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Introduction

At the turn of the 21st century scientists have come to realise that a major ingredient in many modern economic, epidemiological, ecological and biological questions is to understand the **network structure** of the entities they study. Unfortunately, computational bottle-necks have meant that only the simplest analyses have been applied to these large datasets, whereas methodological bottle-necks prevented an integrative view of complex phenomena. Rather than simplifying the methodology prior to seeing the data, modern techniques from **high-dimensional inference** allow the data to select the appropriate level of complexity. The aim of this project is to apply these techniques to the field of network analysis. We approach networks from three different angles:

1. high-dimensional graphical models, including causal models,
2. ordinary and stochastic differential equations
3. random network models, such as stochastic blockmodels and ERGMs.

Our aim is to develop theoretically sound network inference techniques based on penalized inference. In each of these areas, the challenge is to define a sufficiently complex network models for large systems that have computationally tractable inference procedures.

Box 1

ER1 Sed a orci non ipsum posuere placerat. Nunc in mi augue, a adipiscing massa. Donec dapibus gravida odio, condimentum convallis urna.

ER2 Nullam sagittis cursus neque, sit amet mollis elit auctor in. Etiam sed lectus a nulla rhoncus interdum a tempus nunc. Sed at eleifend purus.

Nullam sollicitudin lobortis urna quis varius. Nullam sagittis blandit diam, $DN = G_t(V_t, E_t)$, risus $E_t \subseteq V_t \times V_t$ ($\forall t \geq 0$). vel tortor justo, G_0 , quis malesuada lorem.

$$\cos^3 \theta = \frac{1}{4} \cos \theta + \frac{3}{4} \cos 3\theta \tag{1}$$

Vivamus porta lacus et lectus **porta lacus**. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis. torte G_t hac millis **plates** Idk

Box 3

Nunc sit amet sem ut nulla tincidunt mattis vel nec mauris. Vestibulum odio tellus, lobortis. Vel adipiscing, Aliquam dictum, ligula egestas commodo posuere, lectus lectus congue ligula, sed posuere urna lectus at nisi. Aenean commodo risus ut dolor (viverra scelerisque). Nullam varius, lacus et interdum hendrerit, odio orci ultrices mauris, id interdum eros mauris at urna. Fusce in nisi eros, sit amet volutpat turpis, **porttior magna** (commodo blandit euismod) **facilisis ornate magnis** (dis magnis).

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 1: Table caption

Simplification of complex networks

RESEARCH QUESTION:
Large networks challenge our capacities to visualize and interpret them. Often, one can exploit information on communities to derive a reduced graph summarizing relations between communities.

EXAMPLES:

1. use ontologies/pathways to summarize gene regulatory networks;
2. groups of individuals in social networks (e.g., parties in a Parliament).

METHODS:

1. significance test based on number of links between communities: implemented in R package **neat** (\rightarrow *arXiv:1604.01210*);
2. penalized stochastic blockmodels (\rightarrow *arXiv:1607.08743*).

