The 'What' and 'How' of Network Analytics
Network Theory and Network Data

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[2]Soundcloud

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Outline

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There Are Several Families of Networks

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Family	Example
Biological networks	A living organism's neural system
Cultural networks	A model of the 'returns of education'
Financial networks	A cryptocurrency
Information networks	Information sharing among BA students
Inter-organizational networks .	Technological alliances among pharma industry players
Organizational networks	Knowledge sharing among financial analysts
Social networks	Friendship among BA students
Transportation networks	The Tube

Networks Have a 'Hard' and a 'Soft' Component

The hard component

A network is a collection of nodes and edges, what is formally called a 'graph':

$$G = \{V, E\} \qquad (1)$$

where V is the array of nodes

$$\{v_1, v_2, ..., v_i, ..., v_N\}$$

and E is the set of edges reflecting connections among pairs of nodes

$$\{..., \{v_i, v_j\}, \{v_i, v_k\}, ...\}$$

The soft component

The soft component is the relationship that maps the connections onto the pairs of nodes. Examples of relationships are affilition to a club, music collab (i.e., a 'feat'), friendship, marriage, mentoring, tube route.

!! Pay attention !!

A network is more than a graph. Two nodes may be connected for many reasons — we must be specific about the concrete relationship under investigation!

A Real-World Example: The Soundcloud Networks

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The Structure
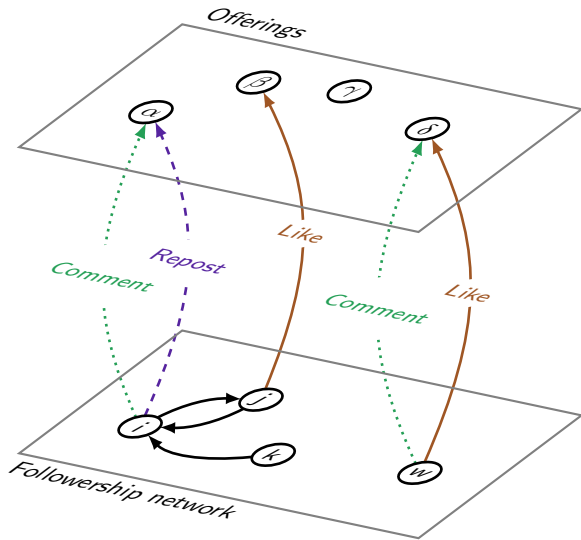of a Network
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Some key general points emerging from the analysis of the Soundcloud example:

- The same pair of nodes can be connected because of multiple relationships (i.e., 'like,' 'repost,' 'comment')

- The nodes of a network may have the same type (e.g., 'following') or different types (e.g., 'like')

- Analytically seprated networks may be correlated (e.g., one tends to like her/his followings' likes)

