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TIME-SERIES DETECTION OF WATER DEPTH IN DARBESON SALT LAKE BASED ON JOINT MULTISEPCTRAL DATA AND LIDAR DATA

MINGHAN HUANG, HAOXIANG SUN, FEI MA, QIANG YIN*

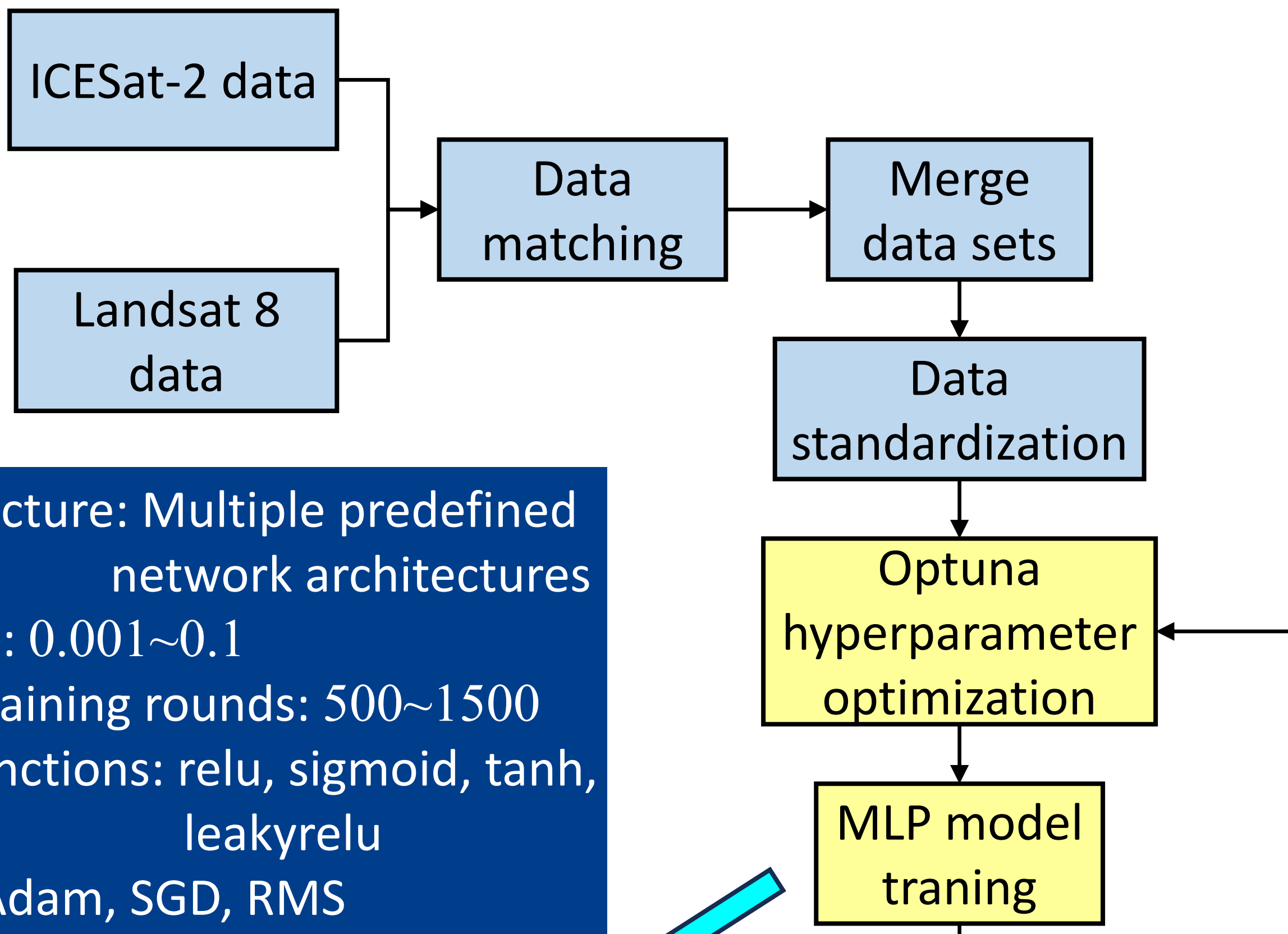
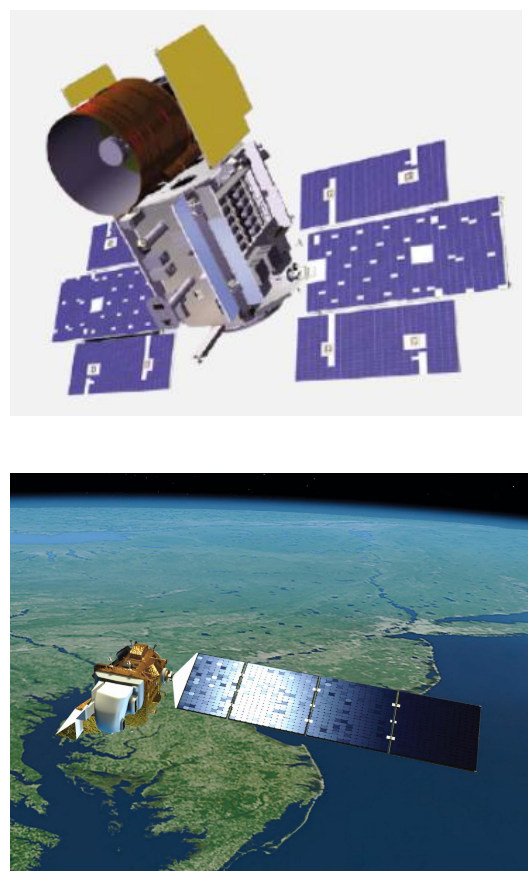
COLLEGE OF INFORMATION SCIENCE AND TECHNOLOGY, BEIJING UNIVERSITY OF CHEMICAL TECHNOLOGY, BEIJING 100029, P.R. CHINA
yinq@buct.edu.cn

