

Supplementary Information for “*SPP-CNN: An Efficient Framework for Network Robustness Prediction*”

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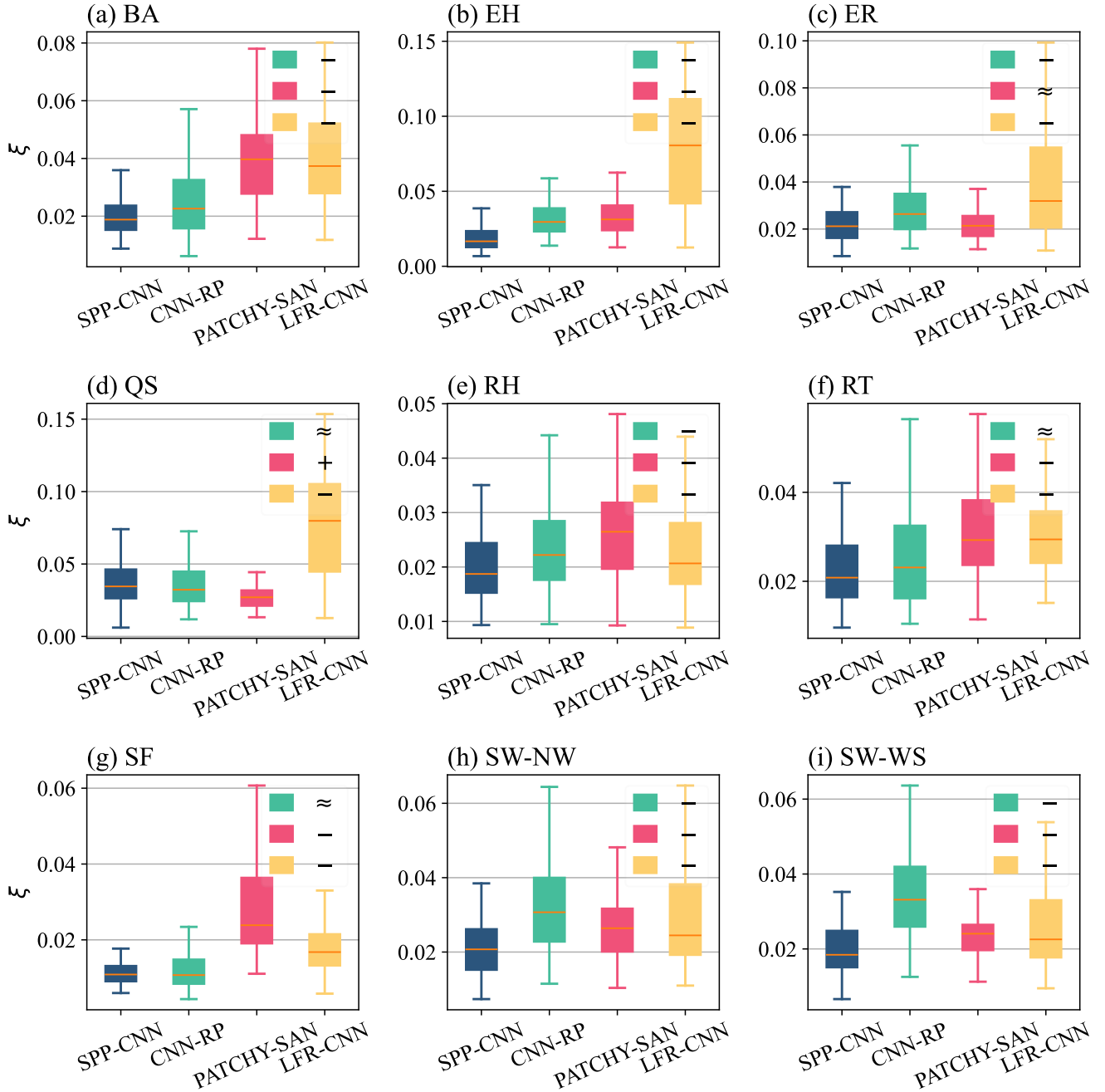


Fig. S1: Boxplots of prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN. Networks of S_1 and $N_a \in [700, 1300]$ are used for both training and test datasets. Connectivity robustness of directed networks under maximum-degree node attacks is predicted.

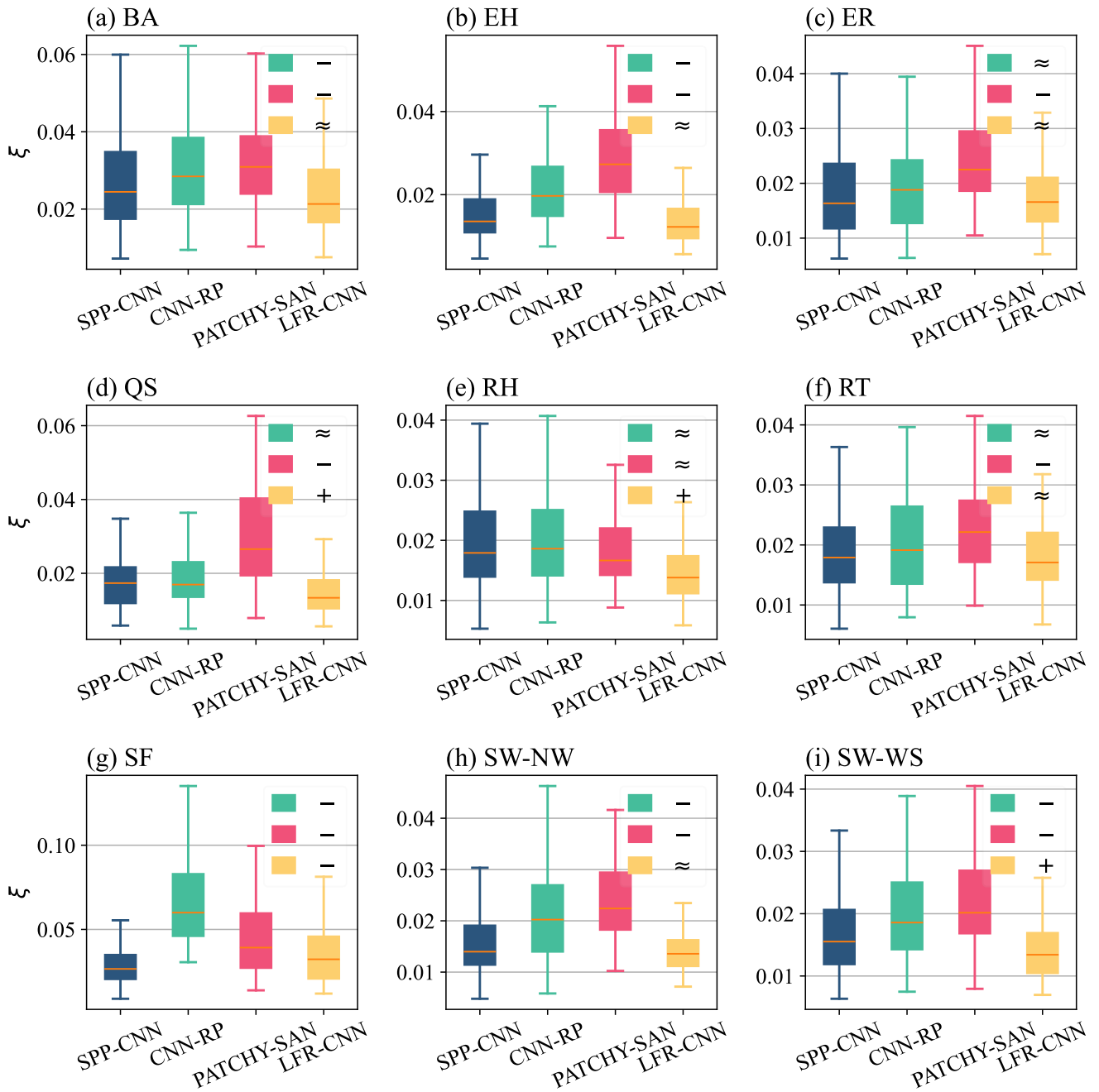


Fig. S2: Boxplots of prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN. Networks of S_1 and $N_a \in [700, 1300]$ are used for both training and test datasets. Controllability robustness of directed networks under random node attacks is predicted.

