

Wavelet-based multiscale similarity measure for complex networks

<https://link.springer.com/content/pdf/10.1140/epjb/e2018-90460-6.pdf>

- ▼ What did the authors try to accomplish?
- ▼ What were the key elements of the approach?

1. Wavelet transform

- Maximal Overlapping discrete wavelet transform

MODWT decomposes the time series into different time scales or frequency components. The wavelet decomposition is realized using the two basis functions known as father wavelet ($\varphi(t)$) and mother wavelet ($\psi(t)$). The general admissibility conditions for ψ to be called a wavelet function are

$$\int_{-\infty}^{\infty} \psi(t) dt = 0. \quad (1)$$

$$\int_{-\infty}^{\infty} |\psi(t)|^2 dt = 1. \quad (2)$$

Any function $f(t)$ can be expressed through these basis functions and their scaled and translated versions are

$$\begin{aligned} f(t) = & \sum_k s_{J,k} \varphi_{J,k}(t) + \sum_k d_{J,k} \psi_{J,k}(t) \\ & + \sum_k d_{J-1,k} \psi_{J-1,k}(t) \cdots + \sum_k d_{1,k} \psi_{1,k}(t) \end{aligned} \quad (3)$$

where J is the total number of scales to be analyzed, and k is in the range of 1 to l (length of the time series). The coefficients $s_{J,k}$ are the approximation coefficients and $d_{J,k}, \dots, d_{1,k}$ are the wavelet transform coefficients at scales J to 1, while the functions $\varphi_{J,k}(t)$ and $\psi_{j,k}(t) | j = 1, \dots, J-1, J$ are the basis functions which are obtained through translation and dilation of the father ($\varphi(t)$) and mother ($\psi(t)$) wavelet function, respectively.

2. Wavelet multiscale correlation

$$\text{WMC} = \rho_{X,Y}^{l_j} \equiv \frac{\text{COV}_{X,Y}^{l_j}}{\text{Var}_Y^{l_j} \text{Var}_X^{l_j}},$$

where

$$\text{Var}_X^{l_j} \equiv \frac{1}{T_j} \sum_{t=M_j-1}^{T-1} [d_{j,t}^X]^2,$$

$$\text{Var}_Y^{l_j} \equiv \frac{1}{T_j} \sum_{t=M_j-1}^{T-1} [d_{j,t}^Y]^2,$$

$$\text{COV}_{X,Y}^{l_j} \equiv \frac{1}{T_j} \sum_{t=M_j-1}^{T-1} d_{j,t}^X d_{j,t}^Y.$$

3. Network construction

- Using WMC
- 95th percentile threshold

▼ What can you use yourself?

- WMC

▼ What other references do you want to follow?

- Mean distance: A.A. Tsonis, K. Swanson, S. Kravtsov, Geophys. Res. Lett. 34, L13705 (2007)
- Spike Synchronization: T. Kreuz, M. Mulansky, N. Bozanic, J. Neurophysiol. 113, 3432 (2015)