Advances of FishNet towards a fully automatic monitoring software for fish migration

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Introduction

FishNet is the software component of the FishCam monitoring system, which enables video-based observation of fish migration in technical fish passes. Until now FishNet has been used to automatically detect/track fish in the videos and to sort out any video not containing at least one fish (~96% of the data). However, human experts are still required for the classification of fish into their species. Because this is a tedious and time consuming work, we try to further automatize this task by applying state-of-the-art machine learning techniques.

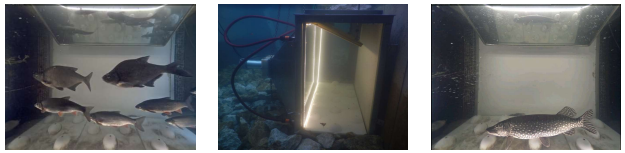

Figure 1: FishCam tunnel (center) and video examples (left & right)

Methods

For any image classification task Convolutional Neural Networks (CNN) are nowadays the widely accepted non-plus-ultra. CNNs are a special architecture of neural networks, that take into account the spatial correlation of pixels within images. Since the quality of the underwater images varies significantly throughout the year (e.g. murky water after heavy rain), the potential of injecting additional information into the model in order to improve model performance was tested.

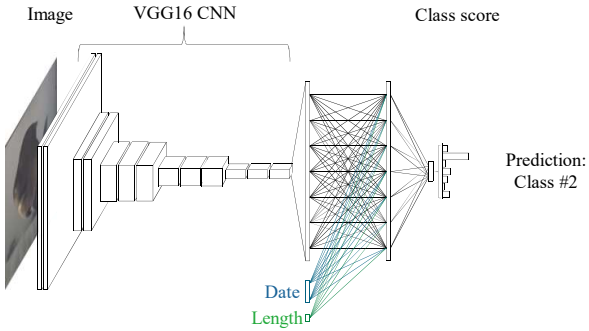

Figure 2: The core of the CNN builds the VGG16 network. The different setups only vary in additional inputs in the second-to-last layer, marked by the colors.

Experiments

To facilitate the development and testing of this approach, only a subset of seven fish living in Austrian rivers was considered. For each fish in the dataset, fish species and length was determined by human experts, which will be used as ground truth data.

Species

	bream	brown trout	burbot	chub	nase	perch	rainbow trout
# fish	1122	461	281	1130	639	377	1050
# imgs	7800	4351	1812	8783	5839	2686	6859

Table 1: Number of fish and images per species in the created dataset.

For each species, the images 80 % of all individuals were used for training and the remaining 20 % for evaluating the trained model. The number of images per individual fish is variable. The final prediction for each fish is derived by summing up the probabilities of all images for each class and choosing the class with the highest accumulated probability value.

Results

We compared the model performances of the CNN model without additional information (image-only) and with additional information on time of migration and length of the fish. The results show:

- Image-only classification (VGG) is the worst
- Using a single addition information: time of migration seems more helpful than the length of the fish
- Image + time + length results in the highest prediction accuracy
- Mistakes are mostly within species that look similar (e.g. rainbow/brown trout)
- Species with very distinctive appearance achieve higher class accuracies (e.g. bream, burbot) than species with similar looks (e.g. chub, nase)

Model	Accuracy [%]
VGG	87.7
VGG + length	89.0
VGG + weeks	90.3
VGG + both	91.7

Table 2: Accuracy of the trained models on the test set data.

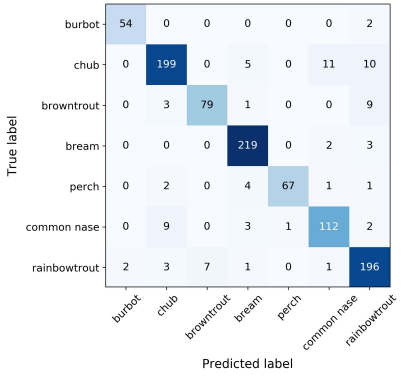

Figure 3: Confusionmatrix of the "VGG + both" model

Which fish do you see?

During presentation time, you can test your classification skills on the real test set data and compare your result to the prediction of the network.

If you want to start right away, scan the QR-Code at the right of the screen.

Conclusion

We tested the potential of integrating an automatic fish species classification framework into the FishNet software. The outcome of the experiment is promising in that it demonstrates that the use of an automatic image classification approach might be feasible for practical use. Nevertheless, more experiments with a greater number of species and data samples are necessary. Moreover, further features should be considered, since the use of additional features significantly improved the prediction accuracy of the network in this study.

#OpenScience

The code of the model, the trained networks, the test data and further explanation are open source and can be found on GitHub.
https://github.com/kratzert/EGU2017_public