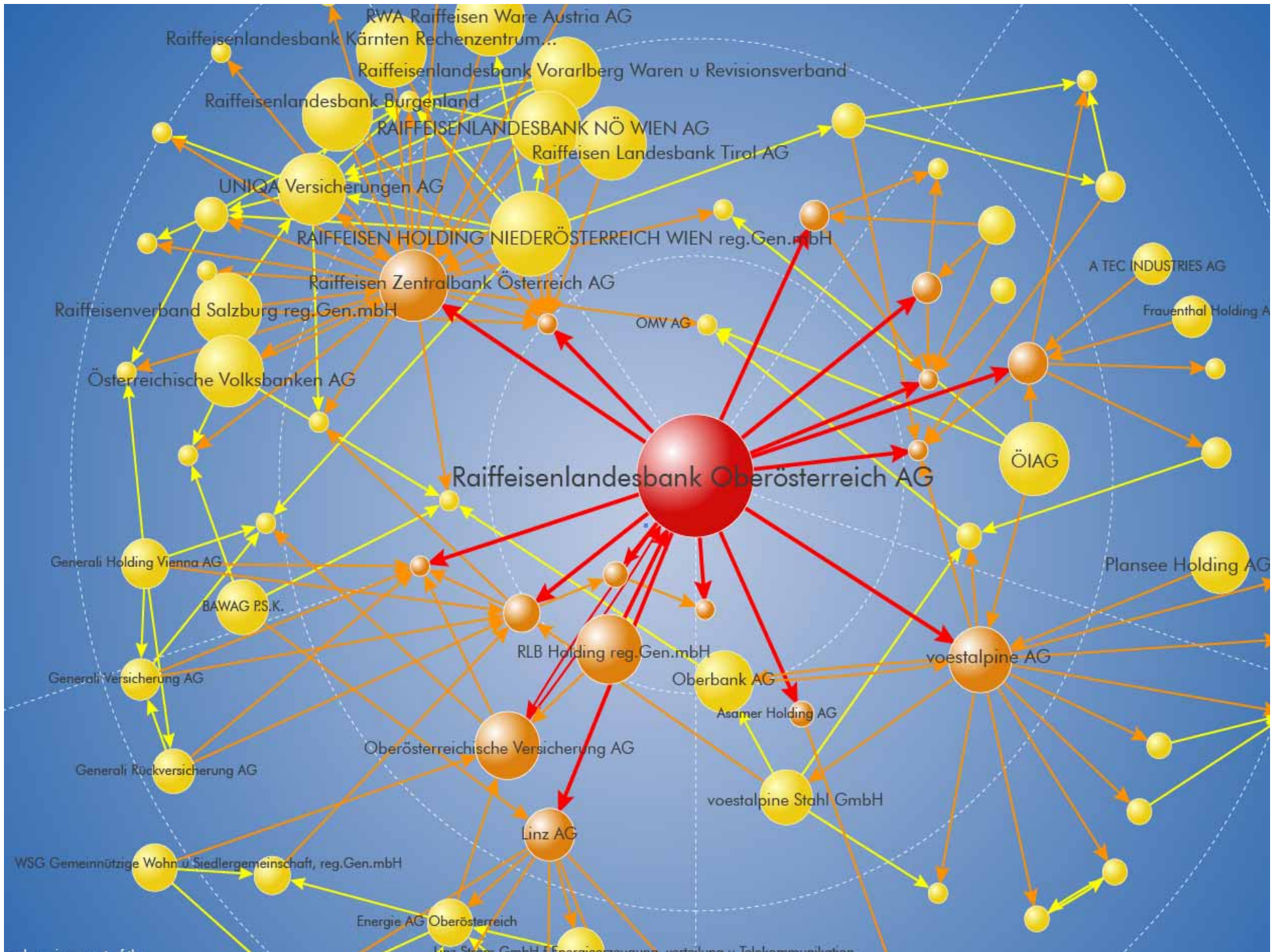


Harald Katzmaier

Netzwerkanalysen. Theoretische
Konzepte, Empirische
Anwendungen,
Zukunftsperspektiven



Elements of a Mapping

Key player analysis

- ▶ Identify key player, insider, local player and peripherals

Key link analysis

- ▶ Identify key connections (strong ties)
- ▶ Identify those connections with the highest strategic impact

Cluster analysis

- ▶ Identify opposing cliques and communities

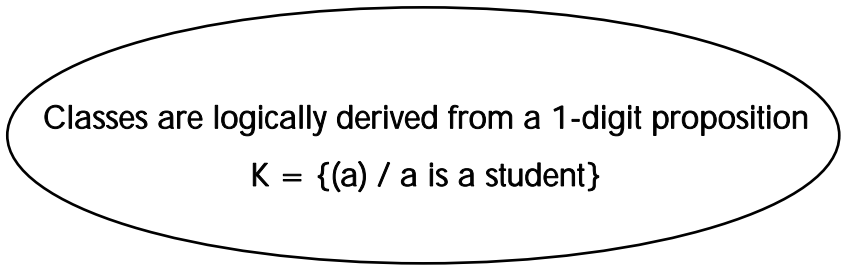
The logical difference between attributes and relations

Attributes

- a is a man/woman
- a is 26 years old
- a is a dog owner
- a has an income of 26.000 \$
- a is a blue collar worker



1-digit proposition = with one algebraic variable a

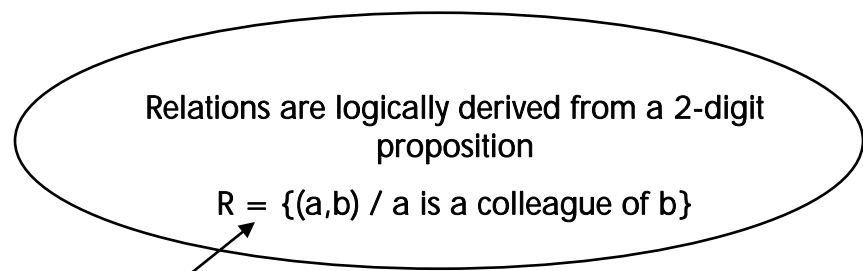


Relations

- a is the boss of b
- a loves b
- a has the same hair colour as b
- a attends the same workshop as b
- a is the enemy of b



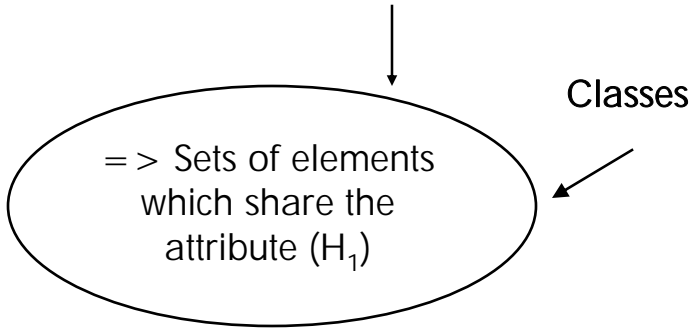
2-digit proposition = with 2 algebraic variables a, b



„is friend of “ is the symbol which is interpreted within the set of ordered pairs (cartesian product) => the result of this interpretation is a logical relation

The logical difference between attributes and relations

1-digit predicates produce



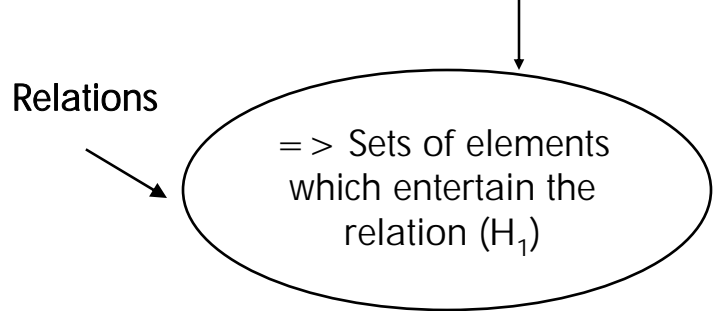
„Attribut“ is a „Composition Variabel“
 Case by variable analysis

case-by-variabel matrix

	Variables				
Cases	Attributes				

$m \times n$

2-digit predicates produce

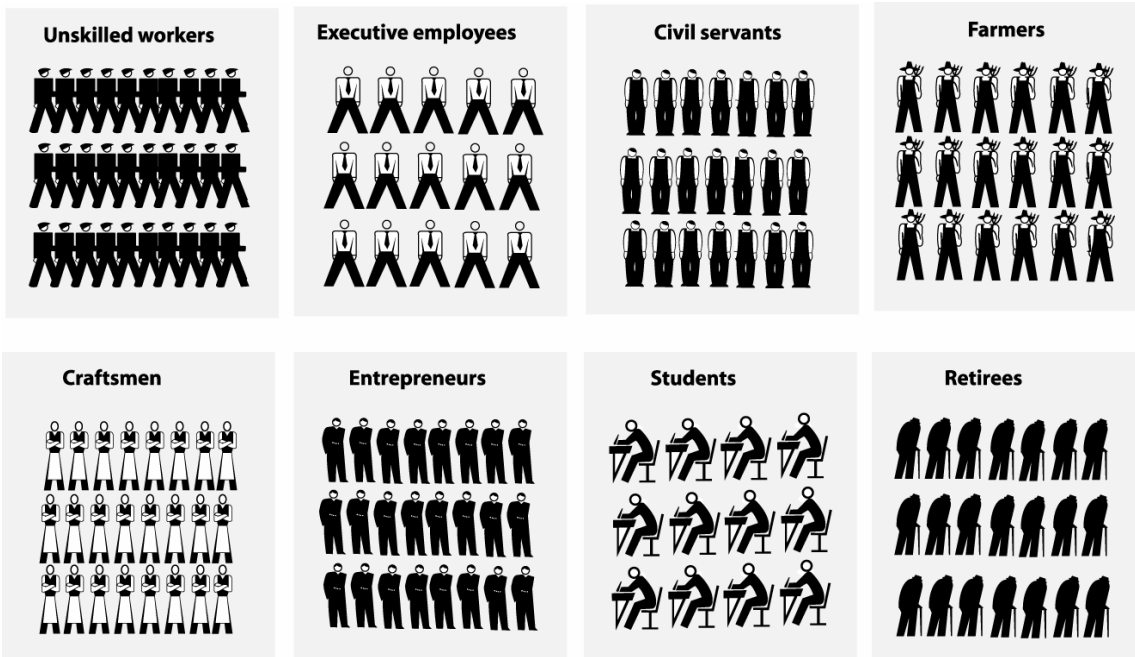


„Relations“ are a Structural Variabel“
 Network analysis

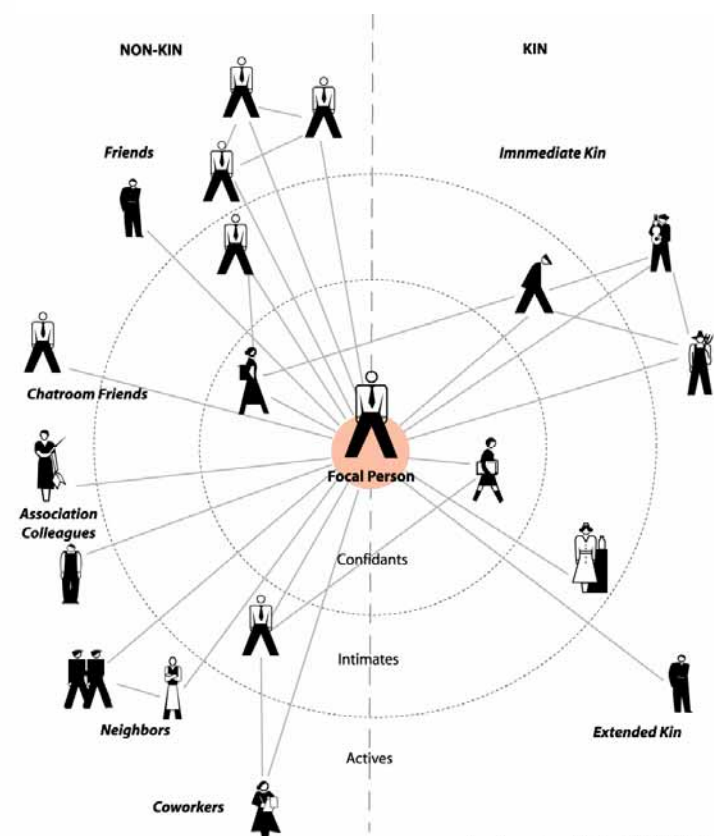
case-by-case matrix

	Cases				
Cases	Relations				

$n \times n$



From: Segmentation
 To: Connection



How does the overall network structure determine the opportunity of the single agent?

Background

- Director interlock research as part of a more global interest in elite networks
- Analyze elite networks to learn and understand how dominant and prevailing networks are shaped (robustness, adaptability and evolvability)
- Specially interested in the operationalization of opportunity

Data

Since 2001 we have collected massive data-sets.

- ▶ Media (TV, newspapers, journals, etc.)
- ▶ Commercial register
- ▶ Internet
- ▶ Public and commercial databases

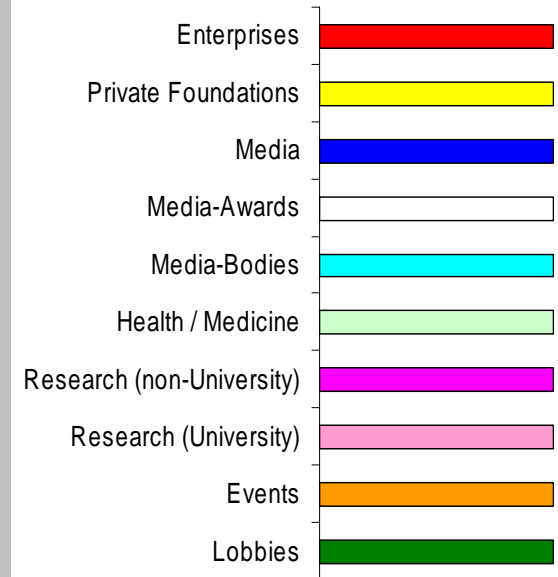
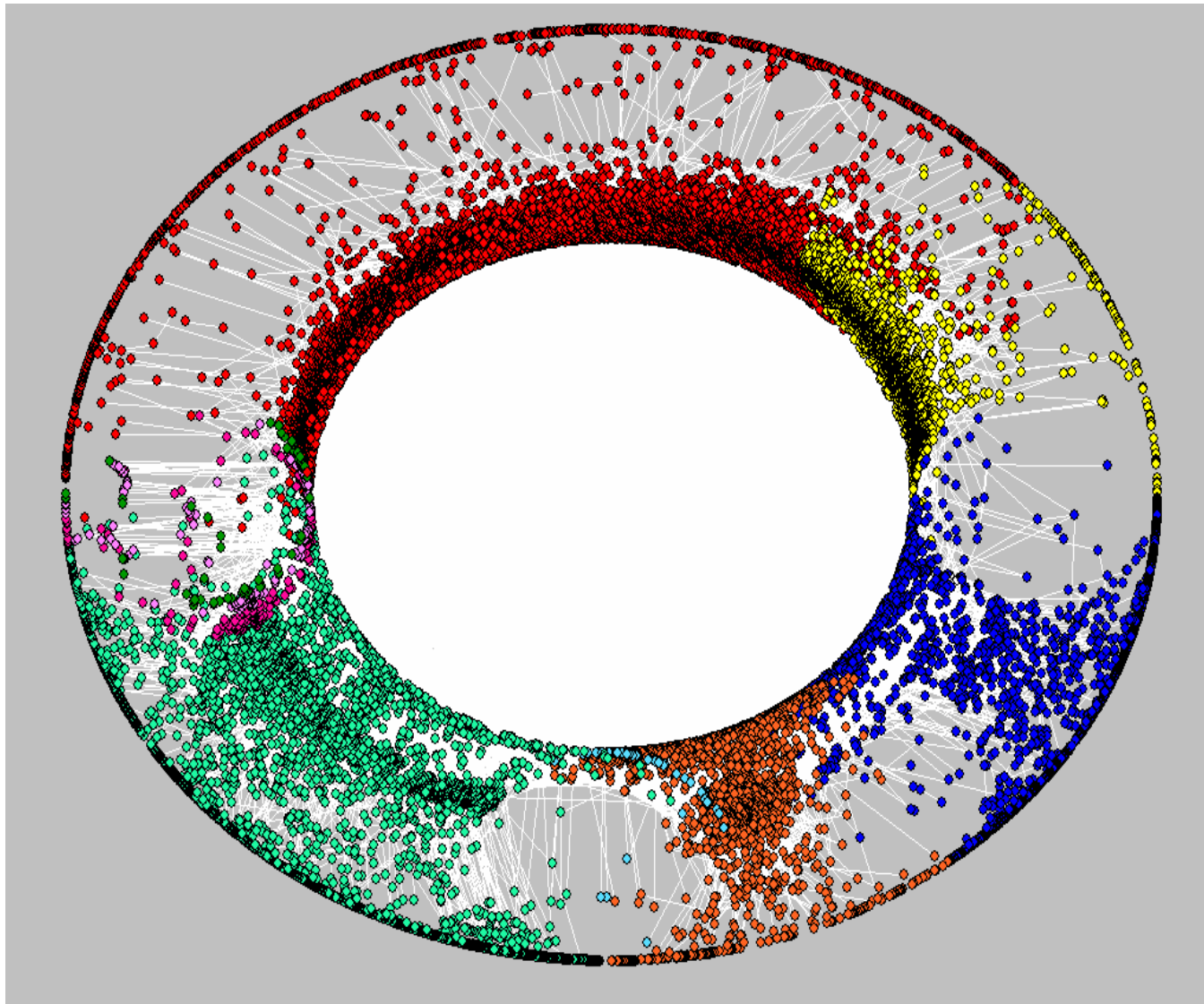


