Supporting Information for: Probing Fault Physics via Transfer Learning

Kun Wang Christopher W. Johnson Kane C. Bennett Paul A. Johnson *

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1 Reproducibility in training on the simulation data and transfer learning on the laboratory data

We performed multiple runs of the same transfer learning workflow to assess the average performance of the trained CED models accounting for randomness in machine learning. Firstly, 5 runs are performed starting from the same initialized model weights and no noisy data augmentation is added. The accuracy measures of the predictions and the average values on all the validation and testing signals in FDEM, Lab p4677, and Lab p4581 are recapitulated in Table 1. Secondly, 5 runs are performed starting from the same initialized model weights and including the noisy data augmentation. The performances are presented in Table 2. The data augmentation is shown to improve the prediction for both learning on FDEM and transfer learning on Lab data. Thirdly, 10 runs are performed with randomly initialized model weights and noisy data augmentation, see Table 3. Among the 10 trained models, the CED model from Run No. 8 is closest to the overall average accuracy.

2 Effect of the sliding window sizes in training on the simulation data and transfer learning on the laboratory data

We performed 4 runs with randomly initialized model weights and noisy data augmentation, using different sizes of the sliding windows 1s, 3s, 4s, and 5s, respectively. The accuracy measures are presented in Table 4. Comparing against the results in Table 3 using 2s time windows as in the main paper, we find that all window sizes lead to similar accuracy of the CED model training on FDEM and transfer learning on Lab data.

*Los Alamos National Laboratory, Los Alamos, New Mexico, USA. paj@lanl.gov

	Training on FDEM	Direct predicting on Lab p4677	Transfer learning on Lab p4677	Predicting on Lab p4581					
Run No.	Validation &Testing	Validation &Testing	Validation &Testing	3MPa	4MPa	5MPa	6MPa	7MPa	8MPa
1	-0.649 4.508%	0.303 3.572%	0.856 1.700%	0.826 1.828%	0.793 2.111%	0.731 2.600%	0.653 3.132%	0.557 3.854%	0.492 4.215%
2	-0.0874 3.805%	-0.583 6.524%	0.508 2.822%	0.571 2.718%	0.442 3.259%	0.192 4.284%	0.00691 5.140%	-0.198 6.041%	-0.449 6.806%
3	-0.0578 3.656%	0.0815 4.228%	0.813 1.889%	0.786 2.004%	0.766 2.235%	0.663 2.811%	0.604 3.295%	0.483 4.004%	0.318 4.779%
4	-0.458 4.067%	-0.392 5.662%	0.625 2.442%	0.677 2.476%	0.590 2.853%	0.397 3.616%	0.254 4.388%	0.118 5.014%	-0.088 5.771%
5	-0.387 4.143%	-0.060 5.100%	0.778 2.034%	0.771 2.094%	0.699 2.403%	0.573 2.912%	0.461 3.583%	0.391 4.110%	0.151 4.888%
R^2	-0.328 ± 0.225	-0.130 ± 0.320	0.716 ± 0.130	0.726 ± 0.0917	0.658 ± 0.129	0.511 ± 0.195	0.396 ± 0.239	0.270 ± 0.277	0.0848 ± 0.328
MAPE	4.036% ± 0.294%	5.017% ± 1.040%	2.177% ± 0.404%	2.224% ± 0.325%	2.572% ± 0.425%	3.244% ± 0.622%	3.908% ± 0.752%	4.605% ± 0.824%	5.292% ± 0.906%

Table 1: Starting from the same initialized CED model weights, records of 5 runs without random noisy data augmentation (noDA) of the same transfer learning workflow. The performance of the model trained in each run is measured by the coefficient of determination (R^2, top row in each cell) and the mean absolute percentage error (MAPE, bottom row in each cell, in %).