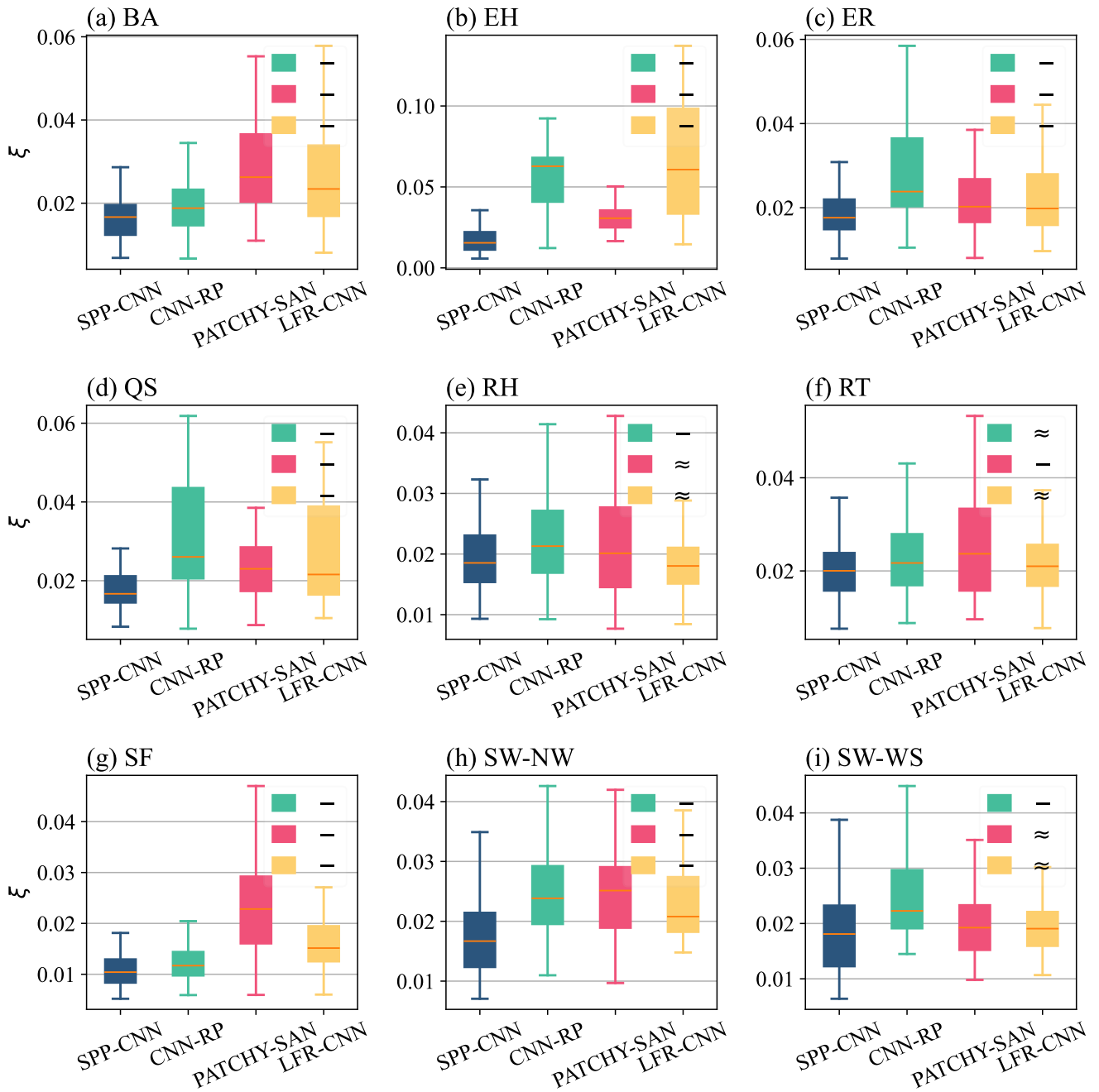


Fig. S3: Boxplots of prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN. Networks of S_1 and $N_a \in [700, 1300]$ are used for both training and test datasets. Connectivity robustness of undirected networks under maximum-degree node attacks is predicted.

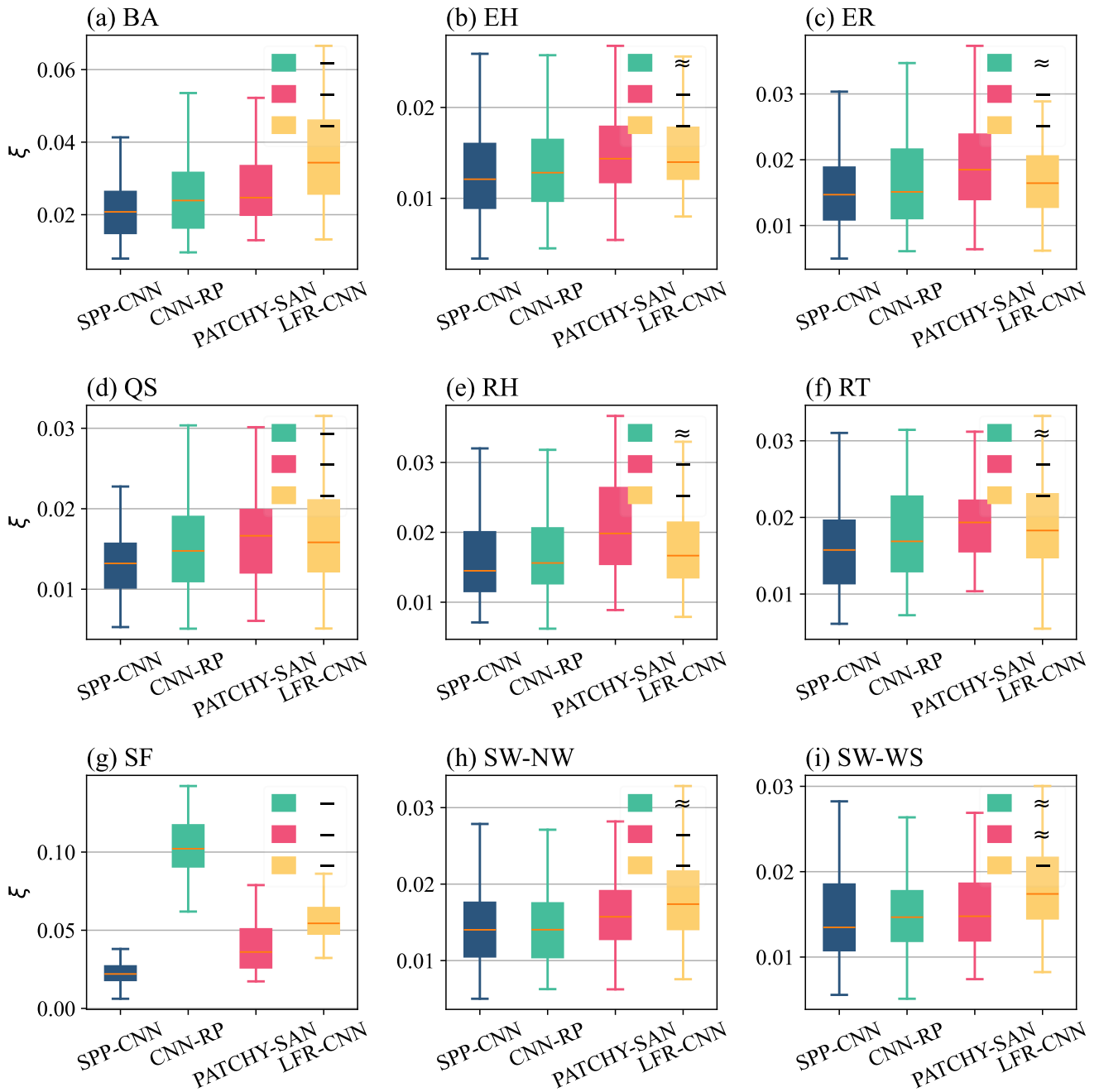


Fig. S4: Boxplots of prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN. Networks of S_1 and $N_a \in [700, 1300]$ are used for both training and test datasets. Controllability robustness of undirected networks under random node attacks is predicted.

