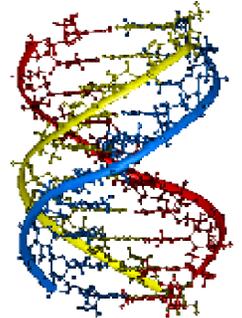
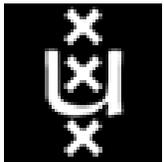


# How are “Big Data” a Challenge to the Social Sciences?

The Alternative of Dualism: mind/body

**Loet Leydesdorff**



University of Amsterdam,

Amsterdam School of Communication Research (ASCoR)

[Loet@leydesdorff.net](mailto:Loet@leydesdorff.net) ; [www.leydesdorff.net](http://www.leydesdorff.net)

# Monism: Priority for Thingness *versus* Dualism: “*Cogito Ergo Sum*”

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Antonio Damasio, *Descartes' Error*, (1994, p. 245):

“Taken literally, the statement (*Cogito ergo Sum*) illustrates precisely the opposite of what I believe to be true about the origins of mind and about the relation between mind and body.” (p. 245)

*Cogito ergo Sum* is not an empirical statement; it is a reflexive statement which generates the mind as a domain different from the body

Husserl (1929), *Cartesian Meditations*:

→ Psychology → **Intersubjective Intentionality**

→ Via Alfred Schutz, American pragmatism → “Double contingency”

# “Double Contingency” (Parsons, 1951)

***Ego expects Alter to entertain expectations as Ego entertains them herself.***

**(Each of us expects the others to entertain expectations as we entertain them ourselves.)**

“Double contingency” is the micro-foundation of inter-subjective intentionality;

**unlike** agency (*homo economicus*).

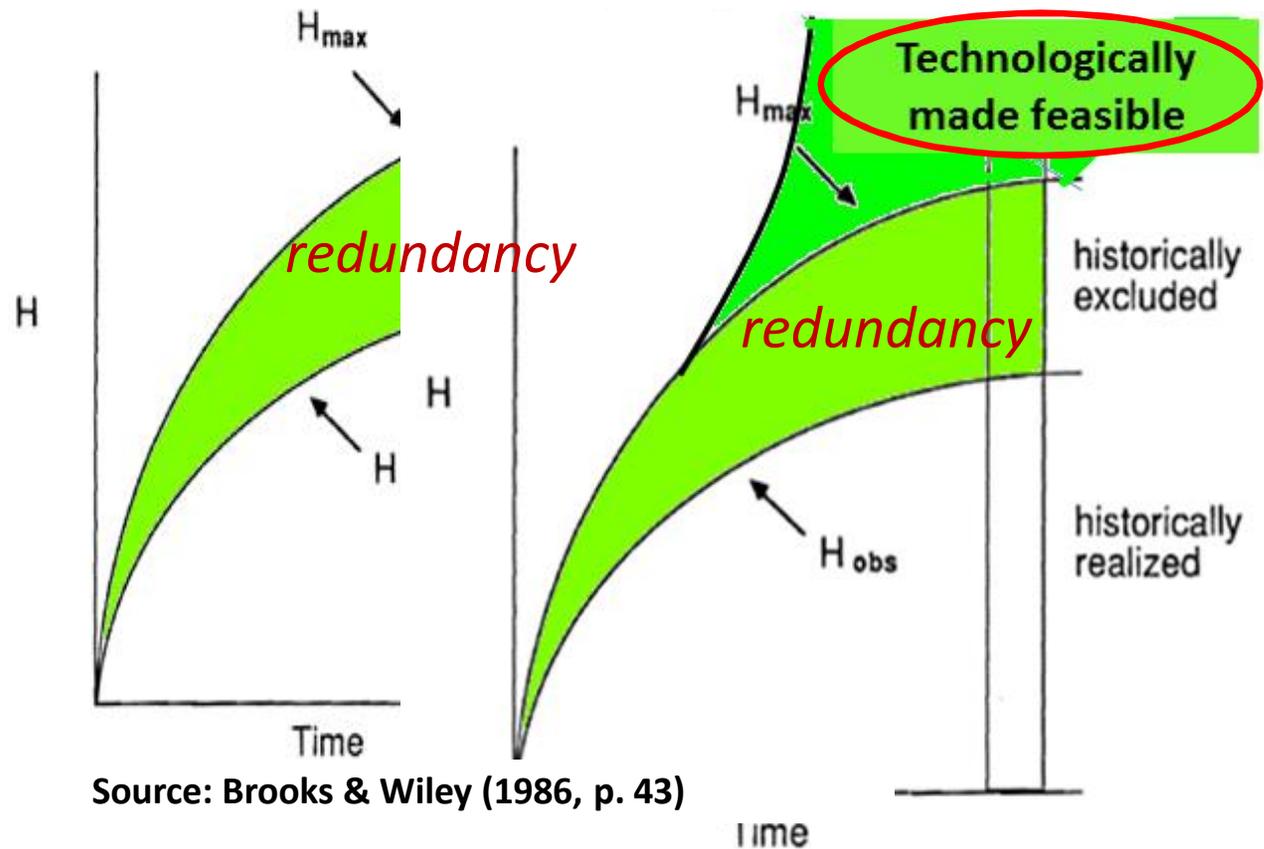
“Double contingency” shapes the social endogenously.

***Not a system, but a logic or in Husserl’s terms: a cogitatum.***

Leydesdorff, L., & Hoegl, F. (under review). **The Evolutionary Dynamics of Expectations: Interactions among Codes in Inter-Human Communications.** Preprint available at SSRN and from my website.

