

I. THE CAUSAL/ASYMMETRIC/DIRECTED NATURE OF OUR FCM: AN EXAMPLE WHERE SYMMETRIC MEASURES GIVE DIFFERENT CELL ASSEMBLIES

In the text, we illustrate the importance of a directed similarity measure using the feedforward example.

Figure 1a shows the wiring diagram of a network which, if analyzed with a symmetric similarity measure lead to different cell assemblies that miss the causality/direction of the connections. This network may produce firing patterns as shown in Fig. 1b.

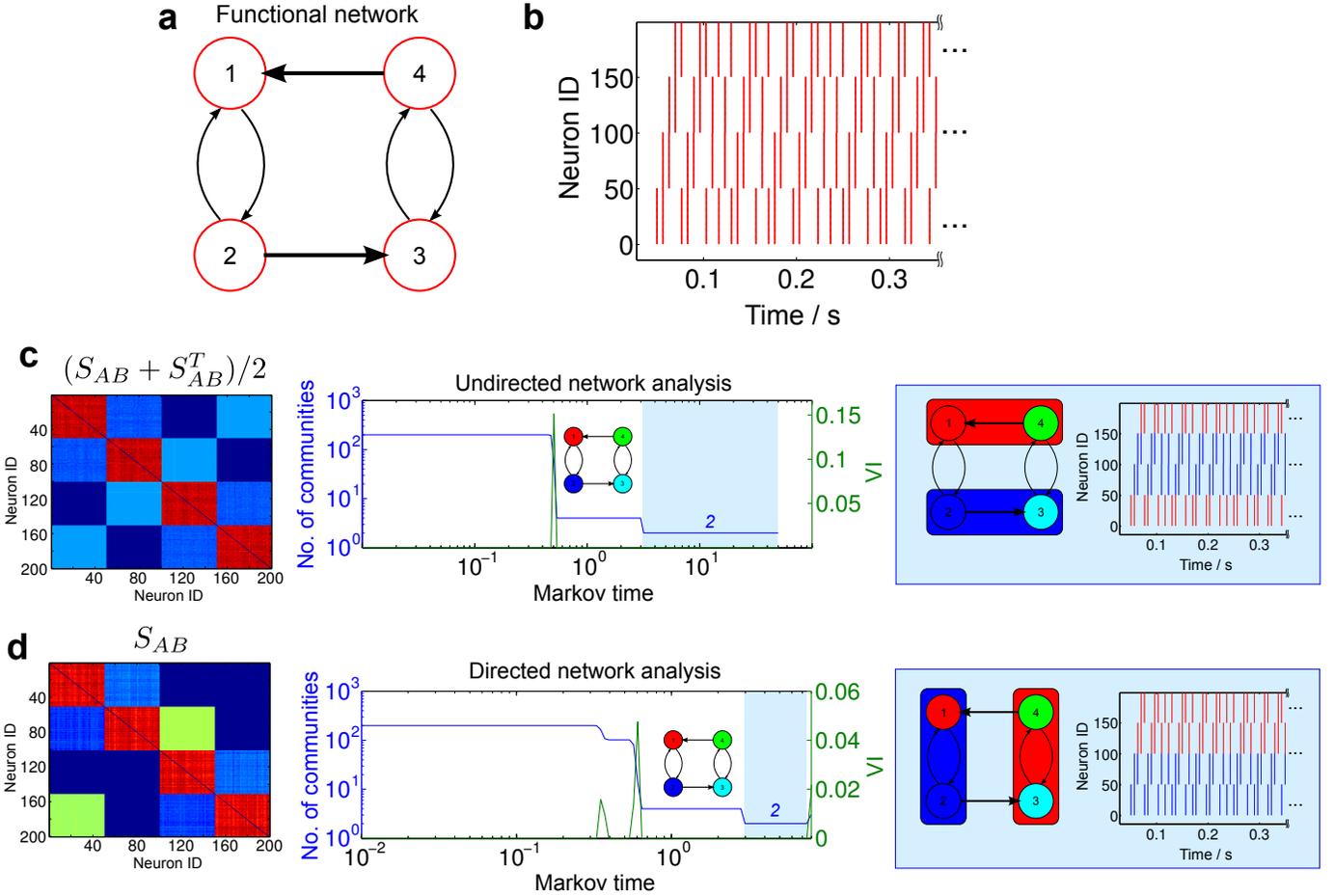


Figure 1. Comparison of how directionality can affect clustering results. **a-b** A functional network as depicted in **a** can be emulated by synthetic data by varying the group firing sequences and delay between individual group firings (**b**). Ignoring directionality (using the symmetrized FCM) leads to finding assemblies based on the strength between the groups (see **c**). Taking into account directionality reveals a grouping based on flow (see **d**).

There are two possible outcomes

- When this spike-trains are analyzed using a symmetric measure, leading to a symmetric FCM, we get a partition into two groups: $\{1, 4\}$ and $\{2, 3\}$, which reflect the strength of the connections but not the causality of the dynamics.
- When the spike-trains are analyzed using the true, directed FCM, we find the assemblies based on flow, which illustrates the fact that clearly different clusterings can arise when taking into account directionality (see Figure 1d).

It is important to remark that only by using a directed FCM we are able to reveal both cases: once we use a symmetric FCM the directions of the links are lost, and thus we can only recover the partition based on strength.