INTRODUCTION

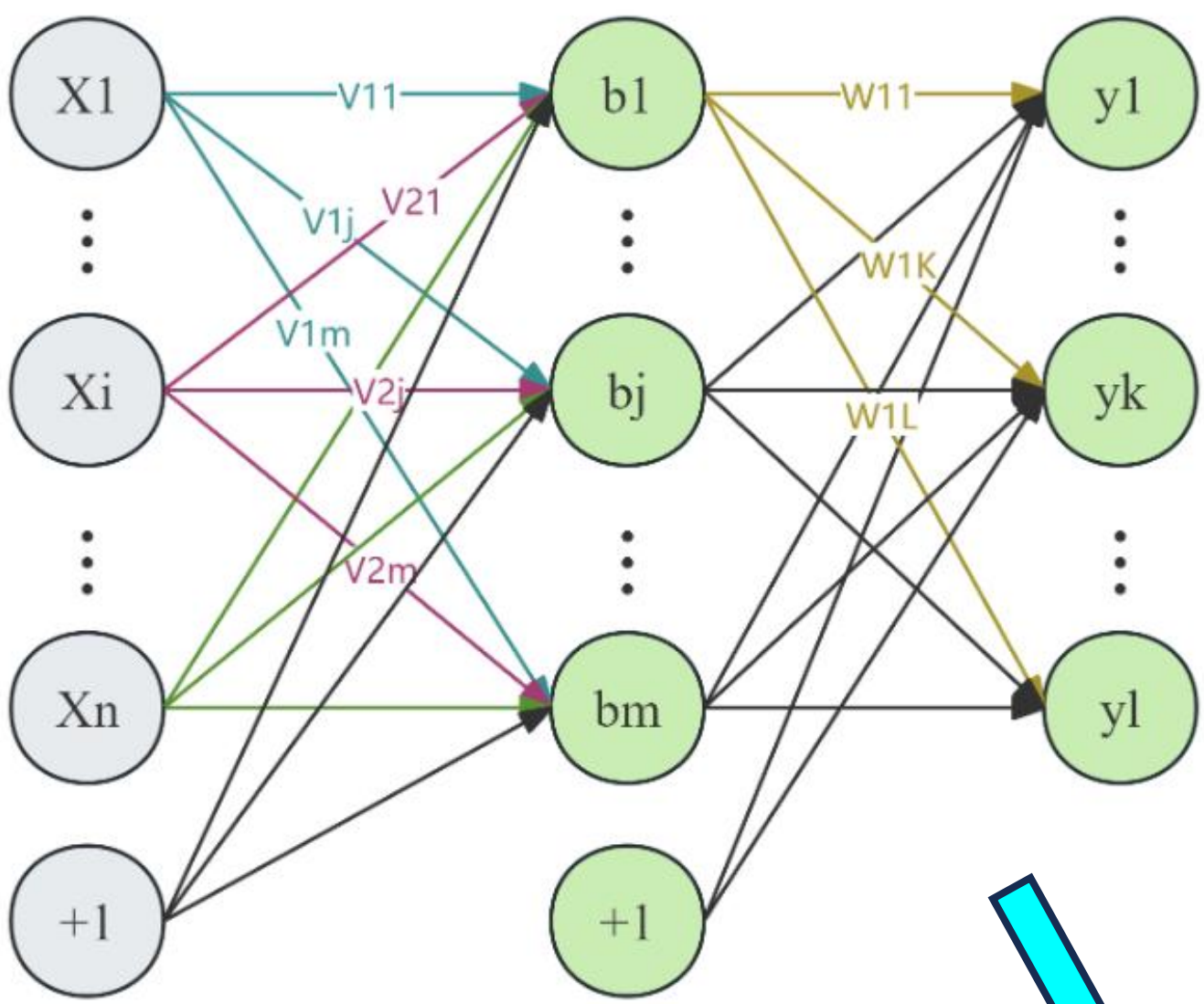
- Given the complementary strengths of multispectral imaging (broad coverage) and LiDAR (high precision), we integrate Landsat8 and ICESat-2 datasets to overcome single-source limitations.
- A multilayer perceptron architecture is designed to synergize spectral reflectance features with LiDAR-derived bathymetry, establishing a robust nonlinear mapping for water depth estimation.