## Redundancy:

- “ the number of options hitherto not realized
- “ the complement of the information to the maximum entropy



Source: Brooks & Wiley (1986, p. 43)

# Operationalization and Measurement

1. Theory and computation of anticipatory systems:

$$x_t = ax_{t+1}(1 - x_{t+1})$$

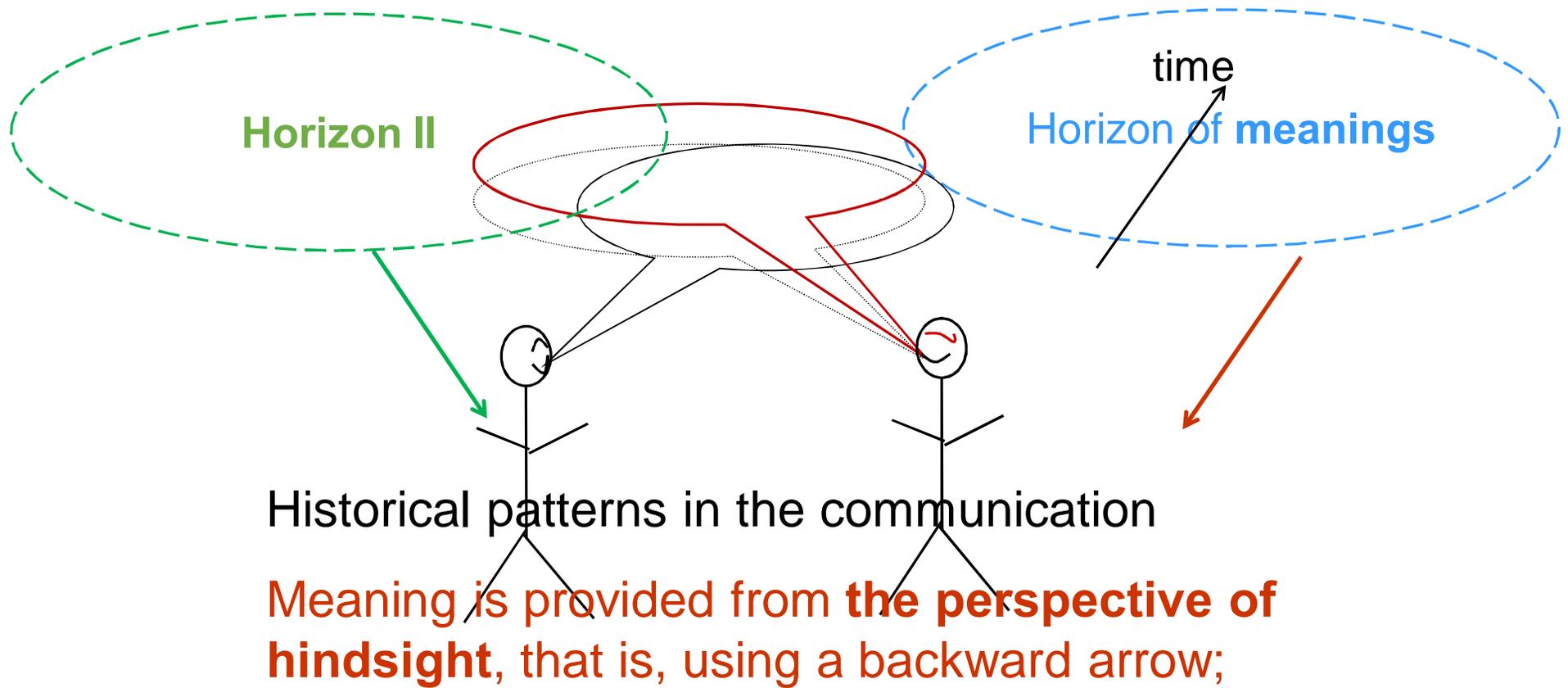
Expectations about future states reconstruct present states (backward).

2. Mutual redundancy among three or more interacting codes (selection mechanisms) may generate **negative entropy**:

$$T_{123} = H_1 + H_2 + H_3 - H_{12} - H_{13} - H_{23} + H_{123}$$

3. Luhmann: the communication self-organizes meaning.

Meaning is provided to events from the perspective of **hindsight, but with reference to** (supra-individual) horizons of meaning.



Historical patterns in the communication

Meaning is provided from **the perspective of hindsight**, that is, using a backward arrow;

Meanings can be codified with reference to a variety of **horizons of meanings**

“Social structures do not take the form of expectations about behavior (let alone consist of concrete ways of behaving), but rather take the form of expectations about expectations.”

Luhmann in discussion with Habermas in 1971.

Codies of the communication

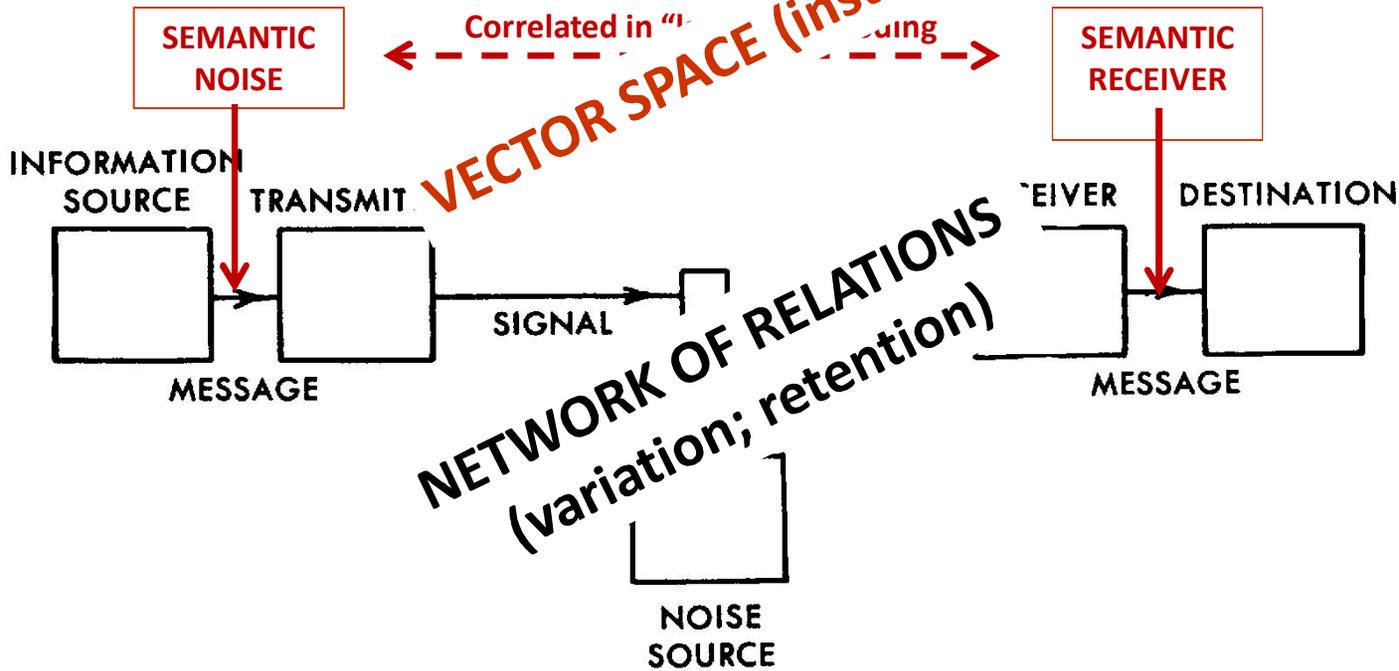
transl-

Codes in the communication

Weaver (1949, p.26): "Similar to the other boxes in the diagram which inserted between the source and the transmitter, should be labeled 'semantic noise' and the problem of semantic coding must take this semantic noise into account."

