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Comparative Benchmarking of ML Models for Magnetic Field Prediction from Simulated ODMR Spectra

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Nitrogen-vacancy (NV) centers in diamond are promising room temperature quantum sensors because optically detected magnetic resonance (ODMR) encode magnetic field information through Zeeman shifts and the projection of the applied field onto the four crystallographic NV orientations [1]. Fast and data efficient extraction of secondary information contained through magnetic fields in ODMR is important for practical magnetometry. This work benchmarks machine learning models for magnetic field prediction from simulated hyperfine resolved four orientation NV-ensemble ODMR [2]. Each sample is an ODMR spectrum and the prediction target is the magnetic field magnitude in the range 0-10 mT.

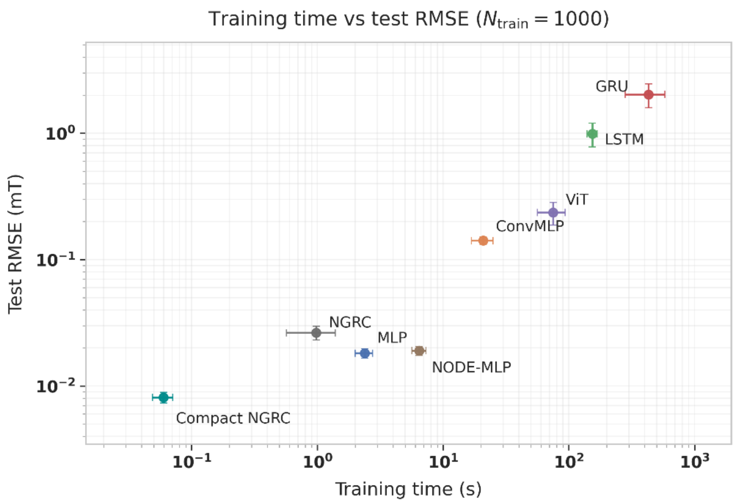

Fig. 1. Accuracy and time tradeoff for magnetic field prediction from simulated ODMR spectra.

We compared Next-Generation Reservoir Computing (NG-RC) and Compact (NG-RC) [3] with common neural network baselines, including Multilayer Perceptron (MLP), Neural Ordinary Differential Equation based Multilayer Perceptron (NODE-MLP), Convolutional Multilayer Perceptron (ConvMLP), Vision Transformer (ViT), Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU). We tested training set sizes from 10 to 1000 samples using six repeated splits. With very small training sets (up to 50 samples), the error bars overlap, from 100 samples Compact NGRC gives the best test accuracy and smallest training time. With 1000 training spectra, Compact NGRC reaches an average error of 0.0081 ± 0.0008 mT and a near perfect coefficient of determination (0.999992 ± 0.000001), while training in 0.0597 ± 0.0109 seconds. At this setting it is about 40 times faster than MLP, 108 times faster than NODE-MLP and more than 7000 times faster than GRU.

REFERENCES

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