

Diffusion in epistemic networks: patterns and processes

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Rationale

“Social and semantic networks often studied separately”

Theoretical suggestions to bind social and semantic networks examining...

- 1 patterns
- 2 morphogenesis phenomena
- 3 processes in knowledge networks

Social networks

Universal networks?

- Networks describing interaction histories and/or structure are *everywhere*...

State of the art

Structural features

connectivity, distances, transitivity, etc.

Mechanisms

growth, rewiring, preferential attachment, etc.

Social networks

Universal networks?

- Networks describing interaction histories and/or structure are *everywhere*...
- ...but they are not all the same.

State of the art

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connectivity, distances, transitivity, etc.

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Knowledge networks

Knowledge communities

Such social networks usually involve semantic interactions, while proposed patterns or interaction mechanisms are seldom adapted to these situations.

- 1 Introduce patterns proper to knowledge communities, directly relevant for social epistemologists, relying on semantic components, in a coevolutionary framework.
- 2 Look at what is crucially **non-structural** in the behavior of such networks

Knowledge networks

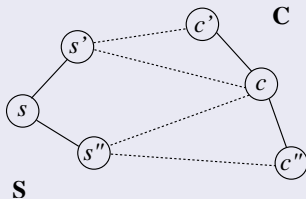
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Epistemic networks

Social and semantic networks evolving together



Empirical protocol

Community of scientists, bibliographical databases (e.g. Medline).

Epistemic communities

A meaningful pattern for socio-semantic systems

- “Group of agents sharing a common set of subjects, concepts, issues; sharing a common goal of knowledge creation” — (*Haas, 1992; Cowan et al., 2000*)
- Unclear how to deal with it using only social network data

Epistemic community

as a formal notion: “An *epistemic community* is the largest set of agents sharing a given concept set”

Epistemic communities

Empirical Galois lattice

Epistemic communities

$$(s_1 s_2 s_3 s_4; \emptyset)$$

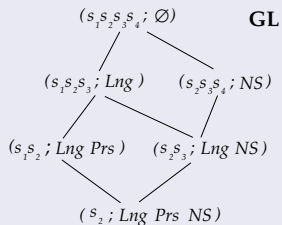
$$(s_1 s_2 s_3; Lng) \quad (s_2 s_3 s_4; NS)$$

$$(s_1 s_2; Lng Prs) \quad (s_2 s_3; Lng NS)$$

$$(s_2; Lng Prs NS)$$

Epistemic communities

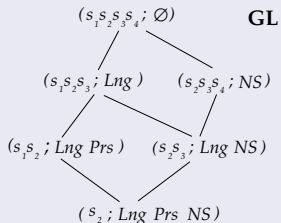
Arranged in a Galois lattice



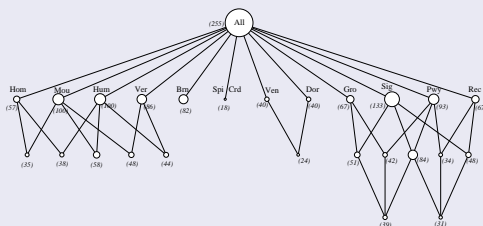
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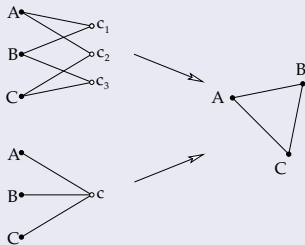
Empirical Galois lattice



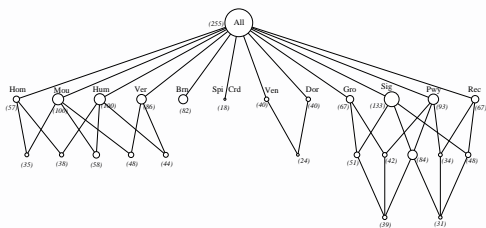
Expert-based confirmation: topics around human/mouse/homologous, signal/receptors/pathway/growth, ventral/dorsal

Epistemic communities

A socio-semantic pattern



Empirical Galois lattice



Epistemic network dynamics

Accounting for network evolution within the present framework

Preferential attachment, but regarding what, and how?

Age (*Dorogovtsev & Mendes, 2000*),
 Competitive trade-offs (*Berger et al., 2004*),
 Cognitive heuristics (*Fabrikant et al., 2002*),
 Past collaborations (*Jin et al., 2001*), Team mechanisms (*Guimera et al., 2005*), types (*Ramasco et al., 2004*), Underlying alleged communities, Partial neighborhood (*Stefancic & Zlatic, 2005*), (...)

