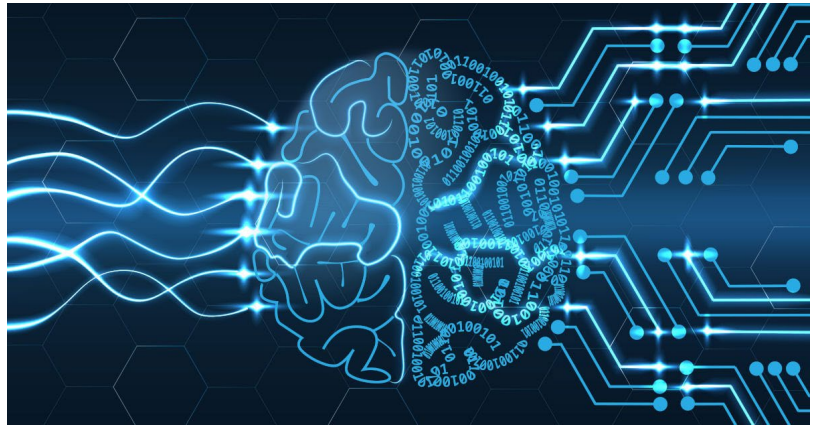
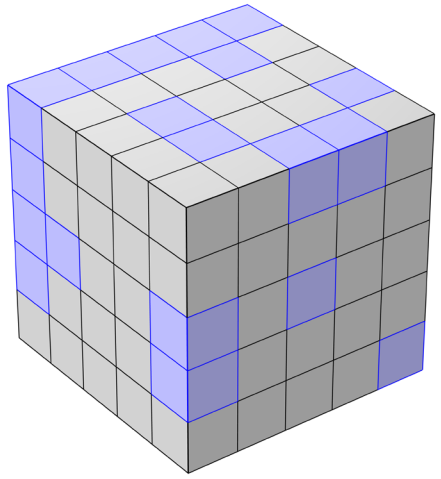
BETHANY
LUTHERAN COLLEGE

Deep Learning on Composites

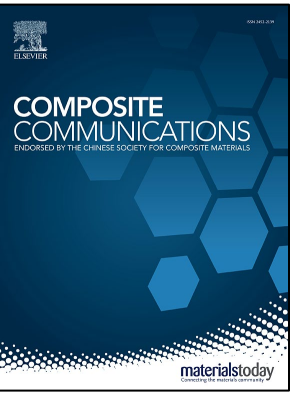


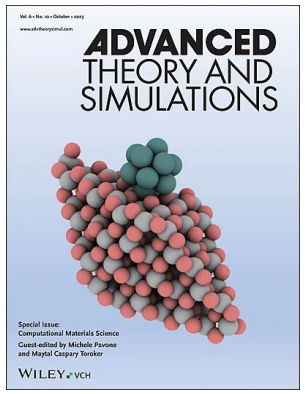


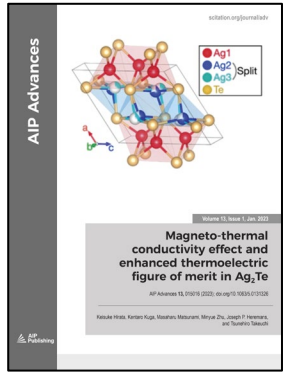
Sheng Sang Ph.D.
Assistant Professor
Department of Engineering Science
Bethany Lutheran College

BETHANY LUTHERAN COLLEGE

Publications:







1. Sang, S., Wang, Z., & Fan, J. (2023). Particle swarm optimization for curved beams in multistable structures. Journal of Mechanics of Materials and Structures, 17(5), 441-453.

2. Sang, S., Xu, C., Wang, Z., Side, C., Fowler, B., Fan, J., & Miao, D. (2023). Accurate prediction of topology of composite plates via machine learning and propagation of elastic waves. Composites Communications, 37, 101465.

3. Sang, S., Xu, C., Fan, J., Miao, D., Side, C., & Wang, Z. (2023). Accurate Prediction of Microstructure of Composites using Machine Learning. Advanced Theory and Simulations, 6(2), 2200674.

