# **Emformation Theory** Theory of Emergent (In)Formation

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for Natural Philosophers



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#### Dilemma and Excuse

- The eternal goal is to understand the world
- This is to be done scientifically (by scientific community & method) because this has proved so successful in the past
- However, in this postmodern era there are challenges, for example, because of attacks by *ironic science*, etc.
- Science seems to build barricades to protect itself: there are rigid paradigmatic dogmas and an unchallenged "clergy"
- Financing is directed through "top units" to efficiently reach the given goals there are no illusions of "general theories"
- And, after all, scientists form a cybernetic "ape like" society!



= This research has not gone through the scientific scrutiny!

#### Fundamental Scientific Deadlocks

- Can science ever attack today's big problems concerning complex (living!) systems?
- Dawn of modern science: Descartes' dualism dichotomy between mind and matter, or subject and object
- We always search for a centralized structure of cause and effect (causing problems to understand economy, etc.)
- However, in reality, all subjects are objects, and all objects are subjects; there is no central coordination or supervision
- Even Platonic "ideal" structures collapse: systems are *pancausal*, and the borders between systems are *fuzzy*
- For example, a hare dies alone; even a population is not sustainable, you cannot detach it from the environment



#### Wider Views Needed Again = Philosophies

- Traditional thinking: for example, Platon ("change is illusion"), and still early Wittgenstein ("world is a collection of facts")
- However, looking from above, matching of surface patterns only is not enough, one needs to recognize *dynamic patterns*
- Heraclitus already held the keys ...
  - "Everything flows, nothing stands still."
  - "Nothing endures but change."
  - "Opposition brings concord. Out of discord comes the fairest harmony."
  - "Nature is wont to hide herself." ...
  - ... But "thinking aids" were available only after Newton.
- Need to escape the Wittgensteinian barriers need new frameworks, need new concepts and languages ...



#### Conceptual Tool: Mathematics

- Natural language is one-dimensional, uses crisp symbols, and makes it difficult to study time-dependent phenomena
- Extend natural language by making differential calculus and linear algebra / matrix methods integral parts of it:
  - In mathematics, generally, interpretations can be left aside, the "reasoning" can be carried out separately, and the semantics applied only afterwards
  - **Statistical tools** make it possible to filter noisy variables so that *abstractions* can be found; with real variables *non-integer quantities* can be manipulated
  - **Differential calculus** makes it possible to study change and infinitely small quantities
  - Linear algebra makes it possible to study cycles and long time scales, and, specially, infinity can be attacked
  - **Matrix methods** make it possible to manipulate high dimensions and, what is more, distributedness. –This is necessary this is what Newton did not have!



#### Role of Emformation Theory

• Technical and philosophical discussions are now separated!



#### Structure in the Structurelessness

- "In the beginning there is Chaos"
- There are countless identical entities with differing properties
- Entities cannot be seen individually, only sums, statistically
- Suddenly, we know exactly what we can know
- Central limit theorem:

The net distributions of properties must all be Gaussian

- Normal distribution of variable *z* is characterized completely by the two independent attributes of the distribution:
  - First moment MEAN  $E\{z\}$  (expectation of the variable)



• Second moment  $E\{z^2\}$ , or (centered) VARIANCE  $E\{z^2\} - E\{z\}^2$ 

#### Now: Metaphysical Interpretation

- There are also two statistics characterizing (scalar) chaos
- The former, the *level* E{*z*}, is what one can directly observe it is **matter**, what one can see in the instantaneous snapshot
- This is what one normally solely concentrates on
- The latter, the *variation* E{*z*<sup>2</sup>}, has somewhat liquid nature and is typically ignored
- But now in the Heraclitean / process philosophical spirit, we are interested in what is varying and changing!
- The quantity E{z<sup>2</sup>} is here called **emformation** and it will be studied exclusively from now on.



#### Intuitions in Retrospect

- Variations are "differences that can make difference" in the world (in the spirit of Bateson)
- Emformation has the capacity to make changes:
  - In the physical world, emformation is typically related to **energy** (for example, kinetic energy is  $1/2 m E\{v^2\}$ )
  - In the non-physical (also mental) worlds, emformation is related to (Fisher) information
- Note: the same principles in ontology and epistemology later it turns out that **interobjectivity** is possible?
- As will be seen, emformation  $E(z^2)$  determines *emergent dynamic structures* where the matter E(z) or z resides in



• There is **new dualism** among matter and emformation

#### Technical Notes

- How to understand the universality of  $E(z^2)$ ?
- Assume that some kind of field is (seen), the variable implementing a string with force:

Energy = 
$$\int_0^z kz \, dz = \frac{1}{2} k \, z^2$$

and remember that energies are scalar and summable

- Thus, variables are seen to store some potential
- Also derivatives (like velocities) can be interpreted similarly
- Everything depends on the origin of the frame of reference
- Why not nonlinear strings, etc.? Remember the chaos!