- Focusing on Dabuxun Lake, the largest water body within the Qarhan Salt Lake region, the developed model achieves >85% temporal accuracy.

METHODS

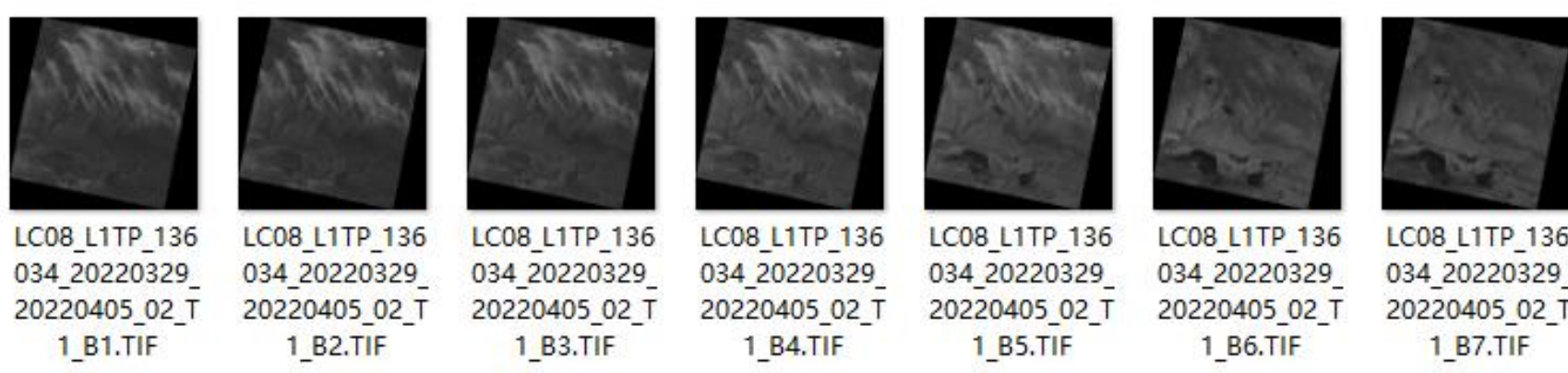
- MLP neural network model architecture.
- Matching multi-source remote sensing data from Landsat8 and ICESat-2.
- Iterative training using Optuna hyperparameter optimization to select the optimal hyperparameter combination for training the model