4. Xiaoming Xu, Jianjun Wei, Sheng Sang; Prediction of elastic wave propagation in composites using 3D CNN. *AIP Advances* 1 November 2023; 13 (11): 115202.

5. Zhang, X., Wang, Z., Xu, C., Side, C., & Sang, S. Architecture Prediction of 3D Composites Using Machine Learning and No-Destructive Technique. Advanced Theory and Simulations, 2300430.

BETHANY LUTHERAN COLLEGE

Conference Presentations:

ASA ACOUSTICAL SOCIETY OF AMERICA

MARCH 01 2023

Generative optimization of sound insulation of composites using deep learning networks FREE

Sheng Sang; Chen Xu

J. Acoust. Soc. Am. 153, A120 (2023)
https://doi.org/10.1121/10.0018368

OCTOBER 01 2021

Study of three-dimensional elastic metamaterials based on a lattice system FREE

Zachary Mumme; Jiadi Fan; Sheng Sang

J. Acoust. Soc. Am. 150, A109 (2021)
https://doi.org/10.1121/10.0007790

OCTOBER 01 2021

Particle swarm optimization of the manipulation of acoustic waves through nonhomogeneous, anisotropic mediums for application in shock wave lithotripsy FREE

Joseph J. Roemhildt; Jiadi Fan; Ziping Wang; Sheng Sang

J. Acoust. Soc. Am. 150, A331 (2021)
https://doi.org/10.1121/10.0008473

BETHANY LUTHERAN COLLEGE

Machine Learning on Composites

Part 1: Accurate prediction of microstructure of composite bars using machine learning

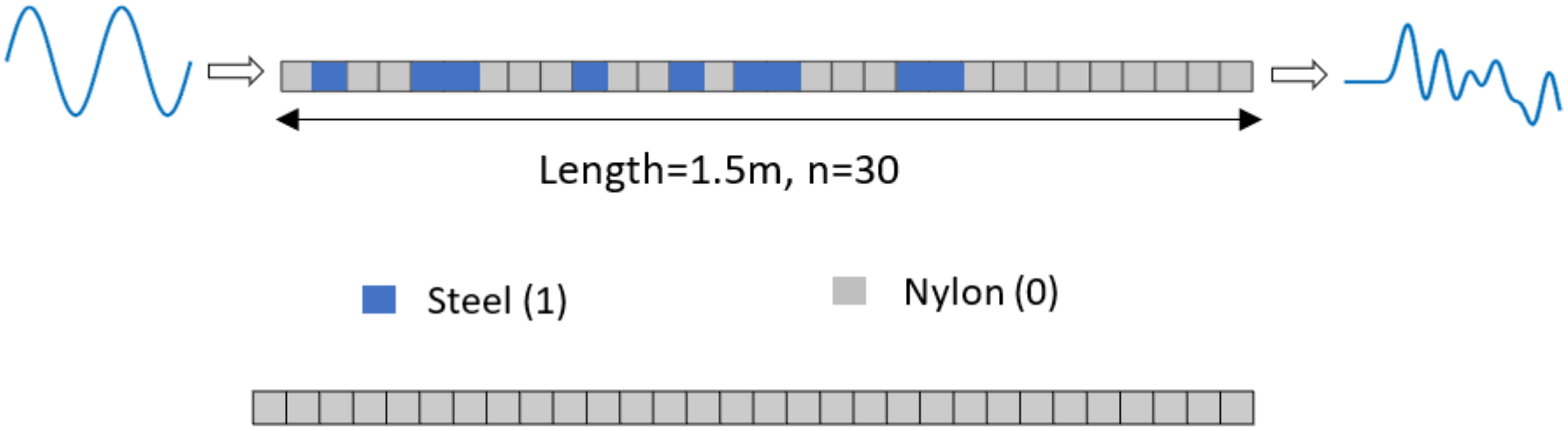


Figure 1 Setup for the wave propagation through composite bar composed of two materials with distinctive dynamic properties.