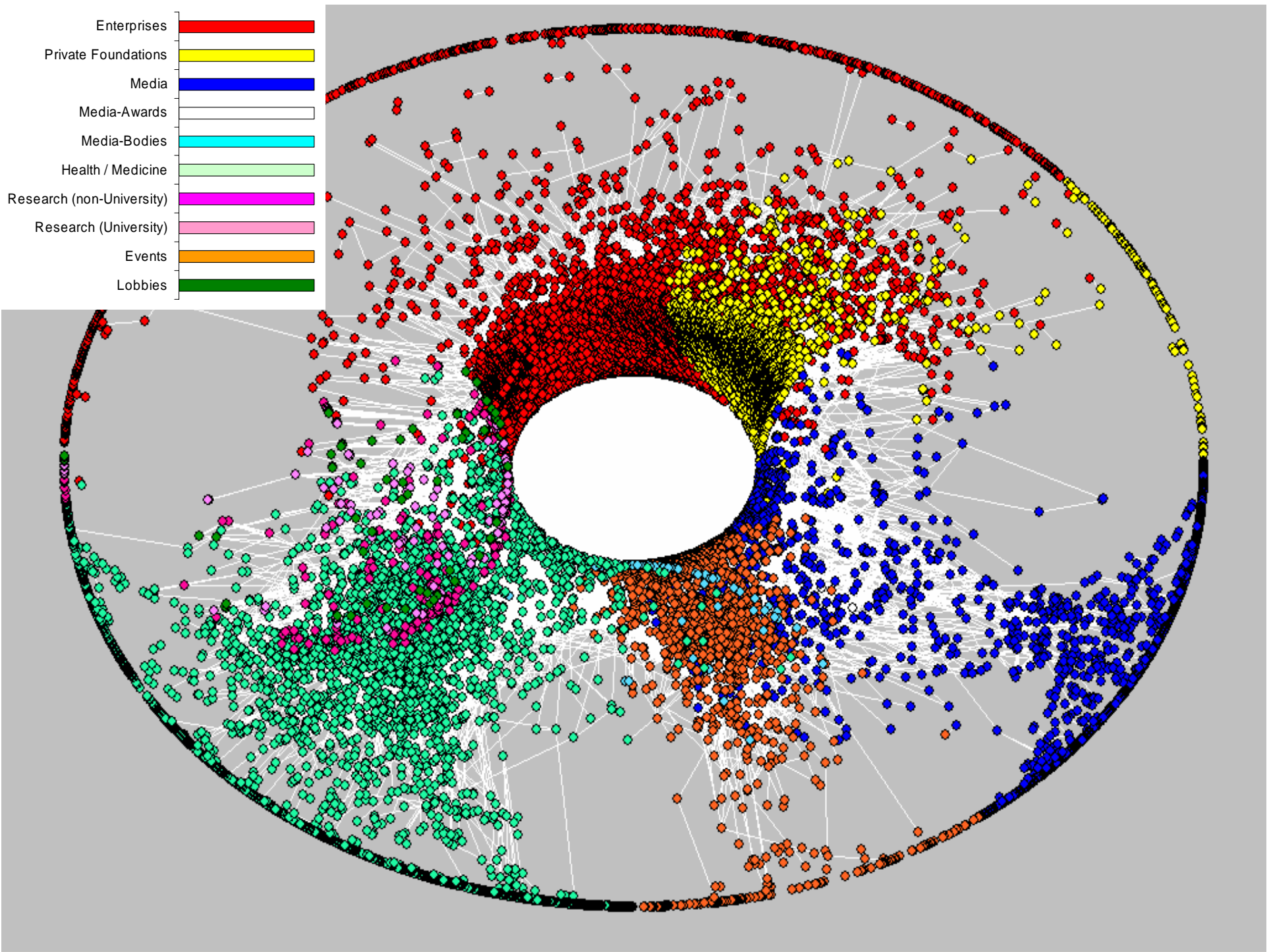
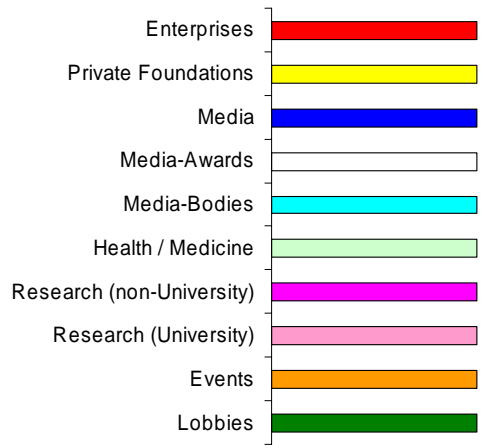
All together: **120,334 different persons** (with almost 9,000 people brokering between different social fields) and **25.748 affiliations**

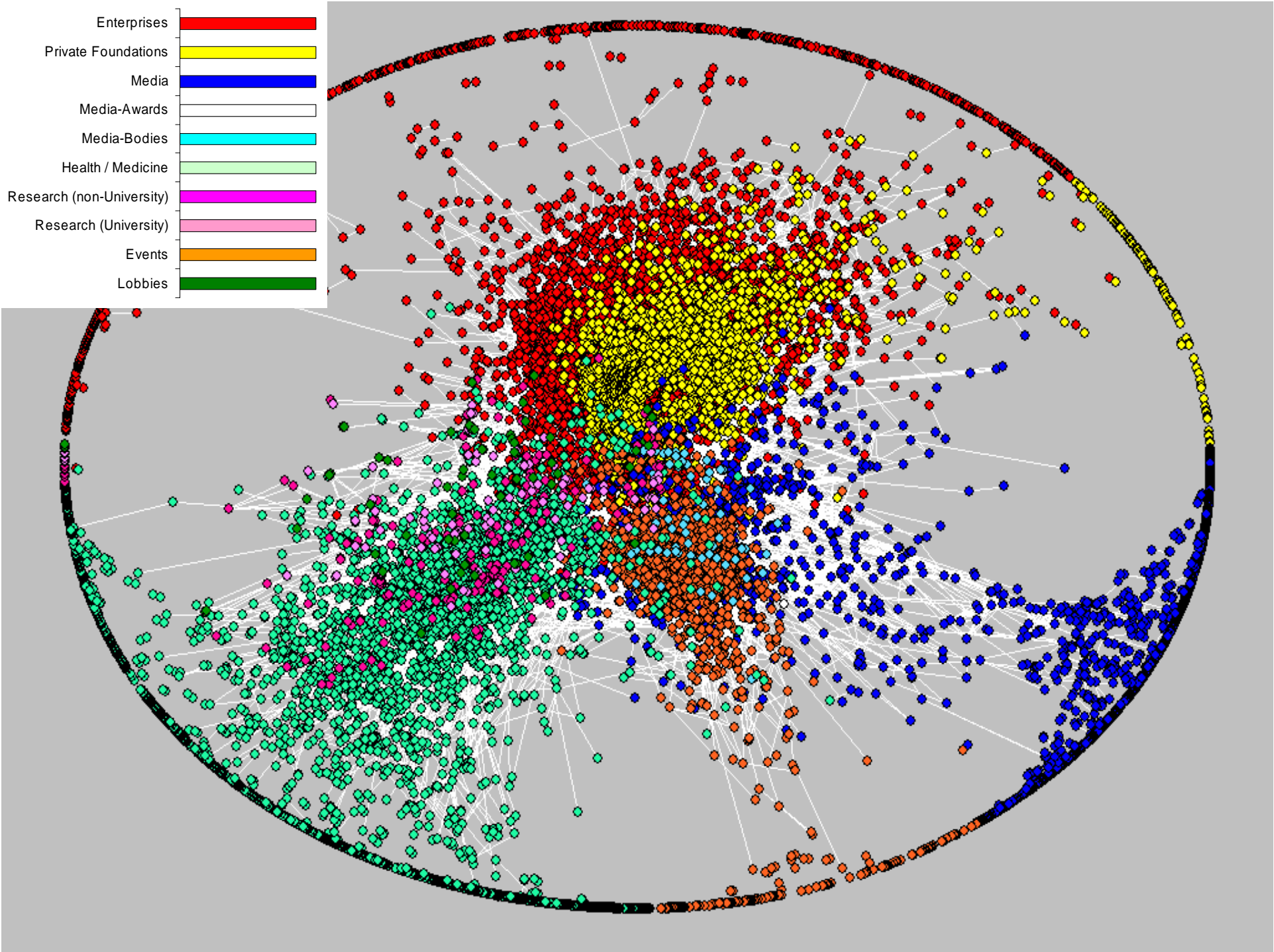
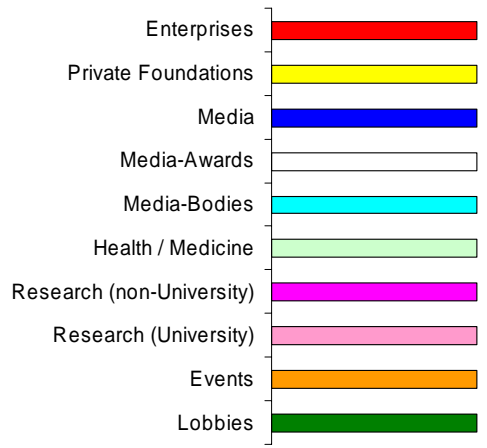
Data Selection

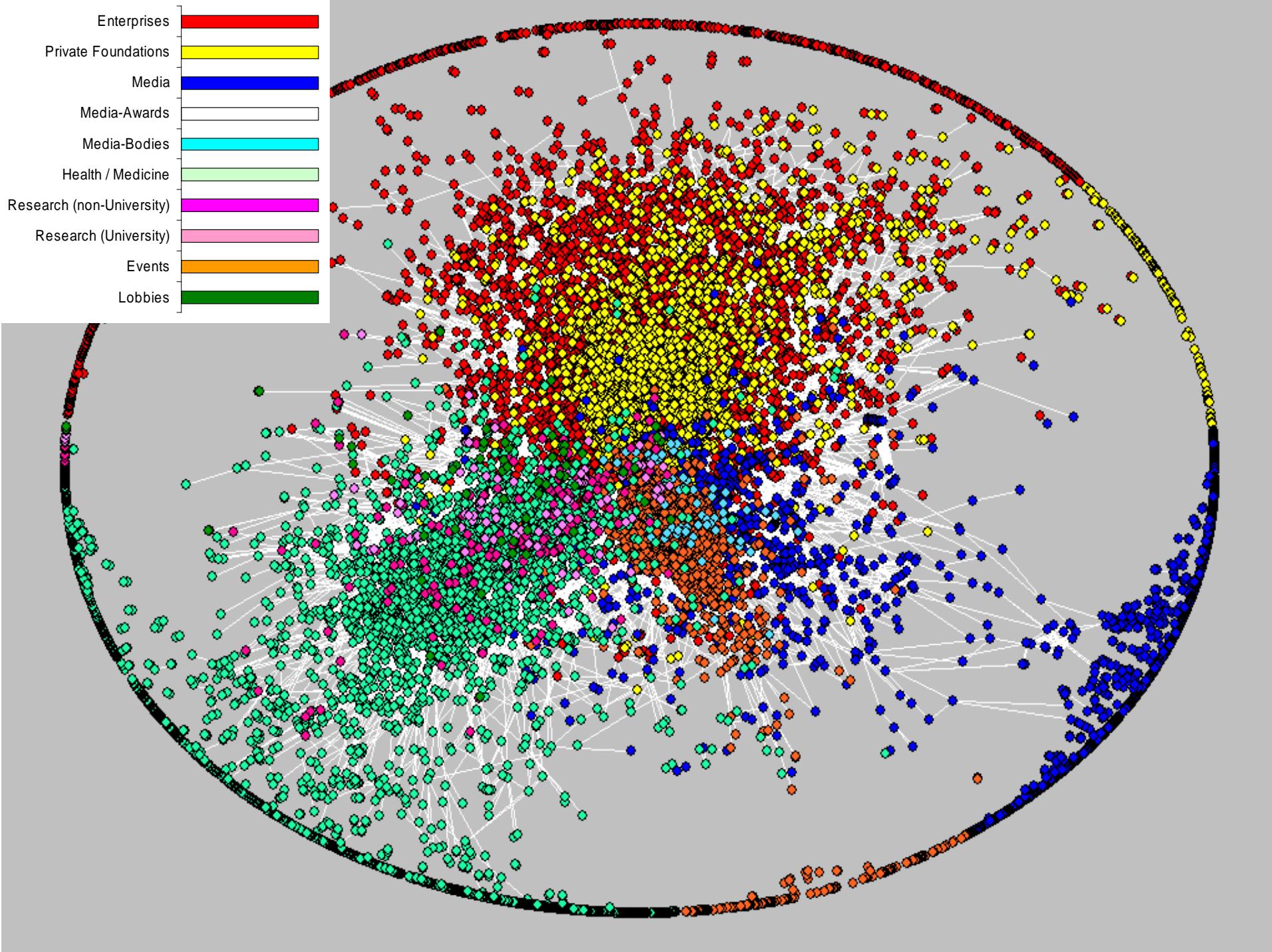
	Persons	Affiliations	Links
Enterprises	21,252	8,108	34,564
Private Foundations	5,359	2,462	8,173
Media, Media Bodies, Juries	7,094	2,858	10,009
Events (Local Celebrities)	6,579	2,480	14,476
Science, Technology	3,069	300	2,737
Public Health	22,262	4,472	27,119
Lobbies	324	68	388
Total Network – 2 Mode (5,605 brokering between social fields)	60,334	20,748	97,466
Total Network – 1 Mode	60,334	20,748	154,884

