DIGITAL HISTORY AND PHILOSOPHY OF SCIENCE:
THE RECONSTRUCTION OF SCIENTIFIC PHYLOMEMIES AS A TOOL FOR THE STUDY OF THE LIFE SCIENCES

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Alexandre Delanoë, Ian Jeantet, Thibault Racovski

EPIQUE Project

http://iscpif.fr/epique

ISHPSSB
Oslo - July 9 2019

CAN WE MAKE SCIENCE EVOLUTION TANGIBLE ?
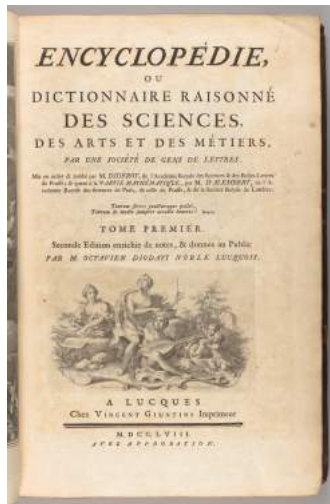
How to represent knowledge spaces ?

*[...] to gather in the smallest possible space and to place, so to speak, the Philosopher **above this vast labyrinth** in a very high view point from where he can see both the Sciences and the main Arts; see at a glance the objects of his speculations, the operations he can do on these objects; distinguish the general branches of human knowledge, the points that separate or unite them; sometimes even glimpse the secret roads that bring them together. It's a kind of **mappemonde** that must show the main countries, their position & their mutual dependence, the straight path there is from one to the other; path often cut by a thousand obstacles, which can only be known in each country by its inhabitants & which could only be shown in very detailed particular maps. These particular cards will be the different items in our Encyclopedia, the tree or abstract plan will be the mappemonde.*

D'Alembert (1751) L'Encyclopédie / Introduction to the 1st edition of the French Encyclopedia

How to represent knowledge spaces ?

*"Knowledge is impossible to draw as a whole in a truthful manner, but only through the **choice of a point of view that is both arbitrary and inevitable** [...] One can create as many different systems of human knowledge as there are **world maps having different projections**, and each one of these systems might even have some particular advantage possessed by none of the others."*

D'Alembert   (1751)
L'Encyclopédie/1ère
édition/Discours préliminaire

DIGITAL SPACES

&
AND SOCIAL BIG
DATA

TIME SCALES

Velocity

Audience

Seconde
> 6k pageview/s
> 40k/s requêtes

Minutes
> 347k/s WhatsApp messages
> 280k tweets/min
> 375k SMS/min

Hours
> 4k/h blog post
>6,25k edits/h on Wikipedia

Days
> 3,2k AFP news/d

Years
79k/y french papers
(> 2M peer reviewed papers/an

DIGITAL SPACES
&
AND SOCIAL BIG
DATA

Develop transversal methods
that makes it possible to
understand the socio-semantic
dynamics through their digital
traces.

Velocity

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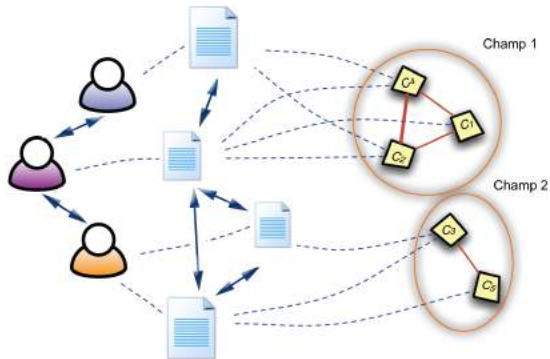79k/y french papers
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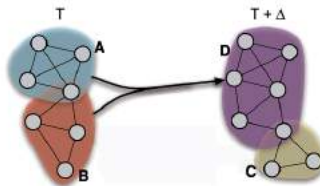
STIMERGY
CATALYST OF
COLLECTIVE INTELLIGENCE

Multi-partite structures
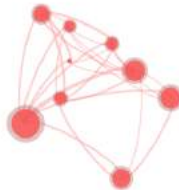
Multi-level structures