**HORIZONS OF MEANING**  
(global perspectives)

**VECTOR SPACE (instantiations)**



# Codes in the Communication Feedback at the Supra-individual Level

- “ Codes operate at the top level; not as systems, but as a logic;
- “ Knowledge generates redundancies against the arrow of time versus the generation of (probabilistic) entropy (Shannon).
- “ The complexity of the communication is evolving as redundancy
- “ Consequences for the “knowledge-based economy”: behavior of firms is phenotypical, the codes are “genotypical”
  - Distinction between historical developments (trajectories) and evolutionary dynamics (regimes)
  - Coordination mechanisms operating as selection environments upon one another → empirically possible generation of redundancy.

*res cogitans*

*res extensa*

Three levels:

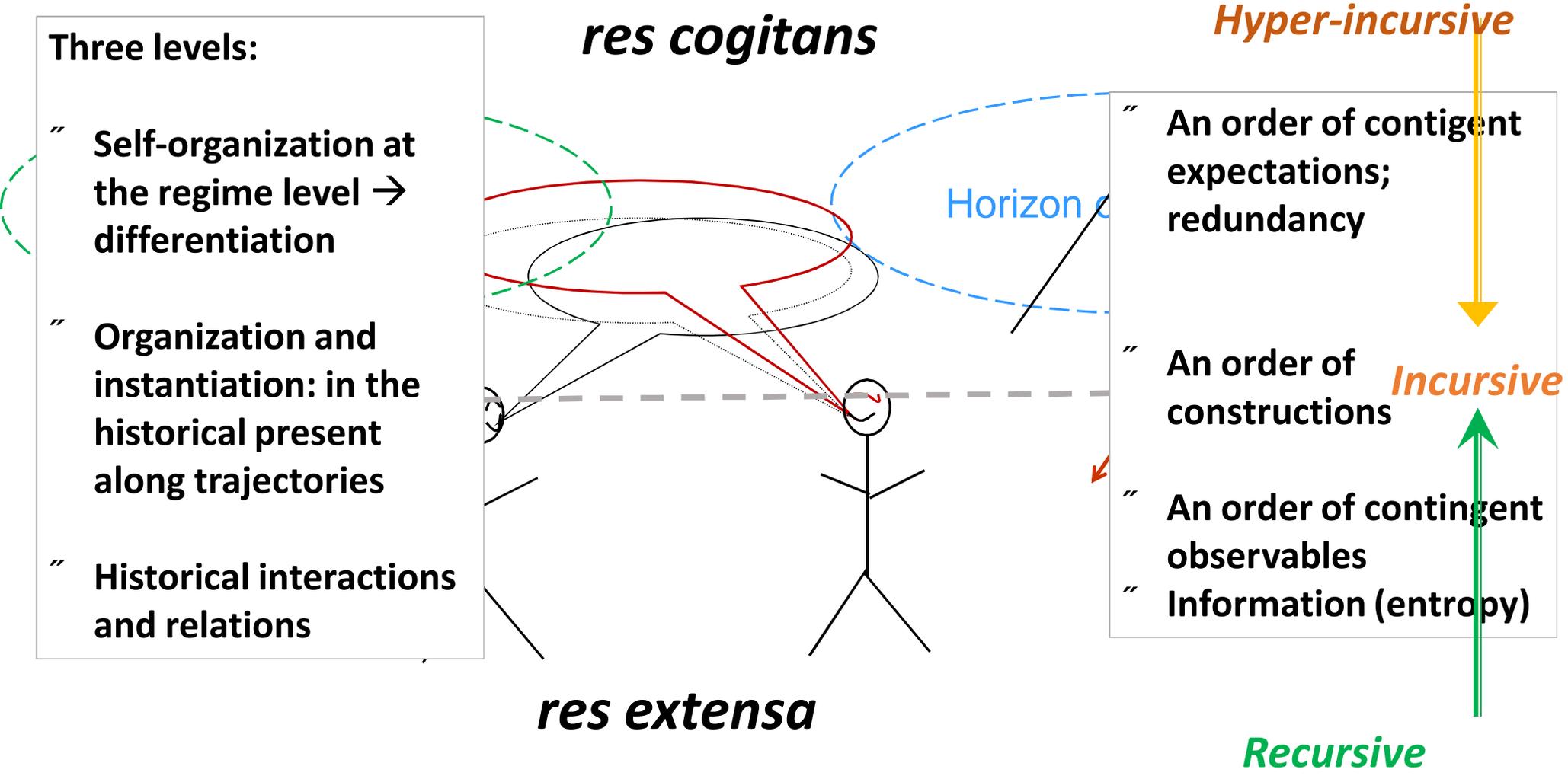
- " Self-organization at the regime level → differentiation
- " Organization and instantiation: in the historical present along trajectories
- " Historical interactions and relations

Horizon

*Hyper-incursive*

- " An order of contingent expectations; redundancy
- " An order of constructions *Incursive*
- " An order of contingent observables
- " Information (entropy)

*Recursive*



Three levels:

- “ Self-organization at the regime level → differentiation
- “ Organization and instantiation: in the historical present
- “ Historical interactions and relations

$$x_t = ax_{t+1}(1 - x_{t+1})$$

Sociological;  
double contingency;  
hyper-incursive

$$x_{t+1} = ax_t(1 - x_{t+1})$$

Incursive  
Innovation studies

$$x_{t+1} = ax_t(1 - x_t)$$

Biological

*Hyper-incursive*

“ An order of contingent expectations; redundancy

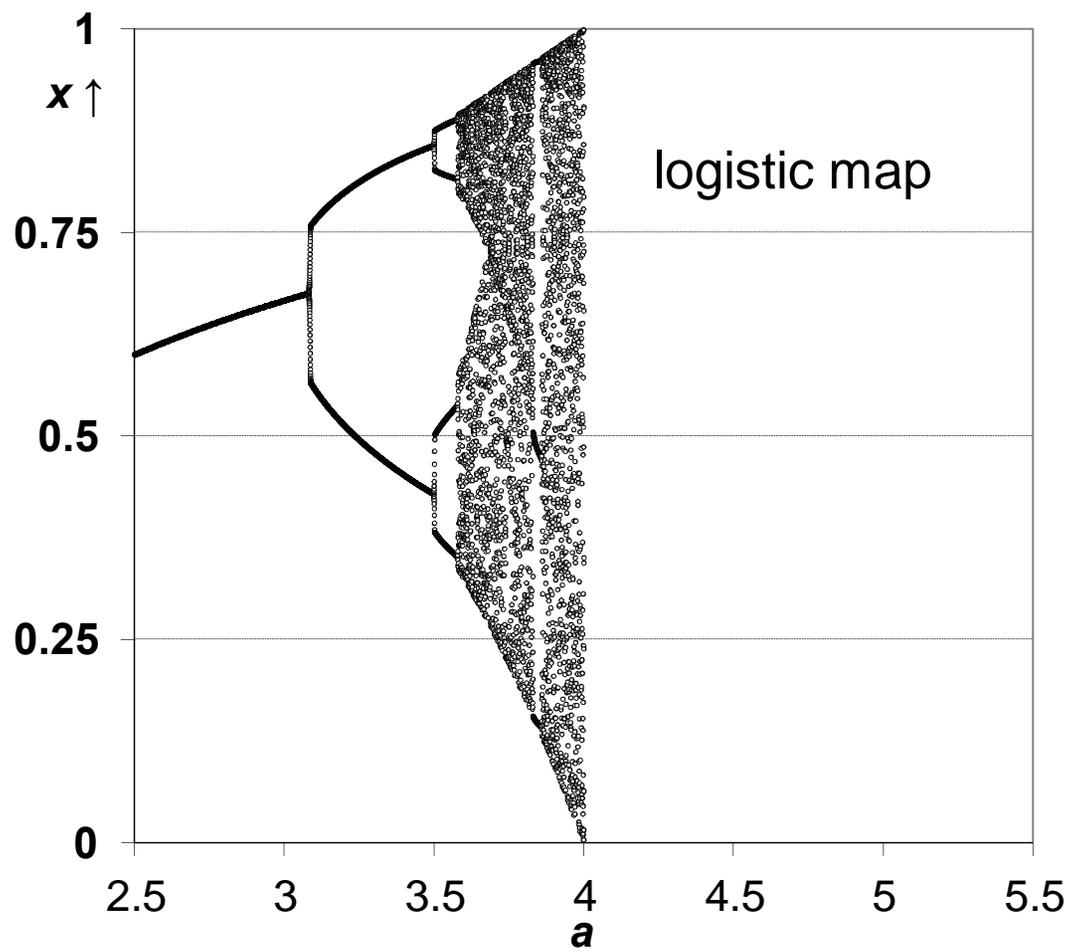
“ An order of *Incursive* constructions

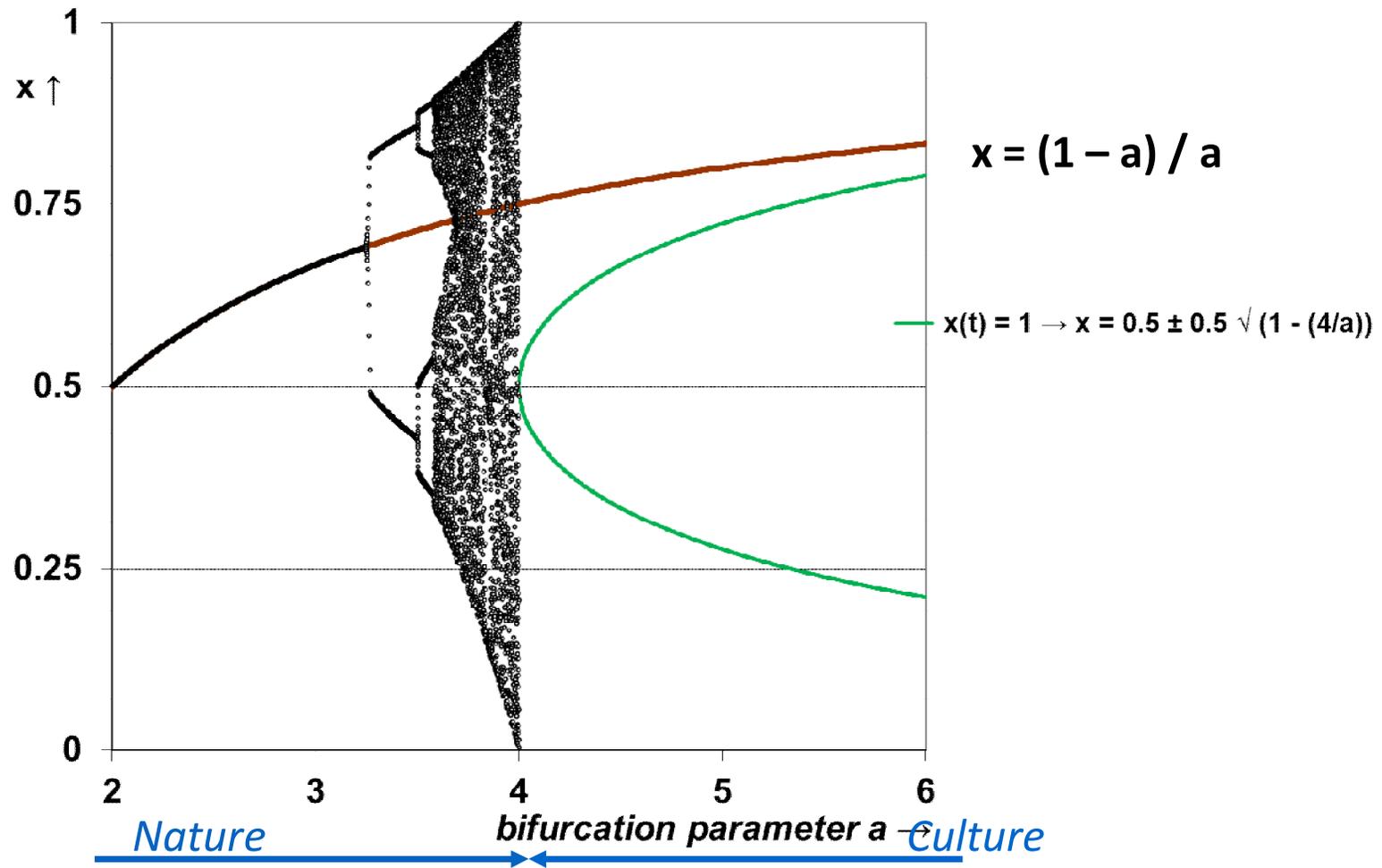
“ An order of contingent observables

“ Information (entropy)