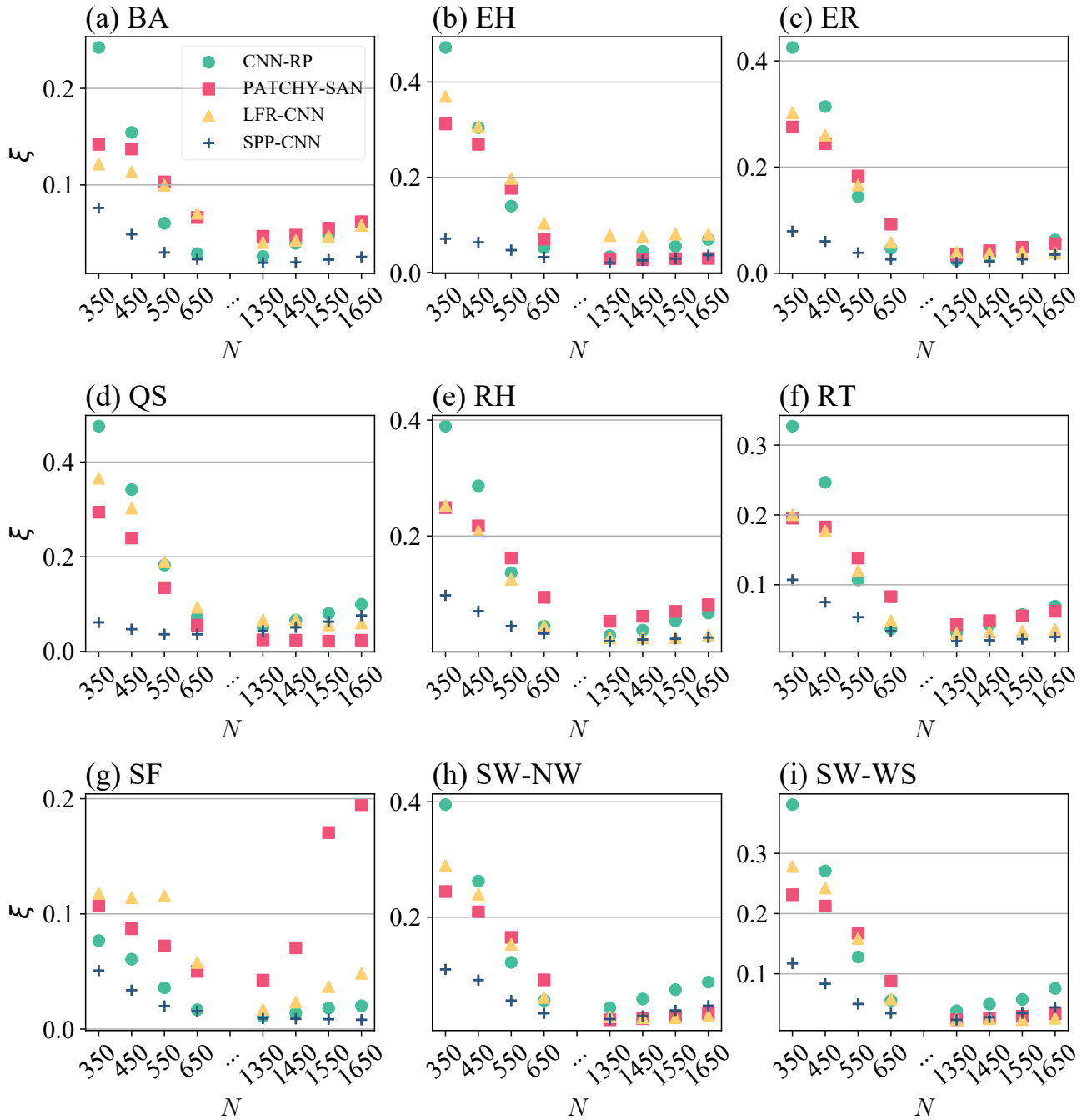


Fig. S5: Prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN for unseen network sizes (UNS). Connectivity robustness of directed networks under maximum-degree node attacks is predicted.

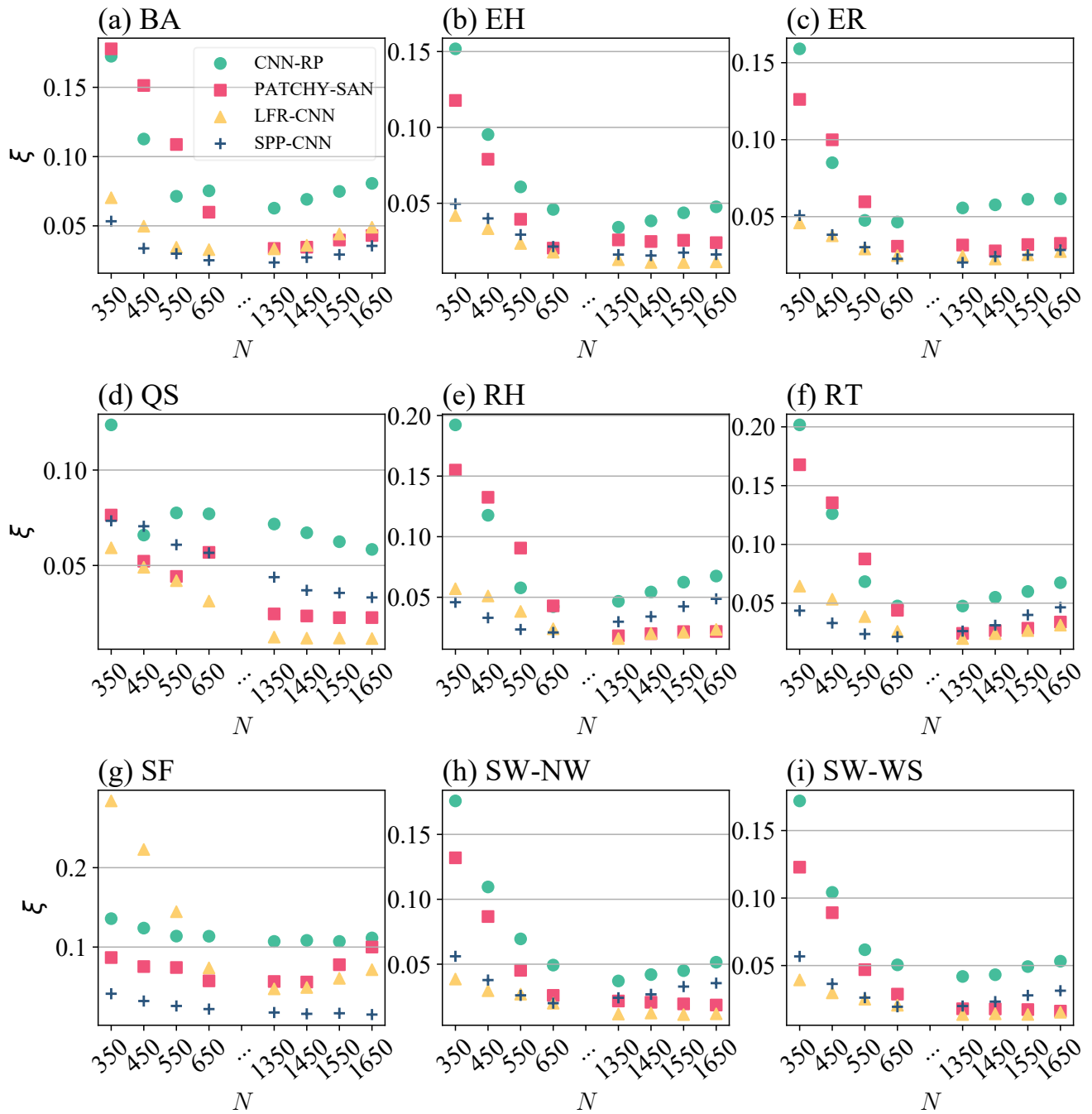


Fig. S6: Prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN for unseen network sizes (UNS). Controllability robustness of directed networks under random node attacks is predicted.

