

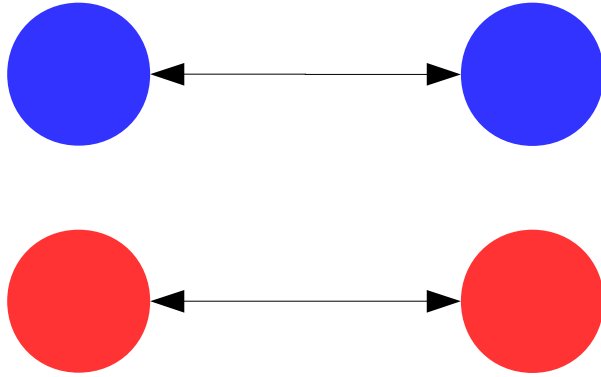
Multi-scale mixing in complex networks

Leto Peel

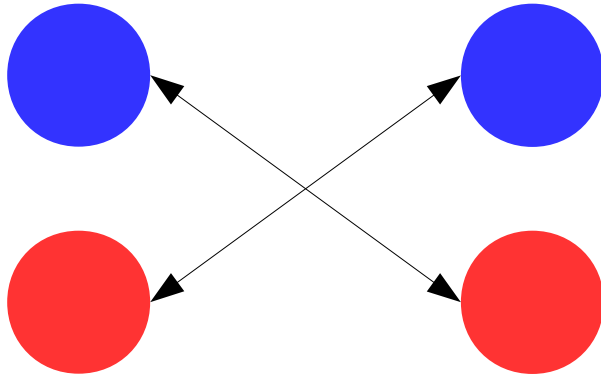
Université catholique de Louvain

@PiratePeel

Assortativity



Disassortativity



Mixing in real networks



Mixing in real networks



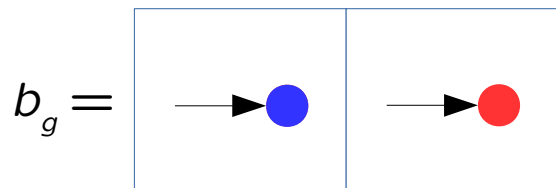
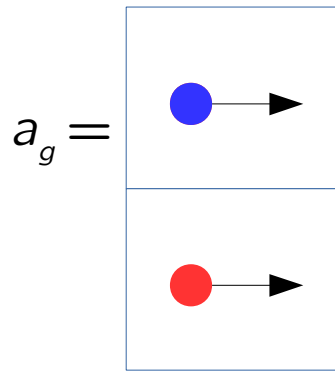
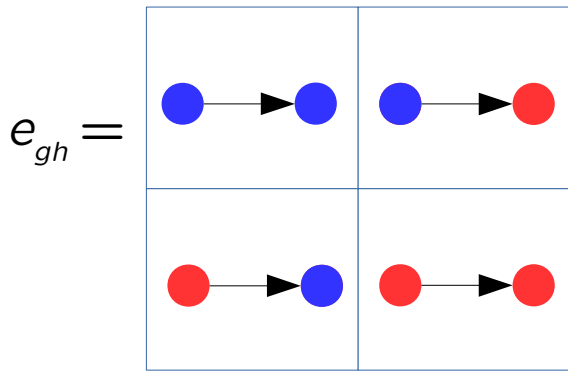
Mixing in real networks

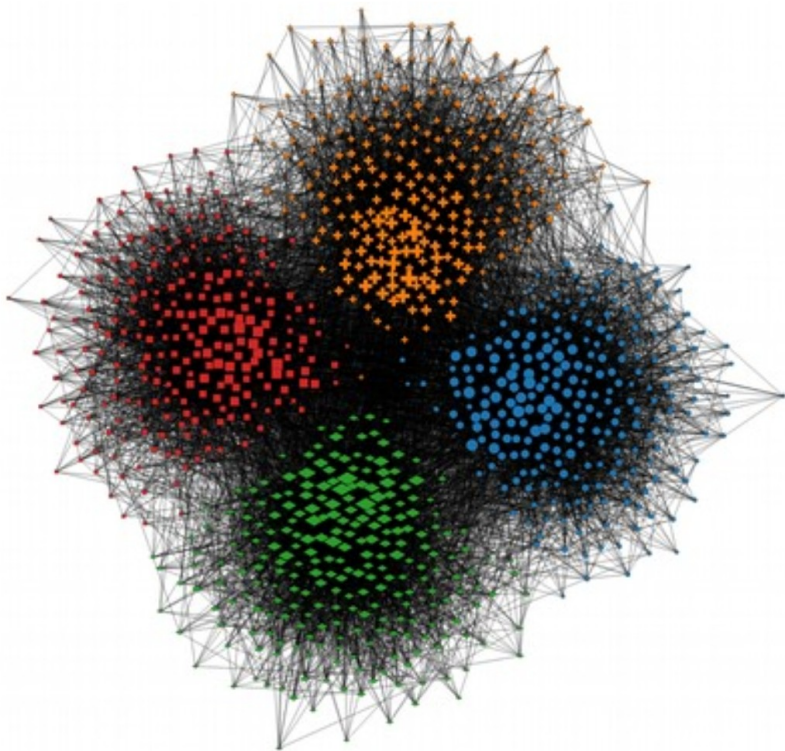
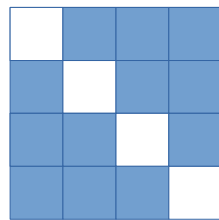
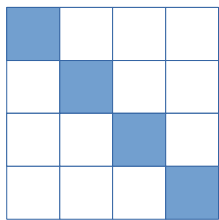


Generalisation, not rules!