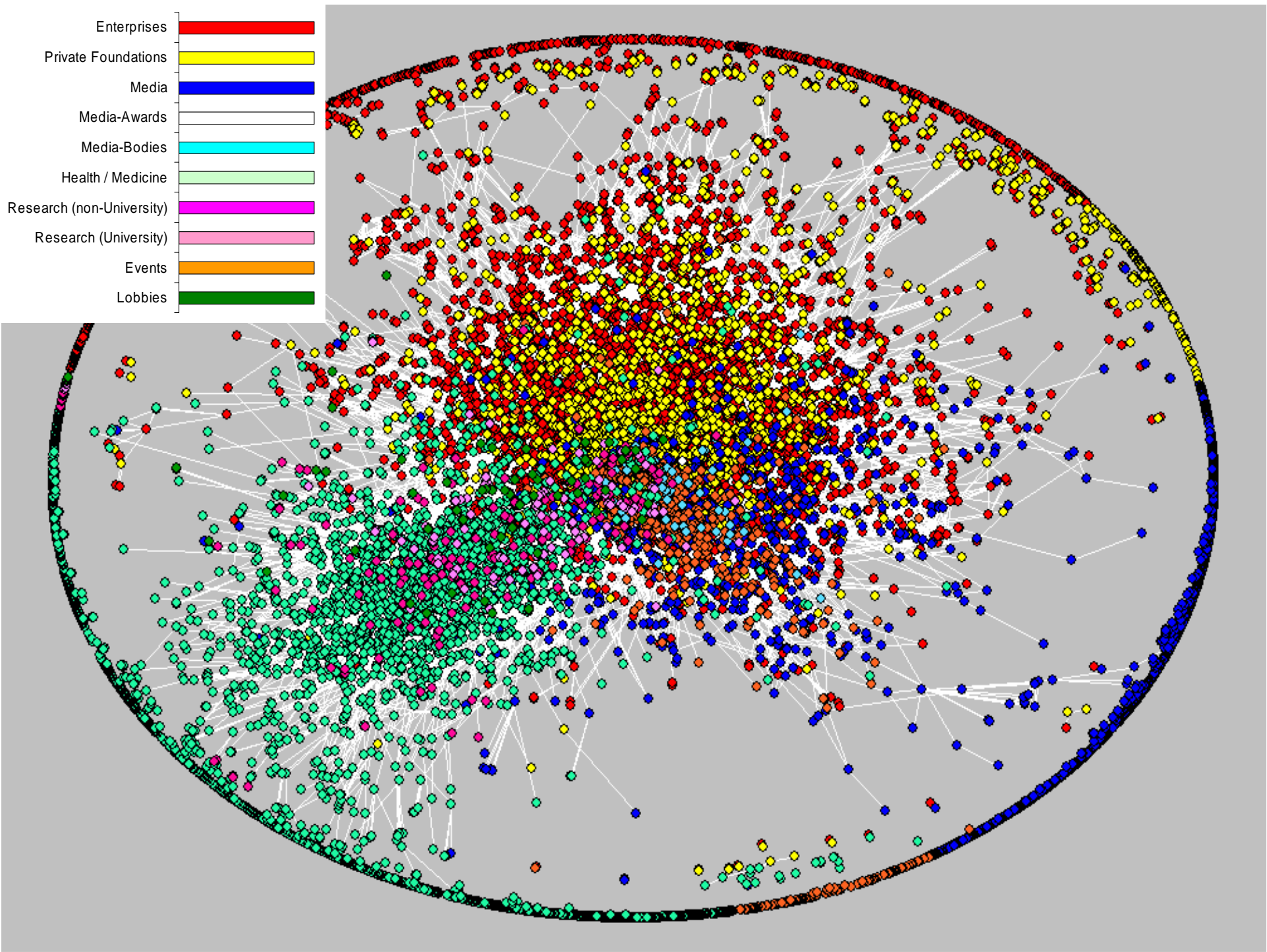
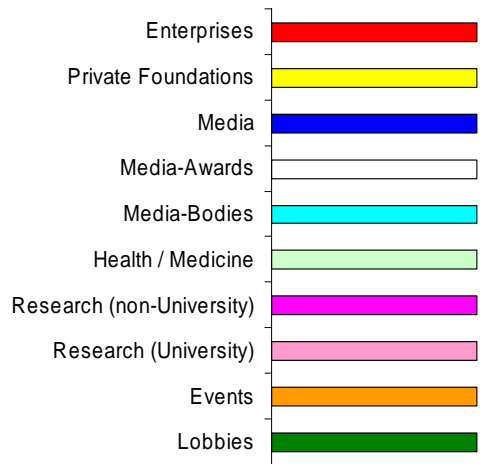
THE AUSTRIAN ELITE'S NETWORK (1mode)

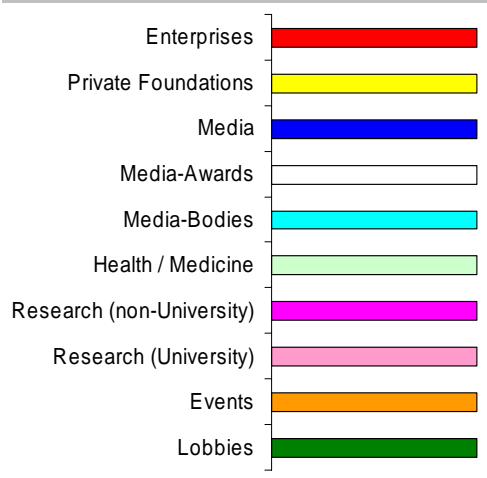




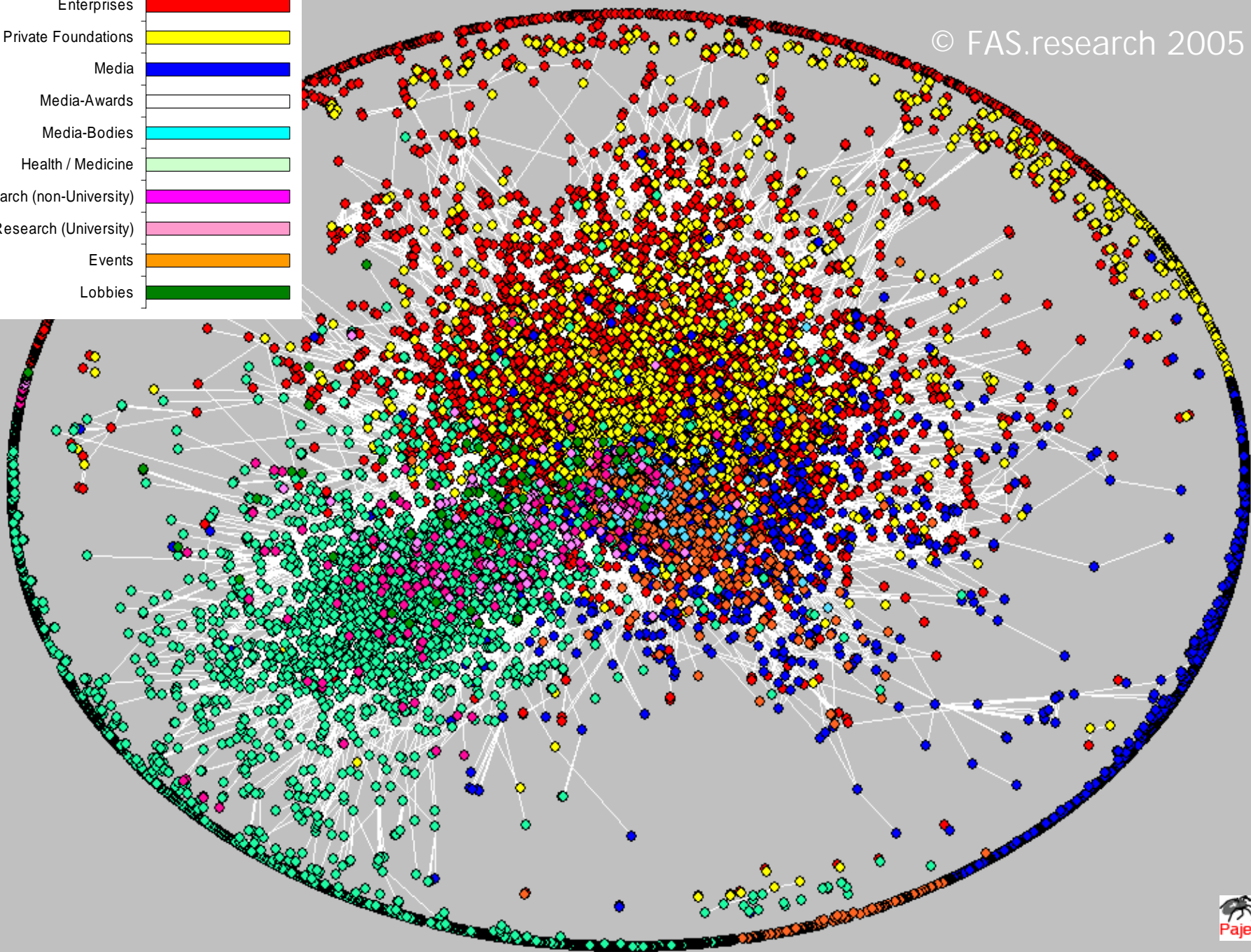


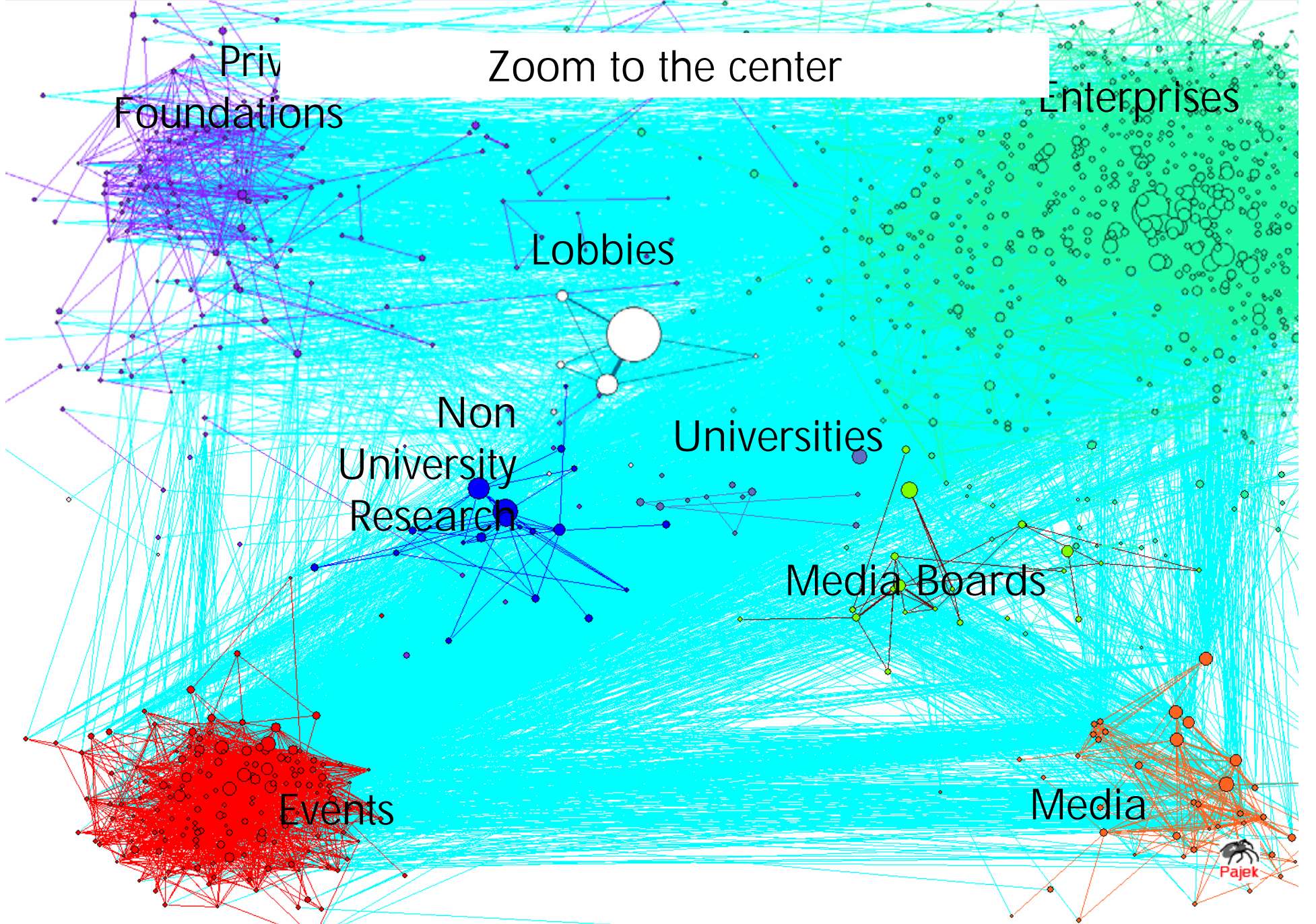






© FAS.research 2005





Variables of success (and poverty)

*How much money
someone actually has*



① Financial Capital

People who do
better have a
better financial
background

*How much know-
how someone has*



② Human Capital

People who do
better have better
abilities and
knowledge

*How much know-who
one has*

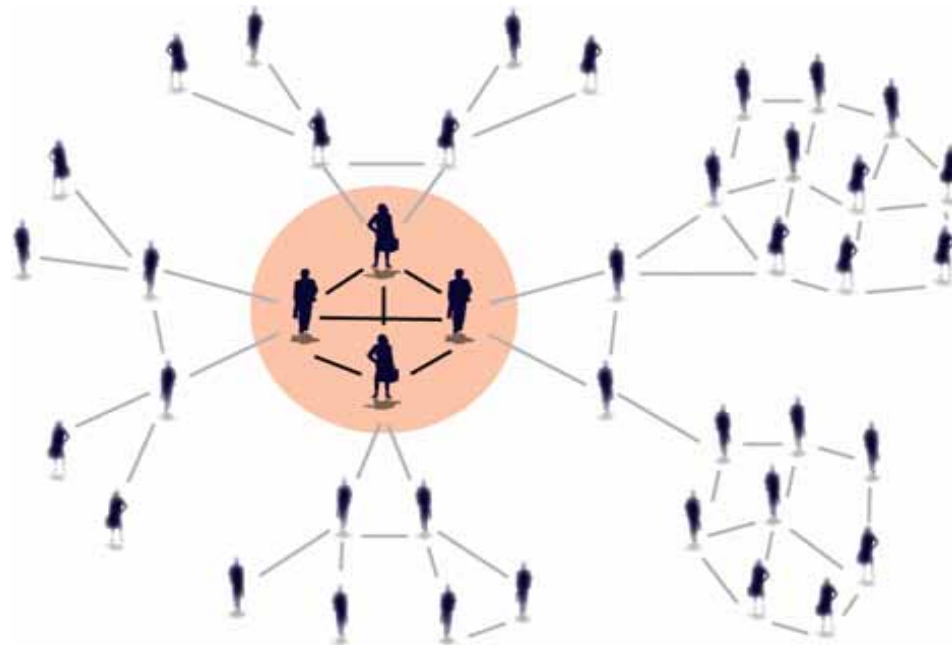


③ Social Capital

People who do
better are
somehow
better
connected

A heuristic approach on the concept of networks

Networks constitute the
intangible infrastructure of an agent
to produce, innovate, to adapt, and to create value.