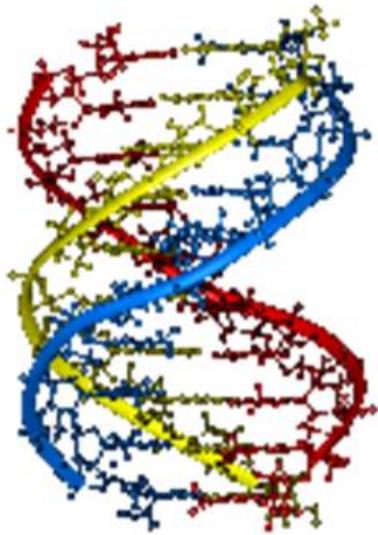
*Recursive*





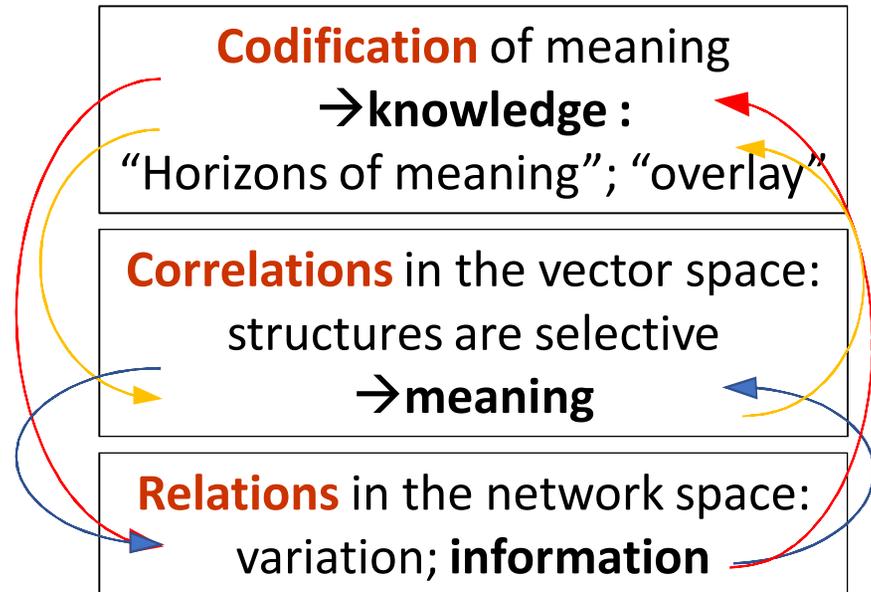


Horizontal differentiation  
(three or more) subdynamics



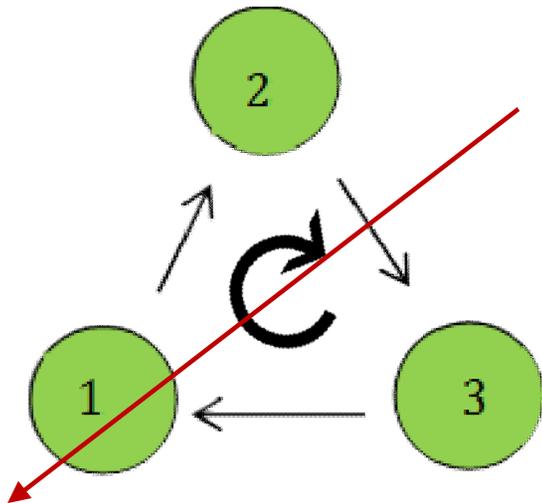
Triple Helix

Vertical differentiation:  
(feedback loops)

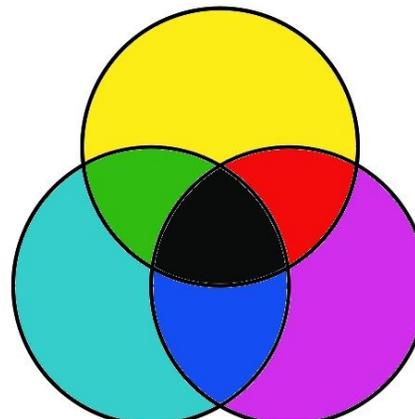
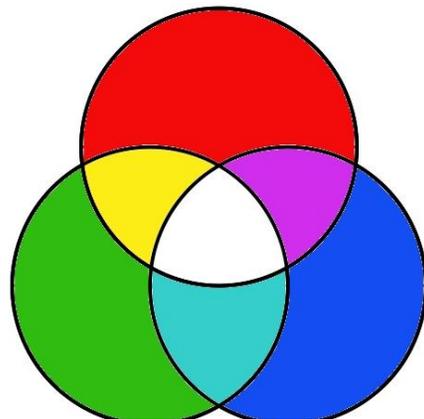
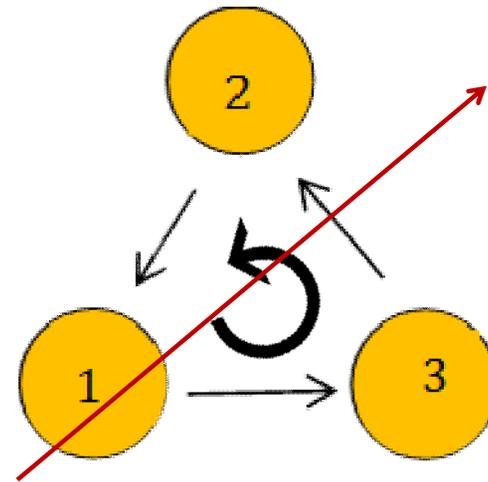


# Three or more interacting codes

*against time;*  
*reduction of*  
*uncertainty;*  
*evolutionary;*  
*redundancy;*  
*“genotypical”*  
*self-organizing*



*time;*  
*uncertainty;*  
*historical;*  
*information;*  
*“phenotypical”*  
*organizable*