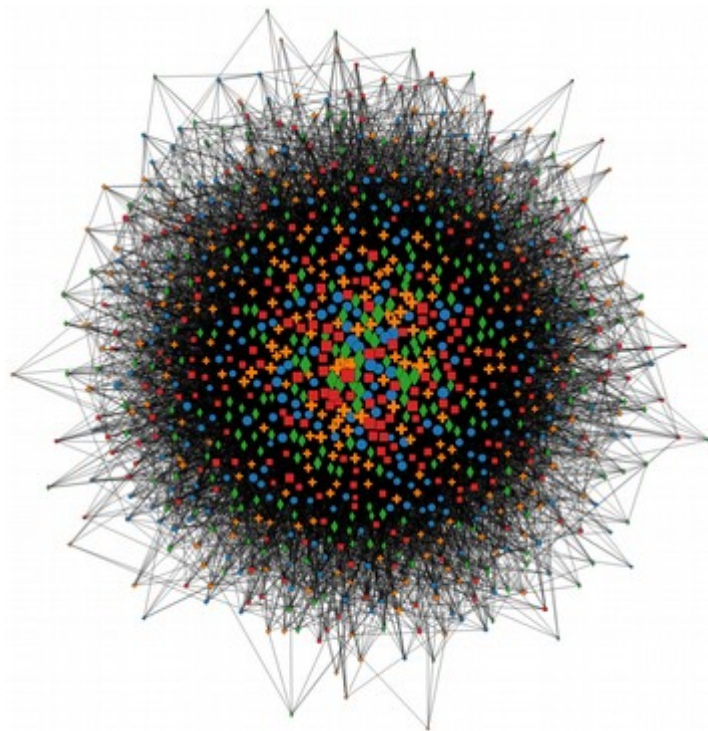


$$r_{\text{global}} = \frac{\sum_g e_{gg} - \sum_g a_g b_g}{1 - \sum_g a_g b_g}$$





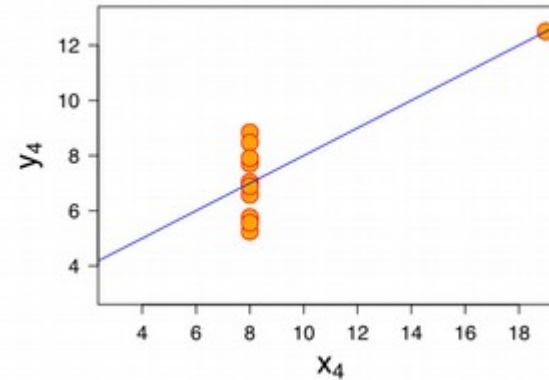
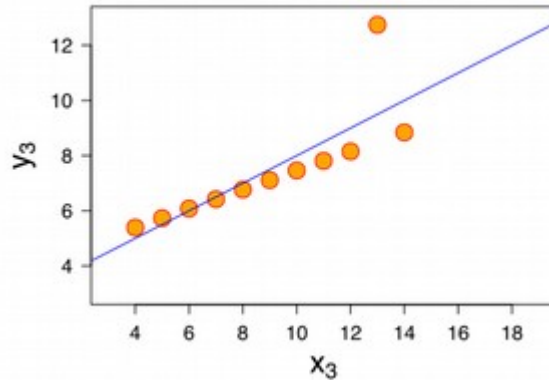
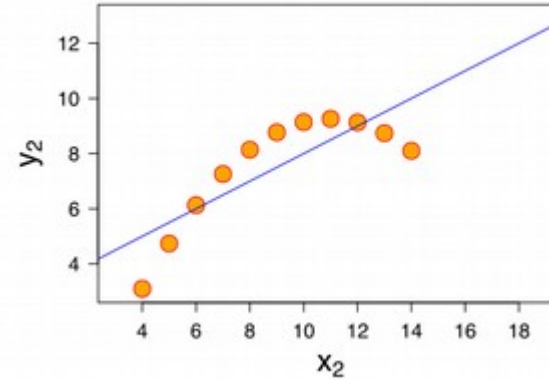
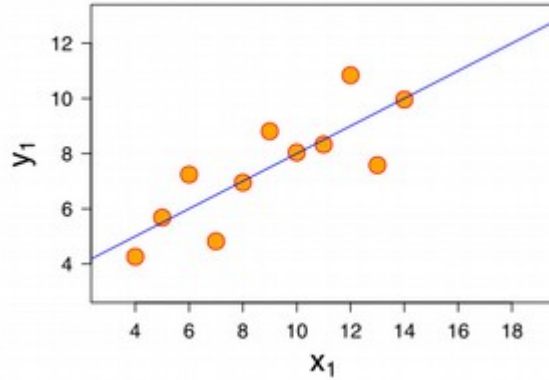
$r \sim 0.7$