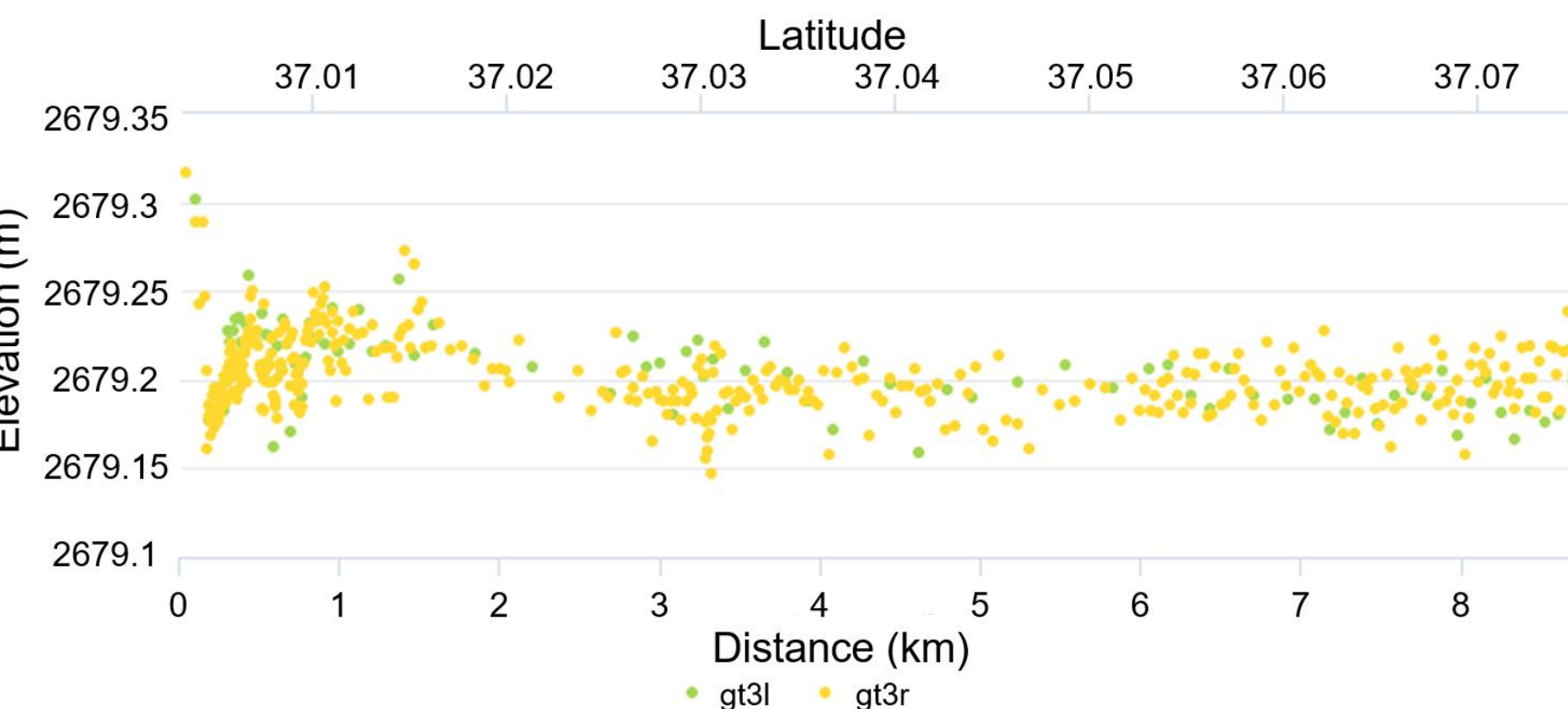
- Network structure: Multiple predefined network architectures
- Learning rate: 0.001~0.1
- Number of training rounds: 500~1500
- Activation functions: relu, sigmoid, tanh, leakyrelu
- Optimizers: Adam, SGD, RMS