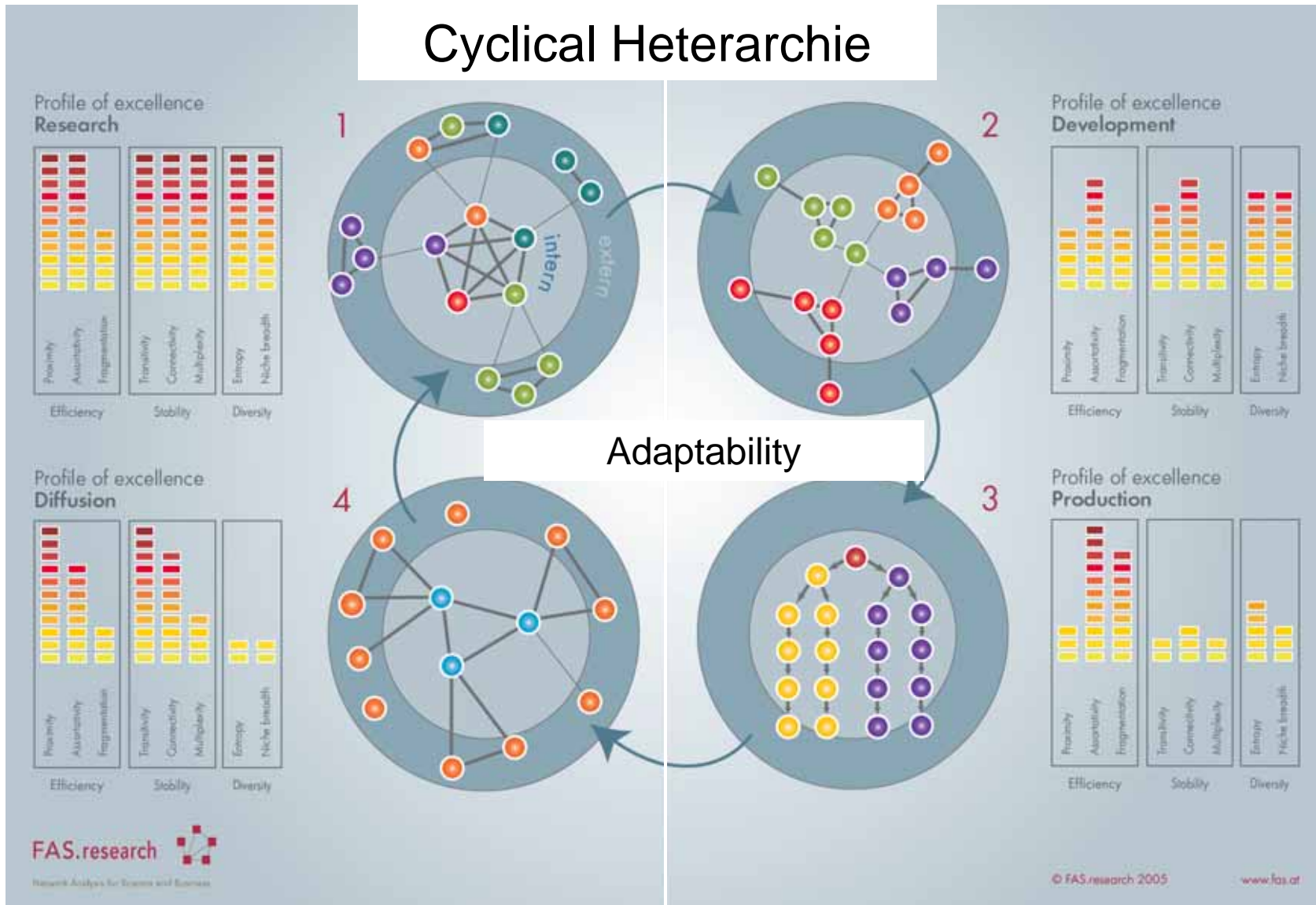
Underlying Question

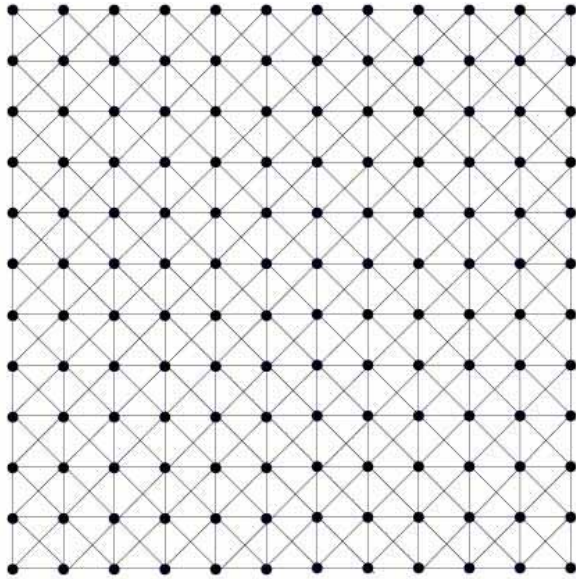
- What are the overall structural conditions which enable agents (people, firms, organizations) to learn, to be creative, to solve problems, to create, exchange and accumulate value - even under conditions of internal and external failure, perpetuations and change?

The notion of robustness in the context of social networks

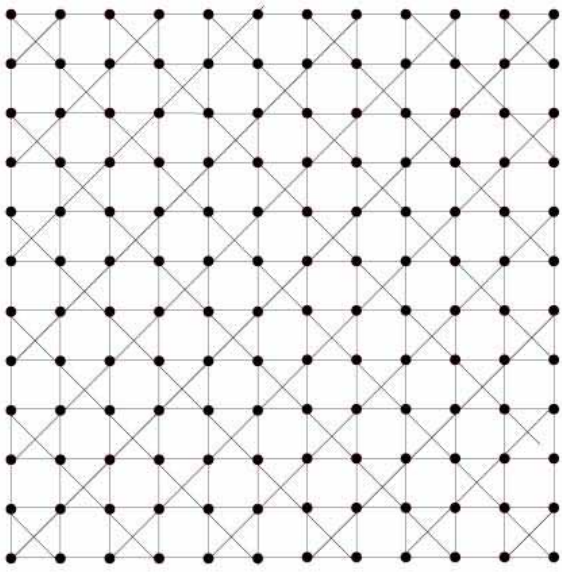
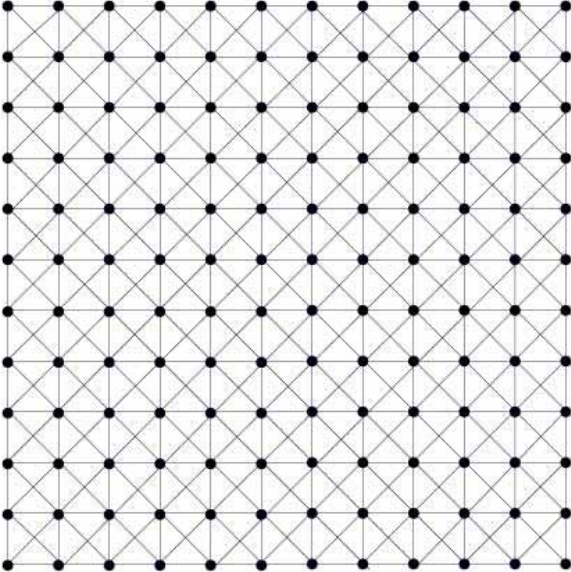
- The ability to peruse and realize a goal function or to adapt to a new goal function even under conditions of change (change of nodes, change of links, change of the context)

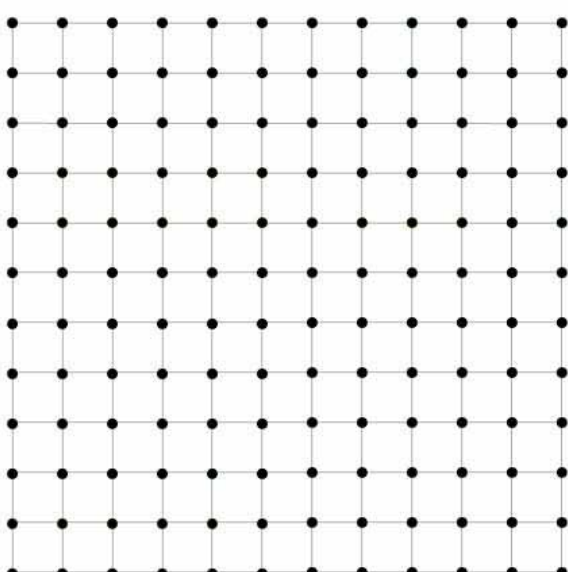
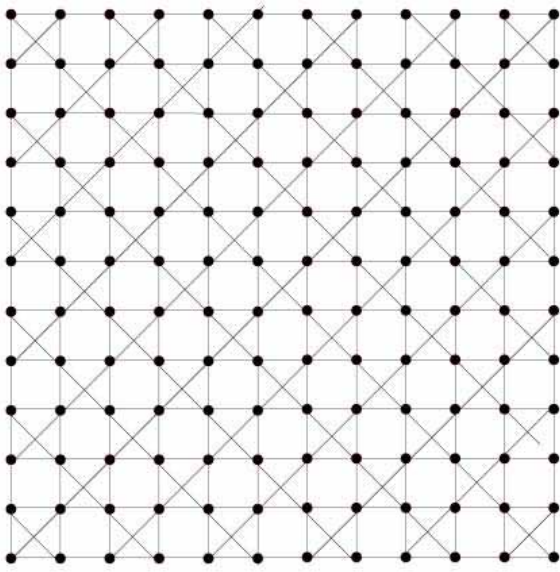
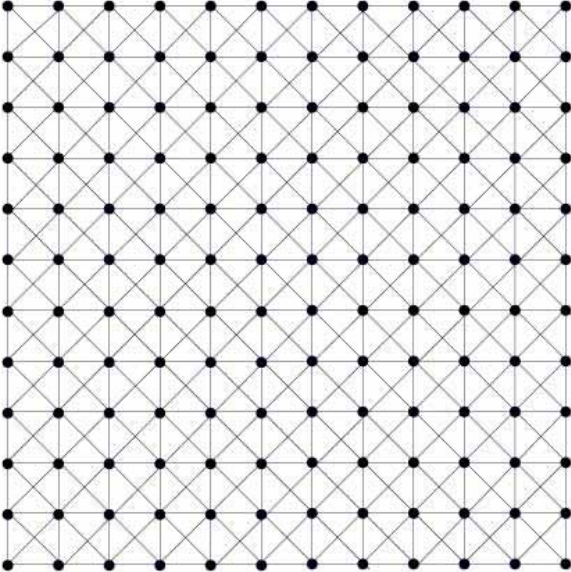
Cyclical Heterarchie

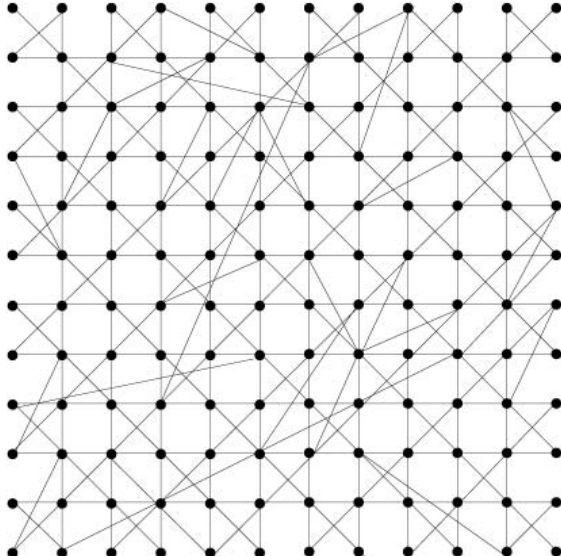
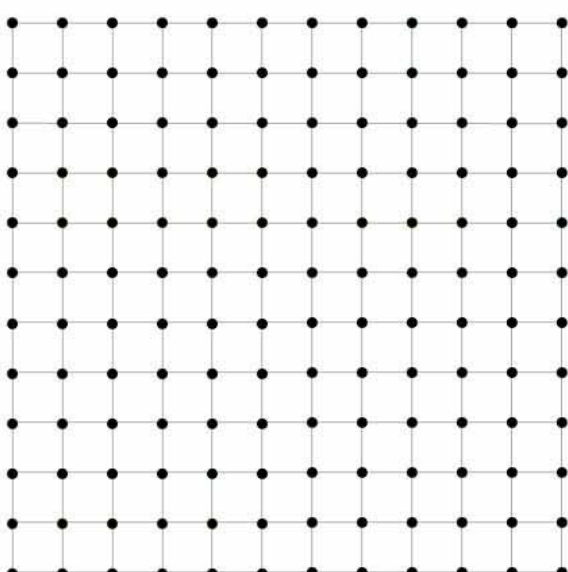
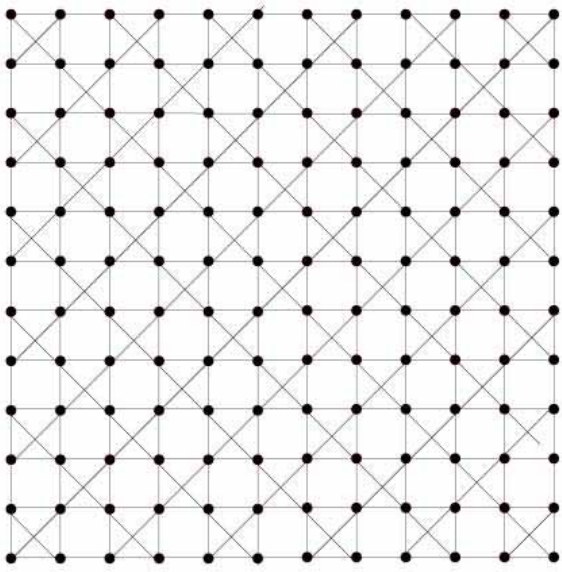
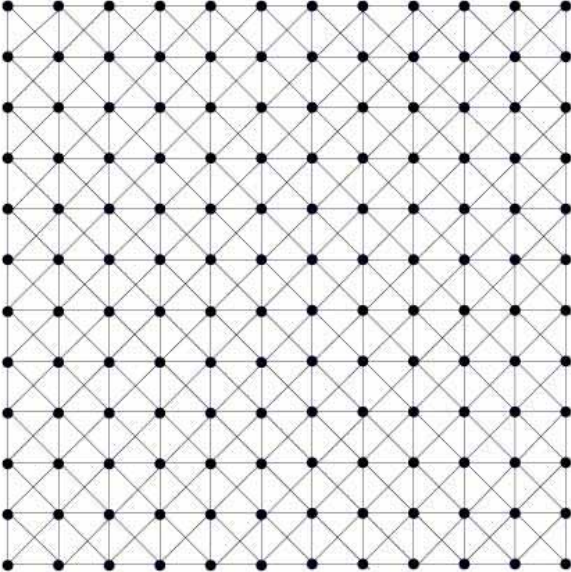


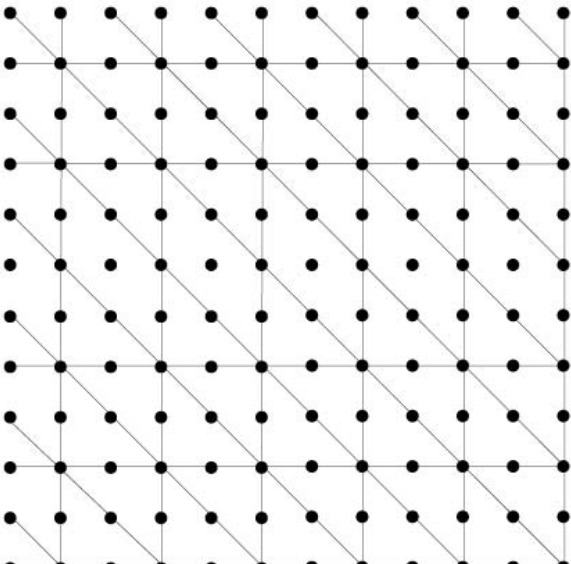
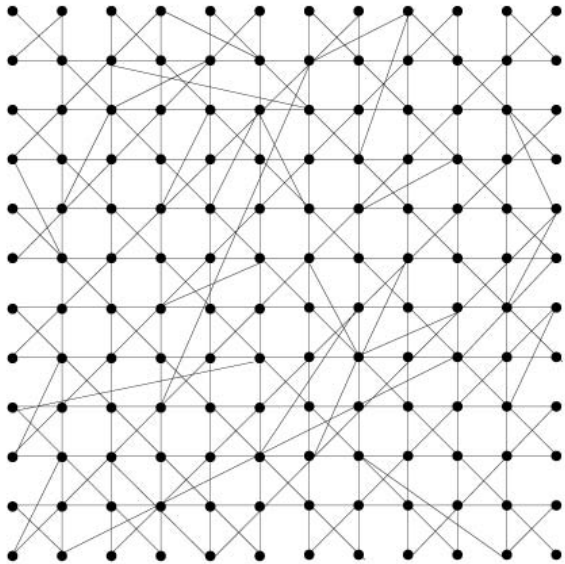
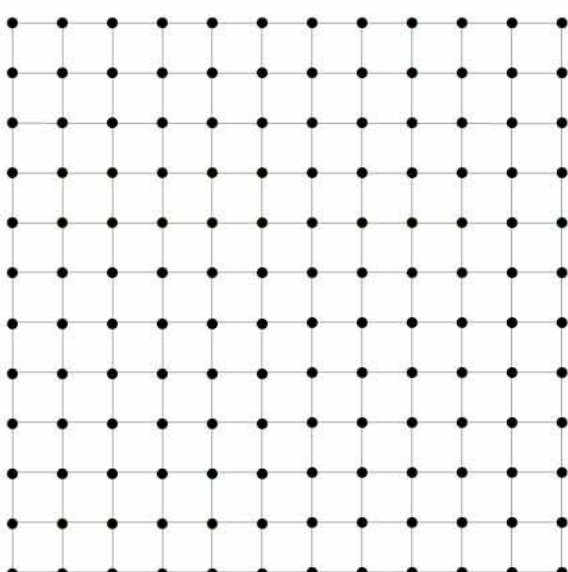
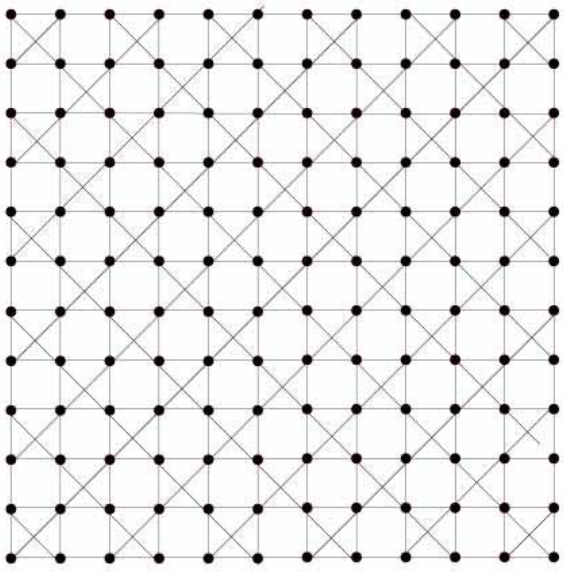
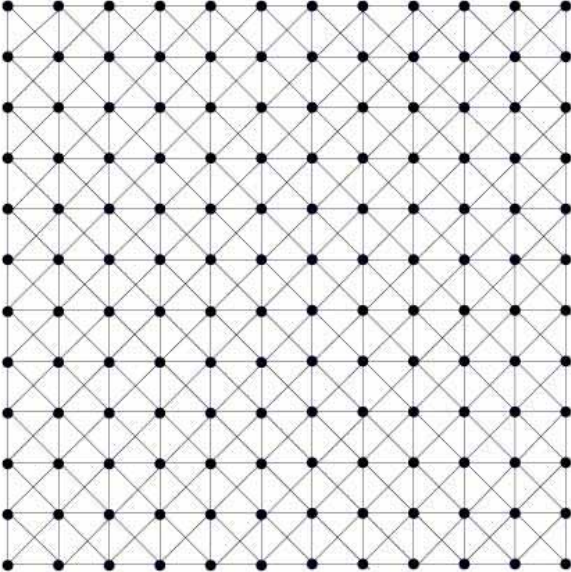