Accurate prediction of microstructure of composites using machine learning (*Sheng Sang et al. Accepted by Advanced simulation and Theory, November 2022*)

BETHANY LUTHERAN COLLEGE

Machine Learning on Composites

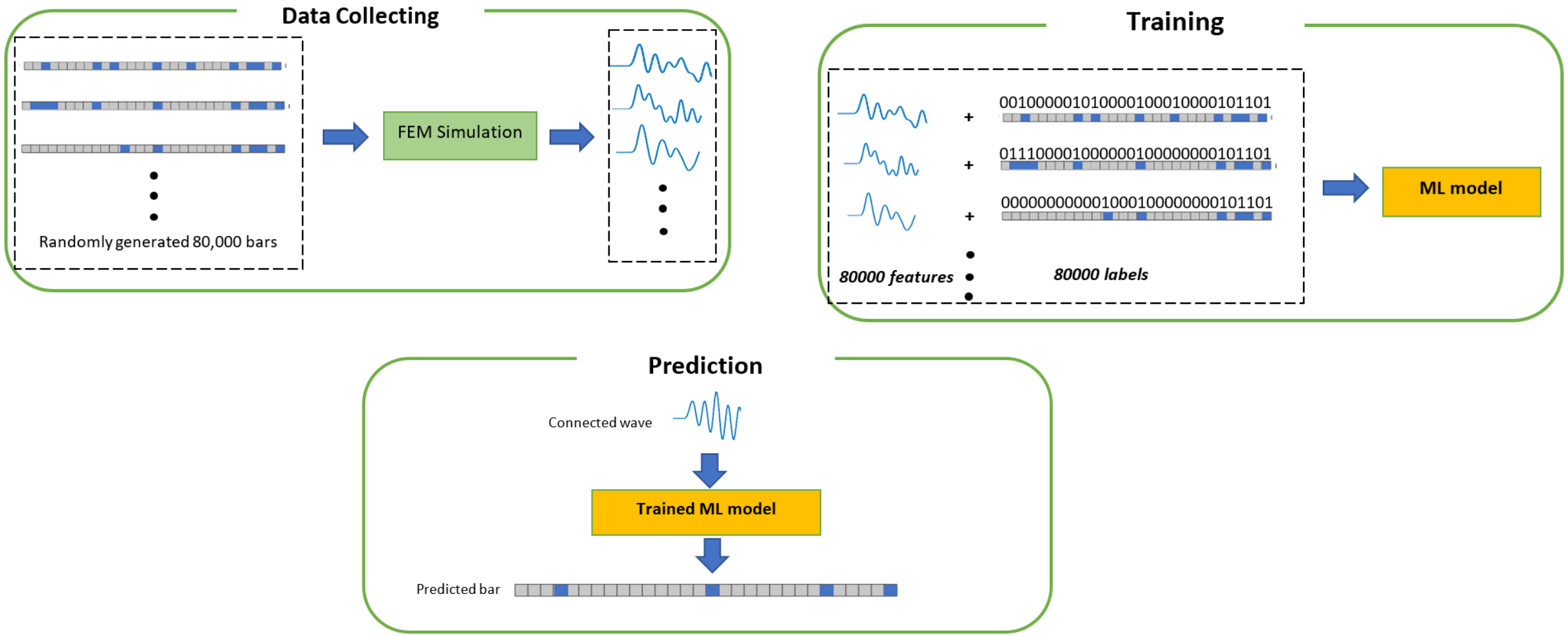


Figure 2. Workflow of modeling process. 80,000 binary bars are randomly generated. FEM simulations are performed to generate the output waves at left edge at the bar for each bar configuration. ML models take output waves as input, the binary vectors representing composite configurations as labels. Finally, the trained models make predictions about composite bars it has not seen in the data set.