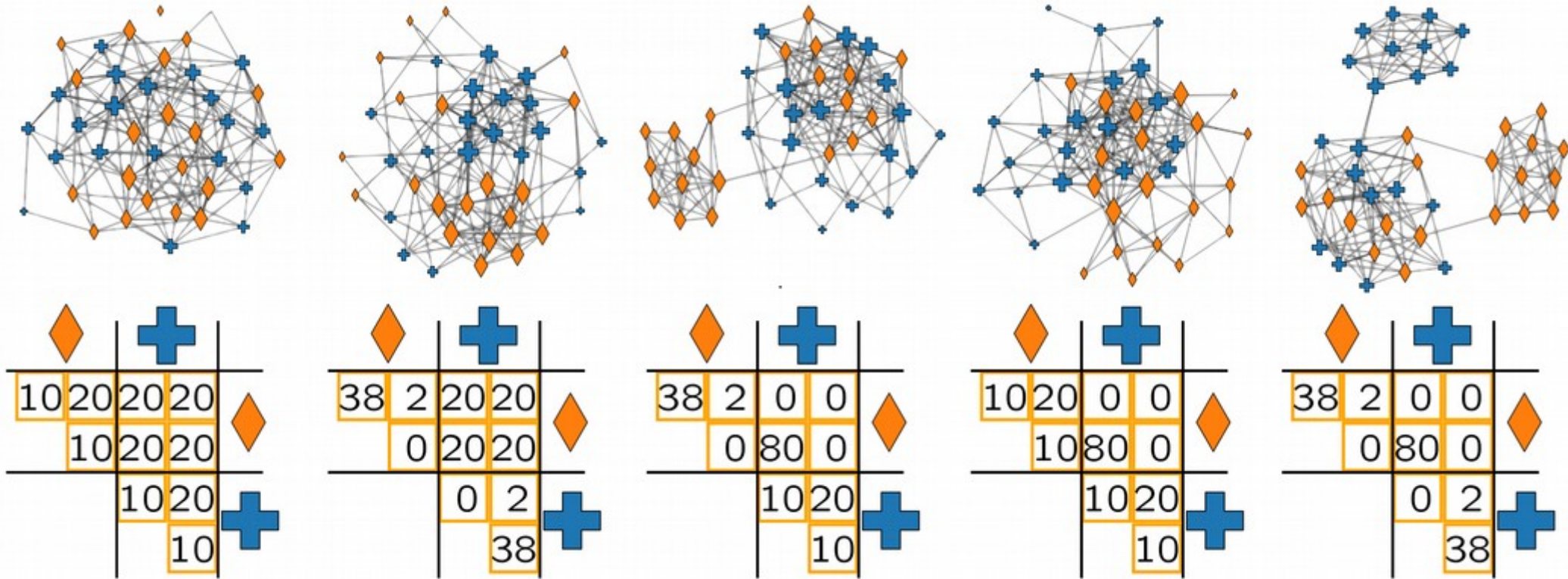
$r \sim -0.3$

Assortativity is correlation across edges

Assortativity is correlation across edges

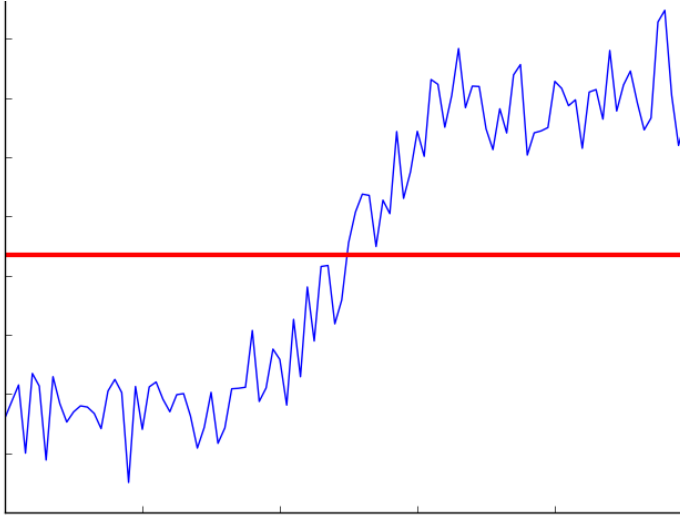


All these networks have assortativity $r=0$



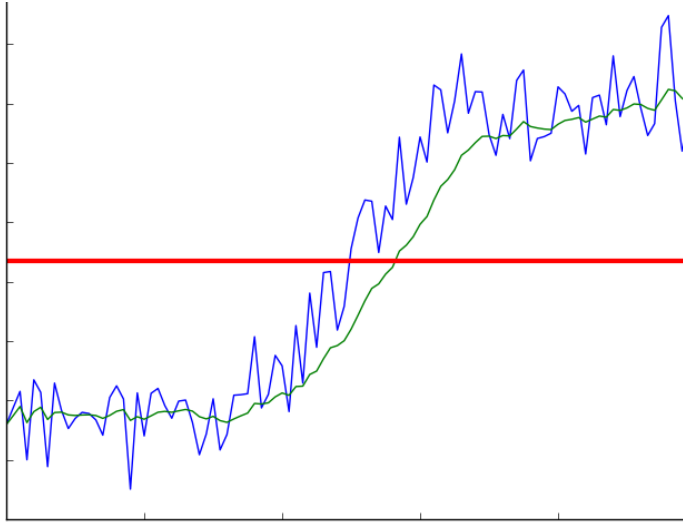
Can we measure assortativity locally?

Time series analysis



The mean is only representative of the data around the middle of the time series

Time series analysis



Exponentially weighted mean

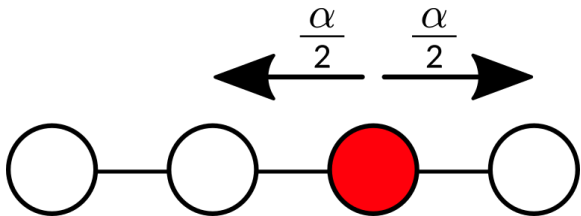
Recent points are more relevant

$$S_t = \alpha y_{t-1} + (1 - \alpha) S_{t-1} \quad 0 < \alpha \leq 1$$

Random walks on a graph



$$e_{gh} = \sum_{ij} w(i) \frac{A_{ij}}{k_i} \delta_{y_i, g} \delta_{y_j, h}$$



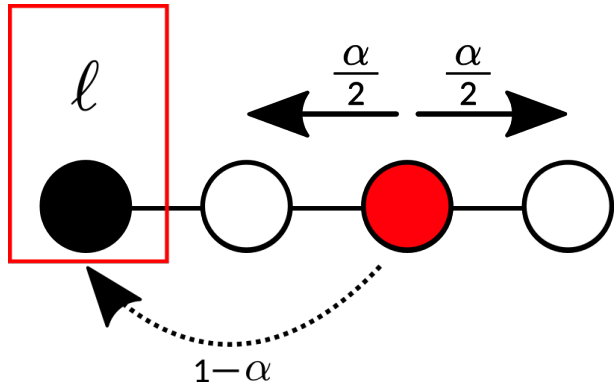
$$w(i; \ell)$$

stationary distribution
of a random walk
(PageRank)