Macro
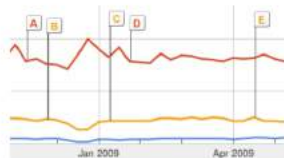
debates

social groups evolution
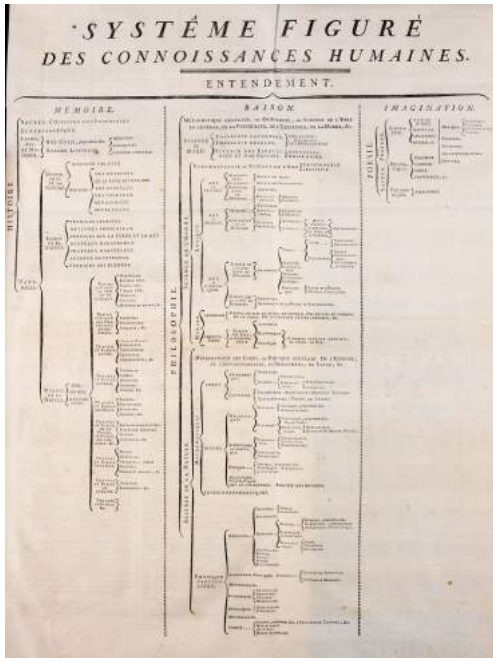
Meso

topics

social groups

Micro

individuals

terms

The knowledge labyrinths

In any case, the one of all encyclopedic trees that would offer the greatest number of connections between the Sciences would undoubtedly deserve to be preferred. D'Alembert (1751) L'Encyclopédie/1ère édition/Discours préliminaire

Quoi qu'il en soit, celui de tous les arbres encyclopédiques qui offrirait le plus grand nombre de liaisons & de rapports entre les Sciences mériterait sans doute d'être préféré.

ADDRESSING D'ALEMBERT'S CHALLENGE: TACKLING THE LABYRINTHS

► Build new interfaces with knowledge labyrinths,

► Shed light on the way they is evolving locally,

► Shed light on the way in which their different parts are articulated,

► Shed light on their global dynamics.

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Multi-scale structure of scientific fields

Macro
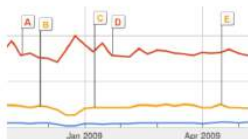
debates
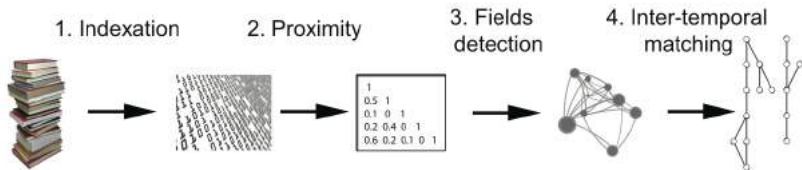social groups evolution
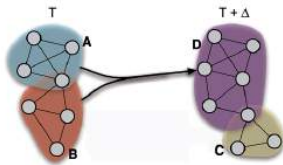
Meso

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Micro

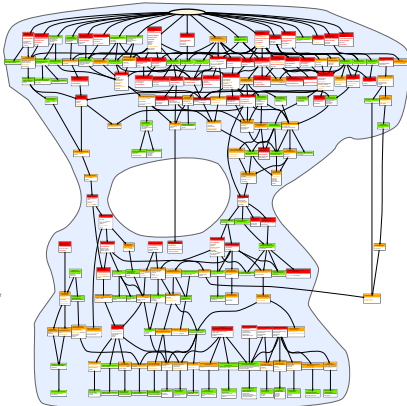individuals
terms

Phylomemies of science

Chavalarias, D., Cointet, J.-P., 2013. Phylomemetic patterns in science evolution—the rise and fall of scientific fields. PloS one 8, e54847.

Science phylomemy

Chavalarias, D., 2016 (HDR) https://hal.archives-ouvertes.fr/tel-01394843v1
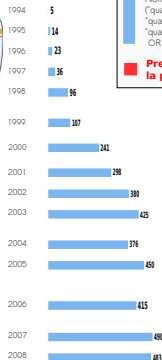
ORDINATEURS QUANTIQUES

1994 - Peter Shor algorithm to factorize
large integers
1995 - First schemes for quantum error correction.
- First realization of a quantum logic gate
1996 - First quantum database search algorithm.
- First public call for research proposals in
quantum information processing
(US Gov. & Army).

1998 - First experimental demonstration of a quantum
algorithm.
- First working 3-qubit NMR computer

2001 Negative result
Demonstration by Noah Linden and
Sandu Popescu that entanglement (so far absent
from experiments) is a necessary condition for a
large class of quantum protocols.
2002 Quantum computation roadmap.