BETHANY LUTHERAN COLLEGE

Machine Learning on Composites

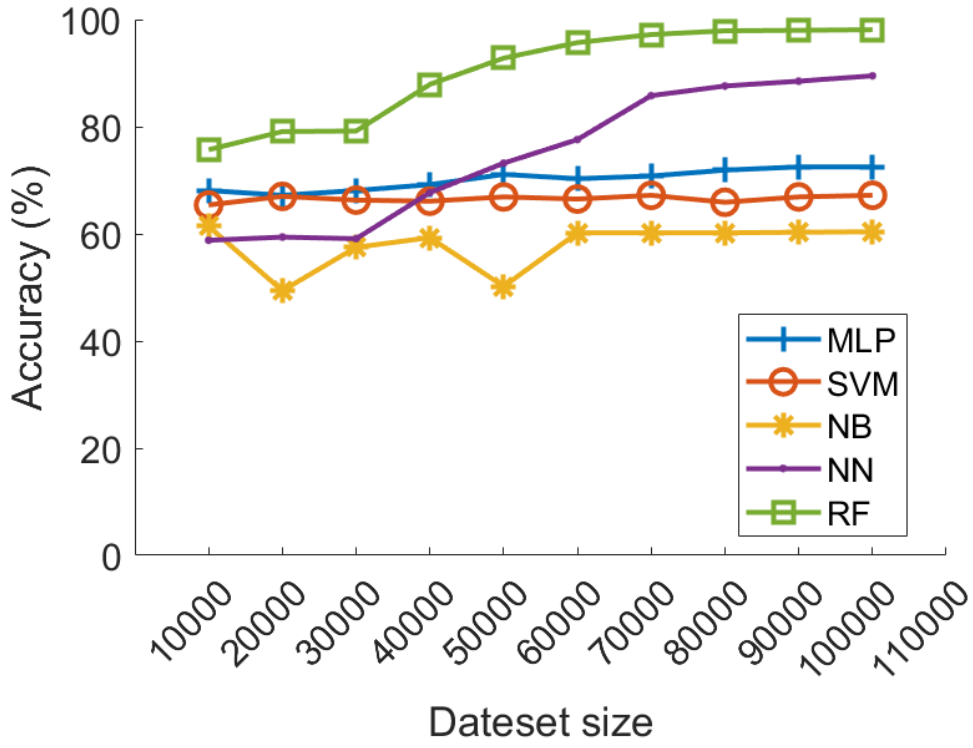
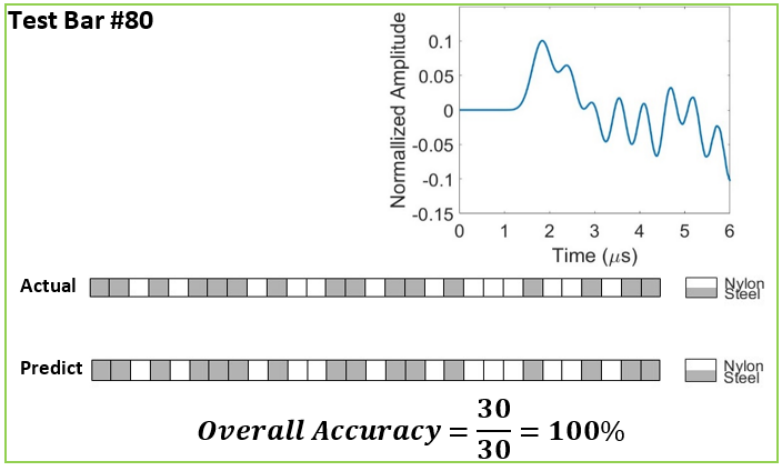
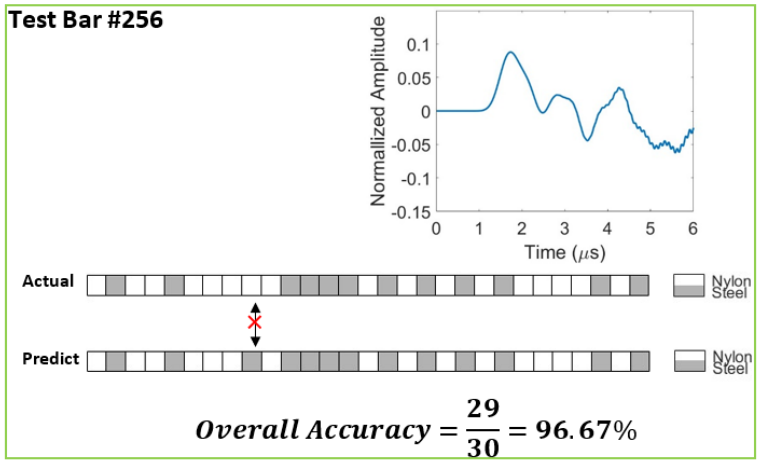


