

Supplementary Material

The S&P 500 stock market index and WTI crude oil futures prices are selected as sample data. We use 70% of the dataset as the training set and 30% as the test set to evaluate the performance of the proposed model. The results are shown in Fig. R1 and R2. Our findings indicate that the hybrid network-based early warning model outperforms the self-dynamic network-based model, with the average accuracies of both models on the training and test sets exceeding 90%. This demonstrates that our model is robust.

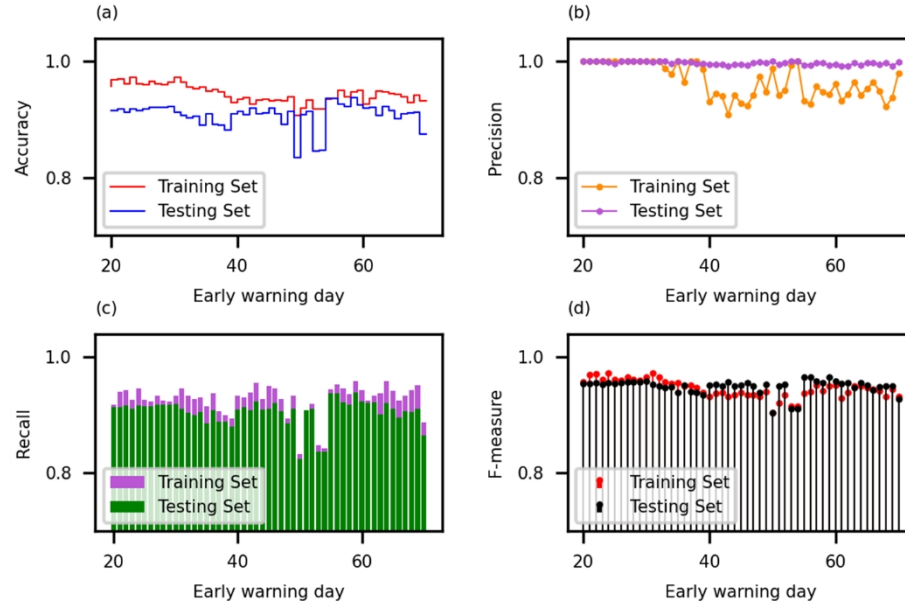


Fig. R1 Dynamic performance of the deep learning-based early warning model integrated with the self-dynamic network on the training and testing sets: (a) Dynamic accuracy of this model on the training and testing sets, (b) dynamic precision of this model on the training and testing sets, (c) dynamic recall of this model on the training and testing sets, and (d) dynamic F-measure of this model on the training and testing sets.

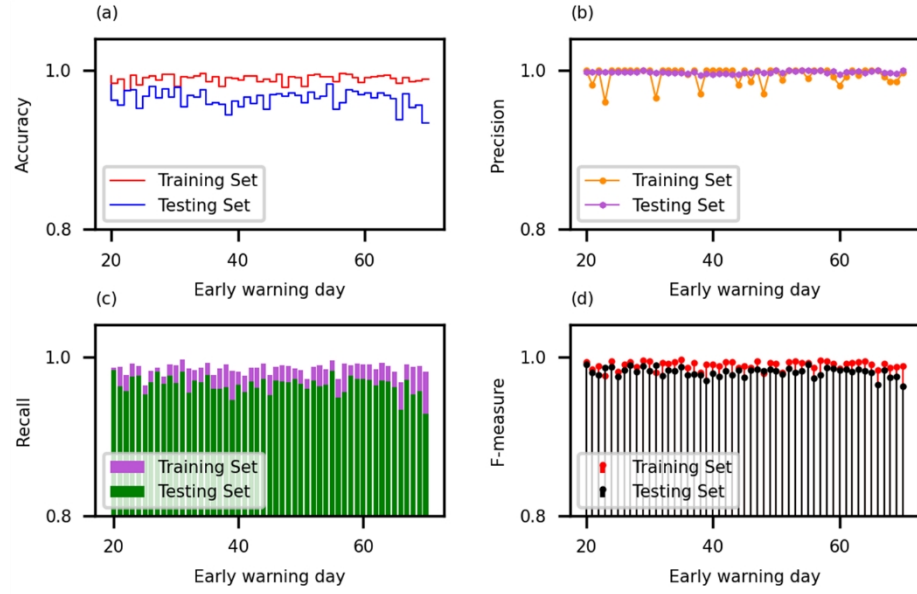


Fig. R2 Dynamic performance of the deep learning-based early warning model integrated with the hybrid network on the training and testing sets: (a) Dynamic accuracy of this model on the training and testing sets, (b) dynamic precision of this model on the training and testing sets, (c) dynamic recall of this model on the training and testing sets, and (d) dynamic F-measure of this model on the training and testing sets. Note: The hybrid network includes the self-dynamic network and the relationship-dynamic network