Random walks on a graph



$$e_{gh}(\alpha, \ell) = \sum_{ij} w(i; \ell) \frac{A_{ij}}{k_i} \delta_{y_i, g} \delta_{y_j, h}$$



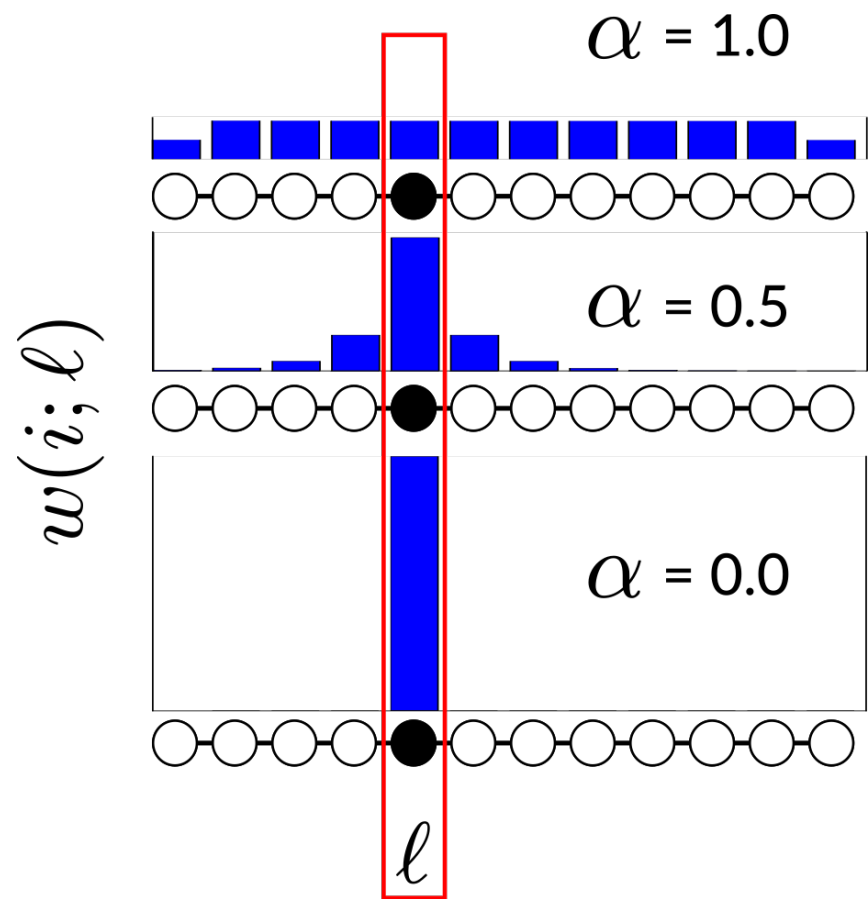
$$w(i) = \frac{k_i}{2m}$$

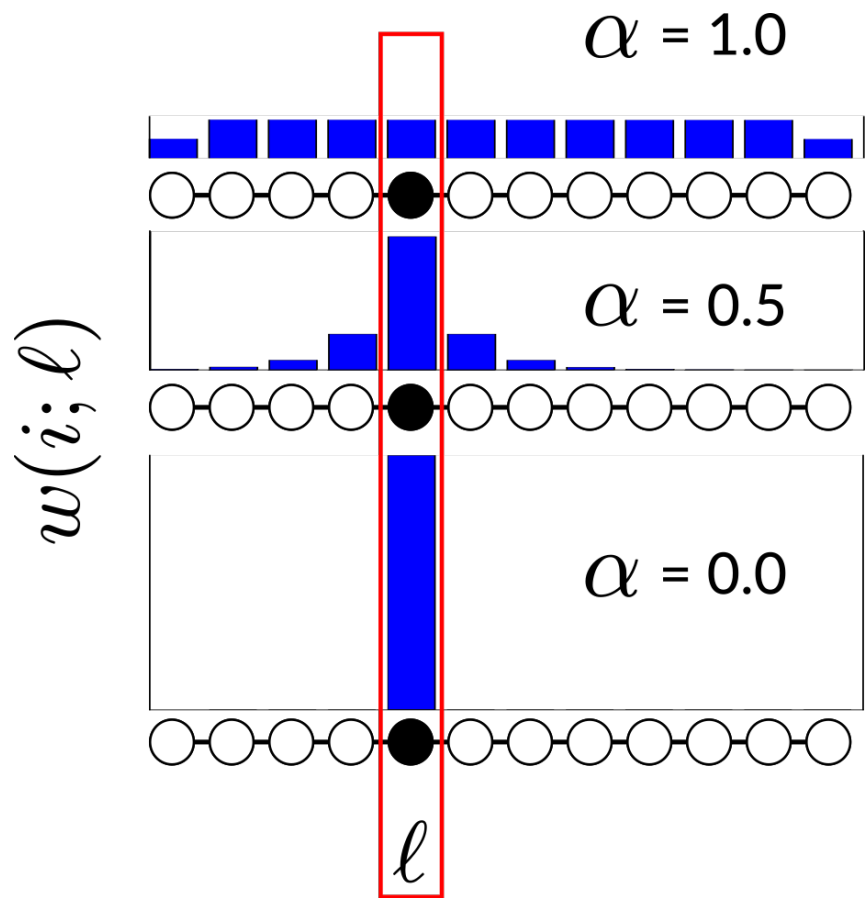
stationary distribution
of a random walk with
restart
(Personalised PageRank)