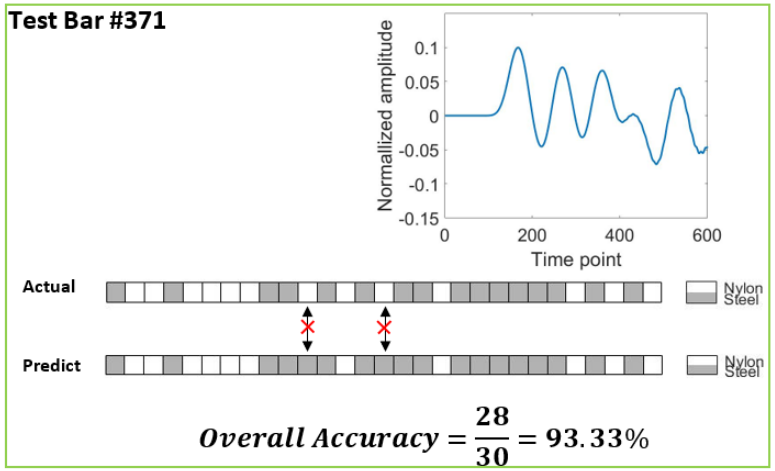
Figure 4 The performance of 5 different ML models on prediction of the configuration of binary composite bars over different dataset sizes.

