Assortativity and resiliency of a Brownian bug network

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Objectives

- Make a network using the Brownian bug model
- Study assortativity and resiliency of the network

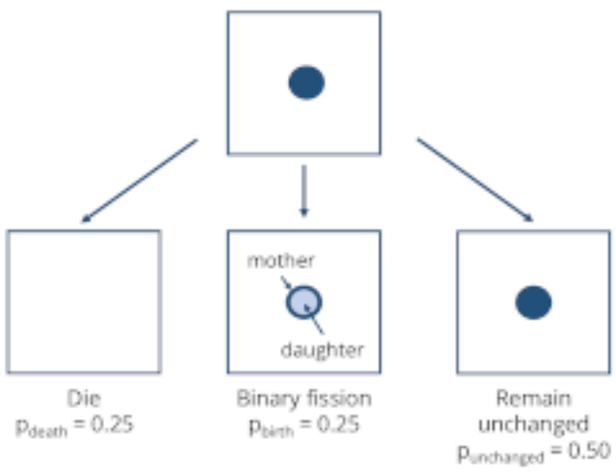
What are Brownian bugs?

Random walkers that undergo one of several steps: (1) die, (2) divide, or (3) remain unchanged; and subsequently move to a new location with a constant step size [1]. A convection current constantly moves the bugs.

Brownian bug model

1. Initialize N number of bugs in a 1x1 square box with periodic boundary conditions.

2. Each bug is assigned with random birth and death rates. A bug will either divide by binary fission, die, or remain unchanged.



3. Each bug is displaced to a new position:

$$r(t + \Delta t) = r(t) + \Delta$$

where Δ is a fixed value.

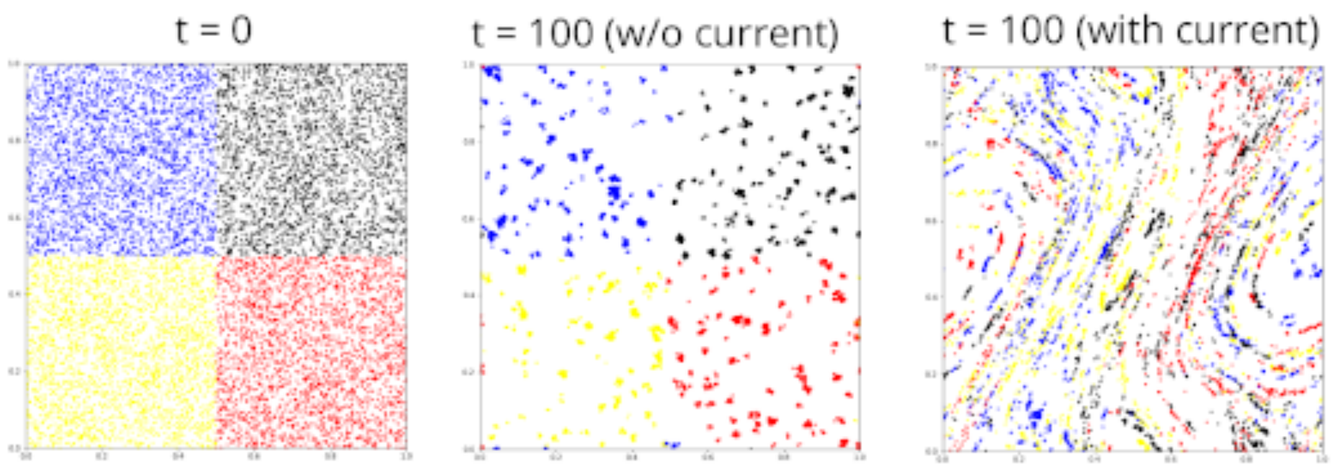
4. Add convection current:

$$x_{t+\Delta t} = x_t + \frac{1}{2\pi}\sin(2\pi y_t)$$

$$y_{t+\Delta t} = y_t + x_{t+\Delta t}$$

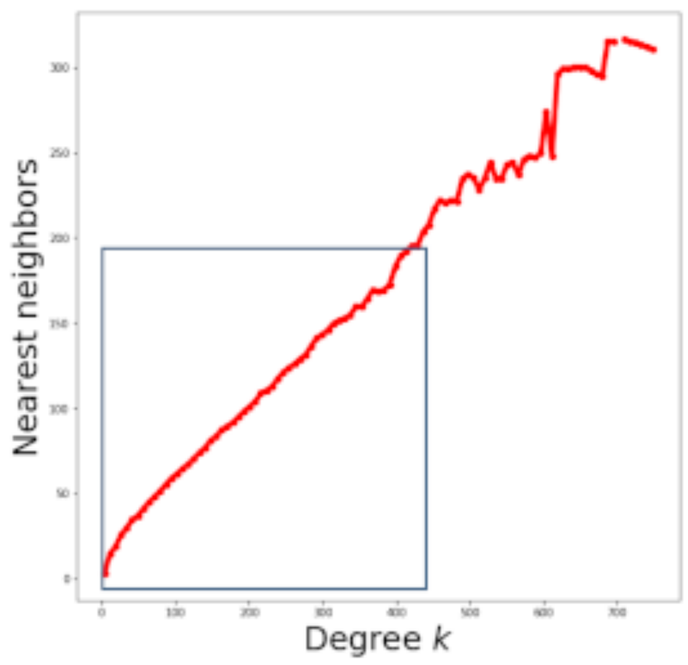
to allow bugs to constantly move.

Effect of convection



Brownian bugs that were initially together tend to remain together. Applying convection to the system prevents the formation of these stationary groups.

Assortativity of Brownian bug network



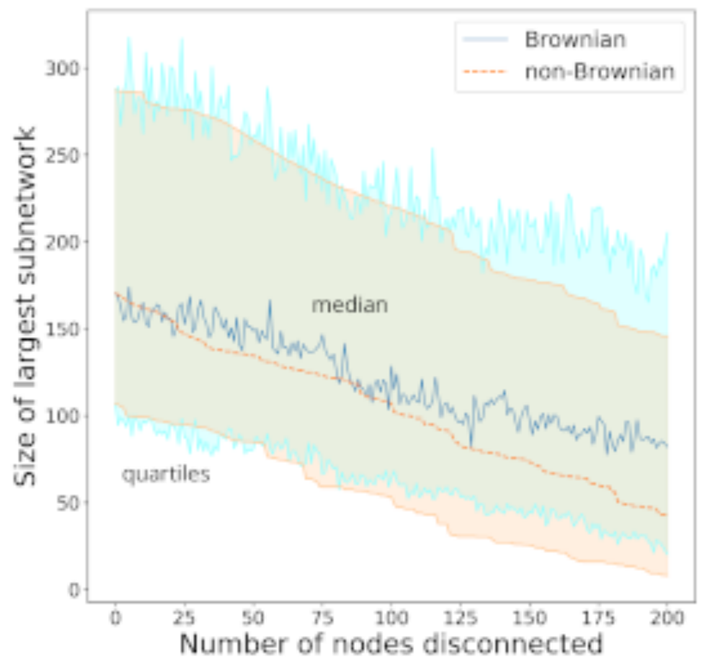
The Brownian bug network is assortative since the mean degree is increasing.

However, there are regions where the trend appears to be flat, suggesting that the network might be disassortative or the nodes have a degree limit [2].

Dismantling networks using targeted attack approach

Largest subnetwork's size of the non-Brownian bug network decreases at an almost steady rate.

The Brownian bug network also decreases but in a slower rate (because it is capable of reproducing another node).



Conclusion

A geometric network was created using the Brownian bug model where the bugs are considered as nodes, and the distance between them as edges. We find that the network is globally assortative but still displays some local assortativity, which is contributed by nodes with high degrees. The Brownian bug network was resilient, but with a trade-off of introduction of cross-talk noise [3].

Acknowledgements

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References:

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[2] H. Safdari, M. Z. Kamali, A. Shirazi, M. Khalighi, J. Gholamreza, and M. Ausloos, Fractional Dynamics of Network Growth Constrained by Aging Node Interactions, PLoS ONE 11, 1 (2016).
[3] A. G. Bouazza and B. Bouazza, Crosstalk Noise and Signal Propagation Delay Analysis in Submicron CMOS Integrated Circuits, 2012 6th International Conference on Sciences of Electronics, Technologies of Information and Telecommunications, SETIT 2012 155(160 (2012).

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