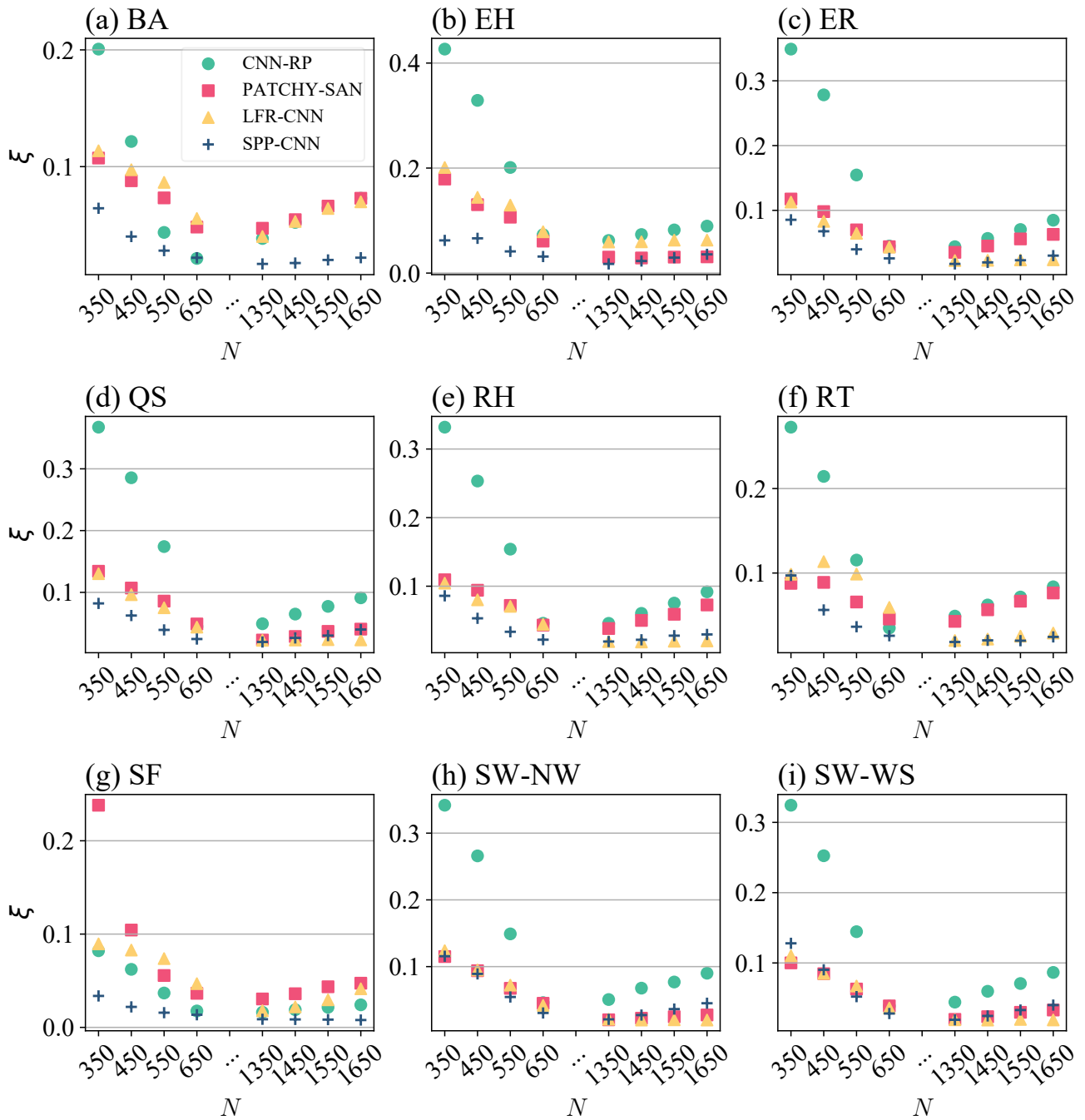


Fig. S7: Prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN for unseen network sizes (UNS). Connectivity robustness of undirected networks under maximum-degree node attacks is predicted.

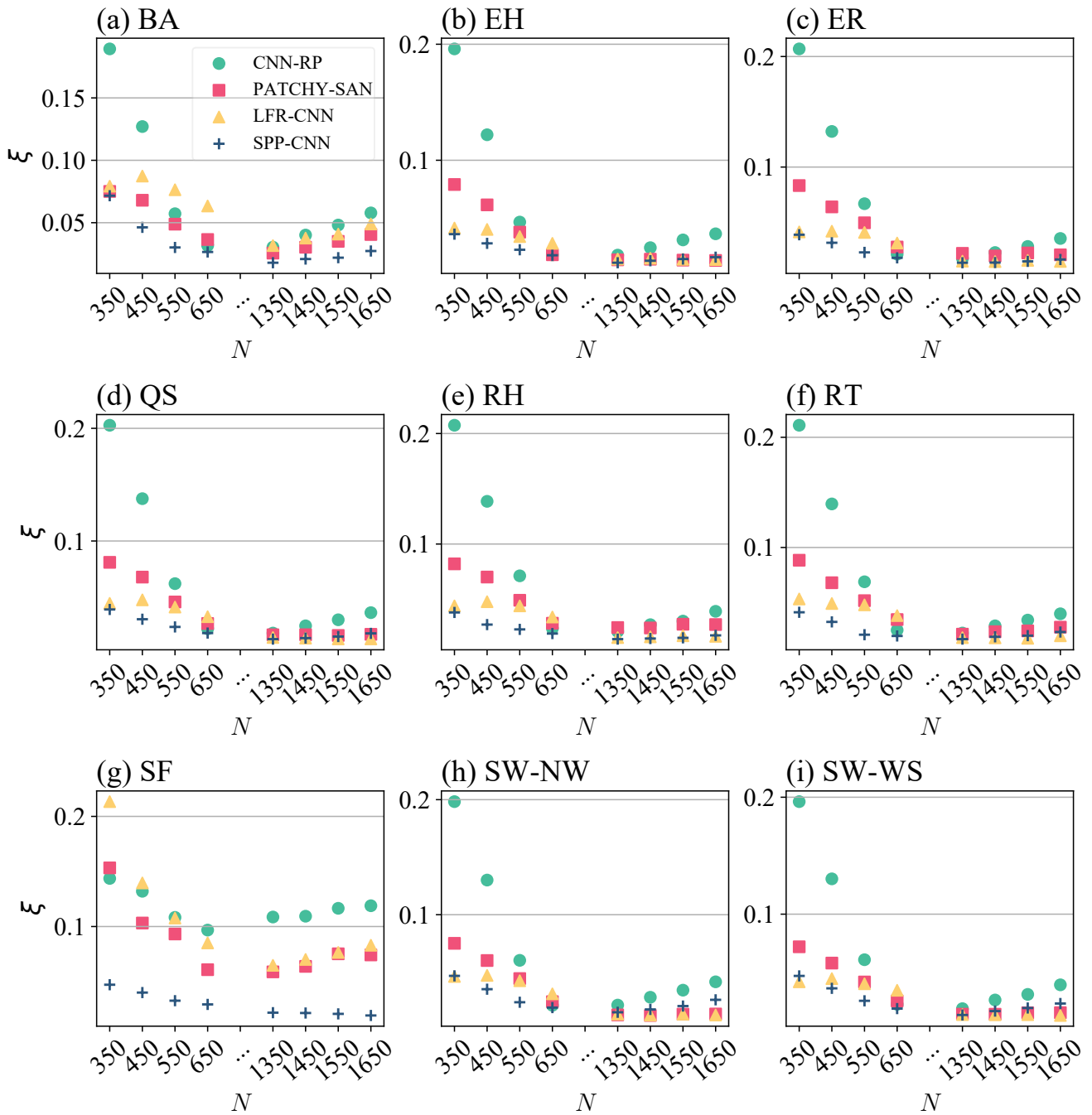


Fig. S8: Prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN for unseen network sizes (UNS). Controllability robustness of undirected networks under random node attacks is predicted.