2003 - Quantum controlled-not gates using only linear
optical elements
- DARPA Quantum Network operational

2004 - First working pure state NMR quantum computer

2005 - First quantum byte, or qubyte
- First transfer of quantum information between
"quantum memories"

2006 - 2007
acceleration of discoveries.
Cf. https://en.wikipedia.org/wiki/Timeline_of_quantum_computing

Year	Count
1994	5
1995	14
1996	23
1997	36
1998	96
1999	107
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2002	380
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2004	376
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2006	415
2007	490
2008	483

1999 Membrane computing, natural

2001 EUV, Quantum matter

2002 Quantum memory channel, topological
quantum computing, magnetodielectric

2003 One-way quantum computing,
superconducting nanocircuits,
pulse engineering, cluster states

LEGENDE

Nombre de documents du WoS pour la requête
("quantum communication" OR "quantum information" OR
"quantum computing" OR "quantum computer" OR
"quantum processing"
OR "quantum algorithm")

**Première apparition du terme dans
la phylomémie**

Science phylomemy

(Chavalarias, D., 2016 (HDR)) https://hal.archives-ouvertes.fr/tel-01394843v1

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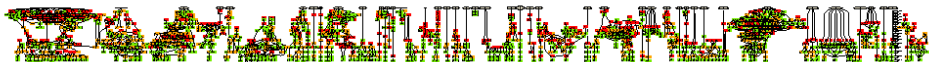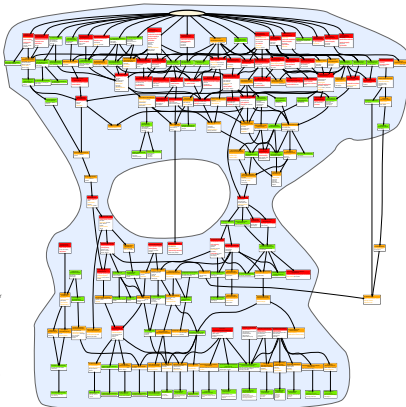– First execution of Shor's algorithm
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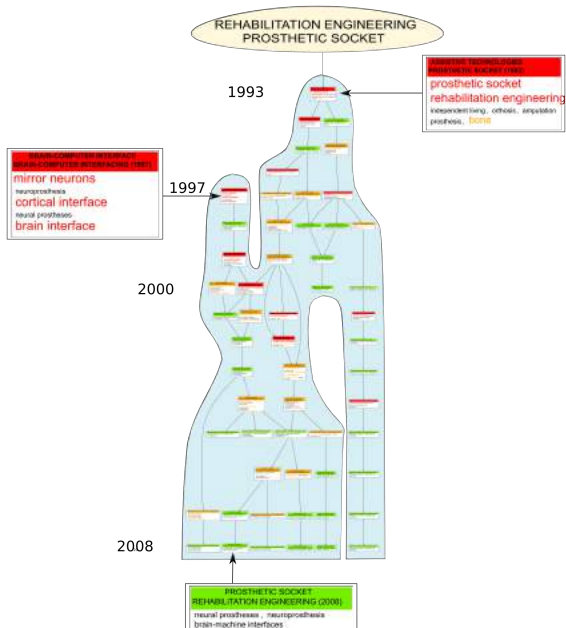2004 – First working pure state NMR quantum computer

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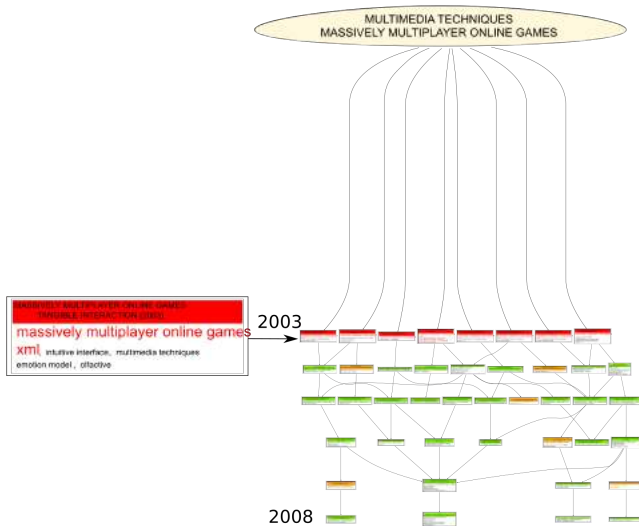"quantum memories"

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"quantum algorithm")

Première apparition du terme dans
la phylomémie

Phylomemies : fields hybridization

Phylomemies : fields emergence

► What are the first questions to address ?
► What kind of interdisciplinarity is this ?