	Training on FDEM	Direct predicting on Lab p4677	Transfer learning on Lab p4677	Predicting on Lab p4581					
Run No.	Validation &Testing	Validation &Testing	Validation &Testing	3MPa	4MPa	5MPa	6MPa	7MPa	8MPa
1	0.0232 3.627%	0.162 4.127%	0.870 1.696%	0.790 1.987%	0.787 2.080%	0.733 2.484%	0.632 3.059%	0.601 3.406%	0.434 4.181%
2	0.102 3.572%	-0.0368 4.758%	0.818 1.785%	0.742 2.232%	0.737 2.321%	0.665 2.827%	0.596 3.335%	0.496 4.020%	0.405 4.605%
3	-0.129 3.882%	-0.0436 4.886%	0.770 2.008%	0.765 2.159%	0.736 2.324%	0.636 2.983%	0.544 3.614%	0.443 4.288%	0.286 4.967%
4	0.117 3.600%	0.0629 4.574%	0.802 2.068%	0.808 1.897%	0.781 2.283%	0.717 2.741%	0.586 3.504%	0.564 3.828%	0.399 4.537%
5	-0.0284 3.877%	0.0472 4.603%	0.727 2.329%	0.746 2.218%	0.669 2.664%	0.514 3.486%	0.351 4.327%	0.257 4.957%	0.0325 5.781%
R^2	0.0169 $\pm$ 0.0901	0.0383 $\pm$ 0.0753	0.797 $\pm$ 0.0478	0.770 $\pm$ 0.0254	0.742 $\pm$ 0.0423	0.653 $\pm$ 0.0778	0.542 $\pm$ 0.0994	0.472 $\pm$ 0.121	0.311 $\pm$ 0.148
MAPE	3.712% $\pm$ 0.138%	4.590% $\pm$ 0.257%	1.977% $\pm$ 0.223%	2.099% $\pm$ 0.133%	2.334% $\pm$ 0.188%	2.904% $\pm$ 0.333%	3.568% $\pm$ 0.423%	4.100% $\pm$ 0.516%	4.814% $\pm$ 0.544%

Table 2: Starting from the same initialized CED model weights, records of 5 runs with random noisy data augmentation (DA) of the same transfer learning workflow. The performance of the model trained in each run is measured by the coefficient of determination (R^2, top row in each cell) and the mean absolute percentage error (MAPE, bottom row in each cell, in %).

	Training on FDEM	Direct predicting on Lab p4677	Transfer learning on Lab p4677	Predicting on Lab p4581					
Run No.	Validation &Testing	Validation &Testing	Validation &Testing	3MPa	4MPa	5MPa	6MPa	7MPa	8MPa
1	-0.0473 3.673%	0.262 3.913%	0.821 1.865%	0.797 1.969%	0.720 2.492%	0.633 3.032%	0.492 3.878%	0.423 4.418%	0.267 5.078%
2	-0.555 4.541%	0.344 4.089%	0.843 1.718%	0.798 1.898%	0.775 2.157%	0.732 2.502%	0.650 2.976%	0.580 3.517%	0.447 4.216%
3	-0.020 3.566%	0.197 3.865%	0.821 1.728%	0.745 2.206%	0.723 2.378%	0.635 2.977%	0.553 3.516%	0.439 4.166%	0.314 4.706%
4	-0.246 4.294%	-0.0621 5.170%	0.805 1.916%	0.787 1.985%	0.744 2.226%	0.653 2.730%	0.559 3.378%	0.459 3.929%	0.325 4.471%
5	0.144 3.438%	-0.0891 4.678%	0.731 2.091%	0.726 2.302%	0.671 2.490%	0.553 2.946%	0.455 3.523%	0.390 3.928%	0.235 4.658%
6	-0.537 4.825%	0.471 3.686%	0.876 1.567%	0.825 1.831%	0.793 1.989%	0.758 2.288%	0.673 2.881%	0.618 3.374%	0.552 3.777%
7	0.0405 3.475%	0.176 3.946%	0.793 2.070%	0.797 2.028%	0.750 2.385%	0.646 3.010%	0.560 3.593%	0.446 4.295%	0.338 4.805%
8	-0.324 4.237%	0.294 4.232%	0.846 1.650%	0.801 1.960%	0.764 2.195%	0.661 2.670%	0.594 3.089%	0.528 3.671%	0.324 4.555%
9	-0.375 4.381%	0.251 4.068%	0.835 1.791%	0.761 2.062%	0.740 2.179%	0.642 2.693%	0.541 3.397%	0.544 3.548%	0.375 4.399%
10	-0.273 4.071%	0.159 4.477%	0.789 1.909%	0.741 2.232%	0.734 2.308%	0.617 2.978%	0.523 3.561%	0.441 4.138%	0.331 4.596%
R^2	-0.219 $\pm$ 0.228	0.200 $\pm$ 0.162	0.816 $\pm$ 0.0377	0.778 $\pm$ 0.0306	0.741 $\pm$ 0.0319	0.653 $\pm$ 0.0543	0.560 $\pm$ 0.0628	0.487 $\pm$ 0.0715	0.351 $\pm$ 0.0860
MAPE	4.050% $\pm$ 0.461%	4.212% $\pm$ 0.424%	1.830% $\pm$ 0.163%	2.047% $\pm$ 0.145%	2.280% $\pm$ 0.152%	2.783% $\pm$ 0.237%	3.379% $\pm$ 0.293%	3.898% $\pm$ 0.339%	4.526% $\pm$ 0.334%

Table 3: Records of 10 different runs with randomly initialized CED model weights and random noisy data augmentation of the same transfer learning workflow. The performance of the model trained in each run is measured by the coefficient of determination (R^2, top row in each cell) and the mean absolute percentage error (MAPE, bottom row in each cell, in %).

