Soft Sensor of Key Components in Recirculating Aquaculture Systems, using Feedforward Networks

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Introduction

Brief Summary

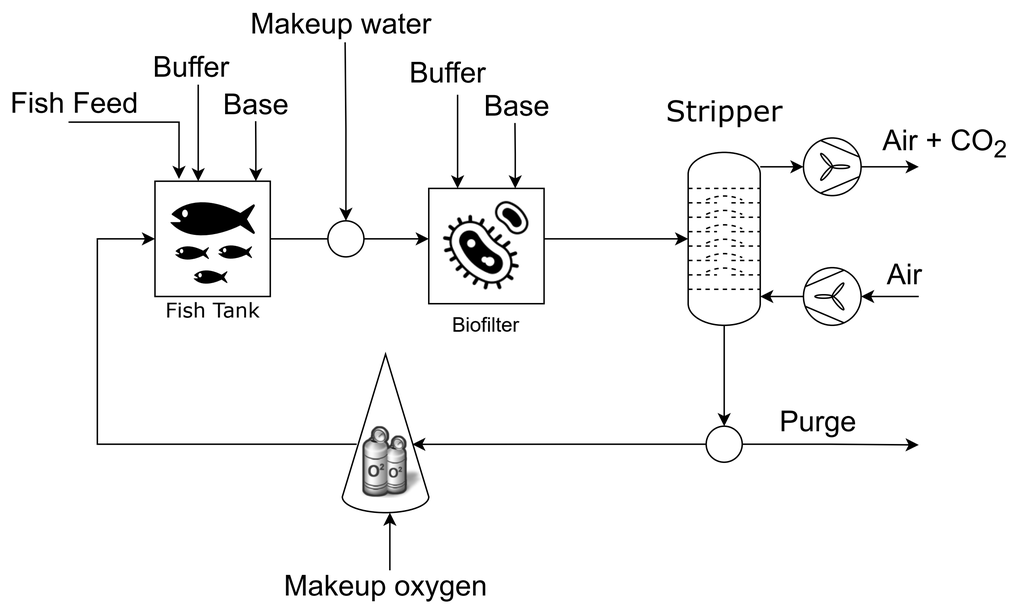
- First-principles model of water treatment system of Recirculating Aquaculture Systems (RAS) to gather data
- Latin hypercube sampling used for designing of experiments
- Training data from steady-state model + white noise
- Test data from fish farm industry (contained in the operating region of the training data)
- Feedforward neural networks generated by the neural architecture search (NAS) named AutoKeras
- Comparison between a combination of multiple-input single-output multilayer perceptron models (MISO-MLP); hybrid model; and multiple-input multiple-output multilayer perceptron model (MIMO-MLP)

Main objective

Develop a multilayer perceptron (MLP) model, using AutoKeras, for monitoring key components in Recirculating Aquaculture Systems (RAS) to complement laboratory analysis, which is time consuming and costly.

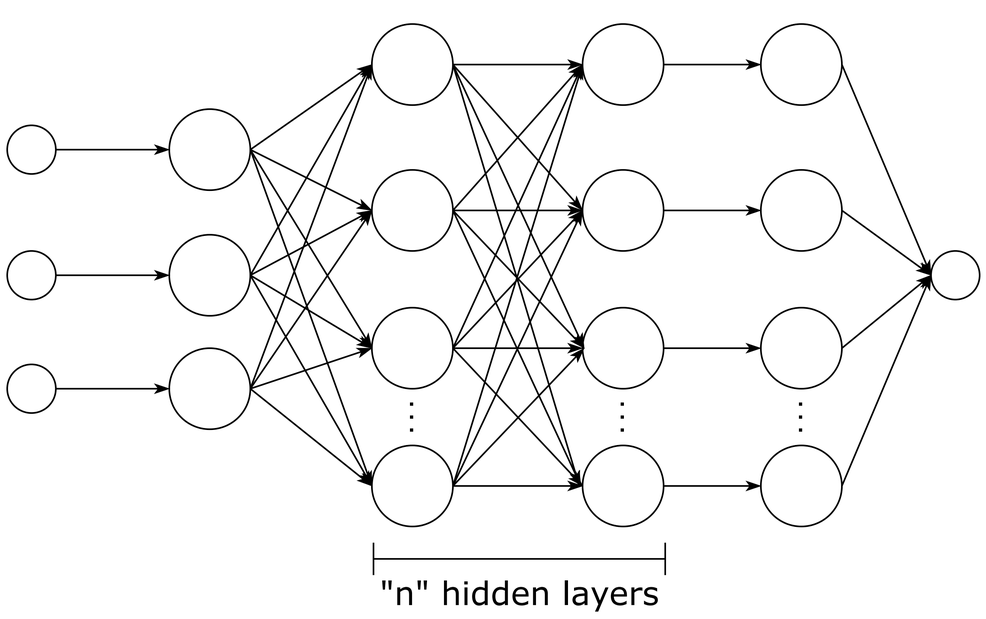
Process Description

Recirculating Aquaculture System:



Neural Network Architecture

Input Normalization Dense_1 $\cdots$ Dense_n Dropout Output



Results

RMSE index

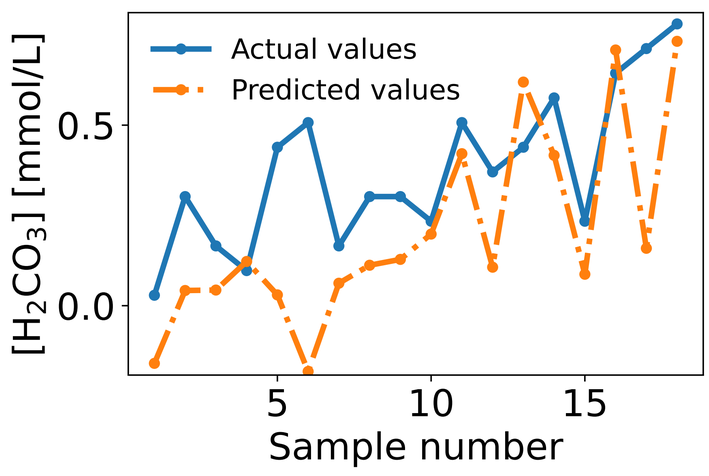
Output	MISO-MLPs	Hybrid	MIMO-MLP
$c^T_{H_2CO_3}$	0.0645	0.0787	0.0694
$c^T_{NH_4^+}$	0.1204	0.1201	0.1230
$c^T_{NH_3}$	0.1322	0.2611	0.1351
Final	0.1097	0.1720	0.1129

Number of nodes in each layer of each MISO-MLP model

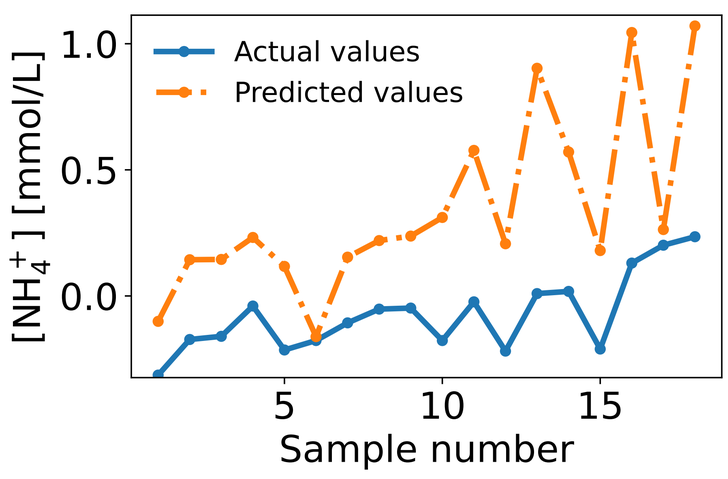
Layers	**MISO-MLP**$_{H_2CO_3}$	**MISO-MLP**$_{NH_4^+}$	**MISO-MLP**$_{NH_3}$
Input	4	3	3
Normalization	3	3	3
Dense_1	32	64	128
Dense_2	32	0	0
Dropout	0	64	128
Output	1	1	1

Model Validation - MISO-MLP combination

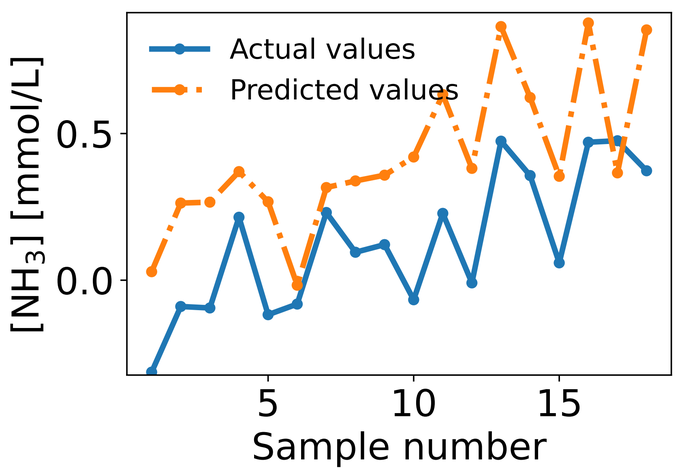
Prediction of $c^T_{H_2CO_3}$



Prediction of $c^T_{NH_4^+}$



Prediction of $c^T_{NH_3}$



Conclusions

- The combination of MISO-MLP models gave a better performance.
- AutoKeras did not find a good FNN, as they all gave similar prediction trajectory to all variables.
- The MLP models could not capture enough information of the process.
- Different types of models should be considered in future work.

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