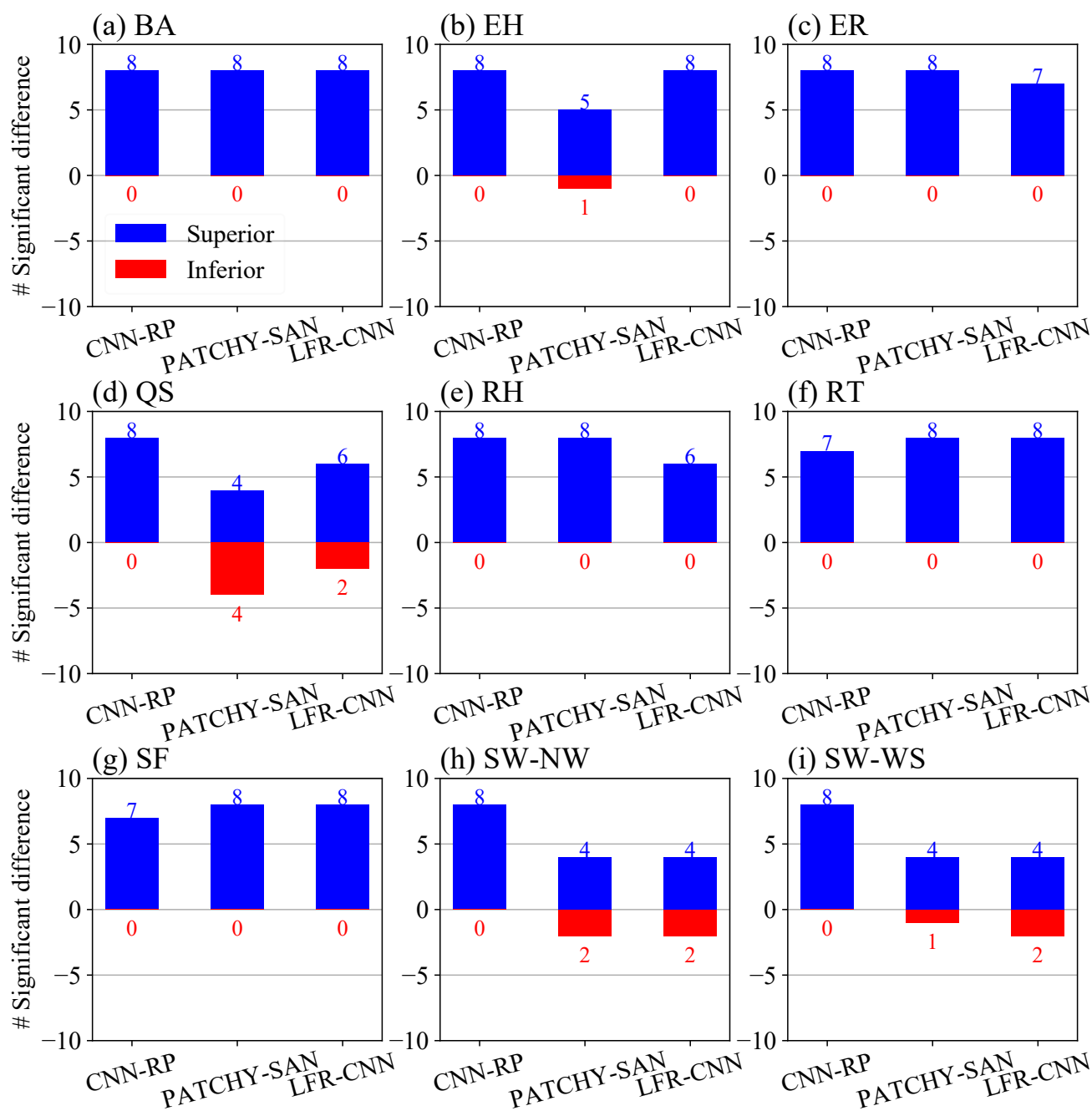


Fig. S9: Numbers of superiors and inferiors obtained by SPP-CNN, compared to each one of CNN-RP, PATCHY-SAN, and LFR-CNN. Connectivity robustness of directed networks under maximum-degree node attacks is predicted.

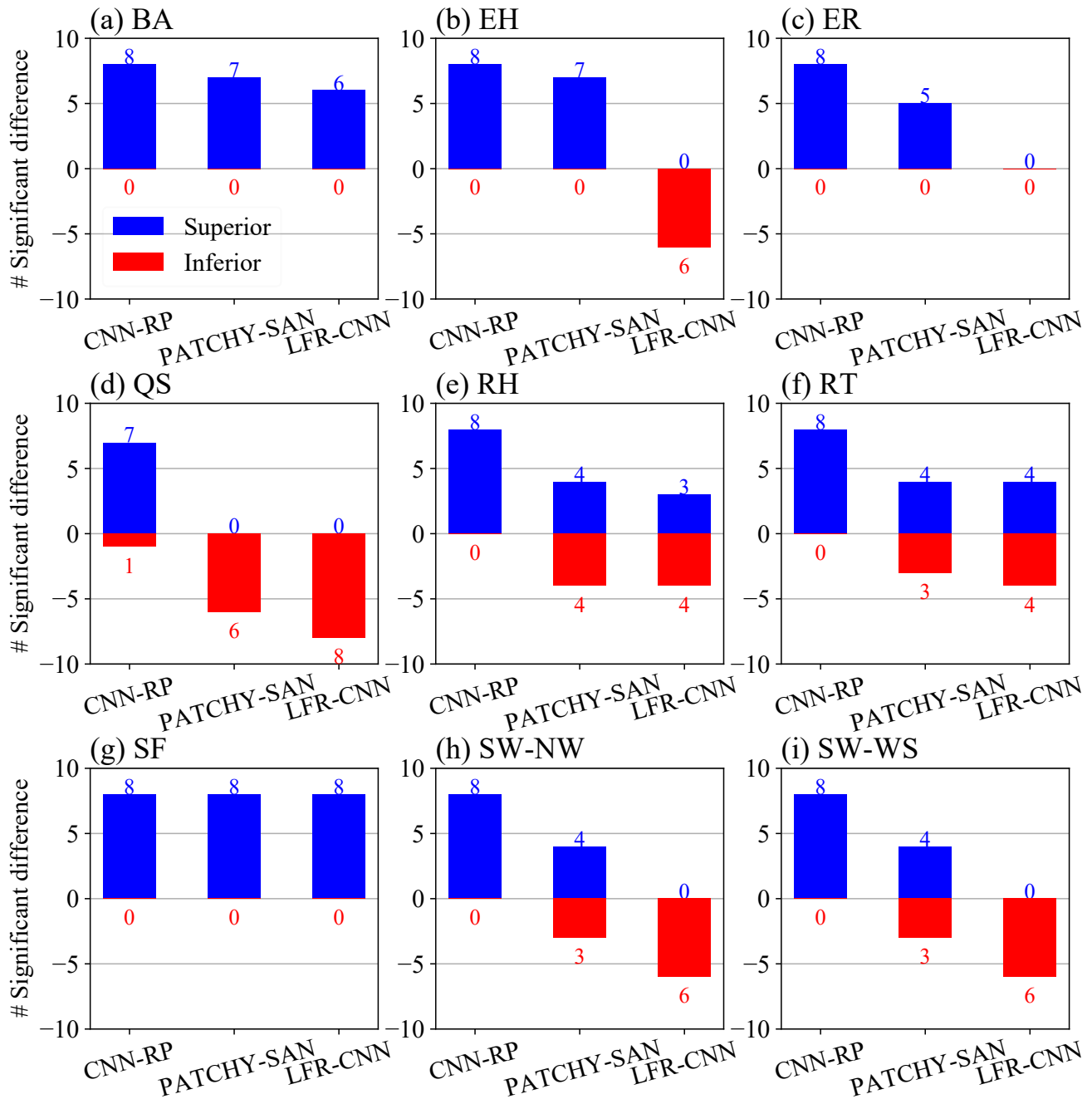


Fig. S10: Numbers of superiors and inferiors obtained by SPP-CNN, compared to each one of CNN-RP, PATCHY-SAN, and LFR-CNN. Controllability robustness of directed networks under random node attacks is predicted.