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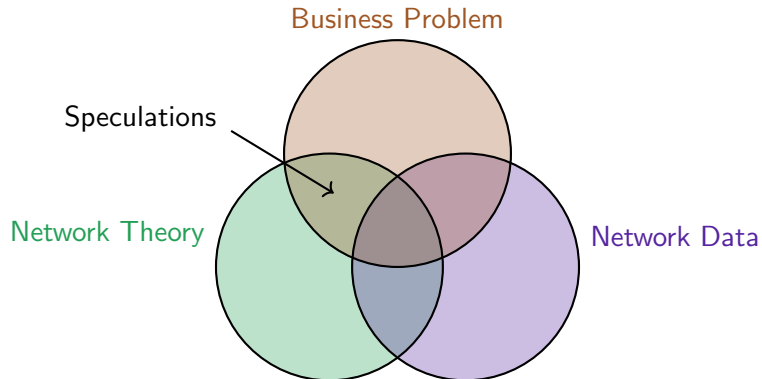
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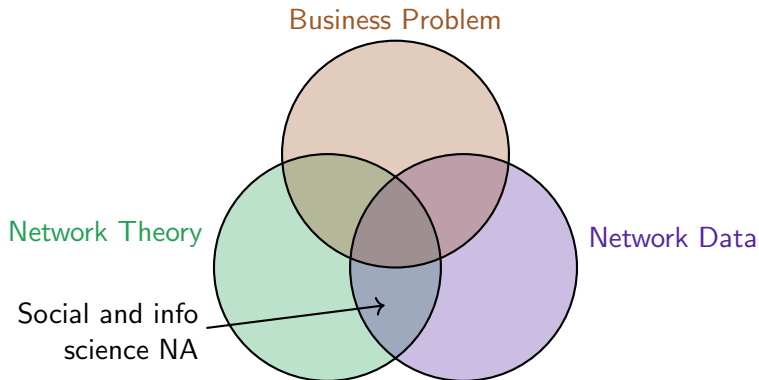
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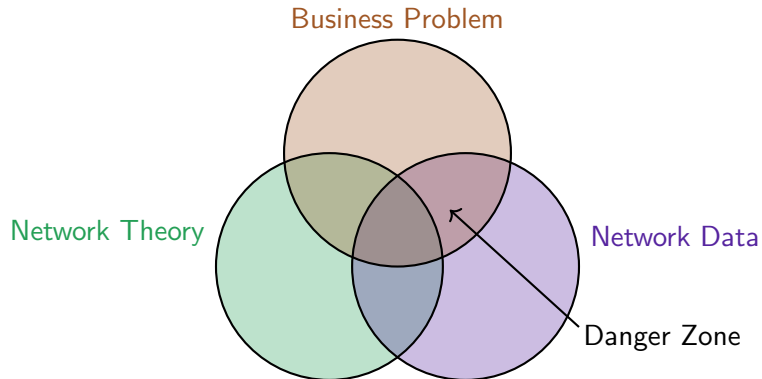Analytics
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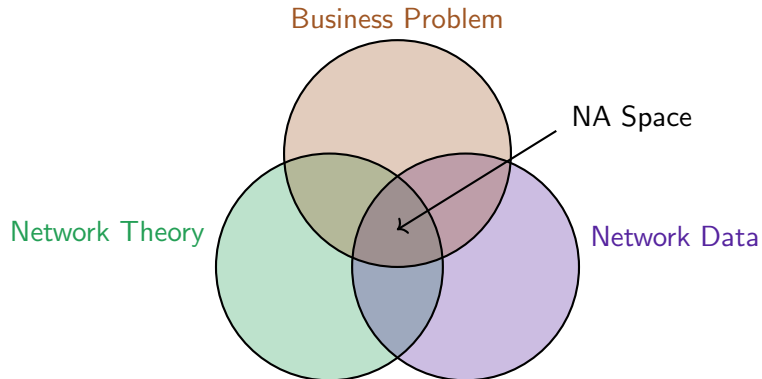
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What is a business problem?

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There are several concurrent causes:

- The overall tendency to over-engineer the problem diagnosis process constraints the peripheral view of organizations — thus, unconventional problems could not receive attention!

- The adoption of time-consuming tools, such as 'Six Sigma,' limit the attention and energy organizations can devote to spot problems

- Organizations tend tend to dig deeper in problems they have already defined

Client-Consultancy Interaction is Troublesome

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Article

How Consultants and Their Clients Collaborate in Spite of Massive Communication Barriers

Michäas Sutter[1] and Alfred Kieser[2]

Abstract

Managers often collaborate with members of consultancies with the aim of improving the performance of their organizations. It is astonishing that, after the completion of such consulting projects, both parties in most cases express satisfaction with the results. It is astonishing because, as we show in this article, consultants and the managers of client organizations, when engaging in joint projects, have to overcome severe communication barriers. These communication barriers originate from different frames of reference the collaborators refer to, different goals they pursue, and different logics they follow. As we demonstrate on the basis of an empirical analysis, the communication barriers are overcome predominantly through the use of boundary objects and prototyping.

