Train Detection with Deep Learning

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INTRODUCTION

In a world where the climate crisis is becoming increasingly pressing, societies need to transition to greener modes of transportation. In particular, public transport provides an important opportunity to reduce traffic emissions.

In Switzerland, an index of public transport quality is available and we aim to compare CNN detections on aerial imagery to this index. We do this in a way that allows reproducibility and a notion of public transport quality can be computed in other places.

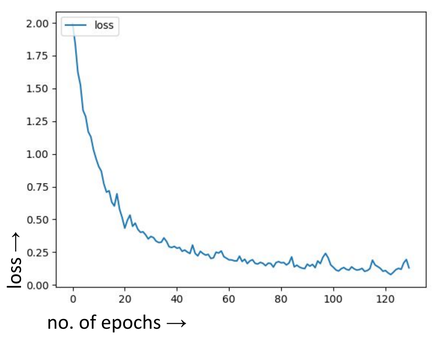
OBJECTIVE

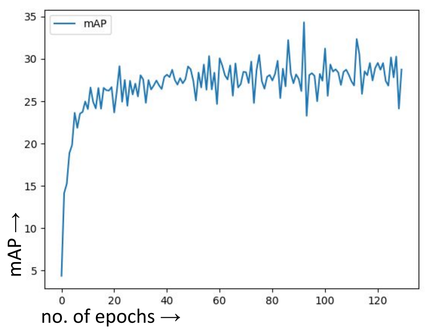
The objective of this study is to detect trains from high resolution aerial imagery with Deep Learning and assess to what extent the amount of detected trains shows any correlation with public transport service quality.

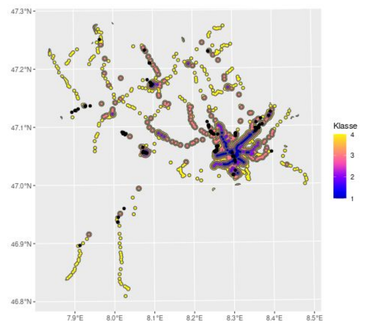
https://github.com/hurielreichel/train-detection

RESULTS

We obtained a classifier accuracy for bounding boxes from Region Proposal Network (RPN) of 97.6%. The total loss was 0.1. The loss and mAP functions are shown in the two graphs below.



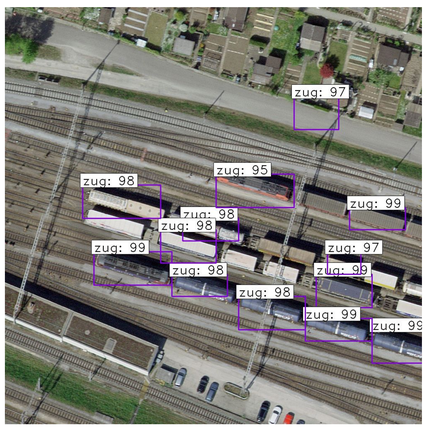




On the left, the detected trains are shown, overlaid by the public transport index. The circles represent the trains and the color gradient indicates the transport quality, which are integer values ranging from 1 (best) to 4 (worst).

input

output



METHODOLOGY

The research was done using a faster RCNN, a deep learning algorithm designed for object detection. The model was taken from this GitHub repo and corrected for this context. In order to train the model, training data from SWISSIMAGE was used. SWISSIMAGE provides complete coverage of Switzerland with 10 cm resolution from aerial imagery. In particular, we focussed on a small area called Muttenz, since there was data available that contained labelled trains. 600 high resolution images were used. For prediction, we used imagery covering the Luzern area. To reduce training time, we used PALMA HPC provided by WWU.

ARCHITECTURE

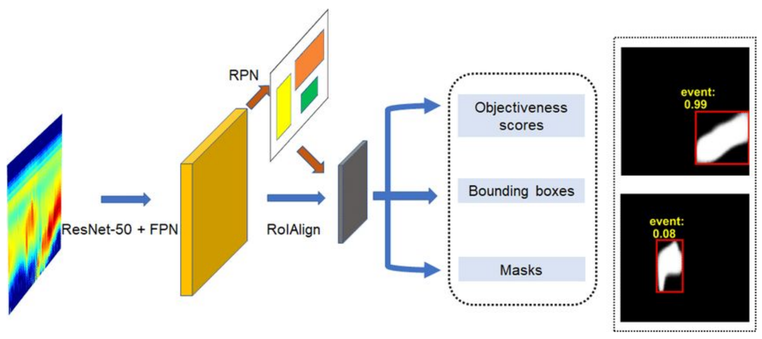


image source: [1]

DISCUSSION

The model shows a high accuracy, however, some trains still remain undetected. Some houses are also mistakenly identified as trains; this is probably due to the fact that some houses have very similar shapes.

Regarding the public transportation index, it should also be taken into account that our data also included cargo trains, which are not part of public transport. This could be corrected in future studies by perhaps making an estimate of the amount of cargo trains and then reducing this in the detected amount.

CONCLUSION

To conclude, usage of a fast RCNN proved to be a suitable method for train detection from aerial imagery. The number of detected trains showed a certain correlation with the public transportation quality index - especially where a lot of trains were detected, there was a high public transport quality index. Higher accuracy could still be achieved by implementing some data augmentation methods. In the future, this model might be used in other countries to determine the quality of public transportation.

REFERENCES

[1] Su, Peifeng & Joutsensaari, Jorma & Dada, Lubna & Zaidan, Martha Arbayani & Nieminen, Tuomo & Li, Xinyang & Wu, Yusheng & Decesari, Stefano & Tarkoma, Sasu & Petäjä, Tuukka & Kulmala, Markku & Pellikka, Petri. (2022). New particle formation event detection with Mask R-CNN. Atmospheric Chemistry and Physics. 22. 1293-1309. 10.5194/acp-22-1293-2022.