

High-throughput processing of telemetry data

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- Core Science Systems
- Ecosystems
- Energy and Minerals
- Environmental Health
- Land Resources
- Natural Hazards
- Water Resources



Upper Midwest Environmental Science Center

Providing the scientific information needed by managers, decision makers, and the public to protect, enhance, and restore the ecosystems in the Upper Mississippi River Basin, the Midwest, and worldwide.







Photo by Ryan Hagerty, USFWS





Responses of invasive silver and bighead carp to a carbon dioxide barrier in outdoor ponds

Aaron R. Cupp, Richard A. Erickson, Kim T. Fredricks, Nicholas M. Swyers, Tyson W. Hatton, and Jon J. Amberg











Data challenges

- 100GB or more per trial
- Requires reasonable turn around times



Old data workflow

- Uploaded and processed annually (prior to 2019)
 - Run locally on any free machines
 - No cluster management system
- Now processed in cloud (2019)
 - Unsure of cloud vendor
 - Workflow lacks transparency
- 3rd party collaborator uses closed source software



Data processing steps

- Convert return times to coordinates
- Process coordinates to cleanup data
 - Errors caused by collection process
 - Errors caused by multiple solution to step 1



Software

- Docker to containerize code
- Python



Converting to coordinates







Converting to coordinates

- Match points to receivers
 - e.g., signal every 2.1 ms might belong to a fish
- Solving Pythagorean theorem

$$t_i - t_j = \frac{1}{c} \left[\sqrt{(h_{ix} - F_x)^2 + (h_{iy} - F_y)^2 + (h_{iz} - F_z)^2} - \sqrt{(h_{jx} - F_x)^2 + (h_{jy} - F_y)^2 + (h_{jz} - F_z)^2} \right]$$



Data cleaning



The goal is to reconstruct the fish trajectory from the output of the hydroacoustics system.

Hydroacoustics Data



Methods

- Convolutional filtering
- Clustering
- Neural networks



Our solution

- Denoising auto-encoder (DAE)
 - The encoder and decoder are implemented with the recurrent neural networks (RNN).



Denoising auto-encoder



Computer vision application with DAE [OpenDeep].



DAE structure [Deep Learning A-Z[™]].



Recurrent neural networks



RNN structure [colah's blog].



Training data preparation

- Representation
- Generation
 - Ground truth
 - Corrupted ground truth



Results





User interface