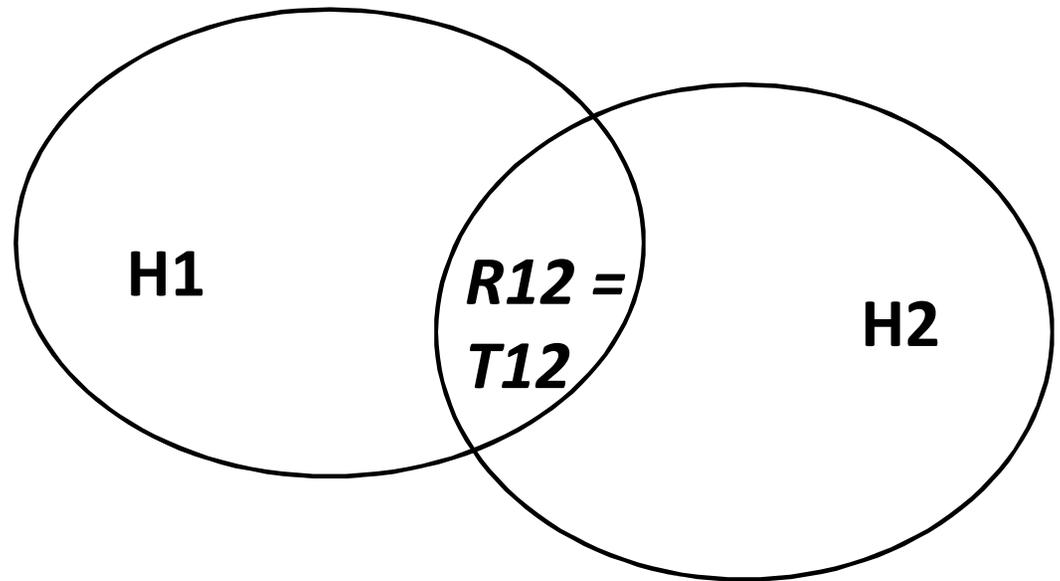


## ***Mutual Information:***

$$T_{12} = H_1 + H_2 - H_{12}$$

$$T_{12} \geq 0; \text{ *always positive*}$$

$$R = T_{12}$$

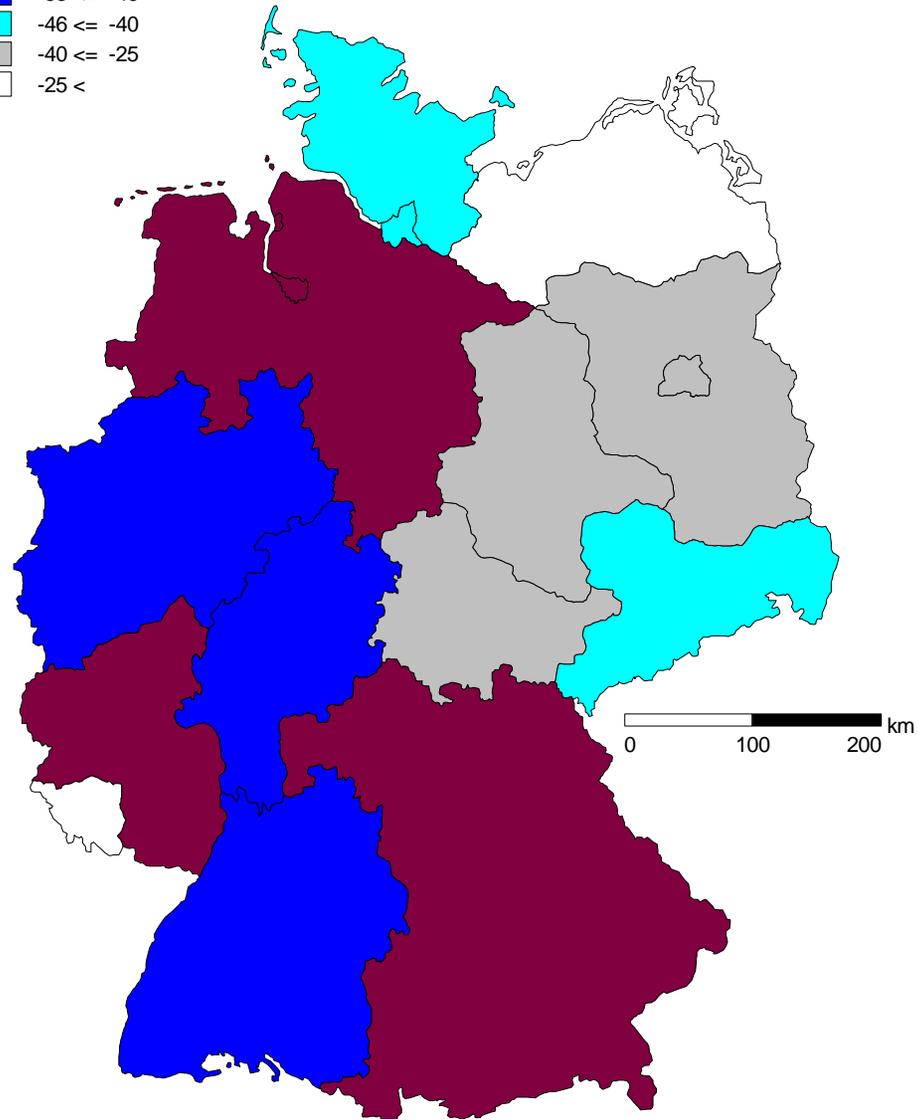


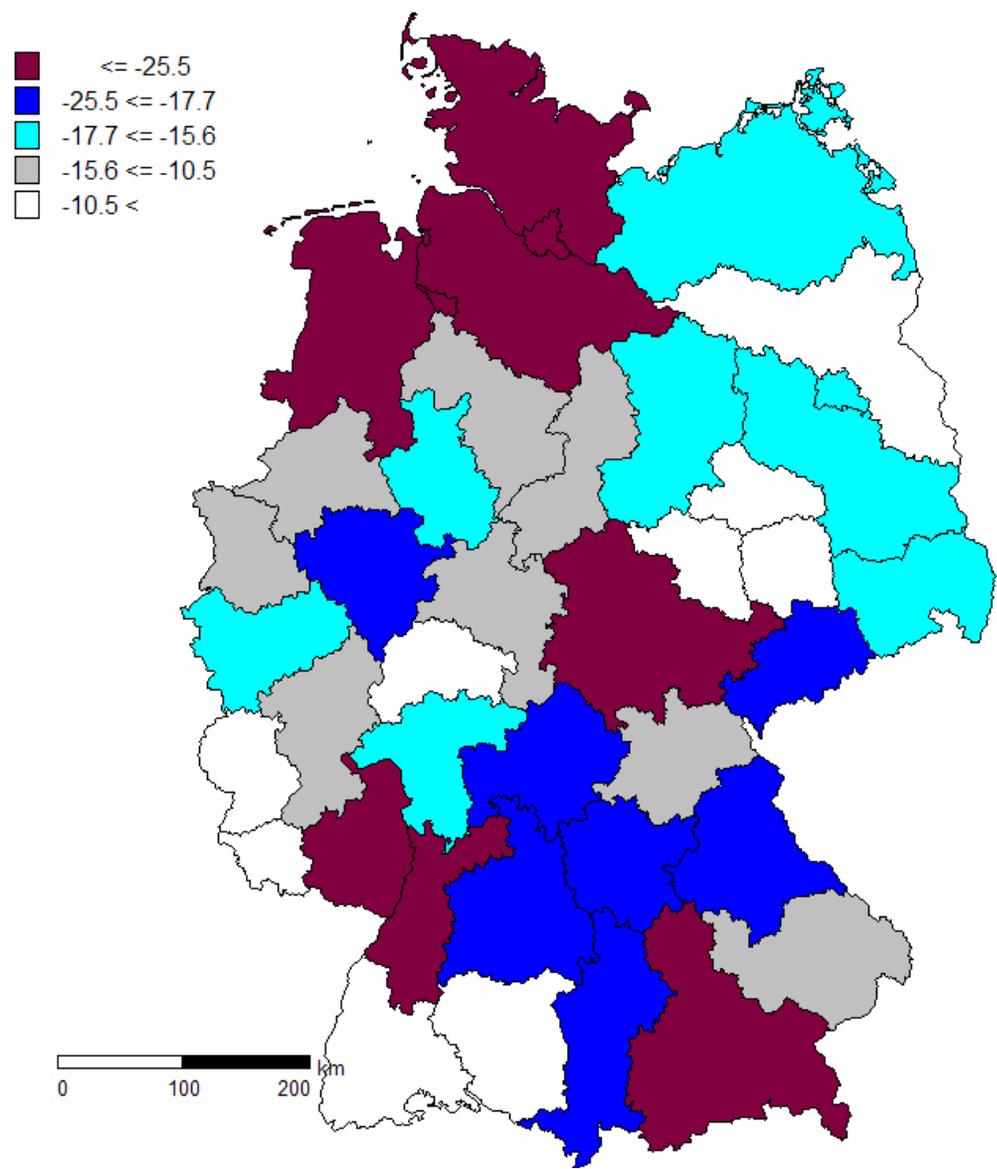
## ***Mutual Information in Three Dimensions:***

$$T_{123} = H_1 + H_2 + H_3 - H_{12} - H_{13} - H_{23} + H_{123}$$