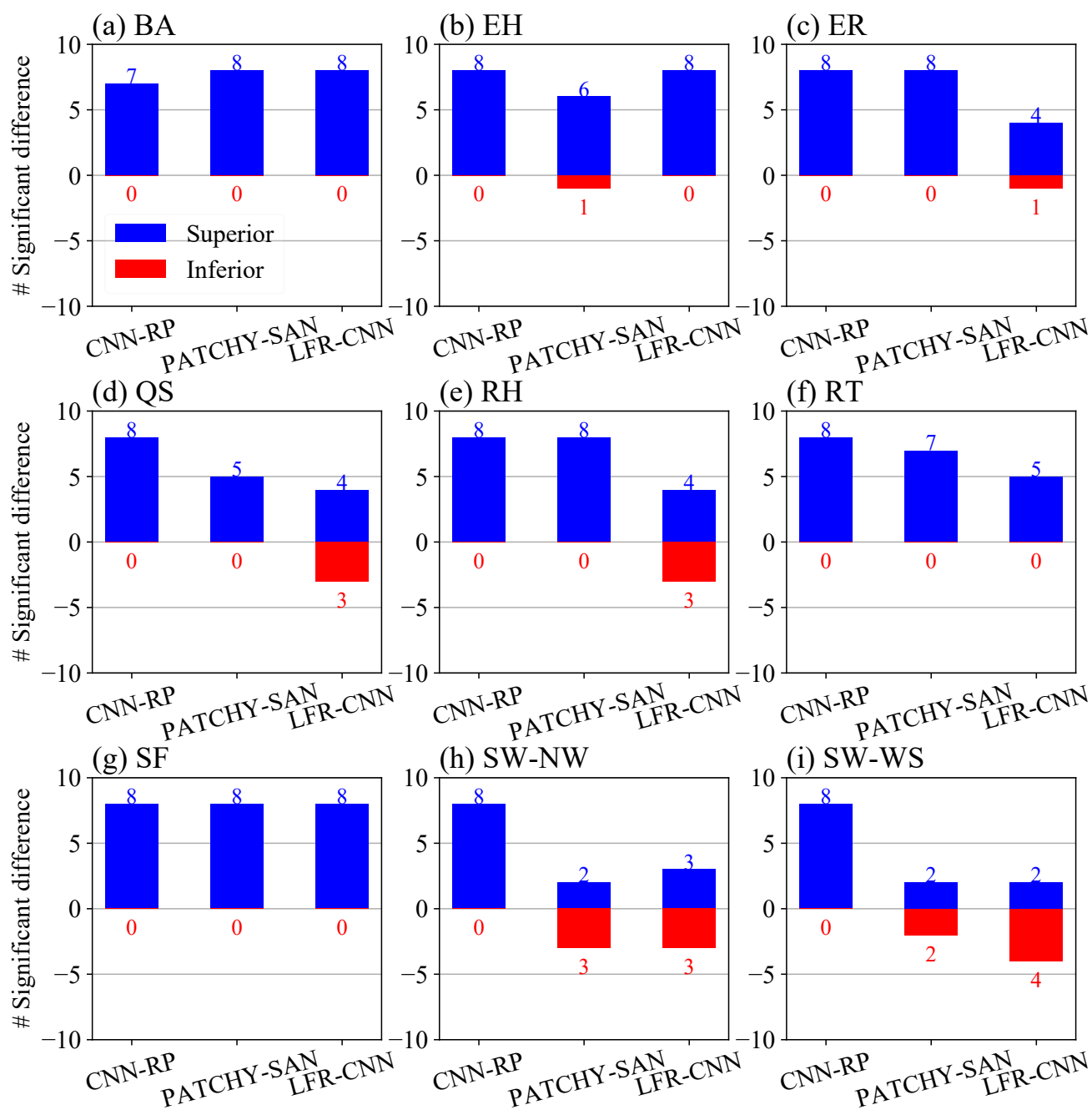


Fig. S11: Numbers of superiors and inferiors obtained by SPP-CNN, compared to each one of CNN-RP, PATCHY-SAN, and LFR-CNN. Connectivity robustness of undirected networks under maximum-degree node attacks is predicted.