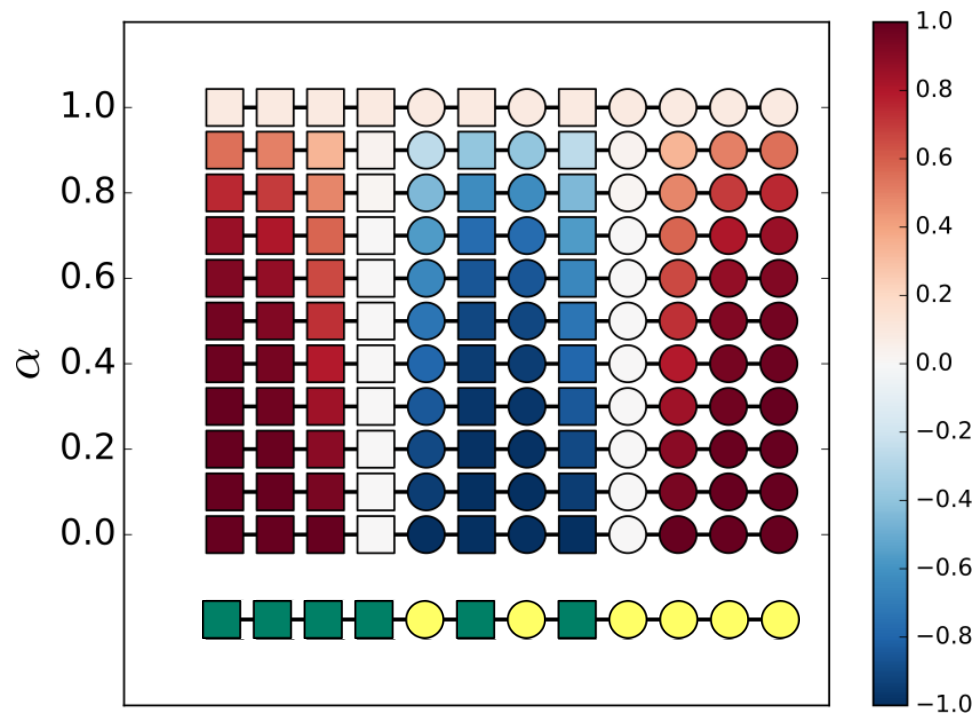
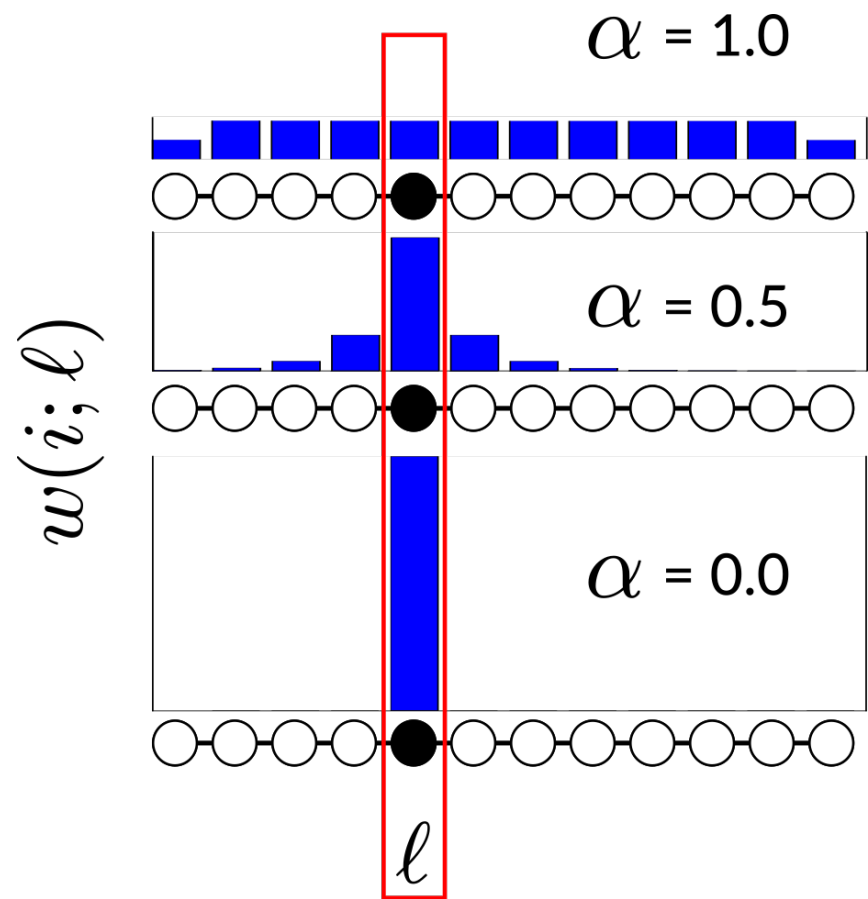
Random walks on a graph

