Agent Based Modeling of Fish Shoal Behaviour

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1 Introduction

In fishery and water protection, modeling of the fish shoal behaviour is relevant for several biomonitoring and bioinformatics tasks from evaluation of the fish welfare and feeding optimization, water quality, and environmental relations to the early warning systems based on fish as biosensors. Such task requires combination of expert knowledge, experimental data, and computational methods.

2 Methods

The typical property of the fish to swim in groups (shoals, schools) is well possible to implement by the agent based modeling, where each fish is represented by the single agent with simple rules. The shoaling behaviour emerges from the cooperation of several agents. The NetLogo environment was chosen for such modeling
- since there already exist models of flock of birds which it could be extended by additional variables and parametrized for the fish agents;
- and since it also offers the modeling of the environment and its interaction with the agents, including gas diffusion (Pelikán (1983)) and water flow changes (Curatolo and Teresi (2015)).

Therefore, the inductive modeling was seected, for we are interested mainly in the question of dependency between the water parameters and fish shoal behaviour. We experimentally observe the fish shoal, while we want to determine the environmental conditions from such observation. Firstly, it is necessary to identify the model. Information from the real experiments are required for the process of identification. Danio and zebrafish were used in several environmental dependency experiments. In data acquisition, the infrared camera (MS Kinect and Picamera NOIR) and visible (Picamera) were used. From monitoring and simple image analysis we got the basic parameters of fish shoal (speed, compaction, average depth and frequency of changes). Currently, we are members of the AquaExcel consortium, where we have approach to the models, and parameters important for the fish welfare description.

3 Results and discussions

Our first 2D fish shoal behaviour NetLogo model is based on already existing model of birds. We had to modify parameters according to the experimental behaviour. The shoal behaviour at the edges of the tank/aquarium were modified by the Wilensky model of bouncing balls (Wilensky (1998)). The environmental model of the vertical and horizontal diffusion of dissolved oxygen was estimated by the theoretical method (Pelikán (1983); Wilke and Chang (1955)) and compared with the real conditions. During the modeling, we also solved the effects

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of the capillary phenomenon on the edges of the tank.

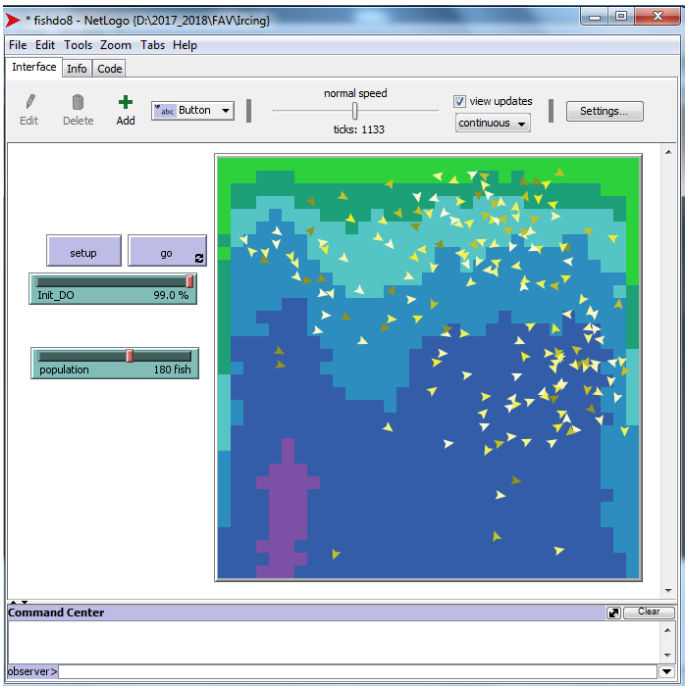

Figure 1: Fish shoal behaviour NetLogo model with several levels of diffusion of dissolved oxygen.

Next step will be identification of another parameters and expanding the model from an ethological and hydrochemical point of view. For searching for inductive bonds it will still be necessary to find suitable criterial function for self parameterization of the model.

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References

Curatolo, M., Teresi, L. (2015) *The Virtual Aquarium: Simulations of Fish Swimming*.

Pelikán, V. (1983). *Ochrana podzemních vod*. Praha, SNTL.

Wilensky, U. (1998) *NetLogo Random Balls model*. Available from: `http://ccl.northwestern.edu/netlogo/models/RandomBalls`. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

Wilke C.R. and Chang P. (1955) Correlation of diffusion coefficients in dilute solutions. *A.E.CH.E. Journal*, Volume 1, pp. 264-270.