Growth mechanisms: what, and how?

Epistemic network dynamics

What drives interaction?

- Preference for degree?
- Design of measure tools
- Non structural features might impact
- Most importantly, homophily does exist (*McPherson et al., 2001*), but to what extent?

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Preferential interaction: $\hat{f}(m) = \frac{v(m)}{P(m)}$

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Jaccard coefficient:

$$d(s, s') \in [0; 1] = \frac{|(s^{\wedge} \setminus s'^{\wedge}) \cup (s'^{\wedge} \setminus s^{\wedge})|}{|s^{\wedge} \cup s'^{\wedge}|}$$

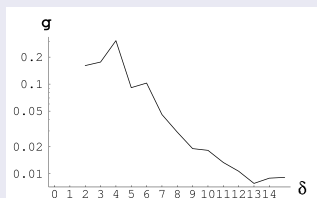
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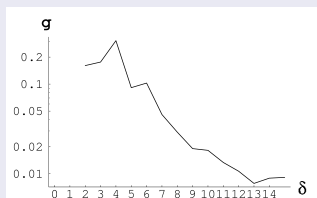
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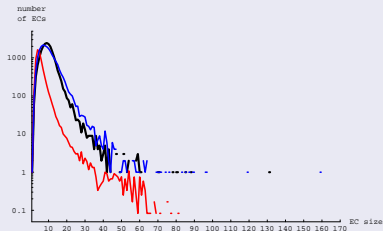
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Epistemic network dynamics

A model involving these mechanisms, along with event-based dynamics, rebuilds several features, in particular epistemic community structure.



Empirical socio-semantic networks

Fact

Network structure generally affects propagation processes (*Morris, 2000; Pastor-Satorras & Vespignani, 2001; Lloyd & May, 2001; Cowan et al., 2002; Deroian, 2002*)

(Knowledge-based) social networks might exhibit particular effects; the notion of universality may heavily depend on modeled processes

- Patterns proper to epistemic social networks may likewise be determinant
- ⇒ let's examine simplistic information diffusion on realistic knowledge networks (introducing a joint work with Jean-Philippe Cointet)

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Real network and impoverished versions

“Real Network” (RN): Scientific collaboration network

Its models

- “Scale-Free” (SF): link reshuffling while conserving connectivity
- “Erdos-Renyi” (ER): conserving density (same # of links & agents)
- “Complete Network” (CN): same number of agents only
- Clustering structure
 - “Event-based” (EB): underlying bipartite graph (event hypergraph), which rebuilds both classical clustering “ c_3 ” and degree distribution, but not “ c_4 ” (proportion of “diamonds”)

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Results

Hypotheses

Minimal interaction rule (immediate transmission) and asymptotic convergence (everybody gets informed)

Convergence speed

- The closest from RN, the slowest the convergence
- ER and SF behave very similarly, distinctly from EB, yet still relatively far from RN

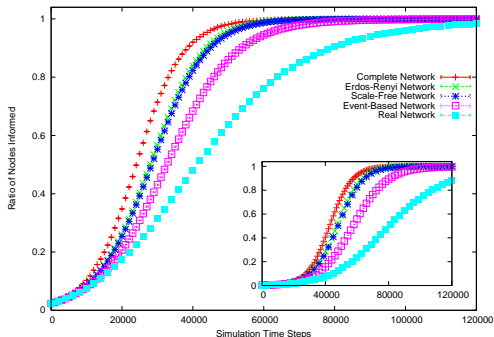
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Information diffusion on realistic structures

Besides “scale-free” networks not being all equivalent one to each other, even for such a simple protocol, they generally do not approximate correctly real-network-based diffusion behaviors.

In such a case, it might be necessary to diverge from universal statistical parameters and explore more precise **epistemic** patterns adapted to knowledge networks

Joint investigation of social and semantic features, morphogenesis and processes

Considering altogether epistemic patterns and diffusion processes may constitute a crucial step in explaining how network structure affects concept propagation and, at the same time, how concept propagation in turn affects the network.

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Thanks!

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<http://camille.roth.free.fr>

Context
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Patterns
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Morphogenesis
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Processes
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N. Berger,
C. Borgs,
J. Chayes,
R. D'Souza,
and
R. Klein-
berg
(2004).

Competition-
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