Exploring Connections: Modeling and Visualizing Complex Networks

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Outline I

Dynamical convergence in Stability Theory of dynamical systems

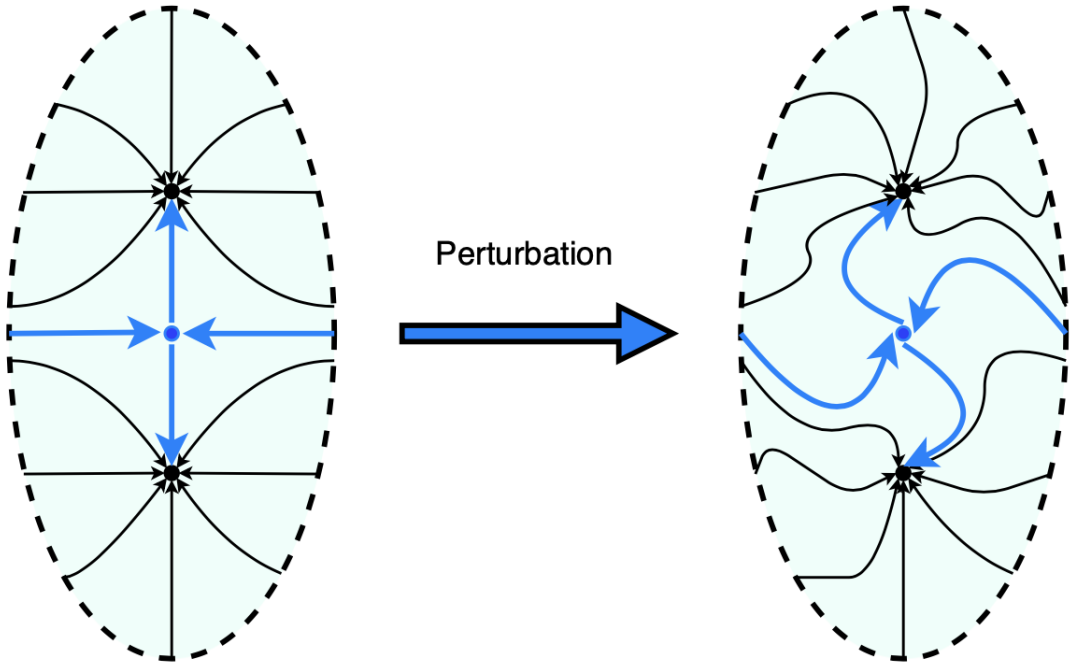

Figure 1: Perturbations in dynamical systems - the dynamics eventually converge into a stable state once particles become active

Complex Network Theory

- graphs with a "story"
- **nodes** = real-world entities
- **edges** = quantified interactions between entities