Input: Seven bands of Landsat 8 images

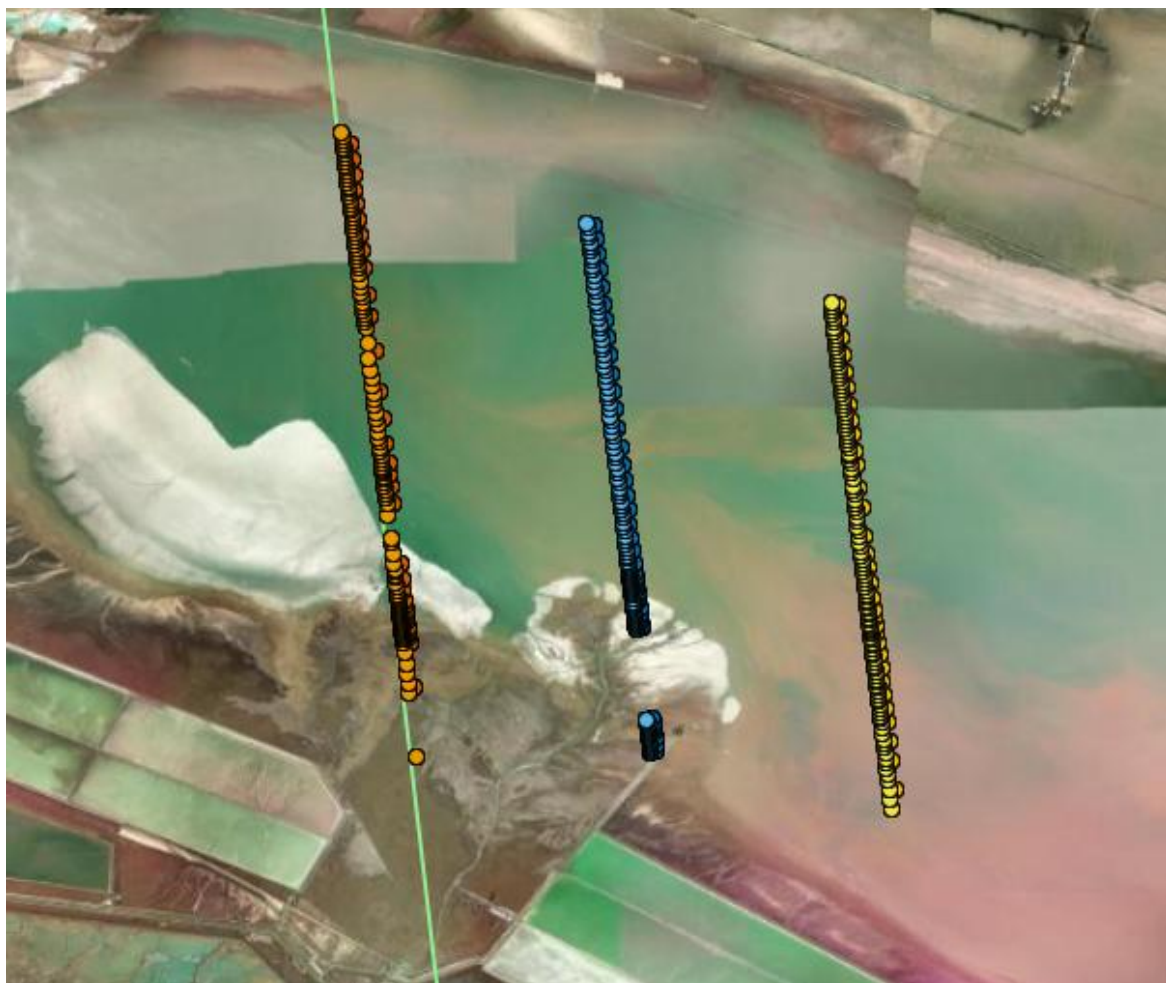