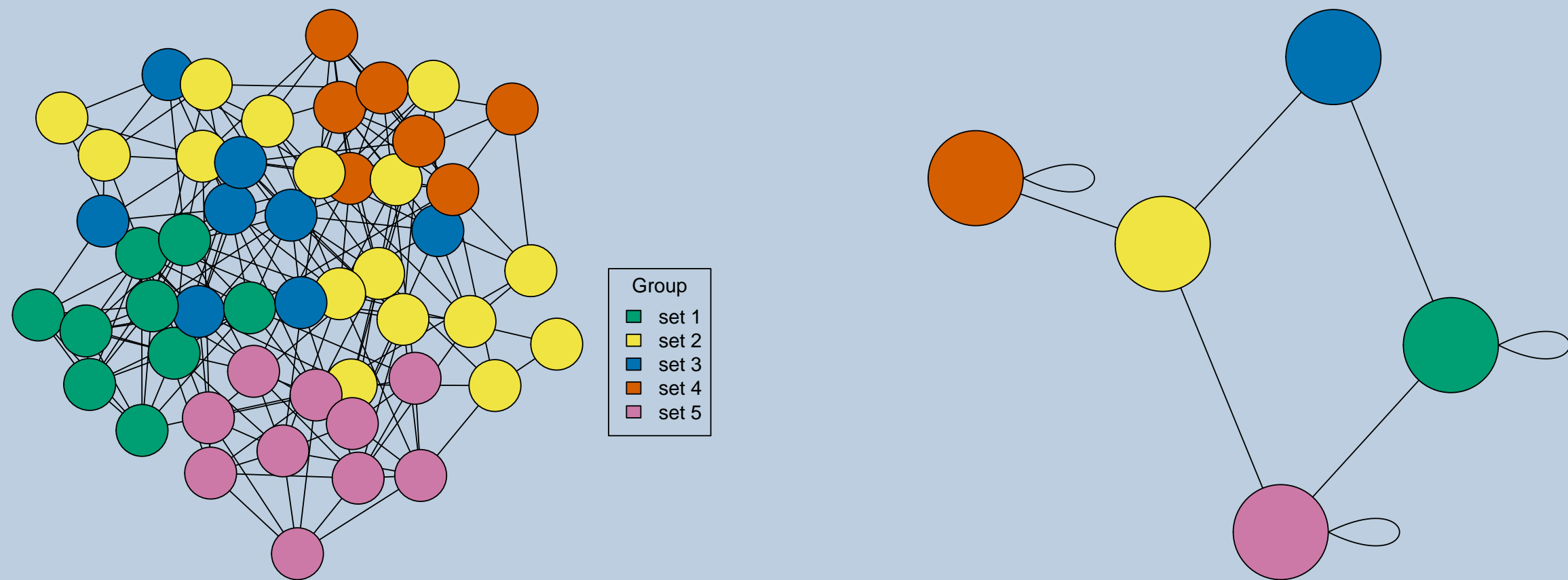


Figure 1: We develop statistical methods that allow to summarize relations between communities in large graphs (left) with a reduced graph (right).

CONCLUSION:
Reduced graphs displaying relations between communities can provide a synthetic and meaningful insight on complex networks.

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Box 4

Nunc sit amet sem ut nulla tincidunt mattis vel nec mauris. Vestibulum odio tellus, lobortis. Vel adipiscing, Aliquam dictum, ligula egestas commodo posuere, lectus lectus congue ligula, sed posuere urna lectus at nisi.

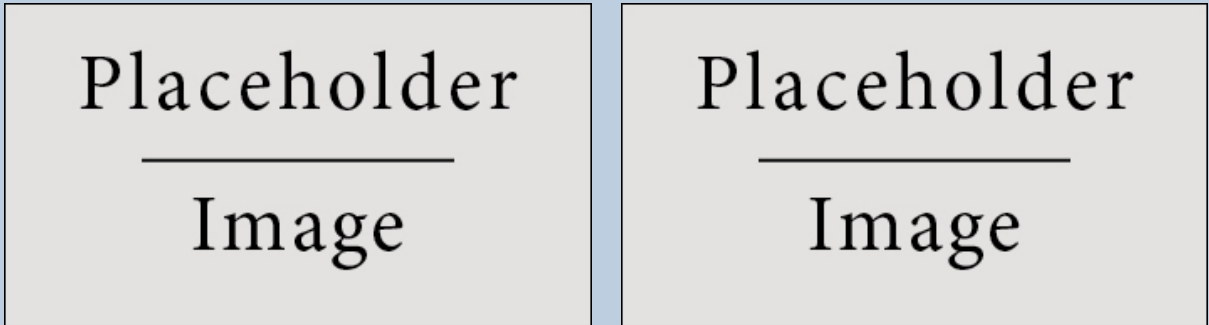


Figure 2: Figure caption 1 (left); Figure caption 2 (right)

Aliquam ac justo lectus. Nunc ultrices aliquet purus non dictum. Nulla facilisi. Quisque vitae urna non purus sollicitudin venenatis. Aliquam erat volutpat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. In hendrerit tortor sed massa consequat eu viverra justo porta. Ut nec felis sem, non elementum.