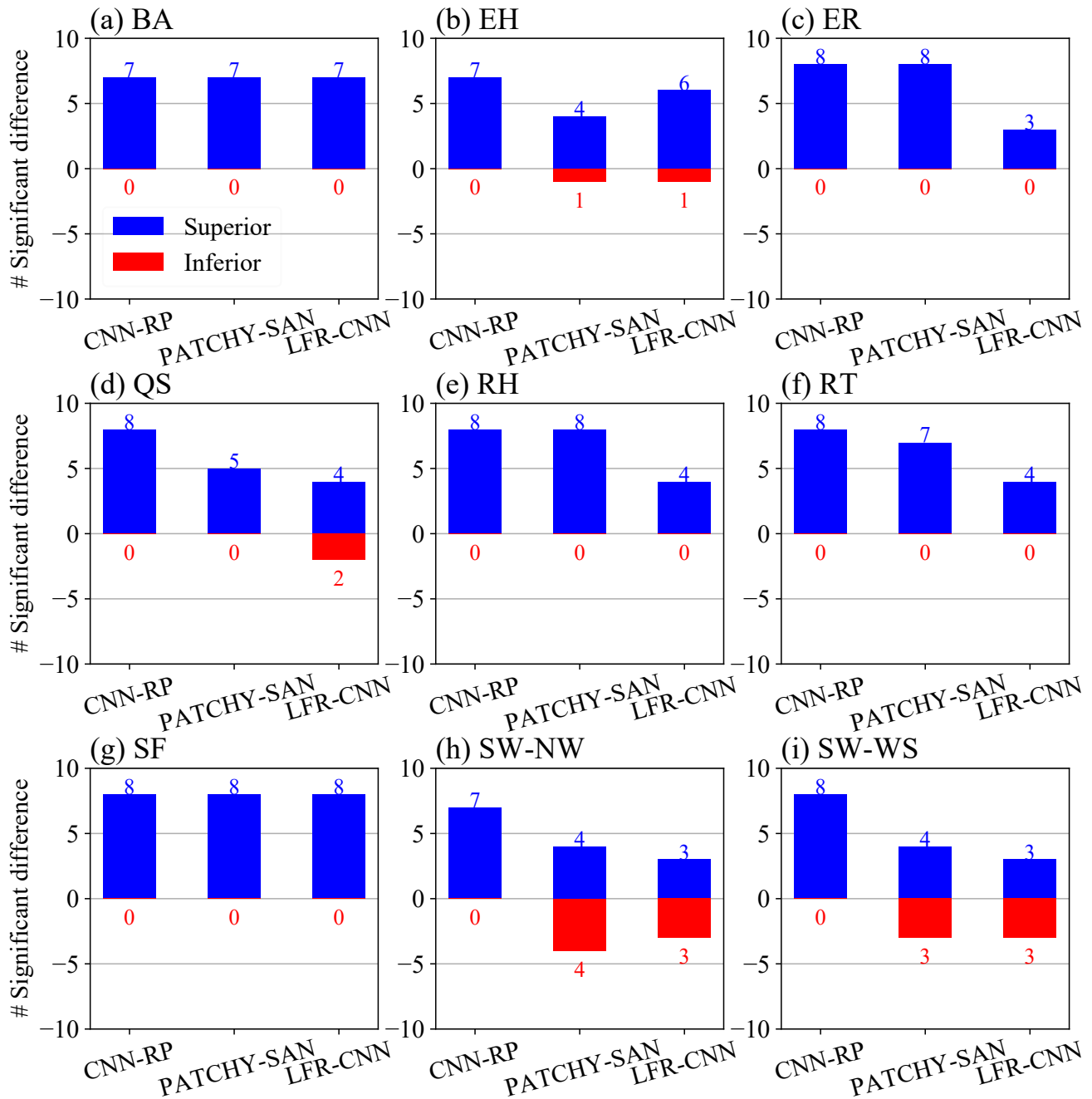
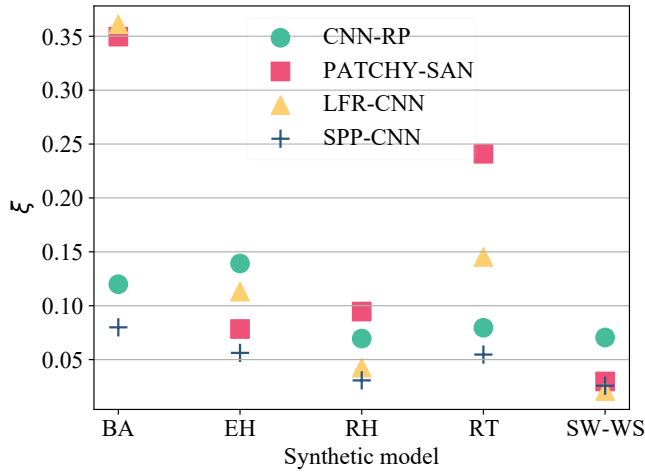
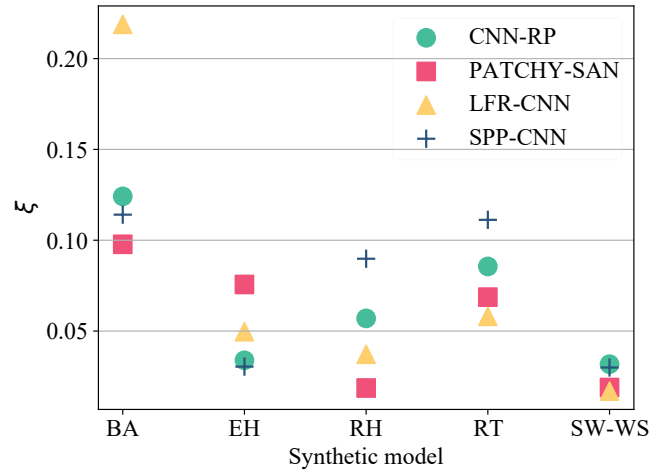


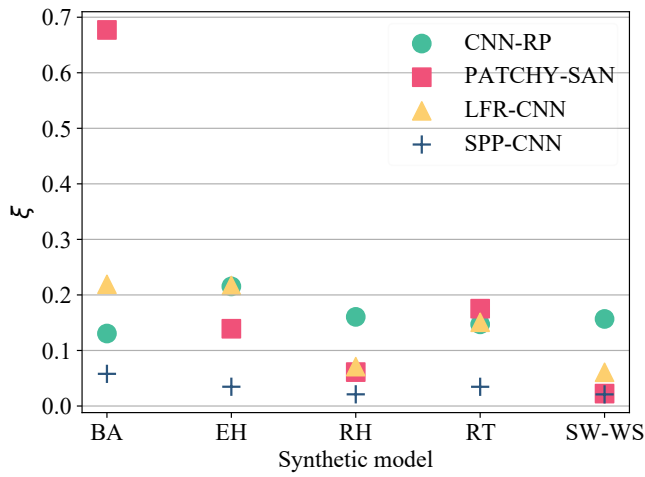
Fig. S12: Numbers of superiors and inferiors obtained by SPP-CNN, compared to each one of CNN-RP, PATCHY-SAN, and LFR-CNN. Controllability robustness of undirected networks under random node attacks is predicted.



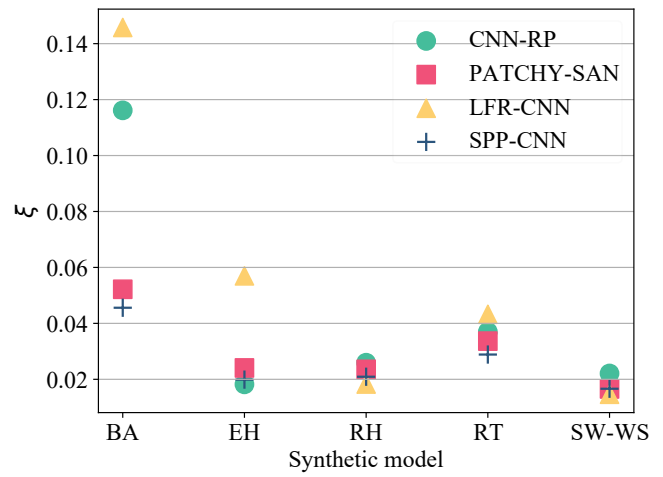
(a) Connectivity robustness of directed networks under maximum-degree node attacks.



(b) Connectivity robustness of directed networks under random node attacks.

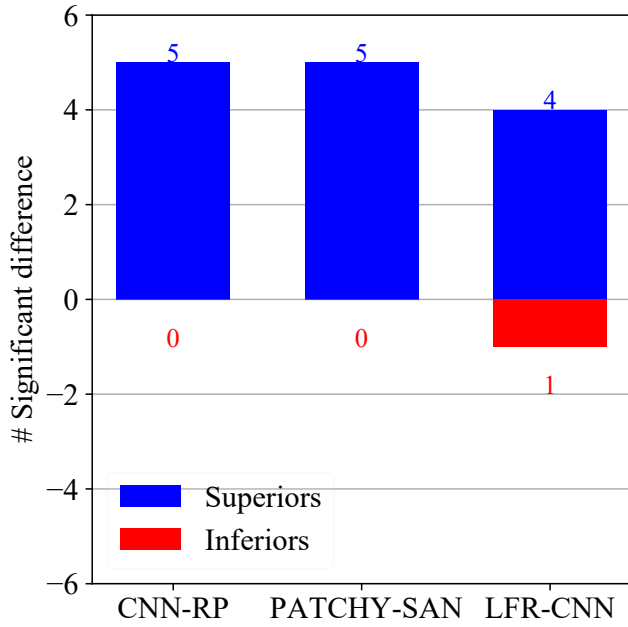


(c) Connectivity robustness of undirected networks under maximum-degree node attacks.

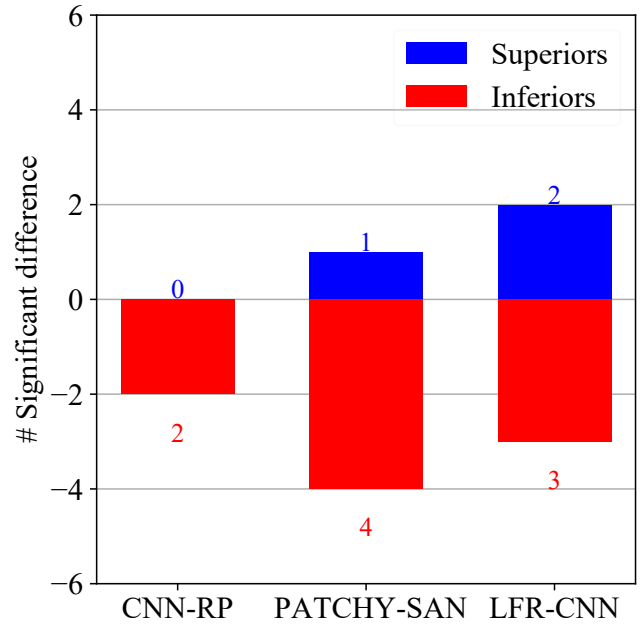


(d) Controllability robustness of undirected networks under random node attacks.

