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# Coherence analysis and Laplacian energy of recursive trees with controlled initial states



**Key words:** Consensus; Network coherence; Laplacian energy

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# Motivation

- To propose a method which obtains the exact solutions of first- and second-order coherences characterized by the Laplacian spectrum for a family of recursive trees with controlled initial states.
- To obtain the scalings of network coherence with respect to network size.
- To reveal the relationship between network coherence and Laplacian energy.

# Main idea

- We introduce a positive integer into this family of recursive trees to control the initial states.
- We compare the obtained scalings of coherence with existing networks.
- We study the effect of Laplacian energy on network coherence.

# Method

- We use the deterministic tree structures to obtain the recursive relationships of Laplacian eigenvalues in two successive iterative steps.
- We apply the features of the initial states to obtain the exact results for network coherence at the first step.
- We numerically calculate the network coherence and Laplacian energy to find the relationship between them.

# Major results

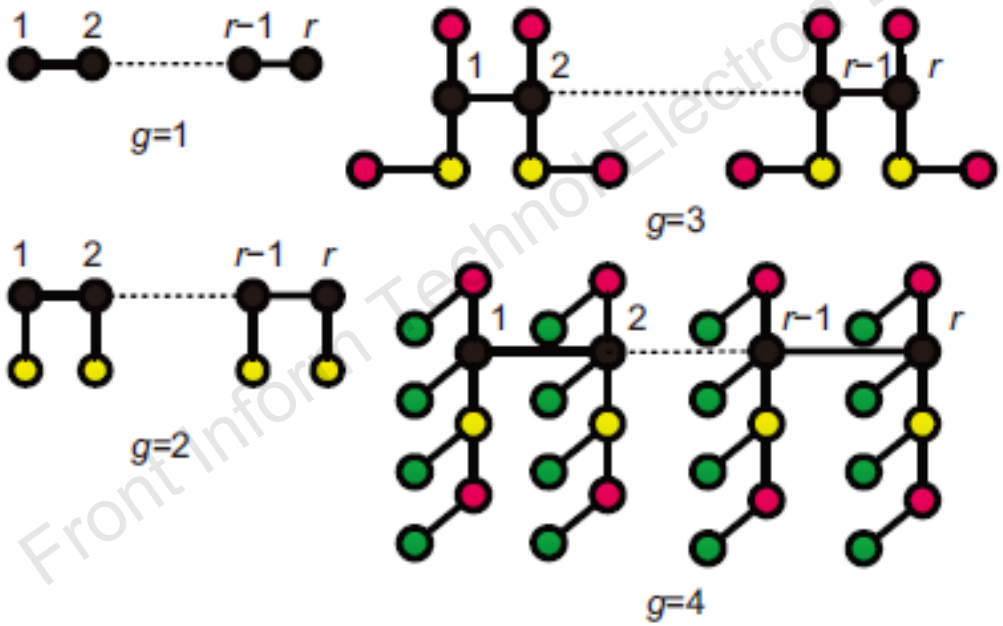




**Fig. 1** Illustration of recursive trees $T_g^r$ $(g = 1, 2, 3, 4)$

# Major results (Cont'd)

1. The consensus becomes better with a smaller number of nodes at the initial states.

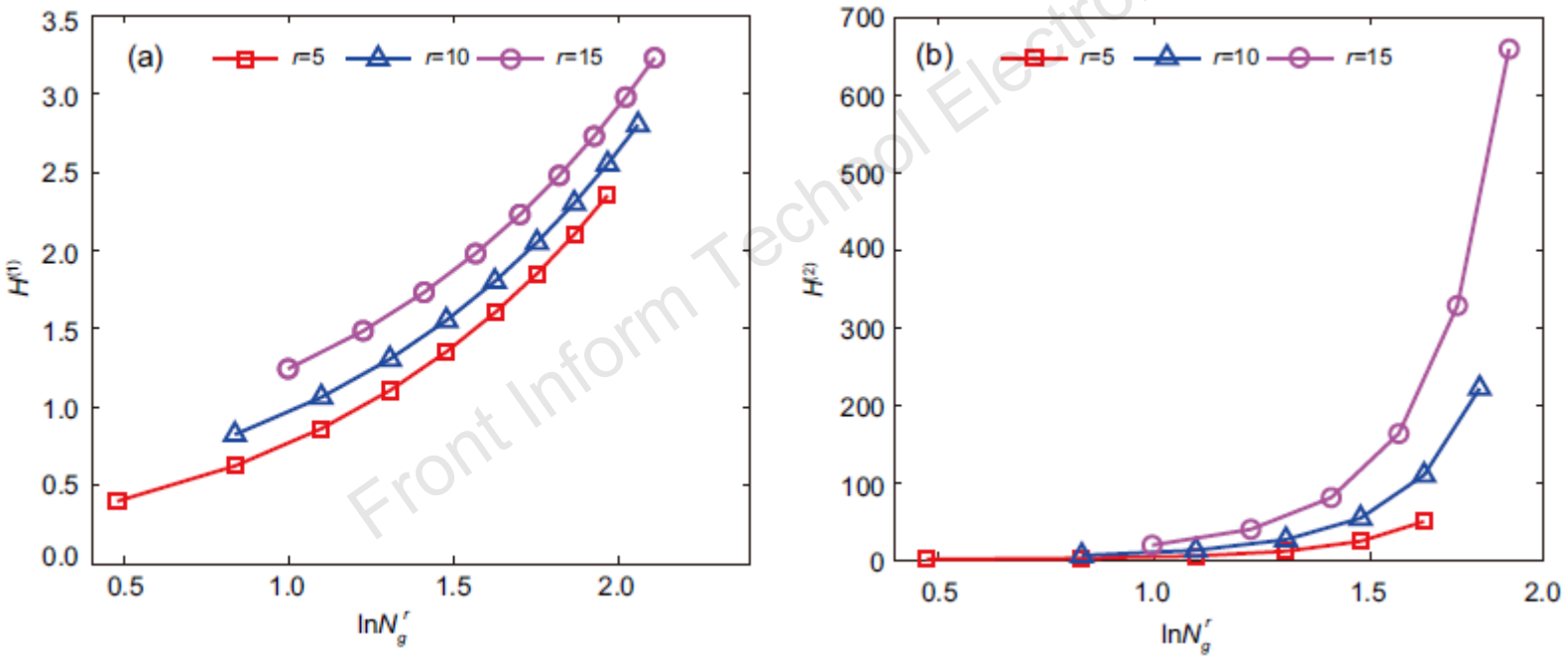




**Fig. 2** Semilogarithmic graph of network coherence with regard to network size $N_g^r$ at different initial states ($r = 5,\ 10,\ 15$): (a) $H^{(1)}$; (b) $H^{(2)}$

# Major results (Cont'd)

2. The first-order coherence increases with the increase of Laplacian energy at an exponential rate, while the second-order coherence increases at a linear rate. It shows that the consensus is worse with the increase of Laplacian energy.

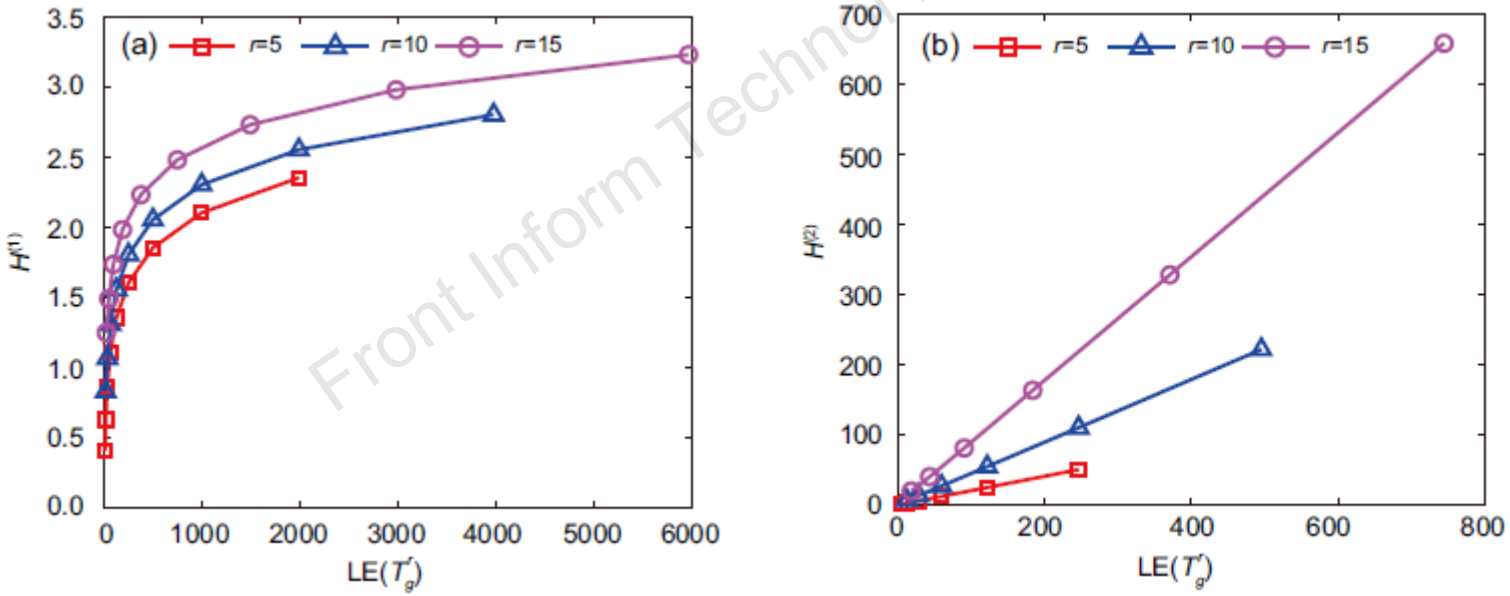


**Fig. 3** Network coherence versus Laplacian energy with different initial states ($r = 5,\ 10,\ 15$): (a) $H^{(1)}$; (b) $H^{(2)}$

# Conclusions

- The exact solutions of network coherence are obtained based on the tree's structures.
- The consensus is better with a smaller number of nodes at the initial states.
- The consensus is worse with the increase of the Laplacian energy.