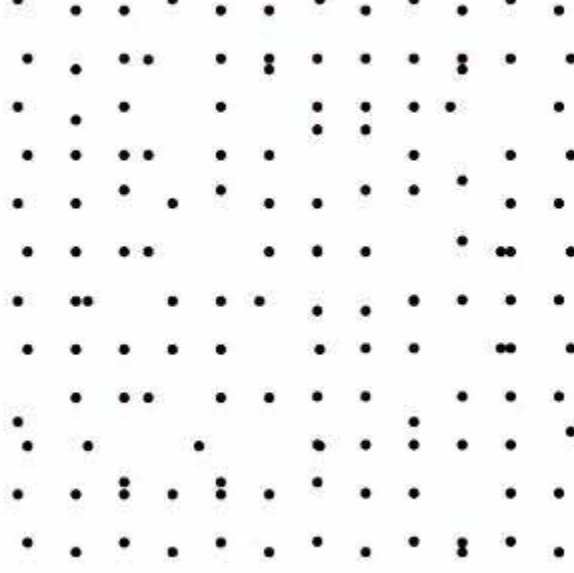
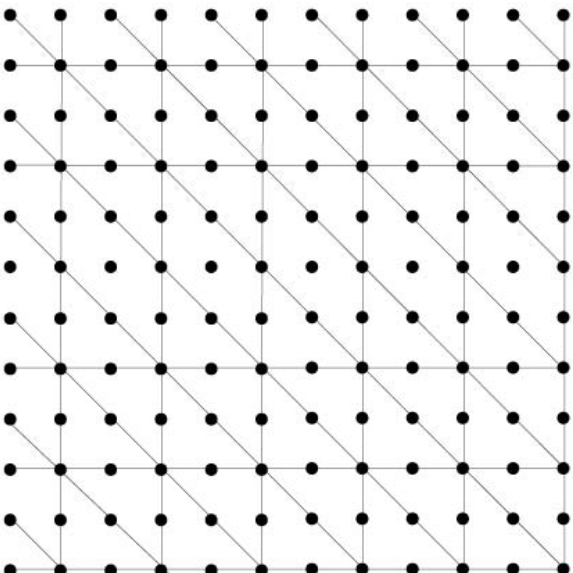
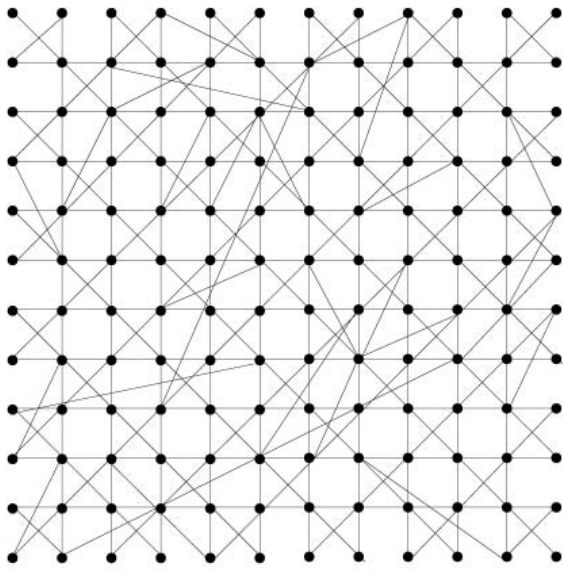
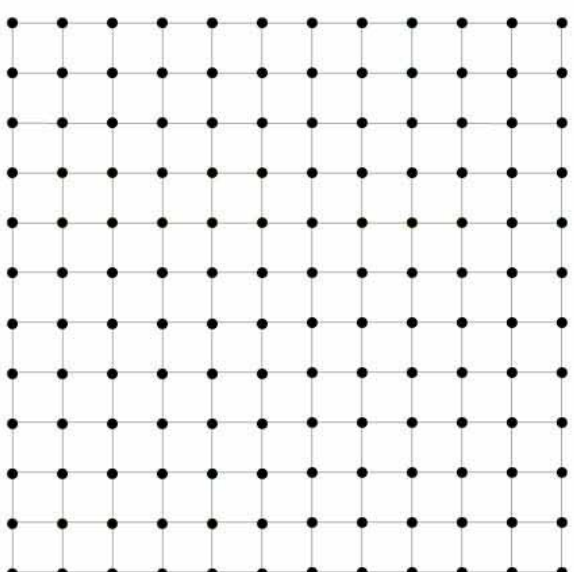
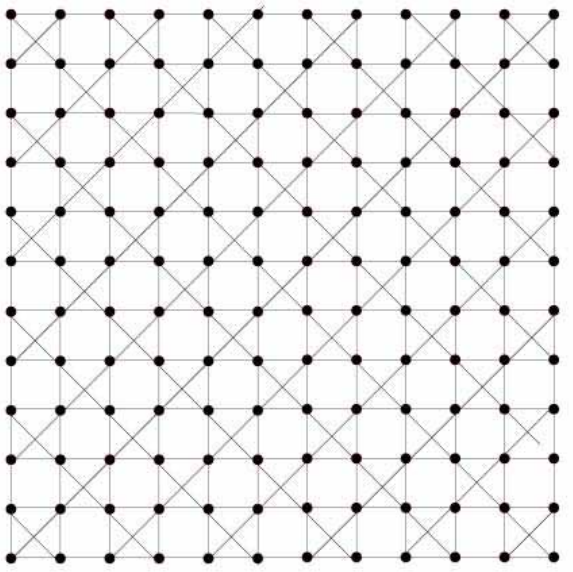
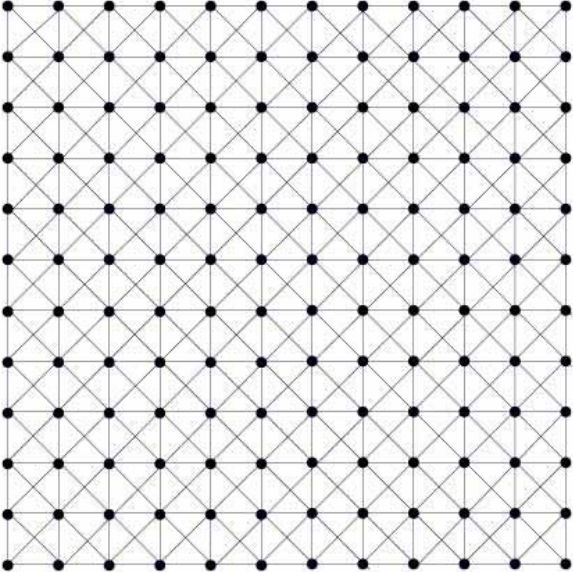
Different model
classes of networks
in terms of
clustering,
connectivity, density
etc.