BETHANY LUTHERAN COLLEGE

Machine Learning on Composites







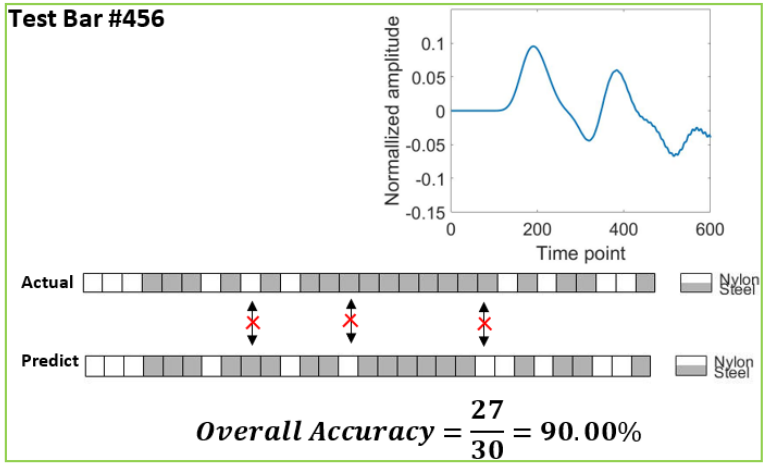
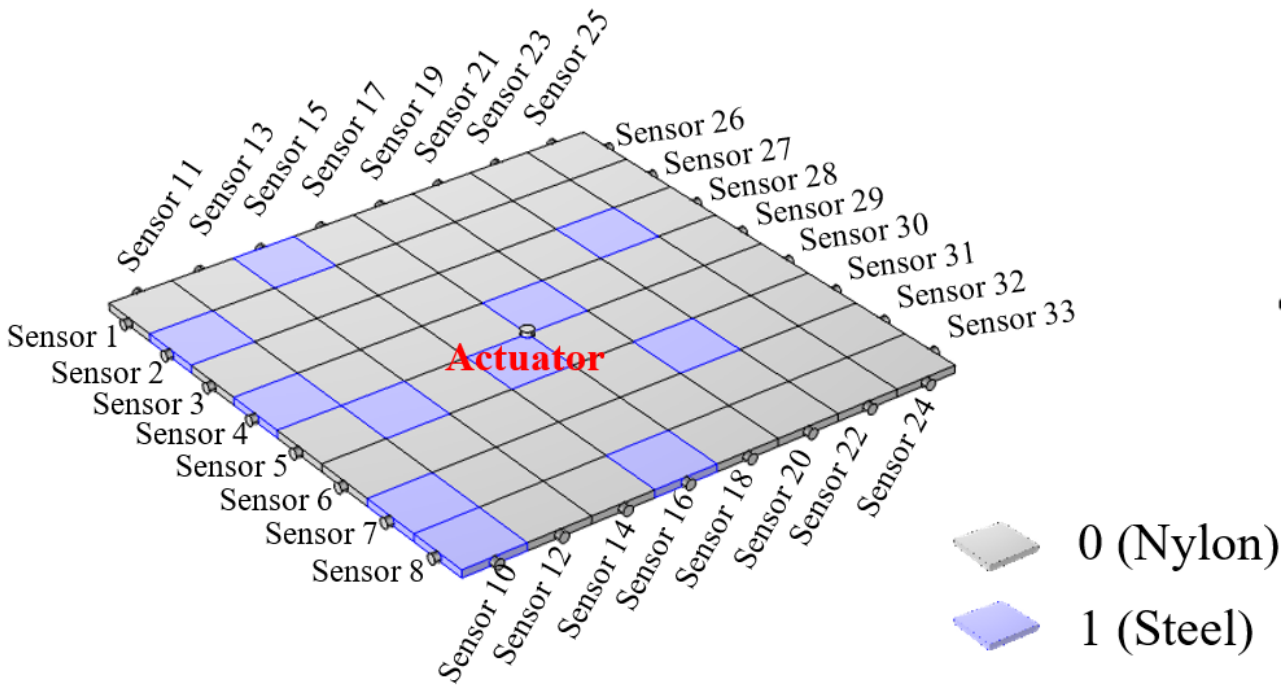


Figure 7 A randomly chosen of 4 predicted bars compared to actual bars with associated output waves included. These examples are drawn from test sets have an overall average prediction accuracy of 95%.

Machine Learning on Composites

Part 2: Accurate prediction of microstructure of composites plates using machine learning