#### System Semiosis

- Assume that there are many variables  $u_j$  and  $x_i$  and they can interact ( $1 \le i \le n$ ,  $1 \le j \le m$ )
- Variables  $u_j$  are here assumed to be independent resources or potentials, and  $x_i$  are induced activities or flows
- Define (generalized) linear *diffusion* in steady state

$$\overline{x}_i = \sum_j a_{ij} \overline{u}_j$$

- Understand the roles of the new variables:
  - $x_i$  = "Short-term storage unit", storage of the momentary state; variable implementing some kind of *inertia*
  - $a_{ij}$  = "Long-term storage units", hosting the emerging structures; in practice, can be implemented through physical construction (like proximities)



#### **Emformation Pursuit in Time Domain**

• The assumed interaction mechanism also is

 $\overline{x}_i = a_{i1}\overline{u}_1 + \dots + a_{im}\overline{u}_m$ 

• The expression for acquired emformation becomes

$$\mathbf{E}\left\{\overline{x}_{i}^{2}\right\} = \mathbf{E}\left\{\overline{x}_{i}\overline{x}_{i}\right\} = a_{i1}\mathbf{E}\left\{\overline{x}_{i}\overline{u}_{1}\right\} + \dots + a_{im}\mathbf{E}\left\{\overline{x}_{i}\overline{u}_{m}\right\}$$

• Evolutionary winning strategy can be defined as

Maximize  $a_{i1} \mathbb{E} \{ \overline{x}_i \overline{u}_1 \} + \dots + a_{im} \mathbb{E} \{ \overline{x}_i \overline{u}_m \}$ when  $a_{i1}^2 + \dots + a_{im}^2$  is bounded • Lagrangian optimization technique gives  $a_{ij} = q_i \mathbb{E} \{ \overline{x}_i \overline{u}_j \}$ 



## "Winning Strategy"?

- One needs no conscious adaptation to take place, it is an illusion when looking the group from outside, after "survival"
- Emformation makes difference, it becomes visible; the fittest entity has evolutionary advantage, emerging most efficiently
- One can interpret that there is *hunger for life* (livelihood)
- It seems that notorious **vitalism** might be coming back?
- It is possible to approach questions of the type WHY
- Analyses starting from below, through emergence ("birth"), in a distributed manner without central control ("subject")
- Yes, this is not science, this is natural philosophy! : O)



#### From Now on ... Mere Mathematics

• When the interaction expression is written simultaneously for all available *x* and *u* in the matrix form, one has

$$\overline{x} = Q \operatorname{E}\left\{\overline{xu}^{T}\right\} \overline{u}$$

- This was the "Hebbian rule" that was used as a starting point in **neocybernetics** studies (see *selfish agents*)!
- See the presentation in 2006 on "neocybernetics"! (in WEB)
- Newer conclusions from <u>http://neocybernetics.com</u> ...
  - <u>http://neocybernetics.com/publications/pdf/cybernetics-of-neuron-systems.pdf</u>
  - http://neocybernetics.com/publications/pdf/STeP2010-HH1.pdf



#### Linear Stabilization: Mechanism of Feedback

- Pure signal flows do not exist: *exploitation* means *exhaustion*
- Such coupling of variables introduces "matching of tensions"





... In Steady State High dimension "Resource"  $\mathcal{U}$ Estimate  $\hat{u} = \phi \ \overline{x}$  $\varphi^{T} = \left( \mathbf{E} \left\{ \overline{xx}^{T} \right\} + Q^{-1} \right)^{-1} \mathbf{E} \left\{ \overline{xu}^{T} \right\}$  $\phi^{T} = Q \operatorname{E}\left\{\overline{xu}^{T}\right\}$  $\overline{u} \neq u - \hat{u}$ Negative feedback  $\hat{\overline{u}} = \overline{\varphi} \, \overline{x}$ • There is a strange dual symmetry • Circulation binds the environment Environment to the system, *u* being "eaten up" System • Simultaneously, "elasticity axes" get instantiated  $\overline{x} = \varphi^{\mathrm{T}} u$ Internal HELSINKI UNIVERSITY OF TECHNOLOGY  $\overline{x} = \phi^{\mathrm{T}} \overline{u}$ state Control Engineering Laboratory Low dimension

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#### Elasticity axes: Case of supply vs. demand



#### "New Dualism": the Visible and the Invisible

- Model, the dynamical attractors, or the systemic "lockers" (niches) are based on statistical correlations over time/space
- For example, *availability of money* in different product groups determines the *clever product portfolios* for companies:





### Systemic (Ecological) Lockers?



#### Properties of a Neocybernetic System

#### • There are various seemingly controversial intuitions:

- Information theoretically, improbable variation is valuable; now, noise gets abstracted away, only consistent covariations are seen to carry *relevance*
- Linearity rather than nonlinearity is valued (this turns out to be optimal for capturing emformation); still, sparsity and crispness ("static friction") emerges
- Rather than searching for "maximum instability", stability is pursued; however, this results in maximum "throughput" and *entropy maximization*
- To start with, the system is seen as a "slave", being completely mastered by the environment; later on, the system seemingly controls its environment
- The system implements optimal model (in terms of principal subspace and sparsity pursuit); simultaneously, it implements optimal estimation of the environment (in terms of regularized least squares regression)
- Neocybernetic systems can be studied in the frameworks of optimal and adaptive control: emformation gets controlled



#### **Extension: Cycles Everywhere**



#### Another View: "Monads" (in the spirit of Leibniz)



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#### Life

- Define LIFE = Fractal structure of monads
- Life is a process rather than a pattern; complexity can vary
- "Mental life" on top of physical and all part of "social life"
- "Organisms" live of the self-modeled emformation, emformation pursuit results in *emergence*
- Life can exist in different phenospheres (noospheres)
- Traditional *descriptive* definitions are seen from above:
  - Cells are not necessary, they just host the monads
  - Reproduction is only needed to regenerate after collapses (see later)
  - Genetic code (or any scriptures!) is only needed to fast instantiate monads after the "individual chaos"; in the right order, without fuss



#### Routes to Collapse



- About the coupling factor  $q_i$ 
  - Coupling takes place (the elementary loop starts) only for large enough  $q_i$
  - There is optimum  $q_i$  where emformation transfer into system gets maximized
  - Better coupling is good for an individual, bad when becomes a general rule!



#### Back to Chaos (also in a Non-Trivial World)

- Neocybernetic system is an *adaptive controller*: as the controller becomes more efficient, emformation gets better eliminated, and after that there is loss of excitation
- Continuing adaptation means that the model is sooner or later no more valid, and eventually there is chaos again
- This is the nature's way to regenerate!
- Indeed, along time axis there is a succession of collapses
- There is a *spectrum* of fresh emformation for a higher-level system to see!



#### Spectra are fundamental: again, birth emerges from below ...

#### Internal Dynamics: Ensemble Kalman Filter

• Find an "ensemble" of simpler data (x) to represent the distribution of the complex data (u), assuming Gaussianity:

$$p(u \mid x) \propto \left(-\frac{1}{2}\left(u - \phi x\right)^T R^{-1}\left(u - \phi x\right)\right)$$

• Solution: update the model from prior to posterior as

$$x^{\text{posterior}} = x^{\text{prior}} + \text{Cov}\left\{x^{\text{prior}}\right\}\phi^{T}\left(\phi\text{Cov}\left\{x^{\text{prior}}\right\}\phi^{T} + R\right)^{-1}\left(u - \phi x^{\text{prior}}\right)$$

• After manipulations, for  $R \rightarrow 0$  this can be approximated as

$$\frac{dx}{dt / \tau}(t) \approx \phi^T \left( u - \phi x \right) = \phi^T \tilde{u}(t)$$



meaning that this is the optimal dynamic state update rule!

#### Entering Frequency Domain

- System grows more internal connections than inputs
- The "virtual inputs" are also monads = dynamic entities:

$$\frac{d\tilde{u}}{dt / \tau_u}(t) = -\phi x(t)$$
 Negative feedback effect

so that, when collected together

$$\frac{d^{2}x}{dt^{2}/\tau_{x}\tau_{u}}(t) = \phi^{H} \frac{d\tilde{u}}{dt/\tau_{u}}(t) = -\phi^{H}\phi x(t) \quad \text{Just one variable - solvable!}$$
  
so that  
$$x(t) = A \sin\left(\sqrt{\frac{1}{\tau_{x}\tau_{u}}}\phi^{H}\phi t + \psi\right) \quad \text{Initial values (amplitude, phase)} determined by the input signals}$$



• What one has, is an undamped harmonic oscillator!

#### Towards Ethics?

- When the signals are electric, loops act like *antennas*?
- Assumption: inter-system interactions become possible through *fields*, free of physical space and time?!
- Seems to offer increased functionalities in neocybernetic molecular orbitals and conscious brains ... lesson to learn?
- In the (extended) Hegelian spirit (and in the spirit of Zen), one should constitute the consciousness of one's world
- But there is no *aether* for "morphic fields" in this case?
- Human has to emulate the signal carriers in one's entirety
- Identify all the fields and their phases, immerse in the world, and apply your own impact appropriately!





#### Conclusion



• Narrative: the eternal cycle from chaos to chaos



- and, perhaps, towards integrity on some higher level