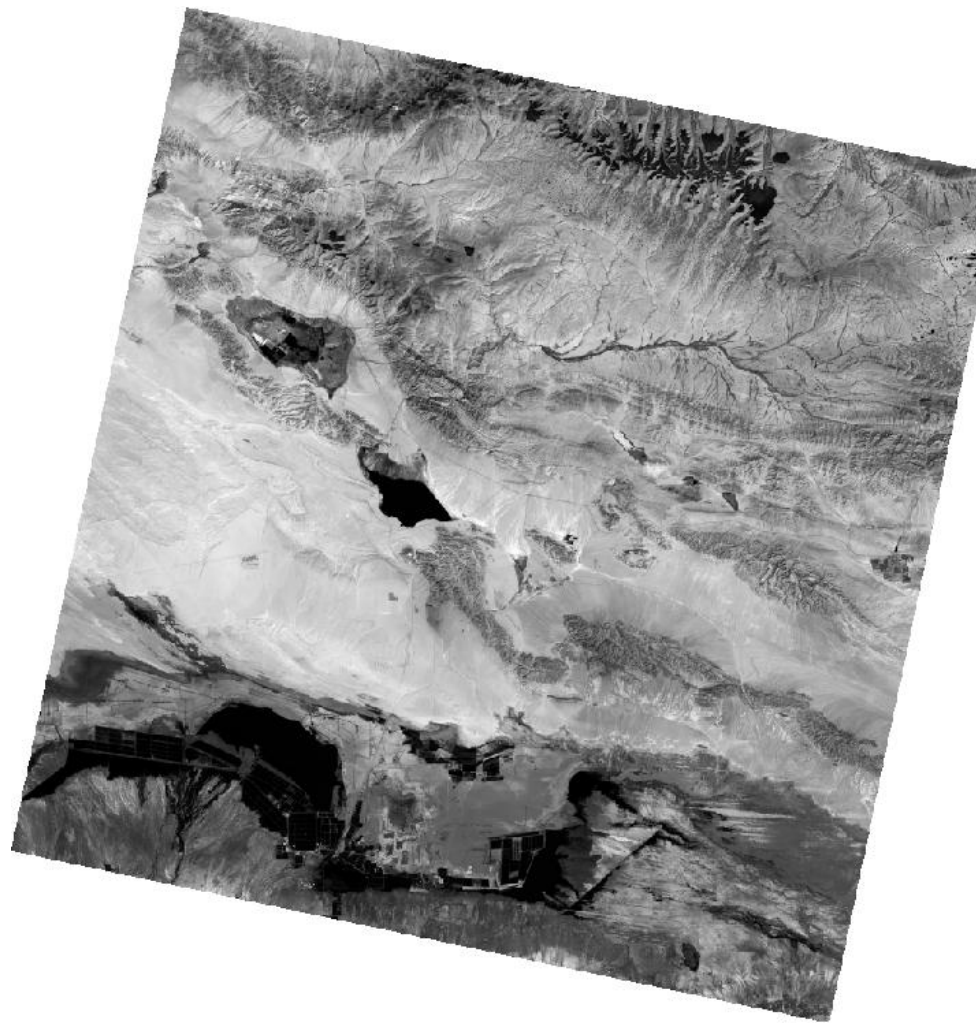