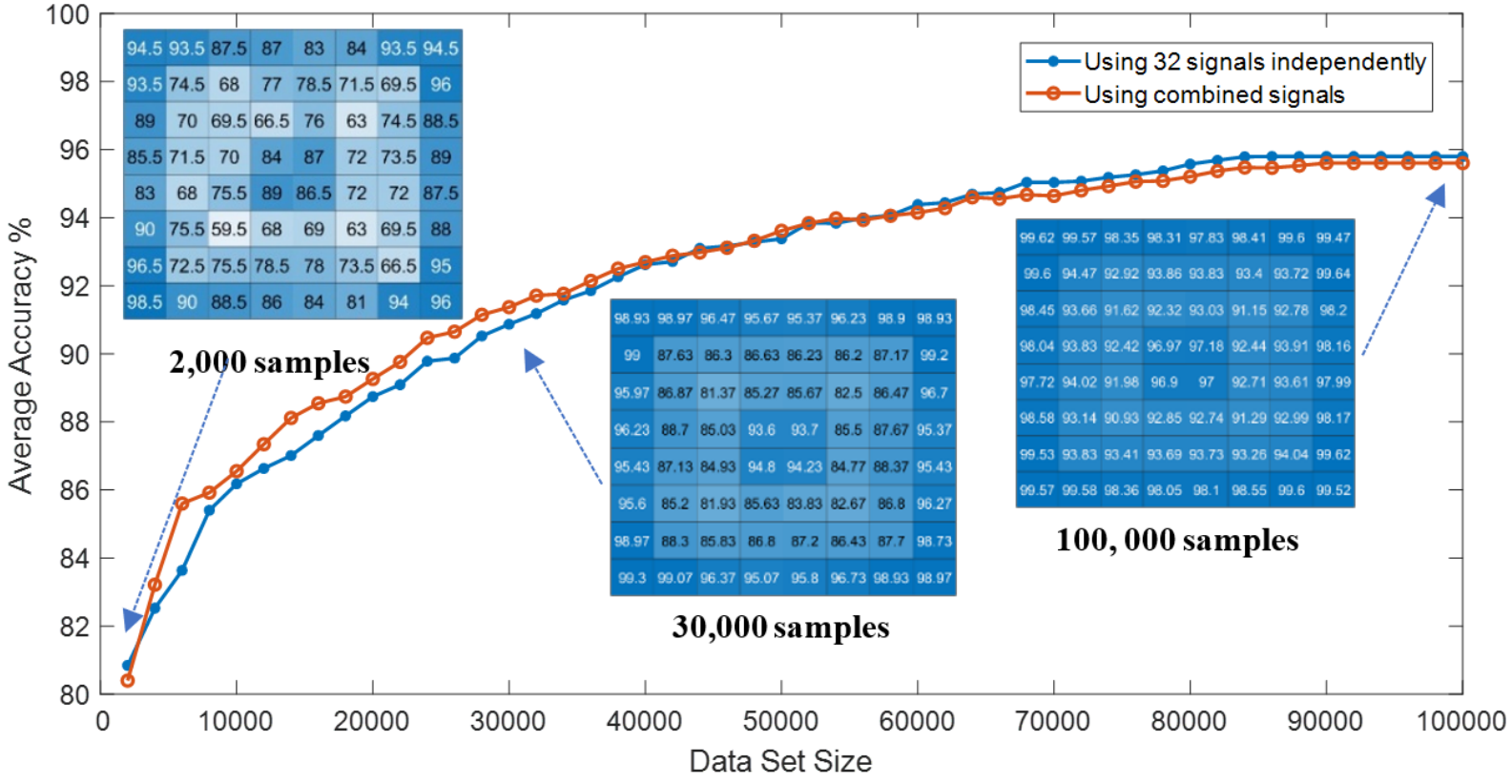


Prediction of topology of composite plates via machine learning and propagation of elastic waves, Sheng Sang et.al *(Under review, Composites Communications)*

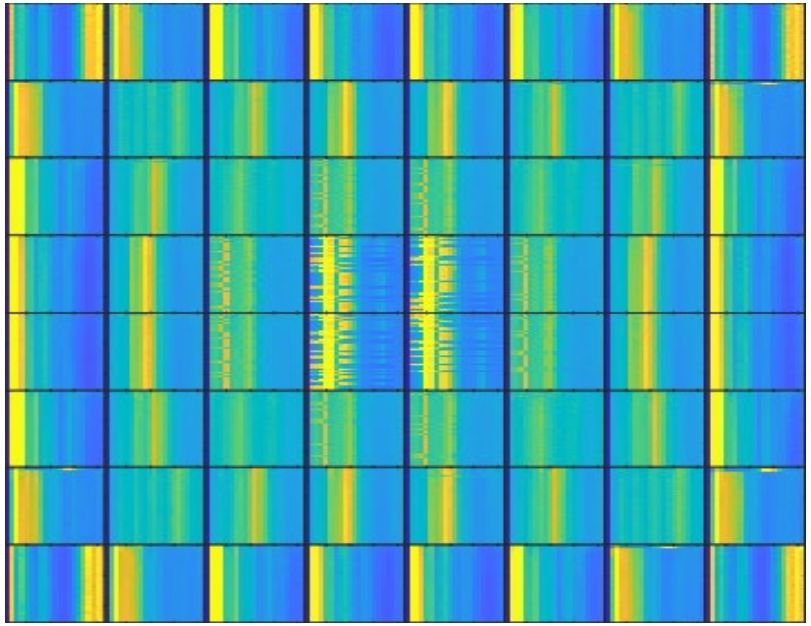
Figure 1 Setup for the wave propagation through composite plate composed of two materials with distinctive dynamic properties.