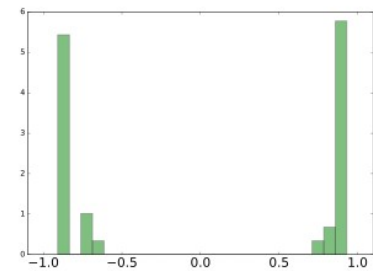
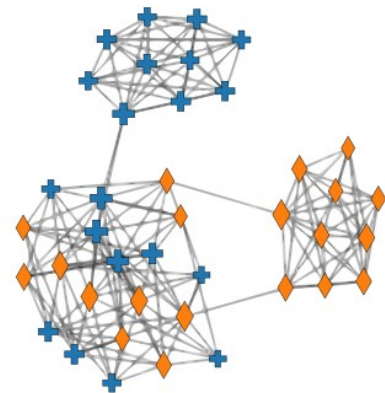
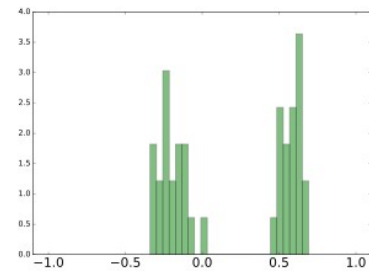
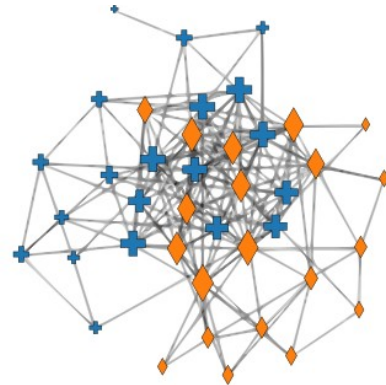
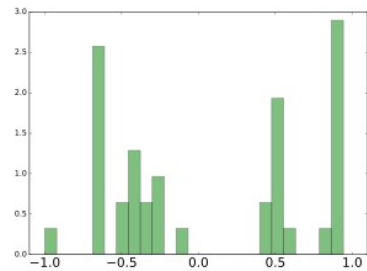
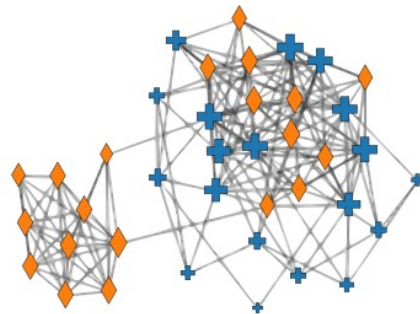
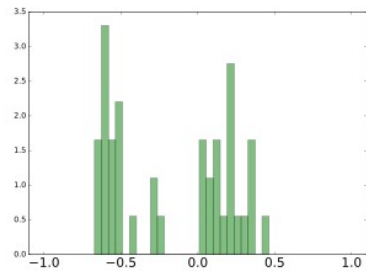
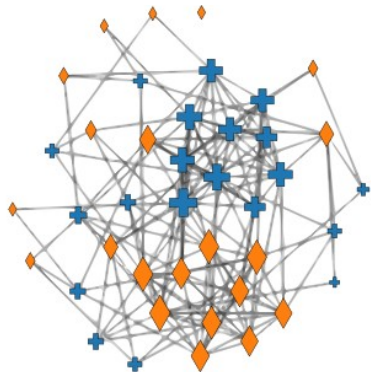
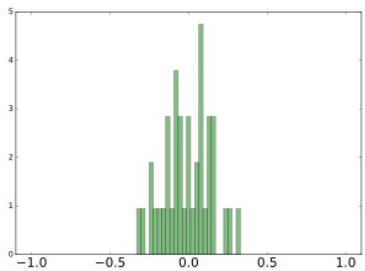
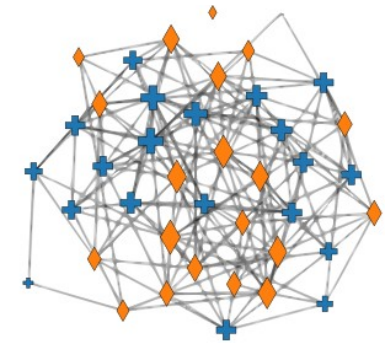
$$e_{gh}(\alpha, \ell) = \sum_{ij} w(i; \ell) \frac{A_{ij}}{k_i} \delta_{y_i, g} \delta_{y_j, h}$$

$$r(\alpha, \ell) = \frac{\sum_g e_{gg}(\alpha, \ell) - \sum_g a_g b_g}{1 - \sum_g a_g b_g}$$