The barriers to an effective interaction originate from differences in:

- Frames of reference — individual organizations develop idyiosyncratic ways of processing information

- Goals — consultancies not necessarily tackle their clients' problems in ways that correspond with their clients' interests

- Logics — consultancies and clients live in different 'thought worlds.' For example clients value specialization and industry knowledge much more than consultancies do

Real World Problem Statements I Worked With

"Our data say employees have not come up with fresh ideas for quite a while. We need to find out."

— The innovation platform manager of a global public utility.

"The people in the [R&D] department do not part-take in the decision making process regarding the selection of the future projects. Shall they?"

— The Head of Reserch of a big pharma company.

"Engineers want more autonomy in forming a new product development team. What are the pros and cons?"

— The CTO of a global semiconductor company.

Mapping Business Problems on Objective Functions and Domains

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	Domain			
Objective function	**Employee**	**Project**	**Organization**	**Inter-orgs**
Creativity	●	●		
Knowledge sharing .	●	●		
Task performance . .	●	●		
Coordination	●	●	●	●
Innovation	●	●	●	●
Econ performance . .			●	

Notes. — The table shows common associations between business problems'
objective functions (what clients want to achieve in essence) and domains (the
level at which the problem should be addressed). Dots denote the existence of
common associations.

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Mainly, network theory aims to explain

1. Why some nodes or groups achieve more (the social capital tradition)
2. Why some nodes or networks are more similar to each other (the social homogeneity tradition)

Network theories mirror two different views of networks

- The first view — known as the 'network flow model' — emphasizes the information, resources, or artefacts that flow through the network and possibly accrue to the individual nodes
  - *Sample proposition*: central nodes have an information advantage over peripheral ones
- The second view — known as the 'network architecture model' — highlights the connection between network structure and individual or organizational outcomes
  - *Sample proposition*: decentralized organizational structures are more suited in high-tech industries than low-tech companies

Groups of Network Theories

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Underlying model	Social capital	Social homogeneity
Network flow	Capitalization (value creation)	Contagion
Network architecture	Coordination	Adaptation (network change)

Source is [1, page 47]

Network theory	2	3	4	5	6	7	9	10
Value creation		●	●					
Coordination				●				
Network change					●	●	●	●
Contagion						●		●

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- All across the various weeks of the module, we will spend substantial time to represent various relations in network terms

- Such a representation exercise is all but trivial — oftentimes, we have to carefully consider the characteristics of the relation at the center of a network

- In order to facilitate the 'network representation exercise,' it is particularly useful to reason with some stylized networks

- Particularly, there are some differentiating dimensions, say features, that we may want to consider in order to understand 'what form of network we are dealing with'

Forms of Networks

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It is socially accepted to distinguish networks between

- Directed Vs undirected
- Weighted Vs unweighted
- One Vs two-mode

!! Pay attention !!

These categories are not mutually exclusive. E.g., a network can be both directed and weighted.

Key features

- A network is directed when there is a sender and a receiver node, undirected otherwise
- Soundcloud's following network is an example of a directed network
- 'Friendship' is tipically represented as an undirected network

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Weighted Vs Unweighted Networks

Key features

- A network is weighted when edges have a numerical value (i.e., not all edges are born equal)
- Information sharing is an example of a weighted network
- 'Friendship' is tipically represented as an unweighted network

One- Vs Two-Mode Networks

Key features

- A network is one-mode when it contains the nodes of the same type, two-mode otherwise
- Soundcloud's following network is an example of a one-mode network
- Soundcloud's like network is an example of a two-mode network

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Algebric Representations for Network Data

The adjacency matrix for a one-mode, directed, unweighted network

$$A_{i,j} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \tag{2}$$

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What have we learned today?

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[1]   John Scott and Peter J Carrington. *The SAGE Handbook of Social Network Analysis*. SAGE publications, 2011.