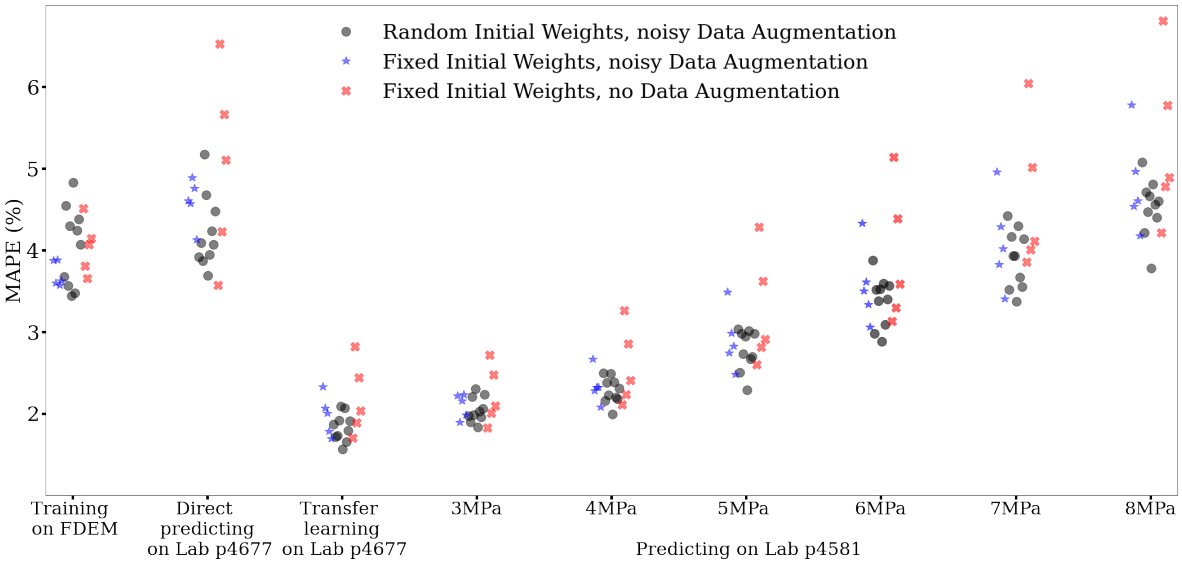

Figure 1: Distribution of MAPE on FDEM, Lab p4677 and Lab p4581 data from models trained in different runs of the proposed transfer Learning workflow. All R^2 and MAPE values are provided in Tables 1, 2, and 3.

	Training on FDEM	Direct predicting on Lab p4677	Transfer learning on Lab p4677	Predicting on Lab p4581					
Size of sliding windows	Validation &Testing	Validation &Testing	Validation &Testing	3MPa	4MPa	5MPa	6MPa	7MPa	8MPa
1s	-0.324 4.012%	0.0142 4.586%	0.837 1.802%	0.733 2.200%	0.705 2.367%	0.549 2.981%	0.339 3.569%	0.416 3.969%	-0.267 5.006%
3s	0.390 2.972%	0.122 4.229%	0.881 1.529%	0.787 2.068%	0.786 2.126%	0.731 2.442%	0.623 3.014%	0.537 3.524%	0.436 3.870%
4s	-0.476 4.514%	0.306 4.192%	0.830 1.743%	0.704 2.440%	0.672 2.744%	0.532 3.449%	0.432 4.041%	0.319 4.663%	0.158 5.305%
5s	-0.641 4.674%	0.376 3.734%	0.853 1.578%	0.790 1.920%	0.750 2.153%	0.586 2.802%	0.520 3.548%	0.407 4.209%	0.229 5.074%

Table 4: Records of 4 different runs, each using different sizes of sliding windows, with randomly initialized CED model weights and random noisy data augmentation of the same transfer learning workflow. The performance of the model trained in each run is measured by the coefficient of determination (R^2, top row in each cell) and the mean absolute percentage error (MAPE, bottom row in each cell, in %).