Target variable: ICESat-2 water depth data



Output: water depth

DATASETS

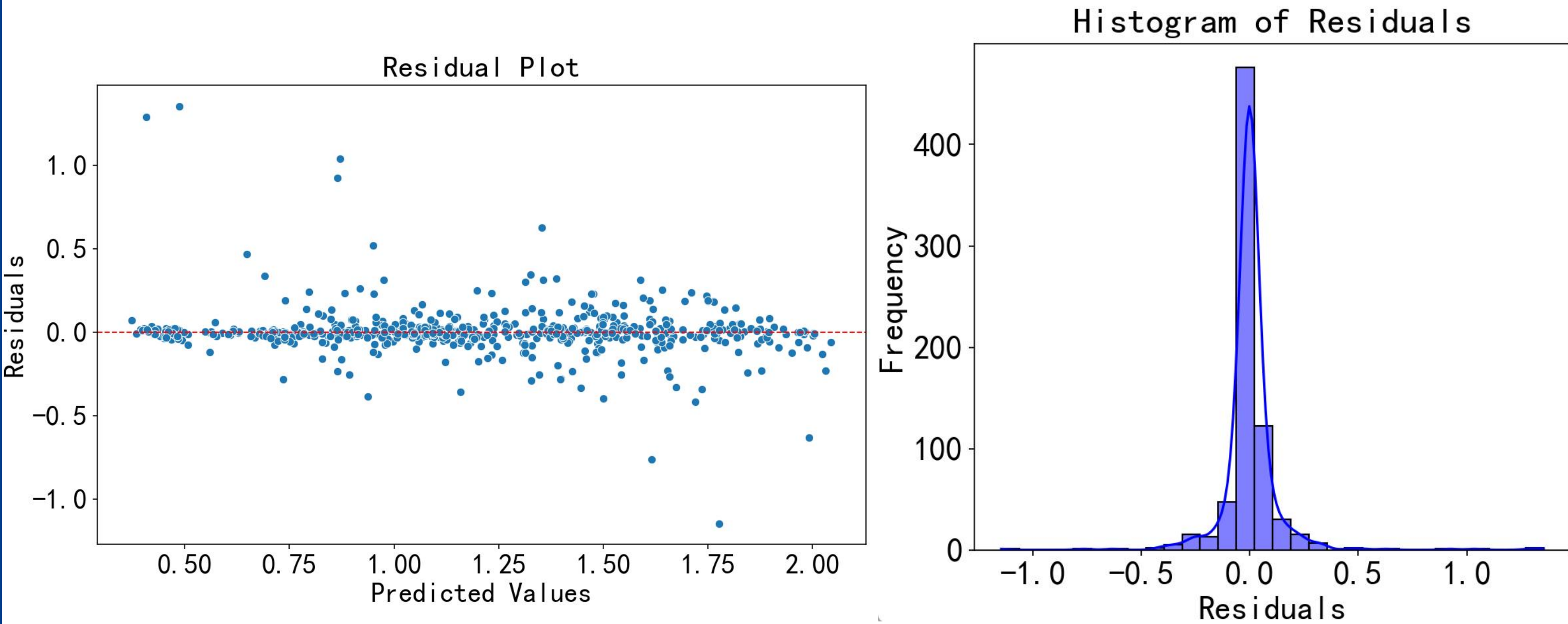


- Seven bands of Landsat 8 images
- ICESat-2 ATL13 product
- Darbesson salt lake (Dabuxun Hu)

EXPERIMENTS

- The inversion accuracy can reach **over 85%** on the test set, even reach **90%**.
- As the number of Optuna iterations increases, R^2 can increase to a certain extent, and MSE can decrease to a certain extent.

Number of Optuna iterations	R^2	MSE
500	0.882068	0.022640
1000	0.897919	0.019597
2000	0.901986	0.018816



CONCLUSIONS

- By fusing Landsat 8 multispectral imagery with ICESat-2 LiDAR measurements, our MLP-based hybrid model achieved >85% depth retrieval accuracy, demonstrating the effectiveness of optical-LiDAR synergy for hydrological monitoring.
- This approach leverages Landsat 8's broad coverage and ICESat-2's vertical precision to overcome traditional data sparsity, optimizing spatiotemporal resolution.
- While Optuna-driven hyperparameter tuning improved model performance (R^2 and MSE), plateauing effects revealed inherent framework limitations.

MAJOR REFERENCES

[1] RUMELHART D E, HINTON G E, WILLIAMS R J. Learning representations by back-propagating errors [J]. Nature, 1986, 323(6088): 533-6.

[2] MARKUS T, NEUMANN T, MARTINO A, et al. The Ice, Cloud, and land Elevation Satellite-2 (ICESat-2): Science requirements, concept, and implementation [J]. Remote Sensing of Environment, 2017, 190: 260-73.