Supplementary Materials for "Machine Learning Application to Two-Dimensional Dzyaloshinskii-Moriya Ferromagnets"

Vinit Kumar Singh[1,*] and Jung Hoon Han[2,†]

[1]Department of Physics, Indian Institute of Technology, Kharagpur 732102, India
[2]Department of Physics, Sungkyunkwan University, Suwon 16419, Korea

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We detail the results of error analyses for various machine-learning predictions mentioned in the main text.

XYZ-type	$\Delta\chi$	Δm	ΔB	ΔT
$H_{\rm HDMZ}$	5.82	3.79	4.91	5.32
$H_{\rm HDMZ}+H_1$	5.83	3.85	5.49	5.62
$H_{\rm HDMZ}+H_2$	6.01	3.77	7.22	6.75
$H_{\rm HDMZ}$ $(b=2)$	7.05	4.15	10.1	4.66
$H_{\rm HDMZ}$ $(b=3)$	6.46	3.69	11.7	4.93
$H_{\rm HDMZ}$ $(b=4)$	6.61	4.07	12.2	5.89
XY-type	$\Delta\chi$	Δm	ΔB	ΔT
$H_{\rm HDMZ}$	7.15	5.4	7.28	5.23
$H_{\rm HDMZ}+H_1$	7.52	6.2	8.5	5.42
$H_{\rm HDMZ}+H_2$	8.25	7.76	11.8	6.37
Z-type	$\Delta\chi$	Δm	ΔB	ΔT
$H_{\rm HDMZ}$	5.98	3.28	5.14	6.33
$H_{\rm HDMZ}+H_1$	6.09	3.2	5.56	6.48
$H_{\rm HDMZ}+H_2$	5.65	3	7.2	6.66

TABLE I: Averaged variance between predicted and actual values of (χ, m, B, T).

Listed in Table 1 are the errors in the machine-predicted values of (χ, m, B, T). The error estimation is done by the formula

$$\Delta X = \sqrt{\frac{\sum_i (X_{\text{predicted},i} - X_{\text{actual},i})^2}{N}}. \qquad (1)$$

Here $X = \chi, m, B, T$ and $1 \le i \le N$ ranges over all the test configurations. Input data types are classified as xyz, xy, and z, according to all three components, only xy-component, and only z-component of the local magnetization vector $\mathbf{n}_i$ being used for training and testing. The pure case $H_{\rm HDMZ}$ refers to the choice $D/J = \sqrt{6}$ corresponding to the spiral period $\lambda = 6$. The two disordered Hamiltonians we considered in the main text are shown in the rows with $H_{\rm HDMZ} + H_1$ and $H_{\rm HDMZ} + H_2$. The sample size is $N = 20 \times 20 \times 100$.

For $b = 2, 3, 4$, only the pure Hamiltonian $H_{\rm HDMZ}$ was used with D/J values corresponding to $\lambda = 12, 18, 24$, respectively. The resulting raw data is compressed according to the block-spin rule (mentioned in the text) before being subject to machine prediction. The predicted values of χ, m, b, T are then compared to χ', m', B', T', which is related to the raw value through the scaling relation $\chi'/\chi = b^{\#}$. The exponents used are 0, 0, 2.32, and 0.73, respectively. For example, the variance ΔB in the case of $b = 2$ is obtained from

$$\Delta B = \sqrt{\frac{\sum_i (B_{\text{predicted},i} - B_{\text{actual},i} 2^{2.32})^2}{N}} \qquad (2)$$

where $B_{\text{actual},i}$ is the magnetic field used in the generation of the $\lambda = 12$ Monte Carlo configuration. The sample size was $N = 14 \times 11$ $(b = 2)$, $N = 14 \times 9$ $(b = 3)$, and $N = 15 \times 7$ $(b = 4)$.

* Electronic address: vinitsingh911@gmail.com

† Electronic address: hanjemme@gmail.com