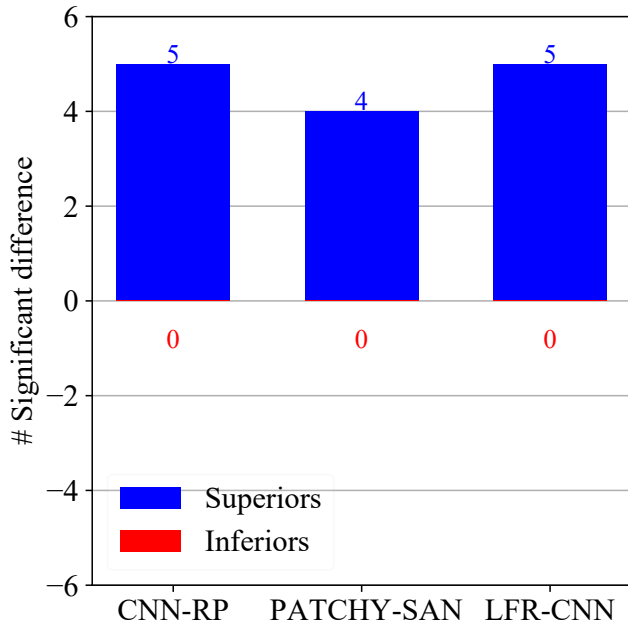
Fig. S13: Prediction errors obtained by SPP-CNN, CNN-RP, PATCHY-SAN, and LFR-CNN for unseen network topology (UNT).



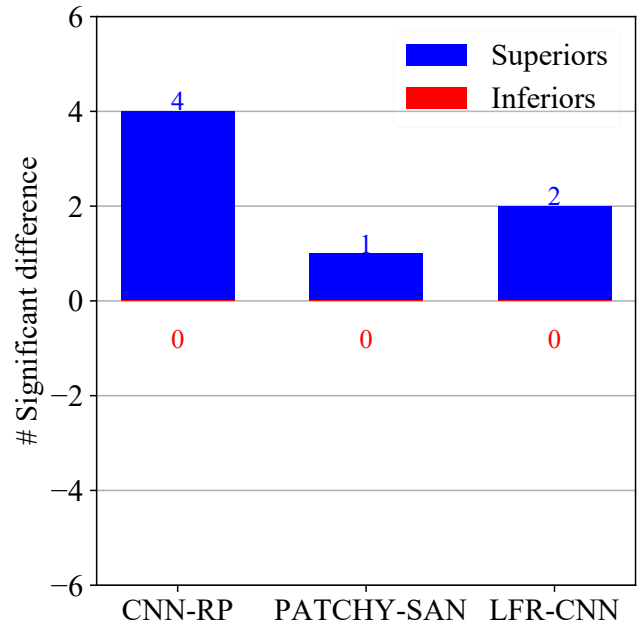
(a) Connectivity robustness of directed networks under maximum-degree node attacks.



(b) Controllability robustness of directed networks under random node attacks.



(c) Connectivity robustness of undirected networks under maximum-degree node attacks.



(d) Controllability robustness of undirected networks under random node attacks.

Fig. S14: Numbers of superiors and inferiors obtained by SPP-CNN, compared to each one of CNN-RP, PATCHY-SAN, and LFR-CNN for unseen network topology (UNT).

Table. S1: For the unseen network size (UNS) networks: the detailed number of significant performance differences (in terms of Kruskal-Wallis H-test) between SPP-CNN and any one of CNN-RP, PATCHY-SAN, and LFR-CNN. ‘(+)’ denotes the number of cases that SPP-CNN is inferior to the other methods with higher errors; ‘(-)’ denotes the number of cases that SPP-CNN is superior to the other methods with lower errors. Non-significant cases are not counted here.

| UNS: Unseen Network Size | | | BA | EH | ER | QS | RH | RT | SF | SW-NW | SW-WS | Σ | |
|--------------------------|----------------------------|------------|-----|----|----|----|----|----|----|-------|-------|----------|----|
| Directed | Connectivity Robustness | CNN-RP | (+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | (-) | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 8 | 8 | 70 |
| | | PATCHY-SAN | (+) | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 2 | 1 | 8 |
| | | | (-) | 8 | 5 | 8 | 4 | 8 | 8 | 8 | 4 | 4 | 57 |
| | | LFR-CNN | (+) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 2 | 6 |
| | | | (-) | 8 | 8 | 7 | 6 | 6 | 8 | 8 | 4 | 4 | 59 |
| | Controllability Robustness | CNN-RP | (+) | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | (-) | 8 | 8 | 8 | 7 | 8 | 8 | 8 | 8 | 8 | 71 |
| | | PATCHY-SAN | (+) | 0 | 0 | 0 | 6 | 4 | 3 | 0 | 3 | 3 | 19 |
| | | | (-) | 7 | 7 | 5 | 0 | 4 | 4 | 8 | 4 | 4 | 43 |
| | | LFR-CNN | (+) | 0 | 6 | 0 | 8 | 4 | 4 | 0 | 6 | 6 | 34 |
| | | | (-) | 6 | 0 | 0 | 0 | 3 | 4 | 8 | 0 | 0 | 21 |
| Undirected | Connectivity Robustness | CNN-RP | (+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | (-) | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 71 |
| | | PATCHY-SAN | (+) | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 6 |
| | | | (-) | 8 | 6 | 8 | 5 | 8 | 7 | 8 | 2 | 2 | 54 |
| | | LFR-CNN | (+) | 0 | 0 | 1 | 3 | 3 | 0 | 0 | 3 | 4 | 14 |
| | | | (-) | 8 | 8 | 4 | 4 | 4 | 5 | 8 | 3 | 2 | 46 |
| | Controllability Robustness | CNN-RP | (+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | (-) | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 7 | 8 | 69 |
| | | PATCHY-SAN | (+) | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 8 |
| | | | (-) | 7 | 4 | 8 | 5 | 8 | 7 | 8 | 4 | 4 | 55 |
| | | LFR-CNN | (+) | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 3 | 3 | 9 |
| | | | (-) | 7 | 6 | 3 | 4 | 4 | 4 | 8 | 3 | 3 | 42 |

Table. S2: For the unseen network topology (UNT) networks: the detailed number of significant performance differences (in terms of Kruskal-Wallis H-test) between SPP-CNN and any one of CNN-RP, PATCHY-SAN, and LFR-CNN. ‘(+)’ denotes the number of cases that SPP-CNN is inferior to the other methods with higher errors; ‘(-)’ denotes the number of cases that SPP-CNN is superior to the other methods with lower errors; Non-significant cases are not counted here.

| UNT: Unseen Network Topology | | | CNN-RP | PATCHY-SAN | LFR-CNN | Σ |
|------------------------------|----------------------------|-----|--------|------------|---------|----------|
| Directed | Connectivity Robustness | (+) | 0 | 0 | 1 | 1 |
| | | (-) | 5 | 5 | 4 | 14 |
| | Controllability Robustness | (+) | 2 | 4 | 3 | 9 |
| | | (-) | 0 | 1 | 2 | 3 |
| Undirected | Connectivity Robustness | (+) | 0 | 0 | 0 | 0 |
| | | (-) | 5 | 4 | 5 | 14 |
| | Controllability Robustness | (+) | 0 | 0 | 0 | 0 |
| | | (-) | 4 | 1 | 2 | 7 |