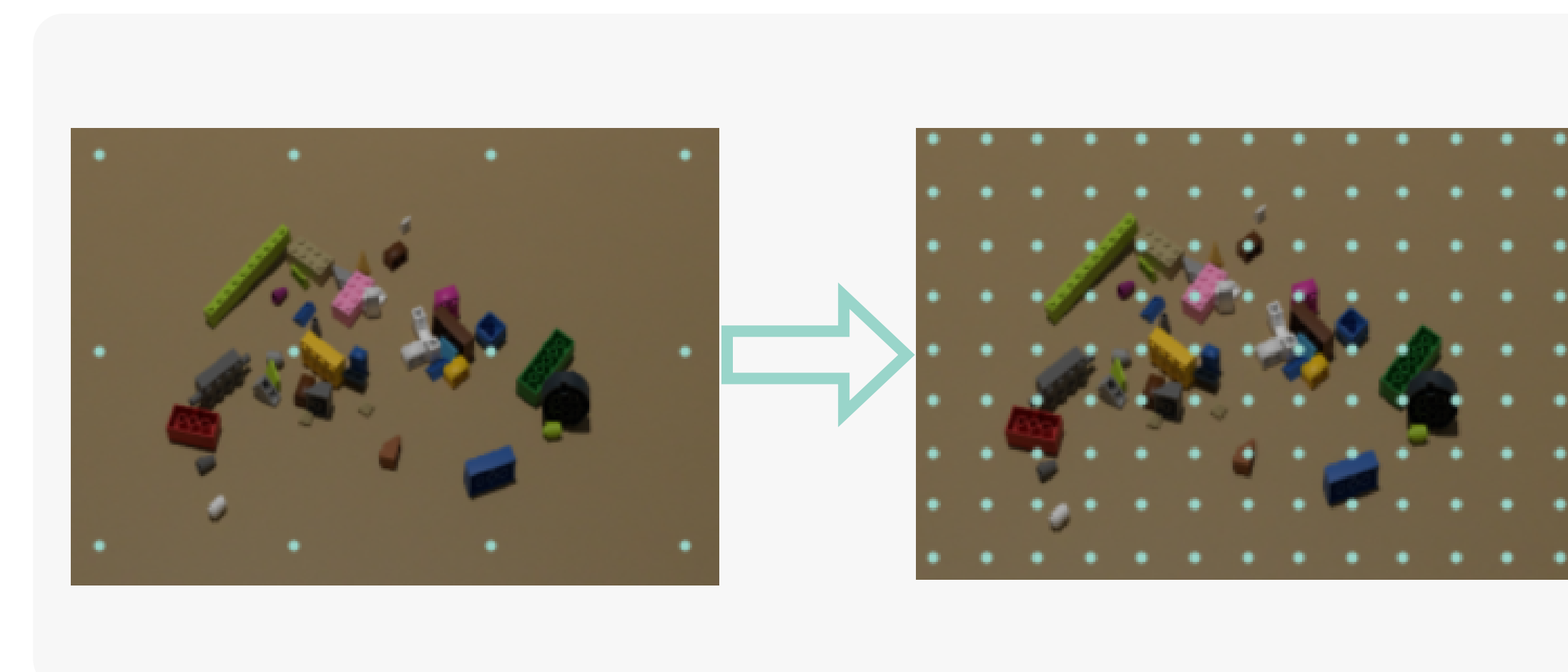
	Data size	Precision	Recall	F1 Score
Rendered-50 bricks	1,191	73.64%	45.70%	56.40%
Rendered-50 bricks-new RPN	1,191	81.73%	64.82%	72.30%

Table 2: Results for rendered images containing 1-50 bricks showing a 15.9% increase in F1 score after modifying the RPN layer of the model.

4 Conclusion



- ▶ Cropping data down to the bricks improves recognizability of the bricks and thus the performance of the model.



- ▶ The smallest original anchor box size was 128x128 pixels. By modifying the anchor box sizes in the RPN layer to cover smaller areas, we can improve the performance on small and cluttered objects.