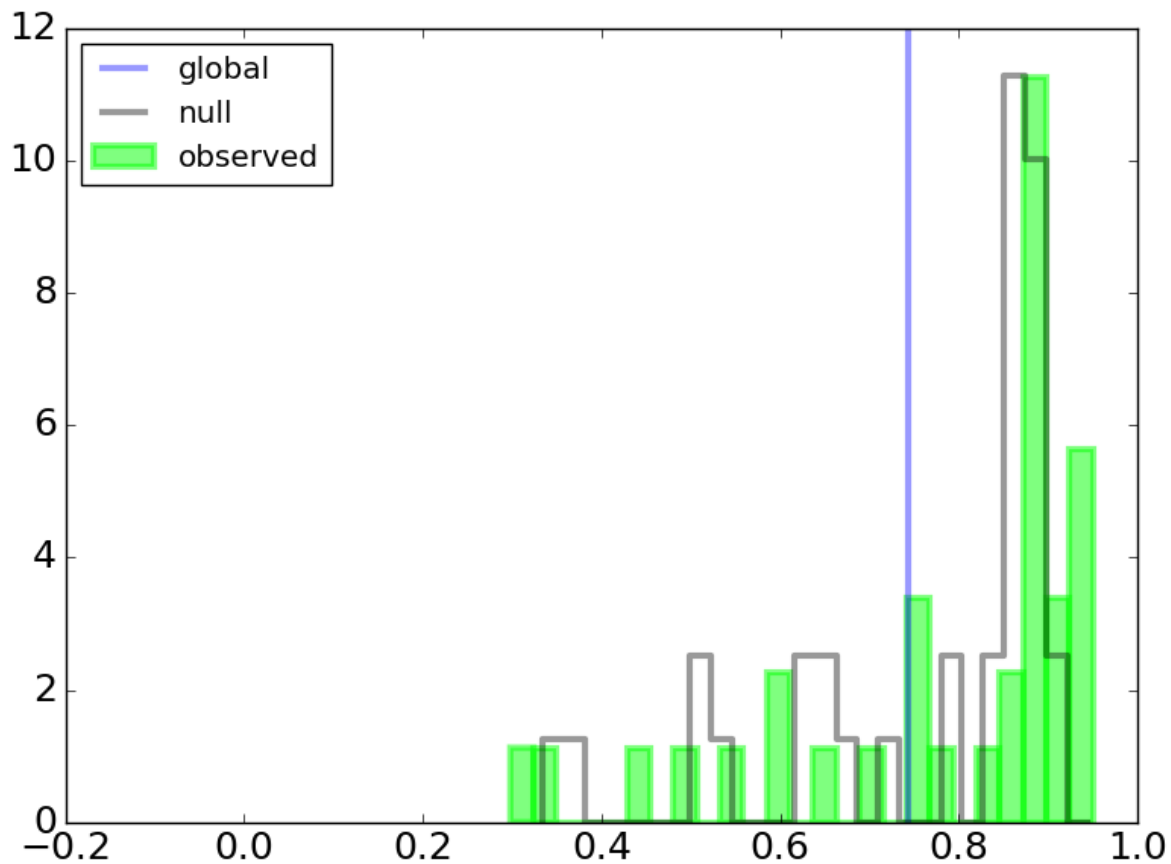
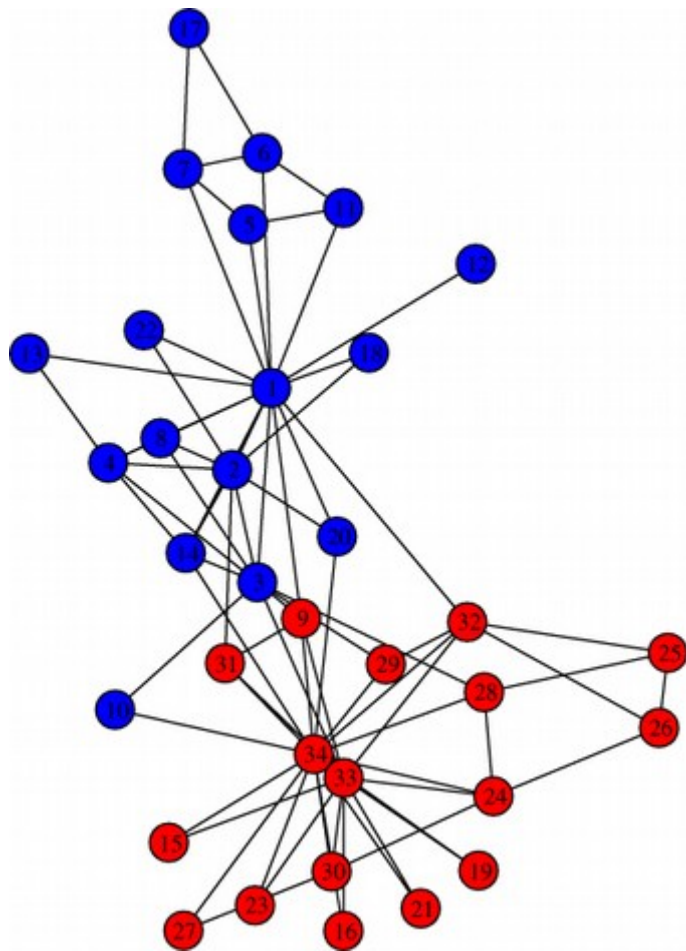