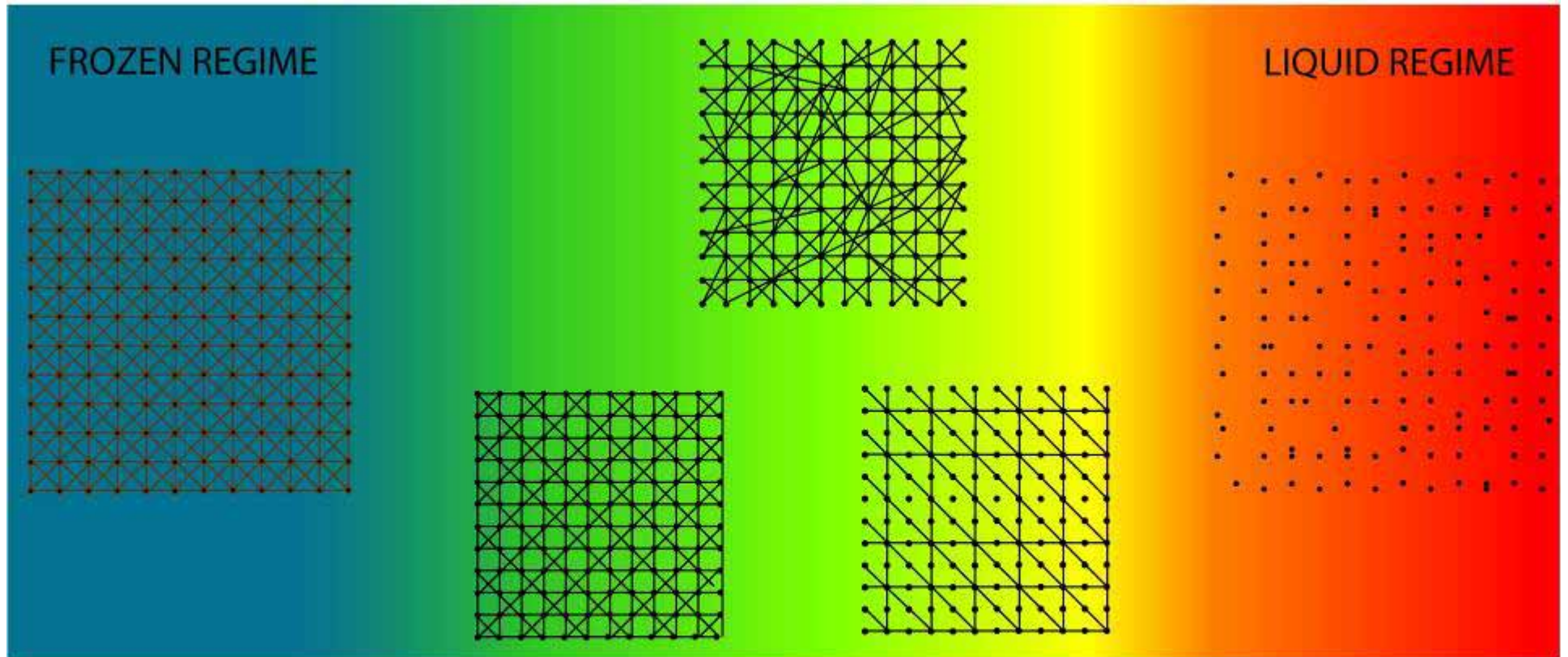




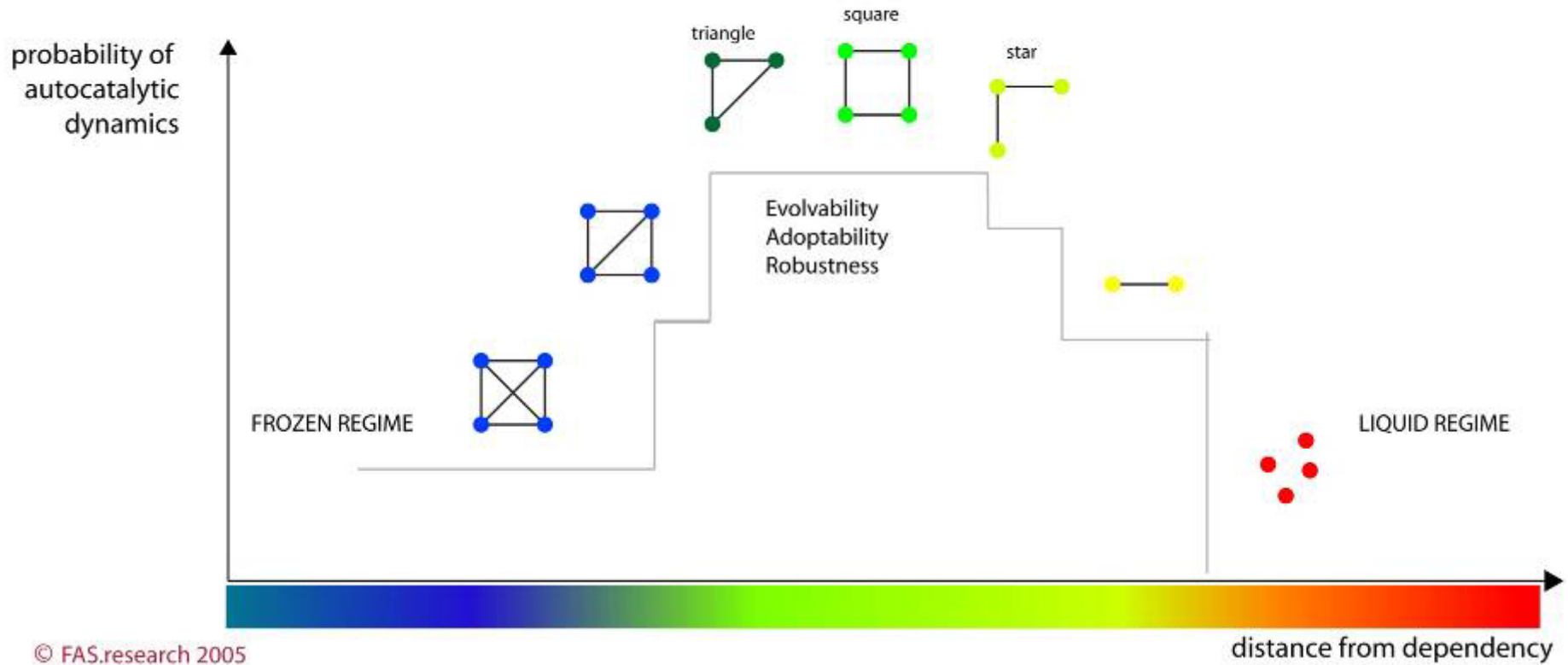




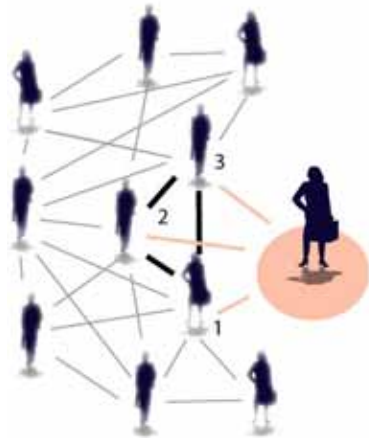
Real World Topologies



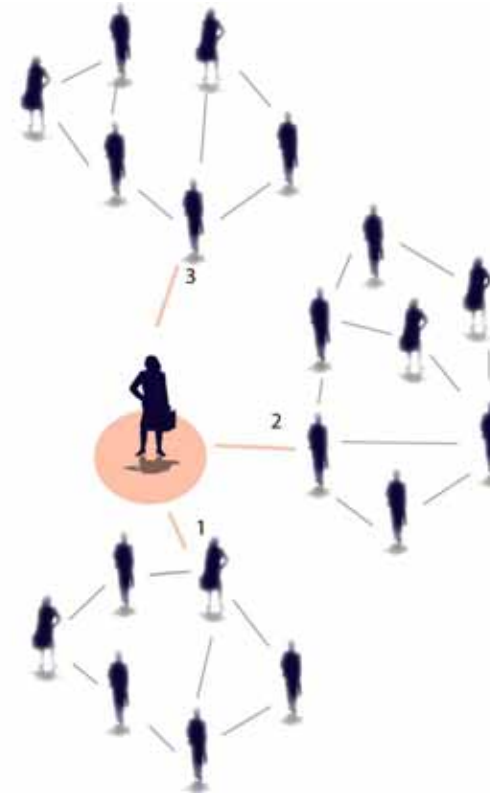
Network Fragments and Complexity



Strong and weak ties



Strong ties

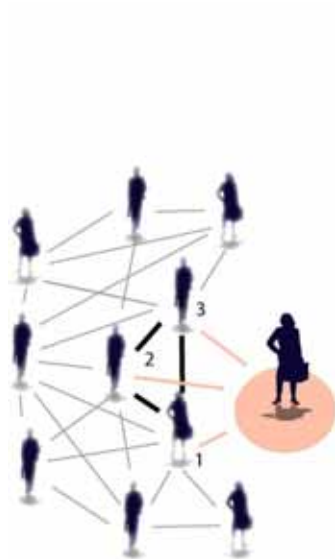


Weak ties

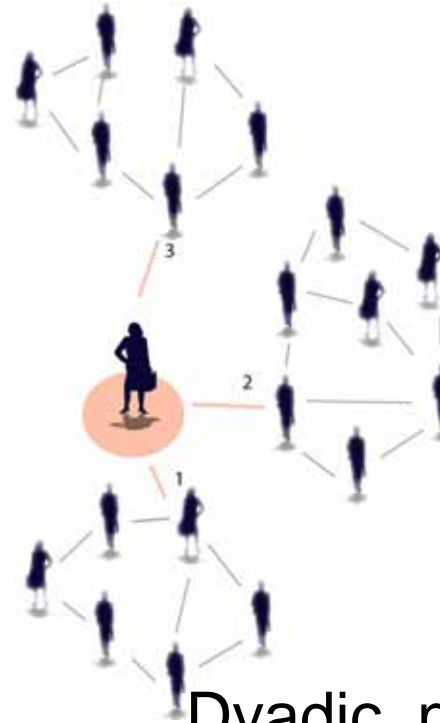
cold

hot

Two basic types of structural capital



Triangular, redundant
architecture



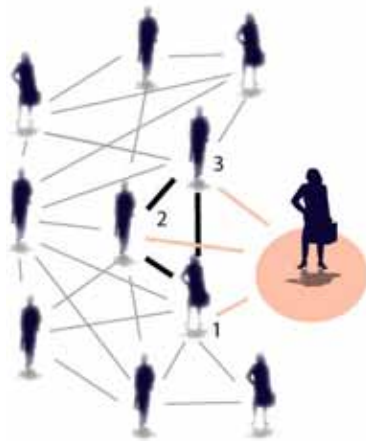
Dyadic, non-redundant
architecture



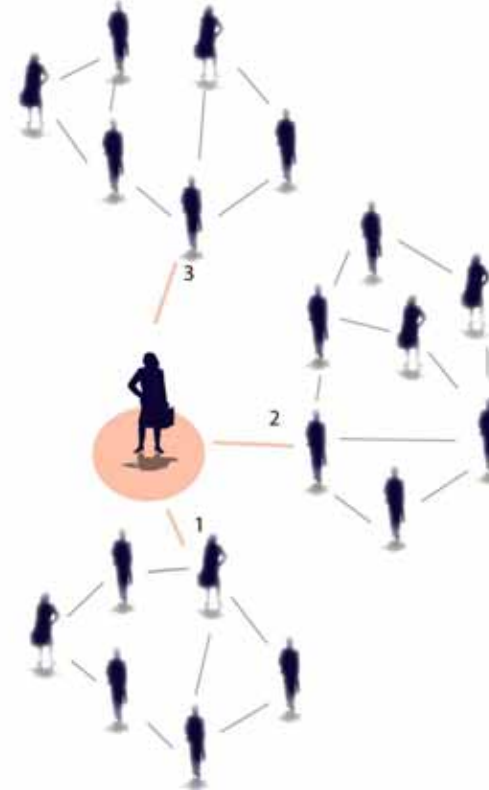
cold

hot

2 oppositional evaluation functions of social capital



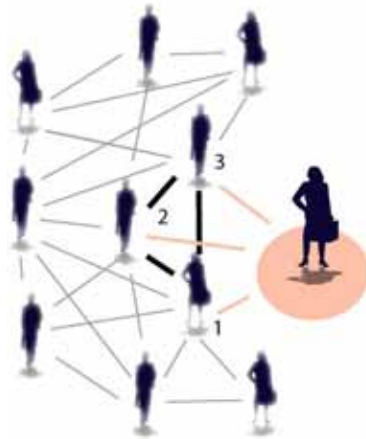
Closure network values



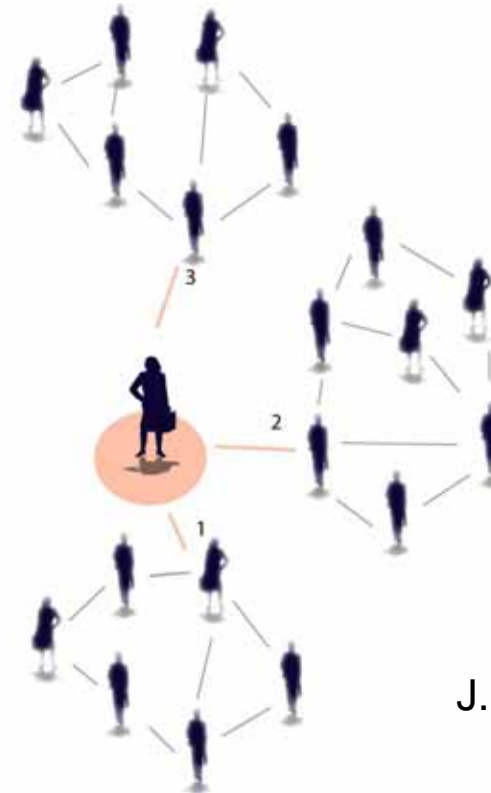
Brokerage network values



2 oppositional story spaces



Loyalty Syndrom

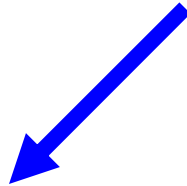


J. Jacobs 2000

Innovation Syndrome

Discount factor $\Delta \mu$: Reward delay with decay function

Stories about identity and difference



Stories about novelty seeking and opportunity



Long Shadow

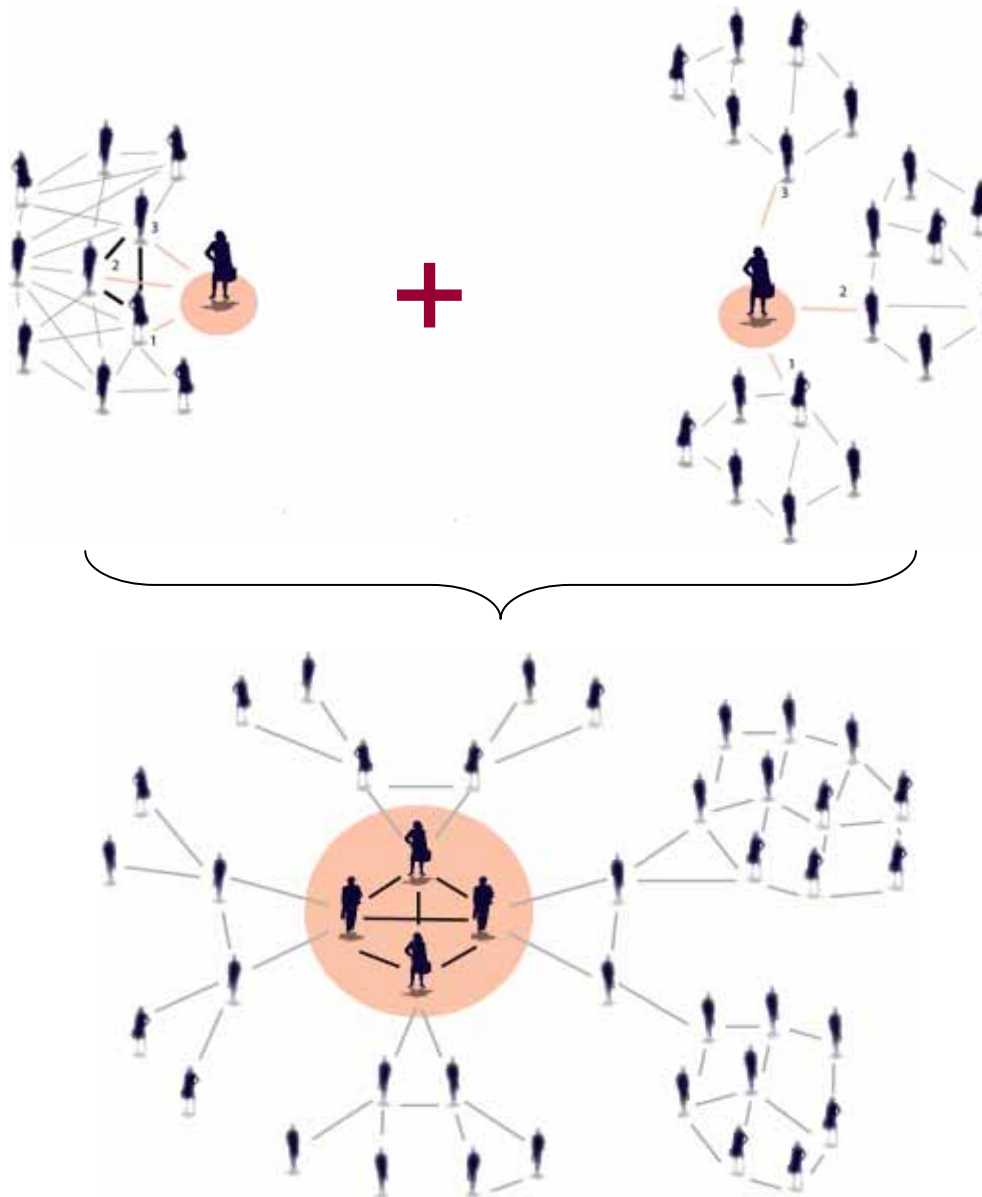
- Guardian-Loyalty Syndrome
- Prescribed and designed Networks
- Forbidden Links
- Stories about Identity and Difference

(Nested) Acyclic-Symmetric Heterachies

Short Shadow

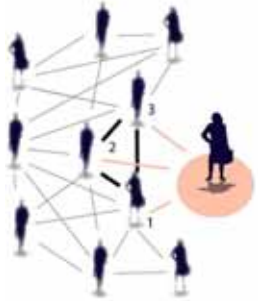
- Commercial Syndrome
- Emergent Networks
- Structural Holes
- "Networking"
- Stories about Opportunity and novelty seeking





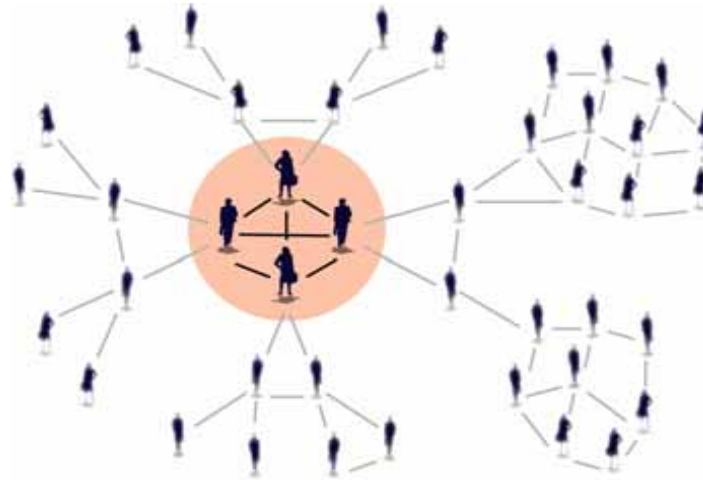
Multi scale
networks –
Symmetric-
Acyclic
Heterarchies

Working class networks



- Closure Network

Elite networks



- Symmetric-acyclic Network



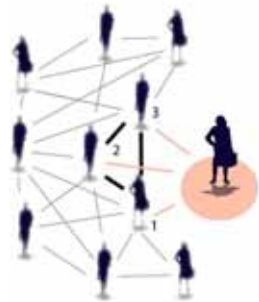
- Structural Holes Networks

frozen

liquified

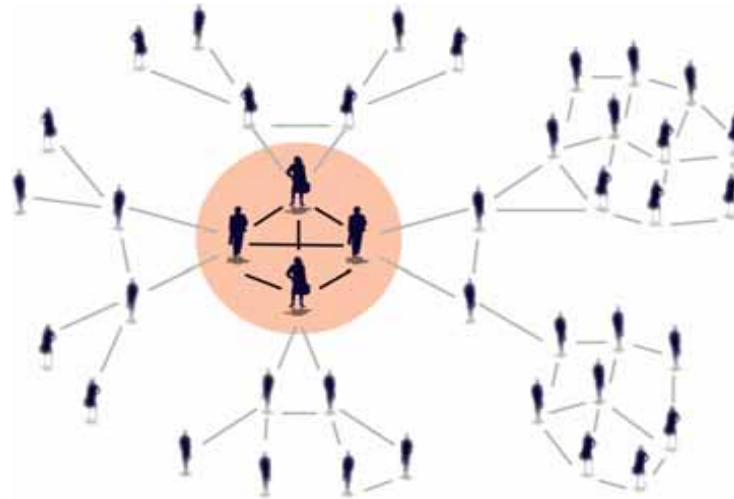
Search strategies over the space of opportunities

Working class networks



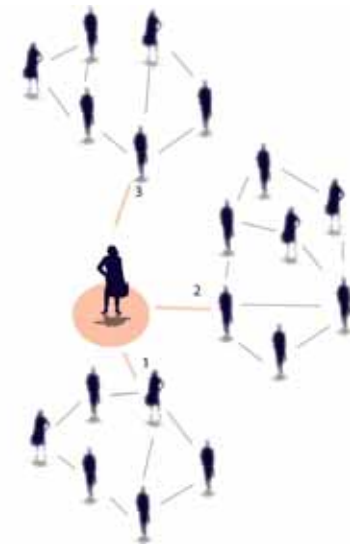
- **Search: Local and collective**

Elite networks



- **Search: Local, global and collective**

Middle class networks

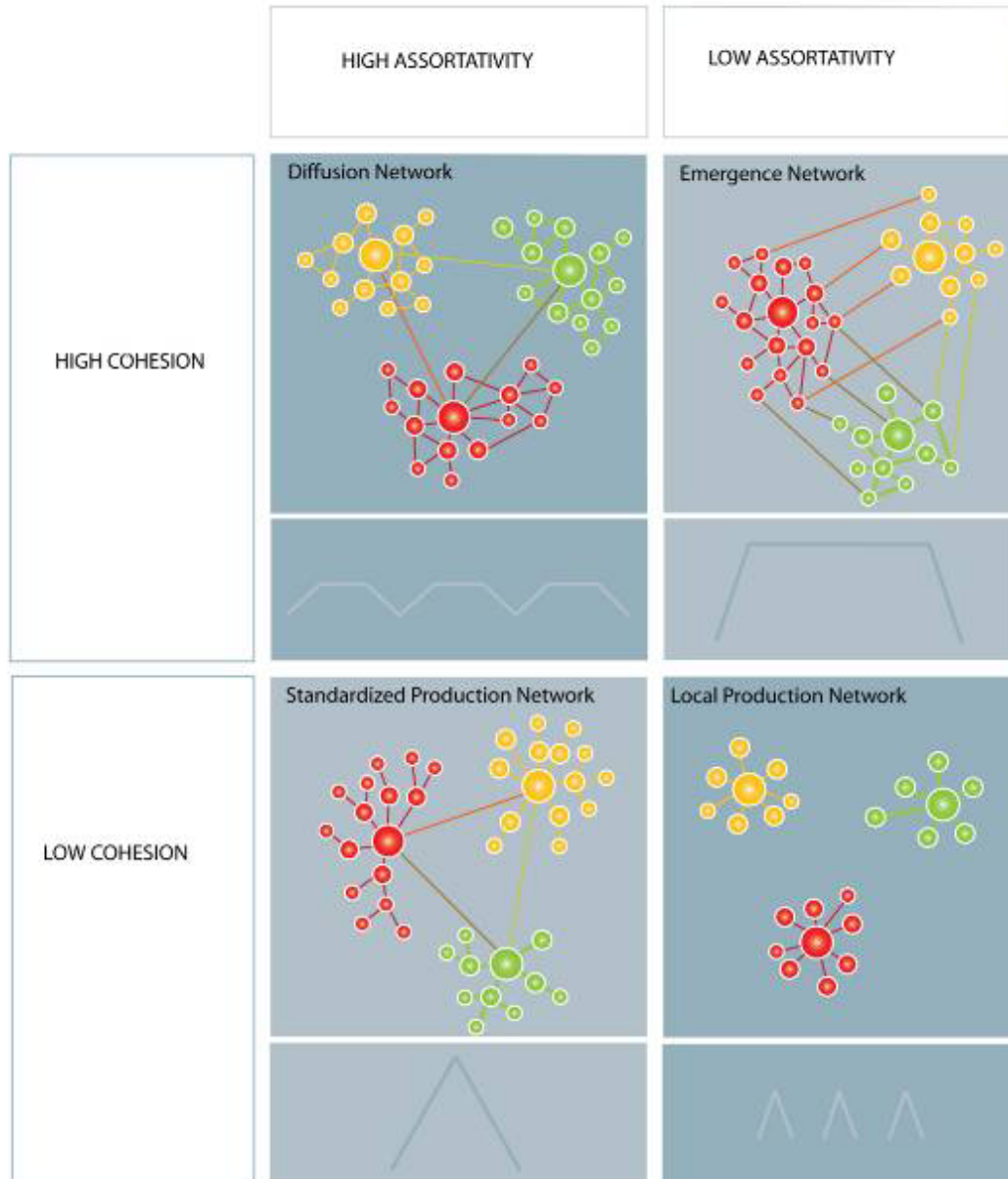


- **Search: Local and Global and individual**

frozen

liquified

Search strategies and opportunities not independent from the morphology



- Multi peaked
- High plateau
- Single peaked
- Local peaked

Key arguments

- The shape of the network landscape determines your opportunity
- Opportunity is not an individual feature. It's both a positional effect (role, centrality) and an effect of the network shape (captain-of-a-shipwreck phenomena)
- Your network shape is related to evaluation functions
- New measures combining morphology and position