BETHANY LUTHERAN COLLEGE

Machine Learning on Composites



(a)



(b)

Figure 2 Influence of the data set size on the ML model. (a) The average accuracy of the ML using 32 signals independently and using combined signals. (b) The normalized gini feature importance obtained using 32 signals independently over different data set size for each block.

BETHANY LUTHERAN COLLEGE

Machine Learning on Composites

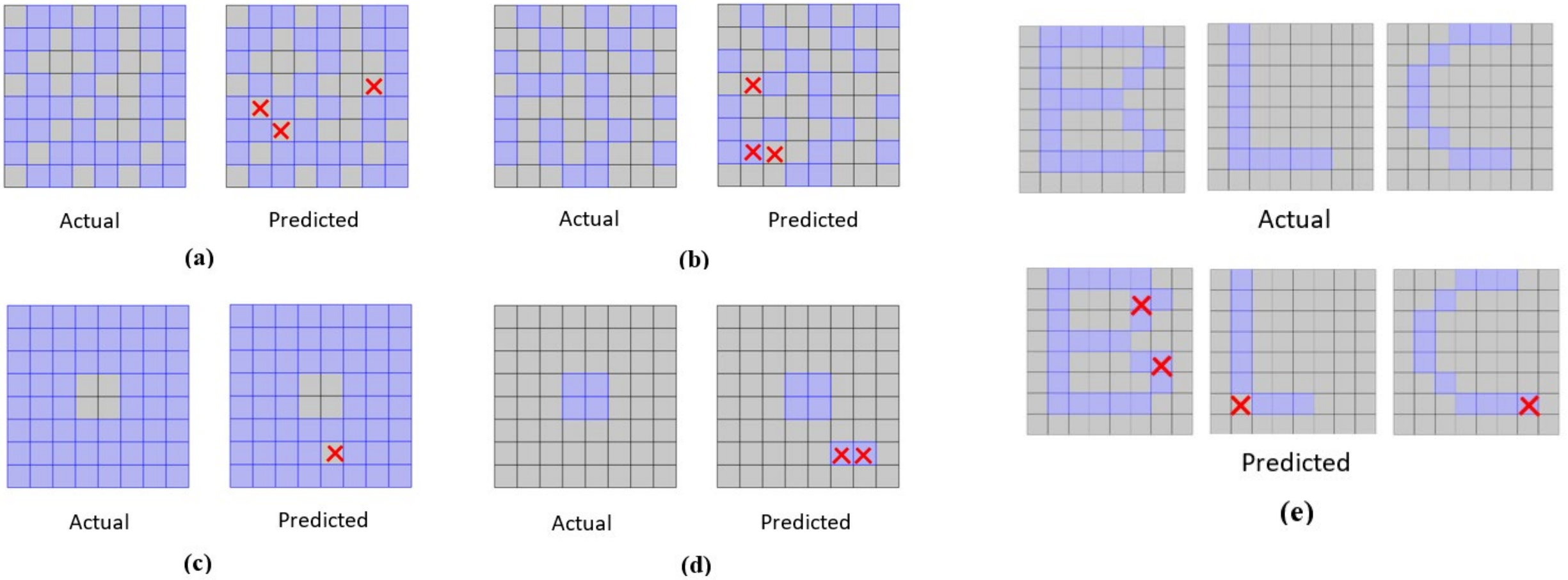


Figure 3. Test of trained ML models. (a)-(b), A randomly chosen 2 actual composite topologies compared to predicted composite topologies. (c)-(d), Prediction of the topologies of composites with only 4 soft blocks, and with only 4 steel blocks, respectively. (e) Prediction of composite topologies with low steel blocks occupation ratios(Letters B, L, and C embedded).