$T_{123} < 0$  : redundancy generation; synergy; options

$T_{123} > 0$  : historical development; exploration; realizations





# Comparing regions

Results



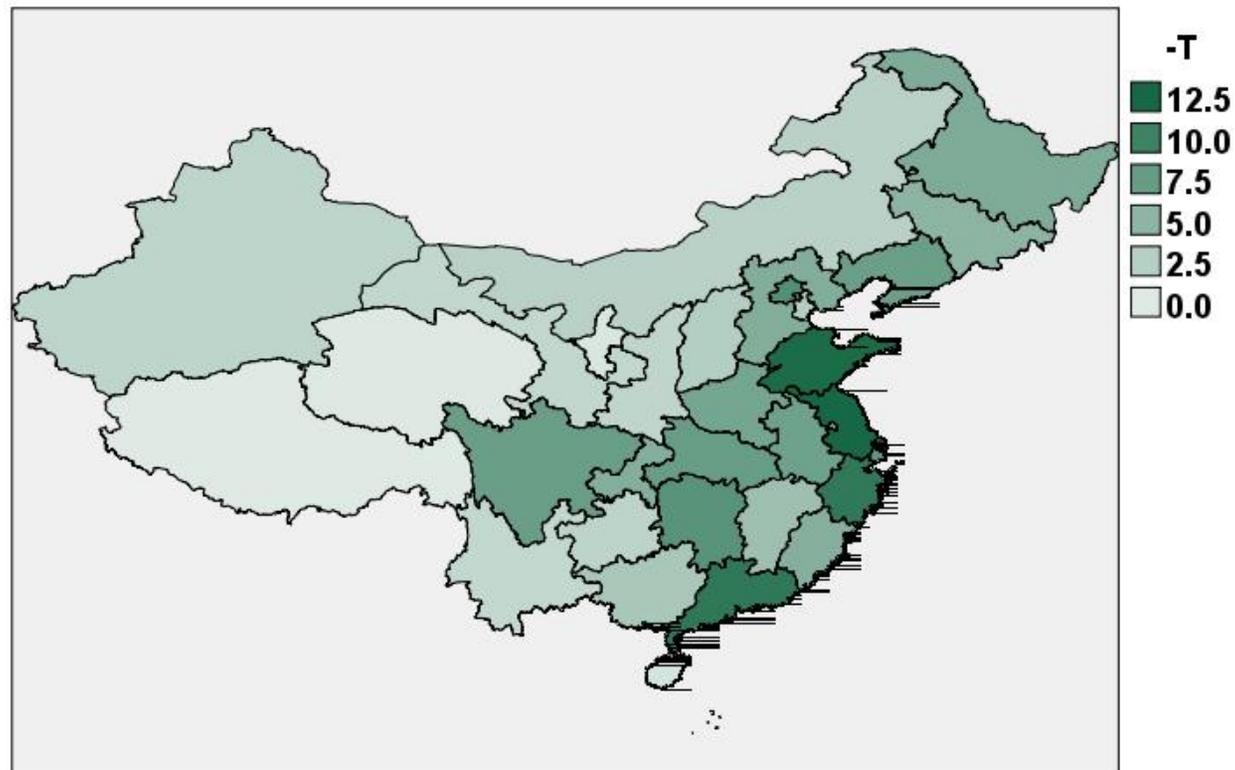
Federal States /  
*Bundesländer*  
(NUTS1)



Governmental Regions /  
*Regierungsbezirke*  
(NUTS2)

