University of Applied Sciences and Arts Northwestern Switzerland
School of Architecture, Civil Engineering and Geomatics

MASTER OF SCIENCE IN ENGINEERING

Analysis and Web Interface for Camera Trap Data on the SNCF Railway Network

The French national railway company SNCF operates the second-largest rail network in Europe and is increasingly challenged by wildlife-train collisions (WTC) especially with wild boars. To better understand what is causing them, the SNCF launched the *Pilote IA SNCF* project in collaboration with the Institute of Geomatics at the FHNW. This master's thesis, conducted within this project, develops a multi-temporal model approach to predict collision numbers with wild boars and a web-based platform for exploratory data analysis including an automated pipeline for detecting wild boars and other animal in camera trap images.

Wild boar on train lines

The number of wild animal-train collisions (WTCs) is currently rising. In 2024 alone, 2'562 collisions with wild animals were reported, causing 5'039 hours of delay. Of these, 1'104 involved wild boars (SNCF, 2025), which are particularly likely to cause serious damage to trains like in Figure 1. The accidents also follow a temporal pattern, with most occurring during the winter months. To better understand the various factors contributing to these accidents and their relation to wild boars, a new machine learning model was trained in this thesis to predict when and how many accidents are expected on SNCF rail lines.

Fig. 1. Train after collision with wild boar between Cherbourg and Paris (Chasse Passion, 2020)

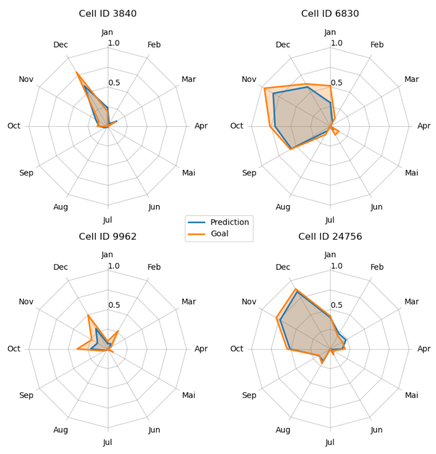

Fig. 2. True and predicted number of collisions on the test dataset of the GBM model.

Risk prediction model

Multiple machine learning (ML) models were trained using the SNCF reported wild boar collision data from 2015 to 2024. More than 34 environmental and railway operational variables were evaluated to identify features that are beneficial to the model performance. The target variable (reported accidents) was derived using kernel density estimation (KDE). The train line was segmented into 1 km sections and predictions are generated for each segment for every month. Among the tested models, the Gradient Boosting Machine (GBM) achieved the best performance. The most influential input features were train speed, track curvature, train density, hunting statistics, and proximity to oak, conifer, and beech forests. The final model achieved a performance score of 0.79 with a root mean squared error (RMSE) of 0.023.

To validate model performance, the model was trained without the 2024 collision data and evaluated on its ability to predict these withheld events. At national scale, the model predicted 1'070 of the 1'104 reported collisions in France, corresponding to an error rate of less than 1%. The model also demonstrated the ability to capture local patterns: in the examples shown in Figure 4 where 13.6 of 15 reported collisions were predicted correctly. Across all of France the model achieved a standard deviation of 0.057 and an RMSE of 0.003 for the year 2024.

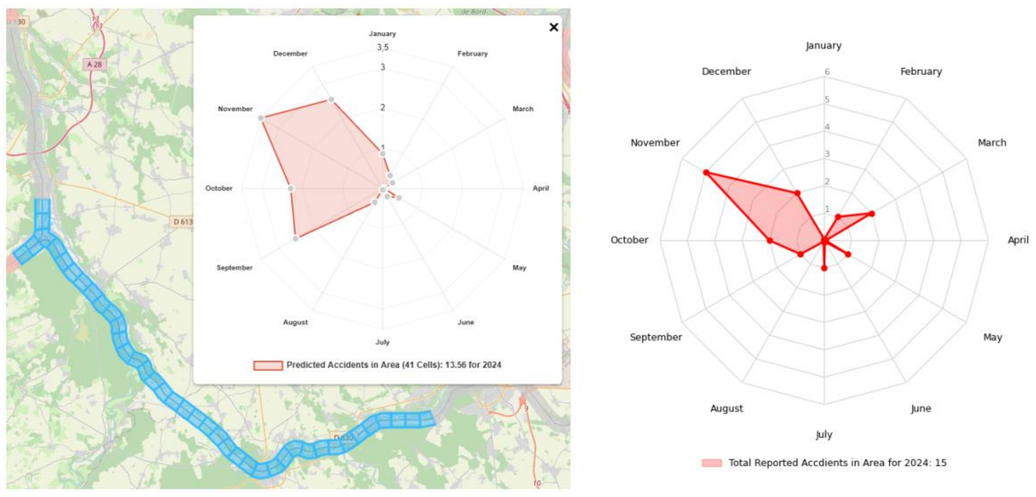

Fig. 3. Number of predicted collisions with wild boars (left) compared to the actual reported ones (right) in 2024 for a train track in Normandy

Camera Trap Analysis

To monitor wild boar activity along the railway lines, over 100 camera traps were deployed at the locations shown in Figure 5 as part of the Pilote IA SNCF project. Since July 2023, these cameras have collected more than 1'450'000 images. As shown in Figure 5, only around 1% of these images actually contain wild boars, while the vast majority capture no animals. To handle this large volume of data efficiently, an automated detection pipeline was developed. It consists of a two-step approach. First, MegaDetector is used to detect objects such as vehicles, humans, and animals in the images. In a second step, the detected animals are classified using DeepFaune (Rigoudy et al., 2023).