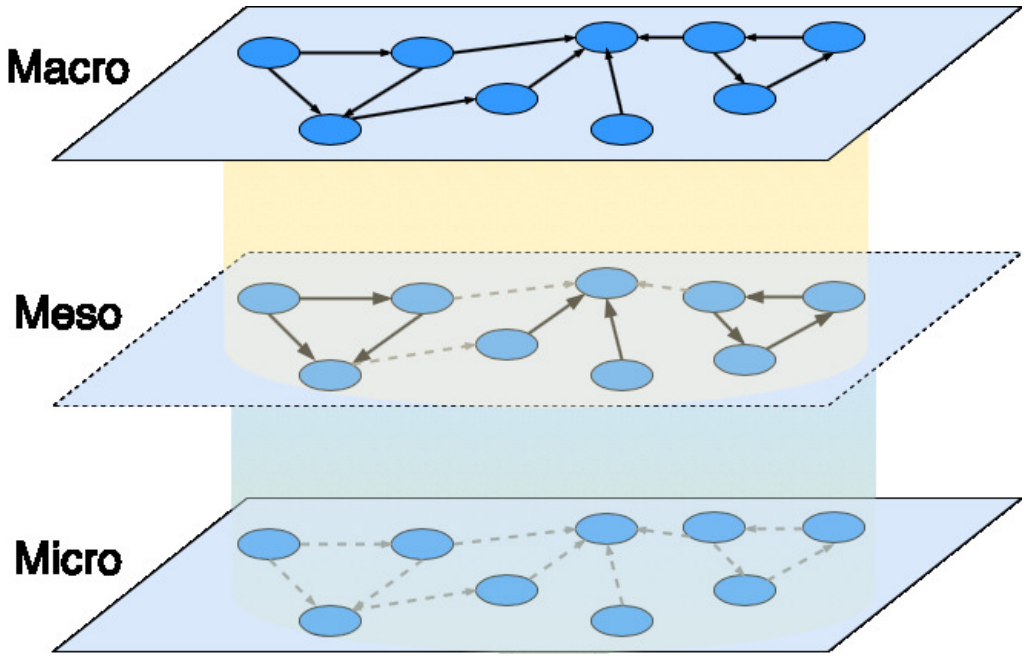

Figure 2: Interconnectivity of the components of the network by scale. Similar to the perturbation mechanism discussed in Stability Theory, the macro level will impact the structures from the meso layer (network motifs, communities), which will affect the behavior on the micro-level stabilizing at the nodes level

Microscale analysis

Table 1: Microscale topological properties

Property	Annotation
Articulation point	AP
Assortivity Degree	ρ
Average degree	d_{avg}
Average Triangles	tr_{avg}
Density	D
Relative edge distribution entropy	H_{er}
Number of edges	E
Gini coefficient	g
Global Clustering Coefficient	CC_G
k-core	k_{core}
Local Clustering Coefficient	CC_L
Maximum degree	d_{max}
Maximum triangles number	tr_{max}
Minimum degree	d_{min}
Number of nodes	N
Power law exponent	γ
Triangles number	tr_{no}

Macrocale analysis

$$\omega = \frac{L_{rand}}{L} - \frac{C}{C_{latt}} \qquad (1)$$

- sparse networks
- small-world networks
- random networks

Mesoscale analysis

Network motifs are patterns of interconnections which can occur in **significantly higher number** in complex networks than in randomized networks which hold the same degree of distribution as the initial network ([1]).

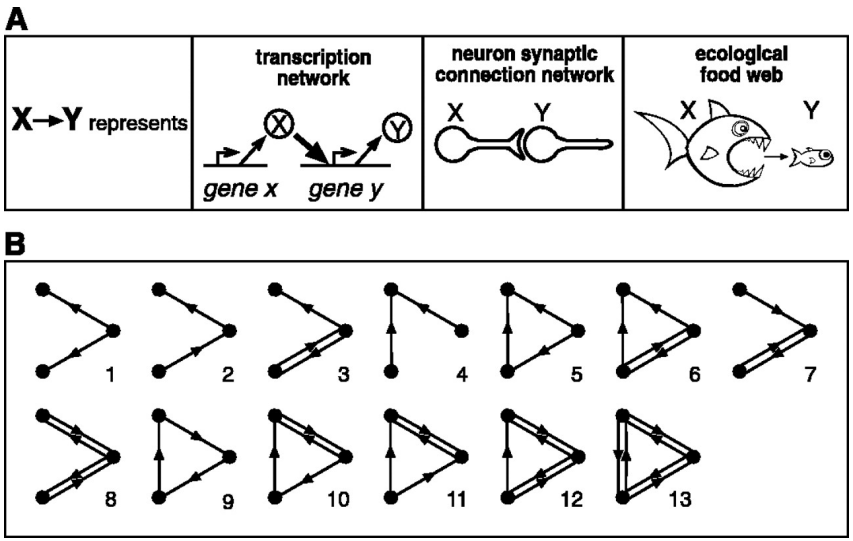

Figure 3: Example of motifs [1]

R. Milo, S. Shen-Orr, S. Itzkovitz, N. Kashtan, D. Chklovskii, and U. Alon, "Network motifs: simple building blocks of complex networks," *Science*, vol. 298, no. 5594, pp. 824–827, 2002.