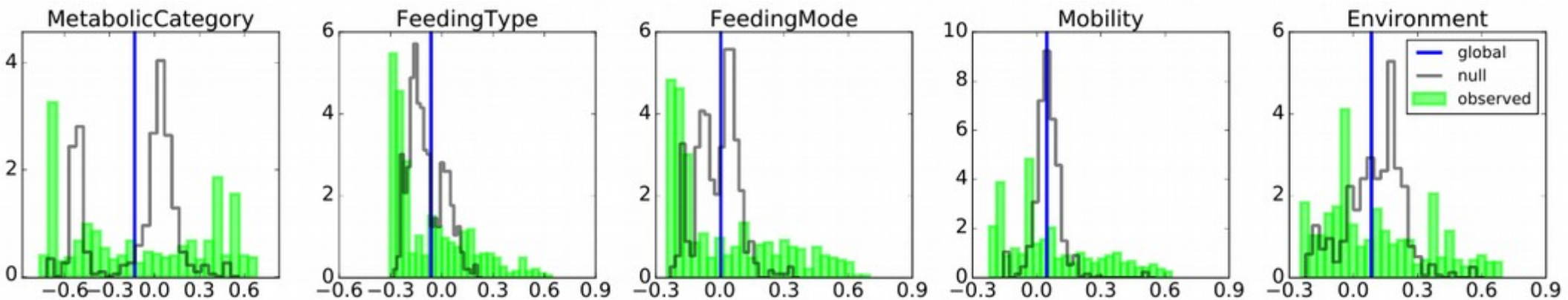




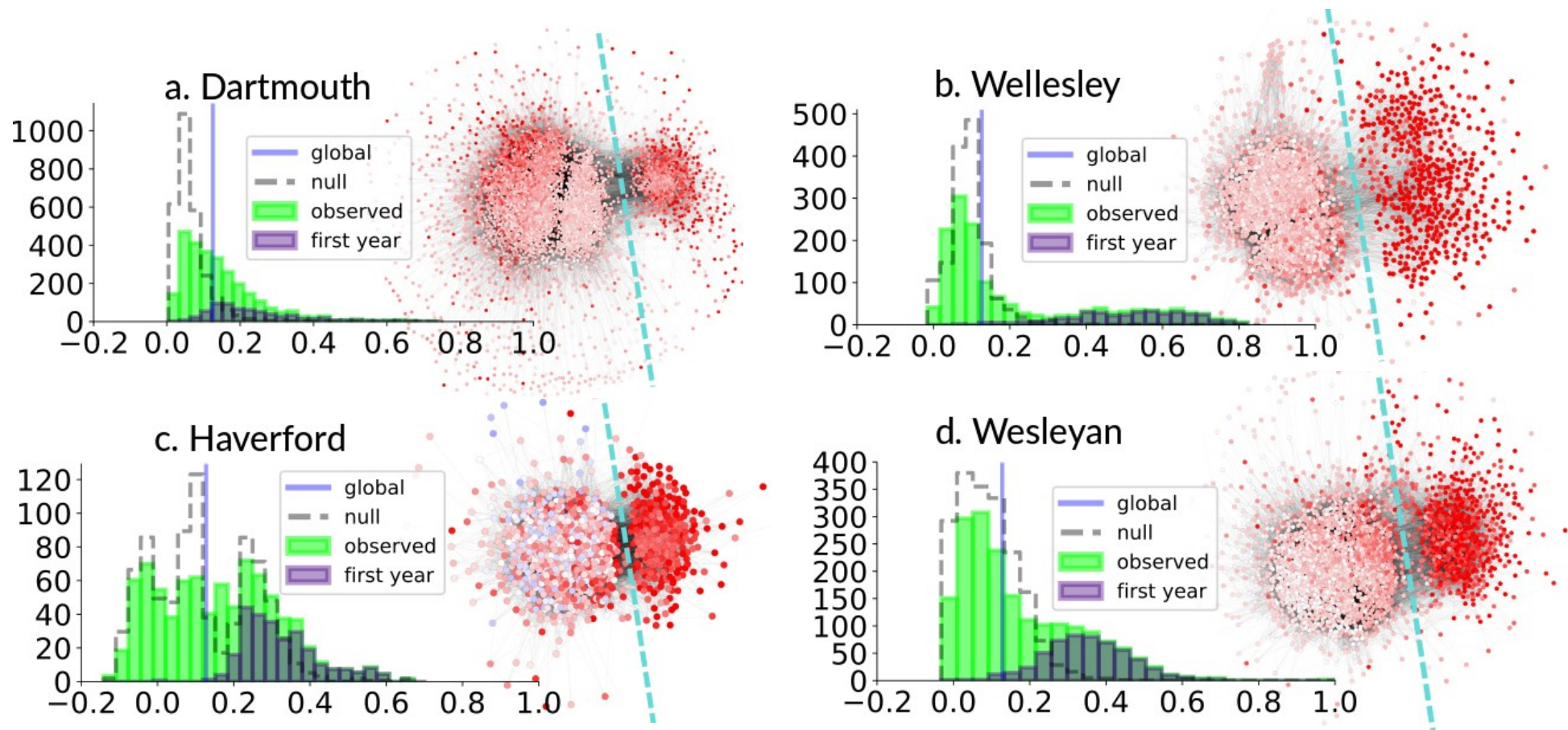
Karate club - factions



Weddell Sea food web



Facebook 100 – residence



Summary

Assortativity is a correlation coefficient (or autocorrelation)

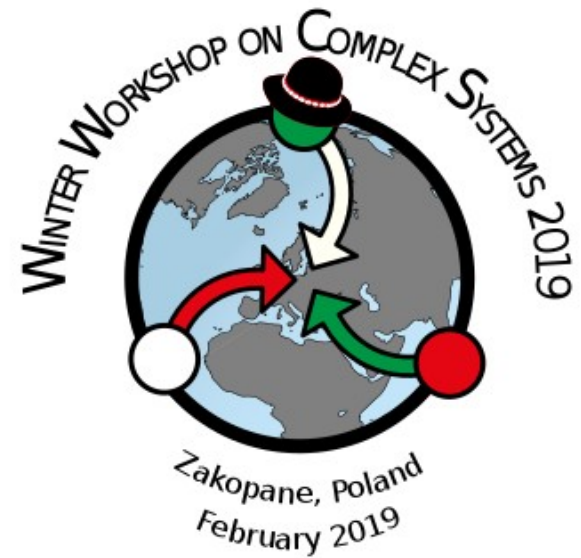
- can lead to ambiguity in its interpretation

Often we observe variation in the assortativity across the network

- In some cases its not possible to have constant assortativity

Our framework provides a means to compute global network measures within a local neighbourhood

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Questions?



Jean-Charles
Delvenne



Renaud
Lambiotte

Multiscale mixing patterns in networks

Leto Peel, Jean-Charles Delvenne, and Renaud Lambiotte

PNAS April 17, 2018. 115 (16) 4057-4062; published ahead of print April 2, 2018.

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