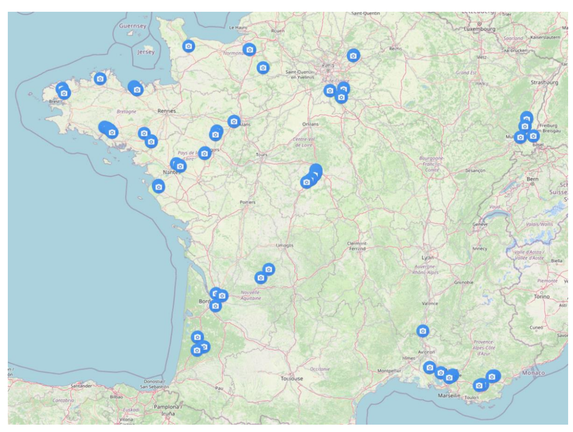

Fig. 4: Spatial distribution of the installed camera traps

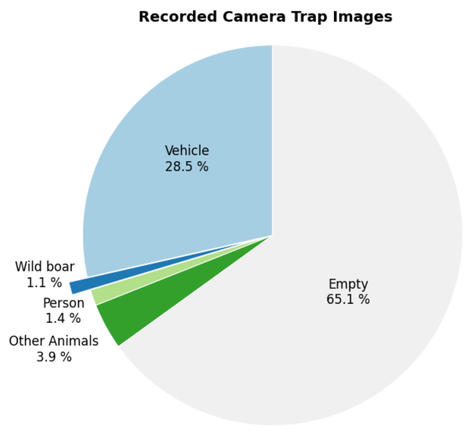

Fig. 5: Class distribution of all recorded camera trap images (MegaDetector – DeepFauna)

Correlation between Camera Trap Activity and Accident Hotspots

Pearson correlation analysis was used to test whether high wild boar activities recorded by camera traps are linearly related to accident risk. For each camera relative abundance (average number of individuals recorded per day) as well as occupancy (probability of recording a wild boar on a given day) were calculated in two-week time windows. The mean values were then compared with collision risk derived from reported accidents. The results indicate a weak but statistically significant linear correlation. However, as visible in the scatter plots in Figure 5 the camera trap activity alone is not a reliable indicator of elevated collision risk. This finding is consistent with the modeling results, which identified railway related parameters such as train speed, traffic density, and track curvature as key predictors of collision risk. Parameters that are not linked to a wild boar activity.

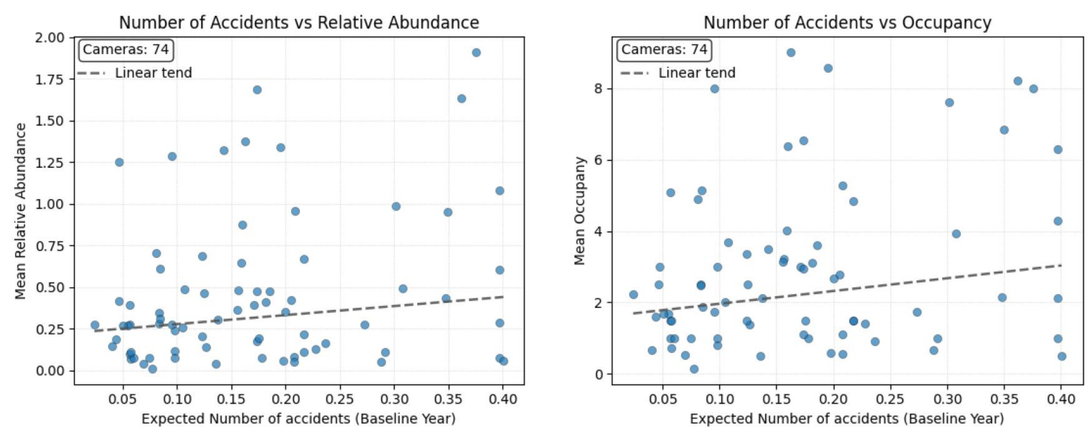

Fig. 5. Scatter plot of the mean Relative Abundance and Occupancy per camera versus the true number of accidents per year

Conclusion

This work successfully developed a multi-temporal risk prediction model for the SNCF network, capable of predicting both the number and temporal occurrence of wild boar-train collisions. In addition, an automated pipeline for detecting wild boars in camera trap images was implemented. All results are visualized and can be interactively explored through a newly developed web-based platform.

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