Hypothesis to test

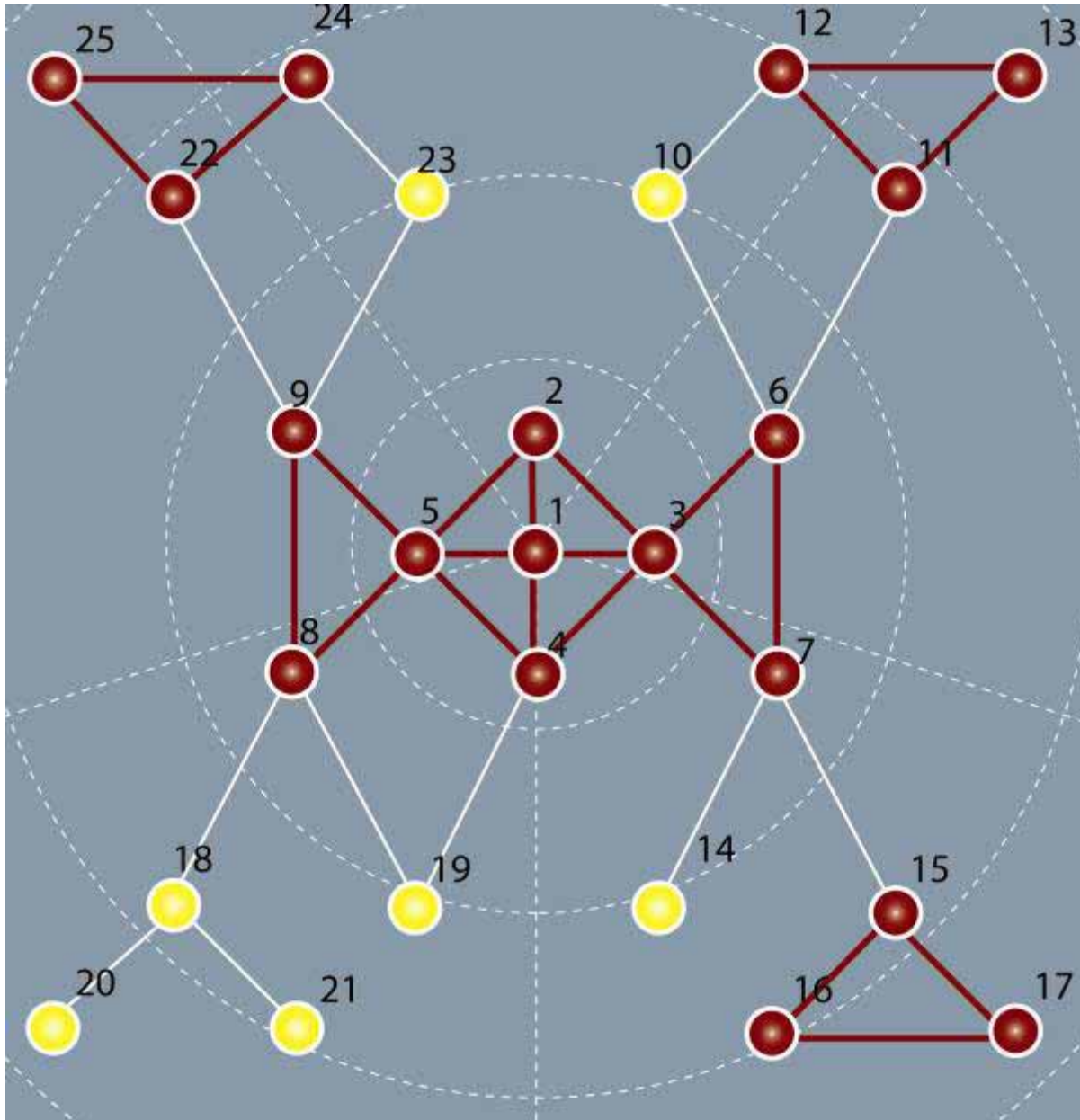
		Working Class	Middle Class	Elites
1.	Efficiency	Low	High	High
2.	Redundancy	High	Low	High
3.	Diversity	Low	Medium	High

Dimensions to operationalize

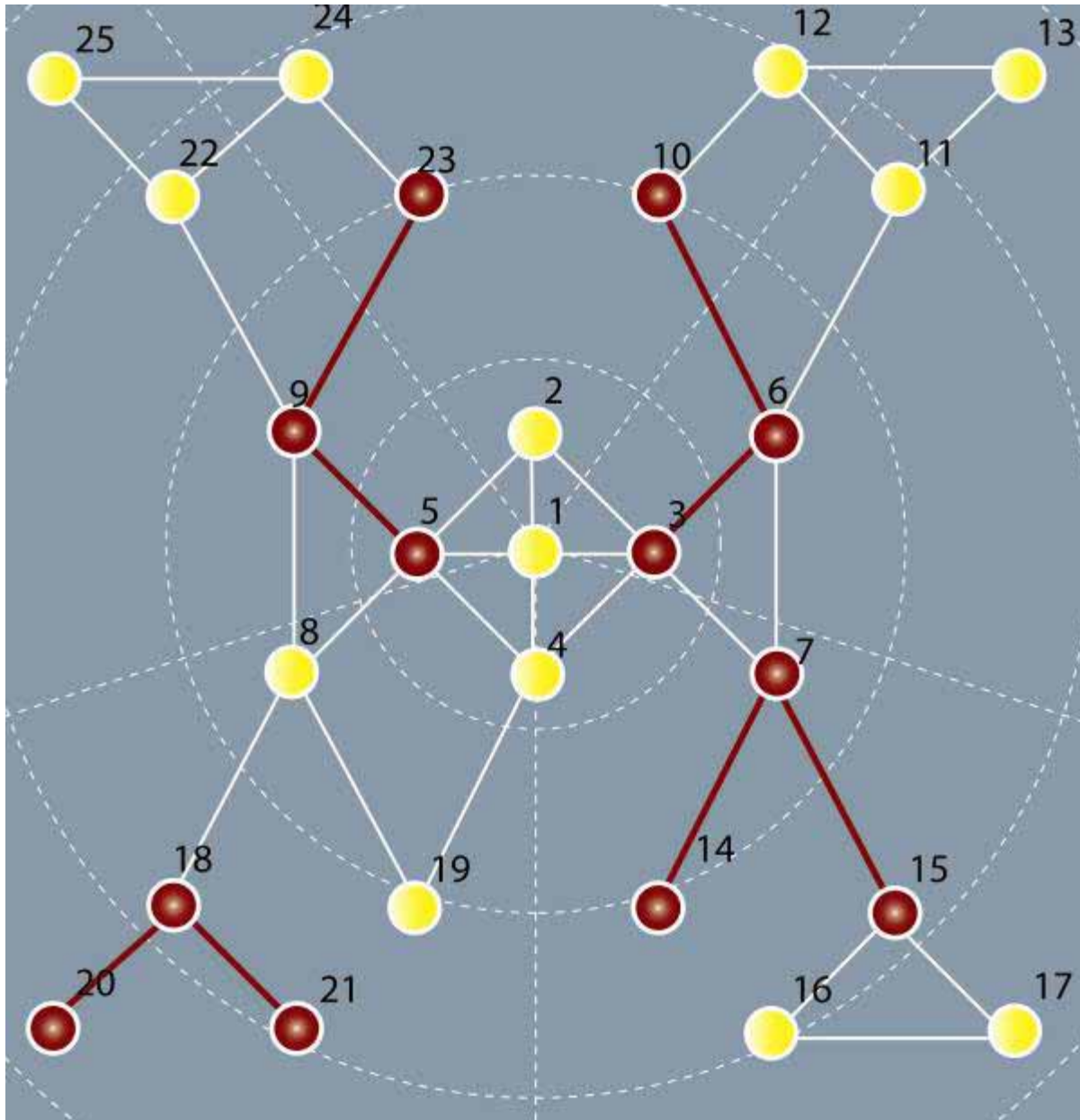
1.	Efficiency	<ul style="list-style-type: none">▪ Short distances– Low transaction costs for accessing, diffusing and exchanging information and resources
2.	Redundancy	<ul style="list-style-type: none">▪ Common valorization systems (common convertible and exchangeable symbolic currencies) and common code through structural and/or regular equivalent settings▪ Trust architectures and low costs of adoptability through structural and/or regular equivalent settings▪ Modularity as form of structural redundancy
3.	Diversity	<ul style="list-style-type: none">▪ Heterogeneity of partition classes▪ Heterogeneity of functional roles indicates heterogeneity of accessible resources

Operationalize the opportunity space

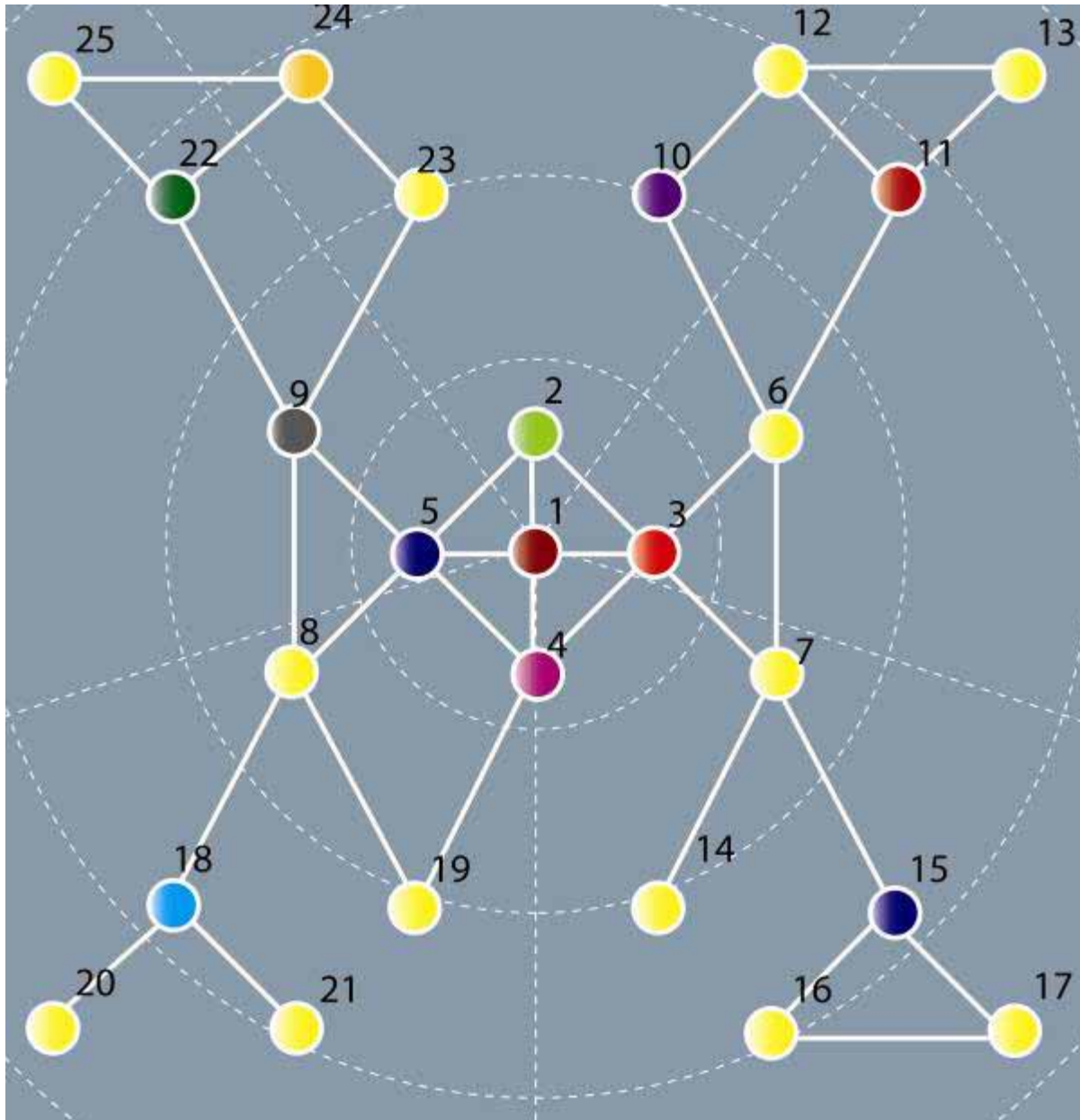
1.	Efficiency	<ul style="list-style-type: none">▪ The (inverse distance weighted) number of reachable nodes in the k-step neighborhood
2.	Stability (Redundancy)	<ul style="list-style-type: none">▪ The (inverse distance weighted) number of triangularized links of all the accessible nodes in the k-step neighborhood.▪ The (inverse distance weighted) number of squared links of all the accessible nodes in the k-step neighborhood.▪ The (inverse distance weighted) number of k-star links of all the accessible nodes in the k-step environment
3.	Diversity	<ul style="list-style-type: none">▪ The (inverse distance weighted) k-step entropy (bits per node) of the accessible nodes based on affiliation attributes



triangle
redundancy
(short cycle
connectivity)



k-star redundancy



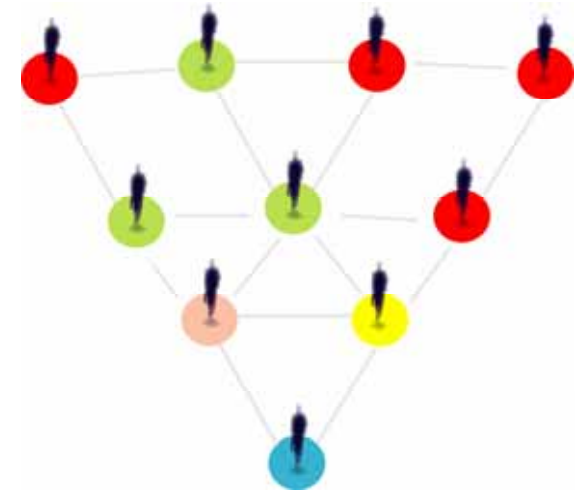
Diversity

Entropy as Measure of Diversity Network Analysis for Science and Business

$$H = - \sum_{i=1}^s (p_i) (\log_2 p_i)$$

H = Shannon / Wiener Diversity Index

p_i = the proportion of the network
represented by partition class i



Information content is a measure of the amount of uncertainty, so the larger the value H, the greater the uncertainty. A social network which is made up of 5 persons who are all males has a no uncertainty in it with regard to gender, and $H = 0$.