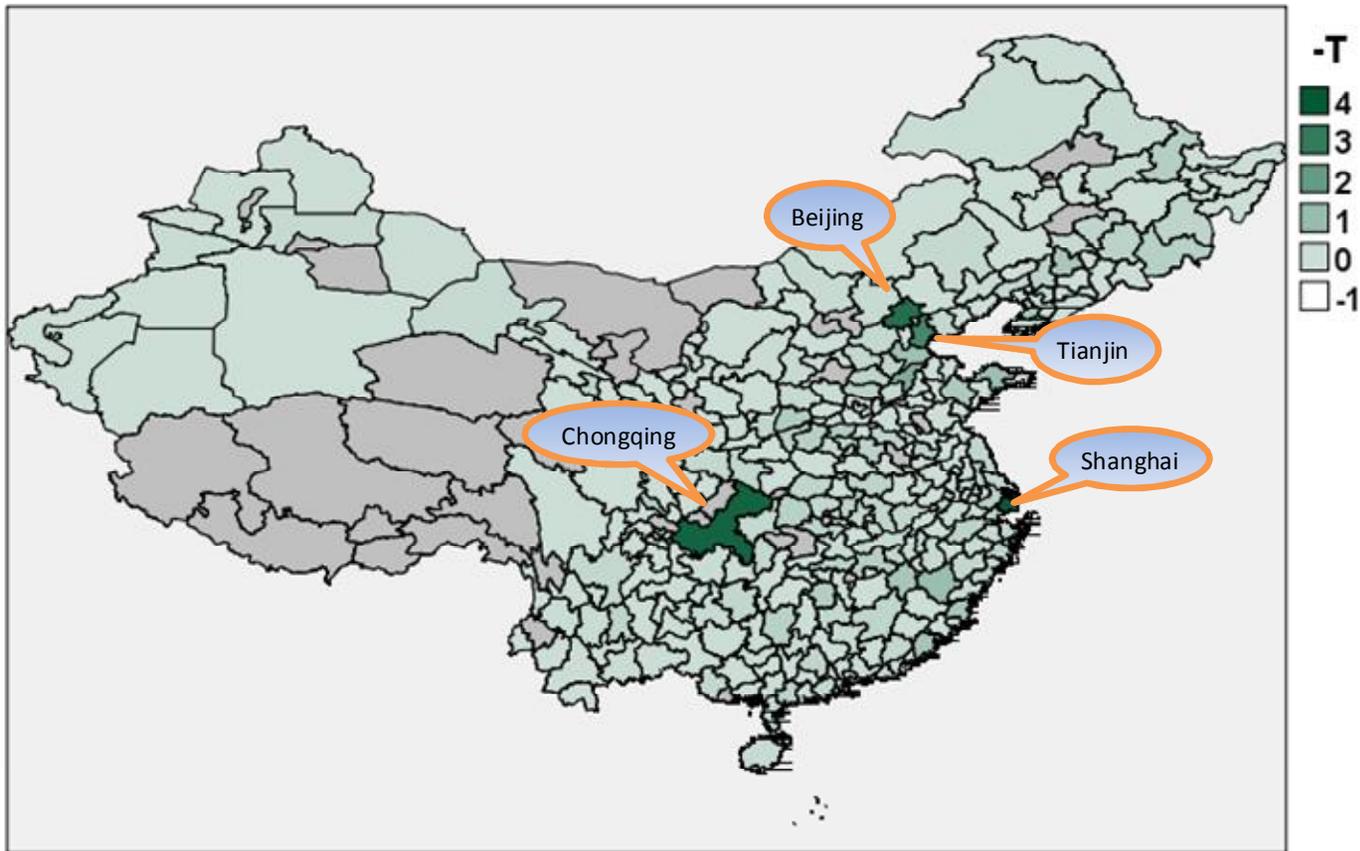


Districts / *Kreise und kreisfreie Städte*  
(NUTS3)



**Figure 3:** Synergies in the knowledge-based economy of China at the provincial level (years 2008-2010;  $N = 379,026$ );

Leydesdorff, L., & Zhou, P. (2014). Measuring the Knowledge-Based Economy of China in terms of Synergy among Technological, Organizational, and Geographic Attributes of Firms. *Scientometrics*, 98(3), 1703-1719



**Figure 2:** The distribution of 339 second-level administrative units in the PRC compared in terms of their contribution to the synergy among technology, geography, and organization.

V1	V2	v3	v4
0	0	3	0
0	6	0	4
9	0	0	3
4	4	0	5
0	3	4	0

V1	V2	v3	v4
0	0	3	0
0	6	0	4
9	0	0	3
4	4	0	5
0	3	4	0

V1	V2	v3	v4
0	0	3	0
0	6	0	4
9	0	0	3
4	4	0	5
0	3	4	0

V1	V2	v3	v4
0	0	3	0
0	6	0	4
9	0	0	3
4	4	0	5
0	3	4	0

T(123)

1	2	3	-0.24
1	2	4	-0.08
1	3	4	-0.23
2	3	4	-0.08

# Synergy indicator

- “ **The generation of additional redundancy**
  - more options than the sum of options in the subsets
- “ **Future options more important for an innovation system than past performance; (South Korea; Keun Lee, 2013)**
- “ **<http://www.leydesdorff.net/software/synergy.triads>**
  
- **Leydesdorff, L., & Hoegl, F. (under review). The Evolutionary Dynamics of Expectations: Interactions among Codes in Inter-Human Communications. Preprint available at SSRN and from my website.**
- **Leydesdorff, L. (forthcoming in 2021). *Communication-Theoretical Perspectives on the Dynamics of Meaning, Information, and Discursive Knowledge*. Cham, Switzerland: Springer.**

# Conclusions, Summary, and Discussion

- “ Cultural evolution is an evolution of expectations; future states can drive the evolving “system”;
- “ The codes are not “hard-wired” differently from DNA;
- “ Interacting selection environments can generate redundancy;
- “ The interactions generate “requisite variety” in the communication so that the communication can take control. The historical case is the one that happened (i.e., the subdynamic of morphogenesis).
- “ This sociological program of studies is *anti-biological* (vs. meta-biological).
- “ Against historicism → historical development vs. evolutionary dynamics; phenotypical vs. genotypical.
- “ Relevance for a knowledge-based economy: generate new options vs. past performance measurement
- “ Innovation systems; deadlocked or weak performance?