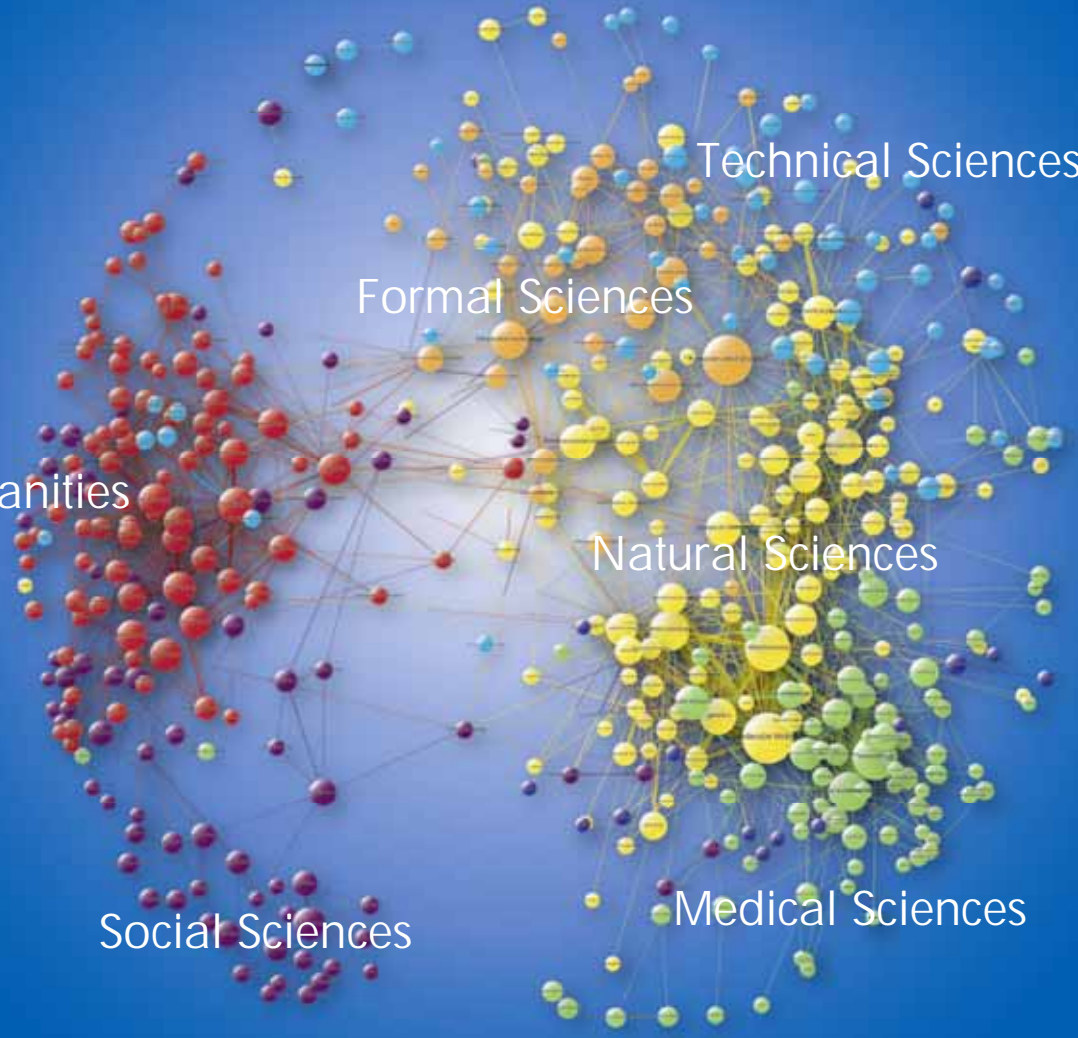
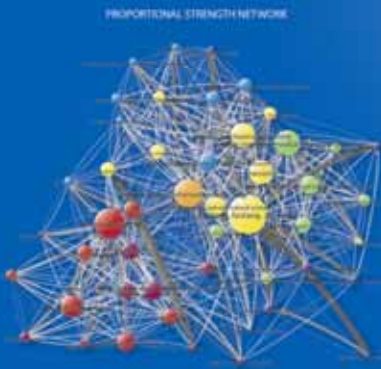
Interests

- Collect data, improve models
- Test framework and hypothesis over the different morphologies
- Most difficult point (like always): find a dependent variable to test the influence of network-shapes on the “fitness” of the node AND the network.
- The link between the story space (semantic network analysis) and the morphological analysis not elaborated. Different stories as accountants and testimonials for different evaluation functions.

Future of SNA?

THE SCIENTIFIC FIELD OF AUSTRIA

Co-occurrence of assigned scientific classification codes in 5217 projects funded by the Austrian Sciences Fund (FWF) from 1994 to April 2004



- LEGEND**
- HUMANITIES AND PHILOSOPHY
 - SOCIAL SCIENCES AND LAW
 - FORMAL SCIENCES
 - ENGINEERING AND TECHNOLOGY
 - NATURAL SCIENCES
 - MEDICAL SCIENCES
 - AGRICULTURAL SCIENCES

NETWORK OWNERS BY

Page 10
 Author: Markus Frey
 RWI, Innsbruck, April 11, 2005

THE SCIENTIFIC FIELD OF AUSTRIA

The network shown here represents the co-occurrence of classification codes assigned by the Austrian Science Fund (FWF) to 5217 projects funded by the Austrian Science Fund (FWF) from 1994 to April 2004. The nodes represent the scientific classification codes and the edges represent the co-occurrence of these codes in a project. The size of the nodes is proportional to the number of projects in which the code occurred. The size of the edges is proportional to the number of projects in which both codes occurred. The network is divided into six clusters, each representing a scientific domain.

BETWEENNESS CENTRALITY NETWORK

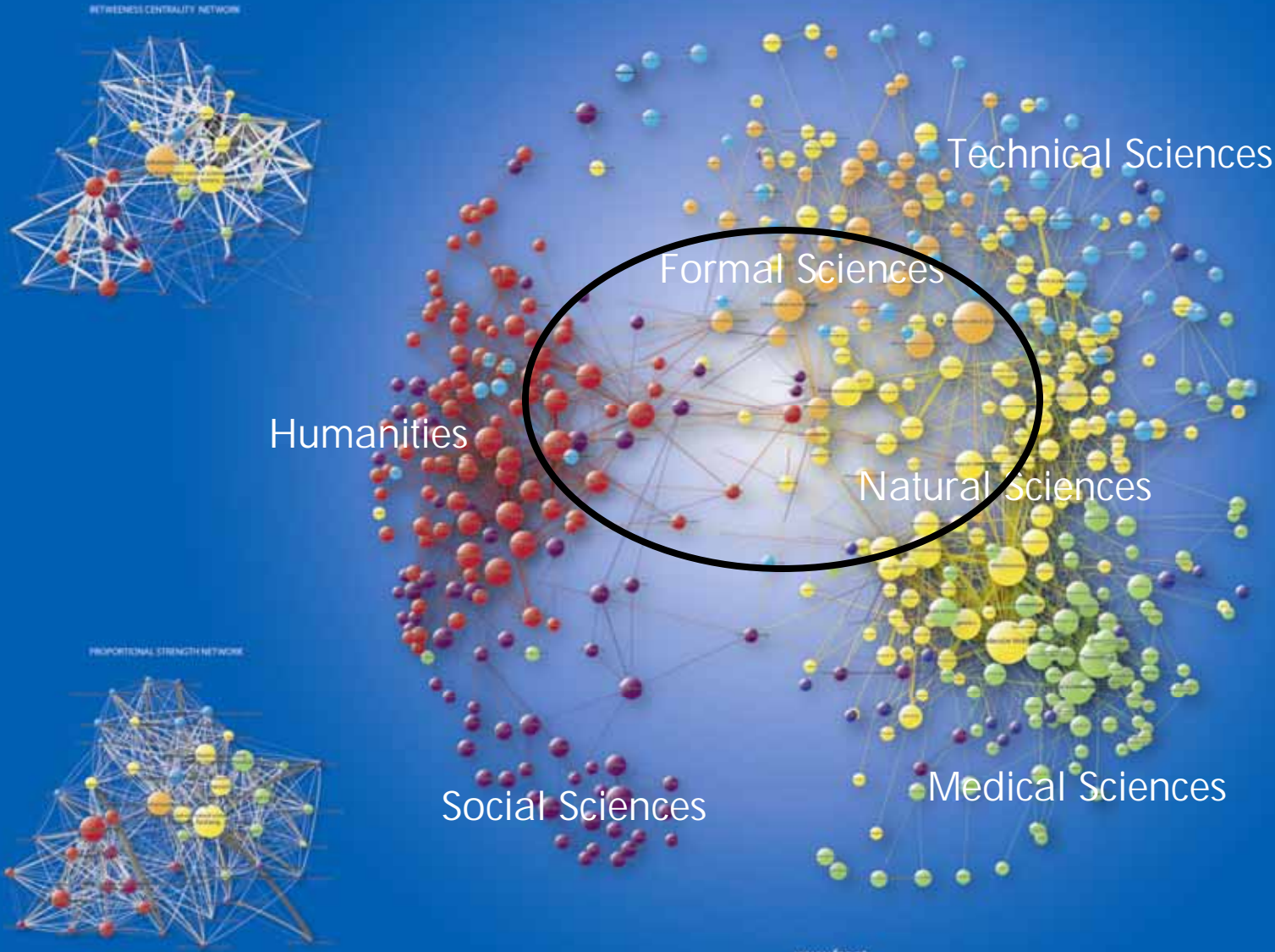
The betweenness centrality of a node is a measure of its importance in a network. It is calculated as the number of shortest paths between any two nodes in the network that pass through the node. The nodes in this network are ordered by their betweenness centrality, with the most important nodes at the top. The edges are colored according to the scientific domain of the nodes they connect.

PROPORTIONAL STRENGTH NETWORK

The strength of a node is a measure of its importance in a network. It is calculated as the sum of the weights of the edges incident to the node. The nodes in this network are ordered by their strength, with the most important nodes at the top. The edges are colored according to the scientific domain of the nodes they connect.

THE SCIENTIFIC FIELD OF AUSTRIA

Co-occurrence of assigned scientific classification codes in 5217 projects funded by the Austrian Sciences Fund (FWF) from 1994 to April 2004



LEGEND

- HUMANITIES AND PHILOSOPHY
- SOCIAL SCIENCES AND LAW
- FORMAL SCIENCES
- ENGINEERING AND TECHNOLOGY
- NATURAL SCIENCES
- MEDICAL SCIENCES
- AGRICULTURAL SCIENCES

NETWORK DIVISION BY

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 Author: Markus Frey
 RWI, Innsbruck, Austria 2004

THE SCIENTIFIC FIELD OF AUSTRIA

The network shown here represents the co-occurrence of classification codes assigned by the Austrian Science Fund (FWF) to 5217 projects funded by the Austrian Science Fund (FWF) from 1994 to April 2004. The nodes represent the assigned codes, and the edges represent the co-occurrence of these codes in a project. The network is divided into six clusters, each representing a different scientific domain. The size of the nodes is proportional to the number of projects in which the code was used, and the thickness of the edges is proportional to the number of projects in which the two codes co-occurred.

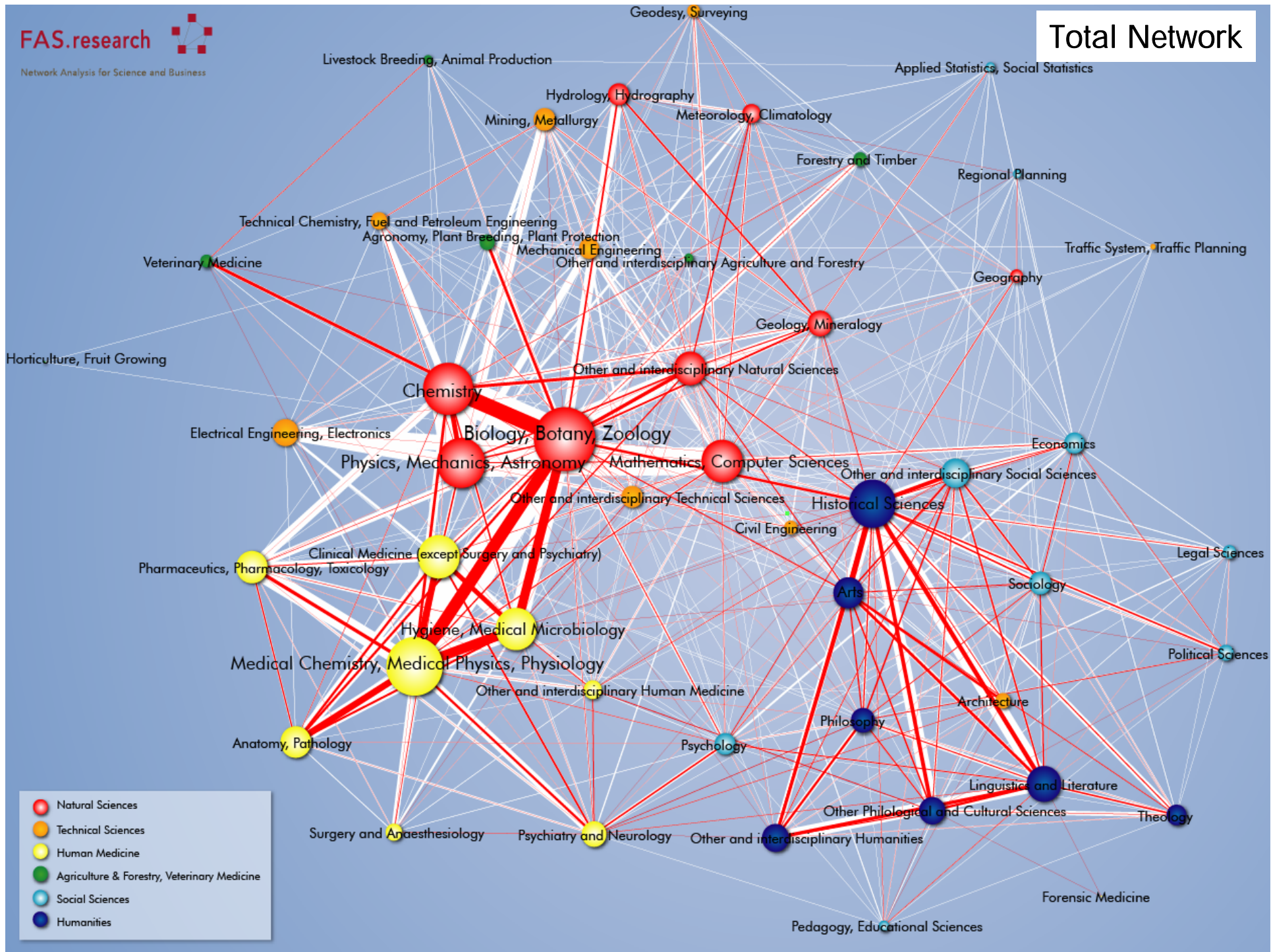
BETWEENNESS CENTRALITY NETWORK

This network shows the betweenness centrality of each node in the network. The size of the nodes is proportional to the betweenness centrality of the node. The edges are colored according to the betweenness centrality of the edge. The network is divided into six clusters, each representing a different scientific domain. The size of the nodes is proportional to the number of projects in which the code was used, and the thickness of the edges is proportional to the number of projects in which the two codes co-occurred.

PROPORTIONAL STRENGTH NETWORK

This network shows the proportional strength of each node in the network. The size of the nodes is proportional to the proportional strength of the node. The edges are colored according to the proportional strength of the edge. The network is divided into six clusters, each representing a different scientific domain. The size of the nodes is proportional to the number of projects in which the code was used, and the thickness of the edges is proportional to the number of projects in which the two codes co-occurred.

Total Network



- Natural Sciences
- Technical Sciences
- Human Medicine
- Agriculture & Forestry, Veterinary Medicine
- Social Sciences
- Humanities

Harald Katzmaier

Danke fuer Ihre
Aufmerksamkeit