School of Industrial and Information Engineering

Campus Leonardo

Department of Electronics, Information and Bioengineering

POLITECNICO DI MILANO

Corso Internazionale di Perfezionamento in Programmazione Neurolinguistica, Modello Pragmatico Elementare, Teoria delle Competenze Relazionali.
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Sogno, Creatività e Tecnologia

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Presentation Outline

1. Introduction (06)
   - Systemic Reference Paradigms
   - Historical Links
   - Classic Scientific Method and Natural Method
2. Double-Bind: Two Examples from CICT (06)
   - Stochastic vs. Combinatorial Noise Characterization
   - First Example (16 by 16 pixel, 256-shades of gray image)
   - Second Example (4,096 by 4,096 pixel, 16,777,216 true color image)
3. CICT (Computational Information and Communication Technology) (10)
   - Information Concept Operative Links
   - Bio-Quantum Physics Evolutionary Principle
   - CICT Contemporary Double-Bind Solution Path
4. Creativity and Learning (13)
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5. Dreaming and Creativity (11)
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   - EPM Logically Articulated Problem Solution Path Hypothesis
6. Summary and Conclusions (02)
   - Main Conclusions
   - Main References
   - Thank You for Your Attention

1. Introduction (00)

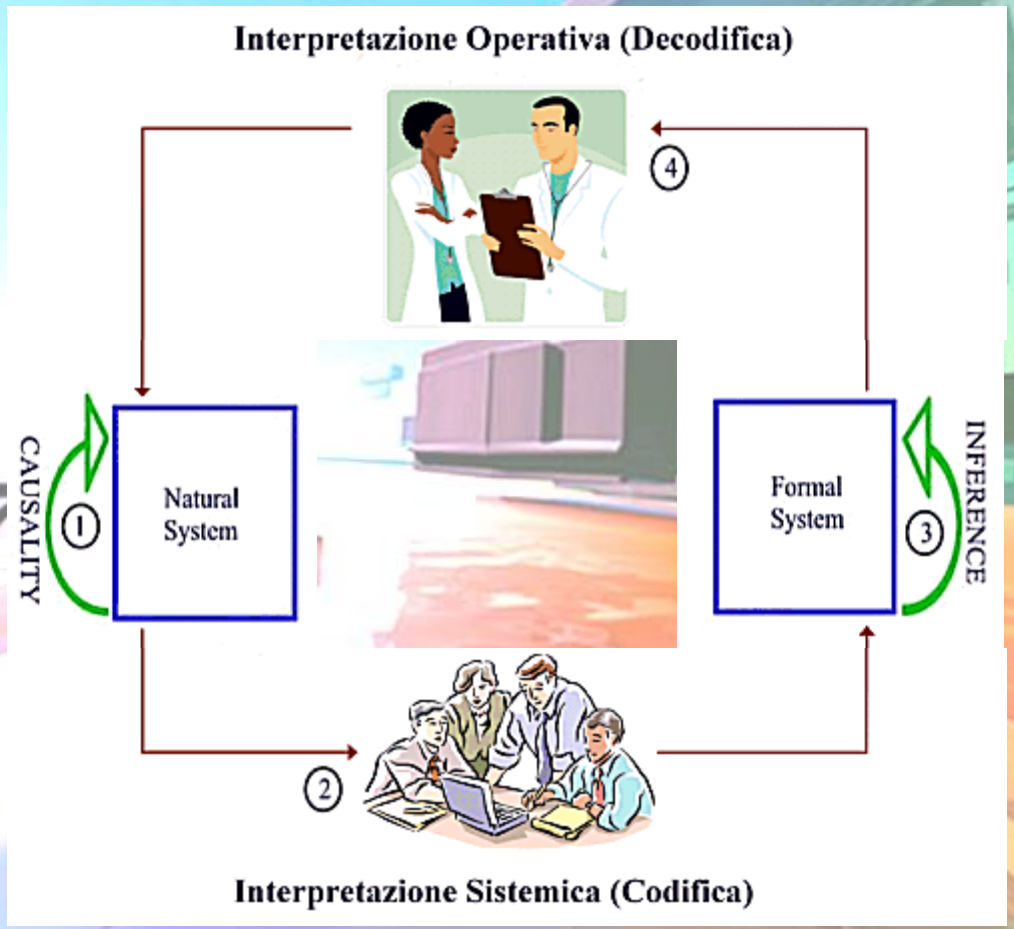
1. Introduction (01)

Paradigma Sistemico di Riferimento

- **Relativistico Galileiano (1632): t ≡ A; s ≡ R.**
- **Positivista Riduzionista (1637): t ≡ A; s ≡ A.**
- **Relativistico Einsteniano (1921): sxt.**
- **Quantistico Statistico (1924–1927): E(f(sxt)).**
- **Quantistico Causale (1992): sxt (Sistema NON Isolato).**
- **Quantistico Relazionale (1996-7): (Sistemi NON Isolati).**

1. Introduction (02)

Paradigma Sistemico Positivista Riduzionista (Approccio Sistemico Modellistico Classico)



1. Introduction (03)

Il fatto che tutti i fenomeni naturali siano soggetti a costante mutamento significa per Aristotele (384 a.C. o 383 a.C. – 322 a.C.) che nella materia è sempre insita la possibilità di raggiungere una forma precisa.

Il compito di scoprire le cause che determinano il perché un oggetto tenda ad evolversi in un certo modo e non diversamente viene interamente demandato alla filosofia.

Aristotele parla in proposito di **quattro cause**, che sono le seguenti:

1. **causa formale:** consiste nelle qualità specifiche dell'oggetto stesso, nella sua essenza;
2. **causa materiale**: la materia è il sostrato senza cui l'oggetto non esisterebbe;
3. **causa efficiente**: è l'agente che determina operativamente il mutamento;
4. **causa finale:** esiste un'intenzionalità nella natura; è lo scopo per cui una certa realtà esiste.

Aristotele con la sua ontologia si propone di mostrare che l'**essere** è determinato in una **molteplicità di attributi**, che lo rendono **multilaterale ed articolato pur nella sua unità.**

L'ignorante afferma, il sapiente dubita, il saggio riflette.

1. Introduction (04)

« Siccome il ferro s'arrugginisce sanza esercizio, e l'acqua si putrefá e nel freddo s'agghiaccia; così lo 'ngegno, sanza esercizio, si guasta. »

« L'acqua che tocco dé fiumi è l'ultima di quella che andò e la prima di quella che viene. Così il tempo presente. »

« Nissuna umana investigazione si può dimandare vera scienza, s'essa non passa per le matematiche dimostrazioni. »

Leonardo da Vinci (1452 – 1519)

La ragione dall'emozione: nasce l'**"Osservazione Relazionale"** ed il **"Metodo Naturale"**.

1. Introduction (05)

« Parlare oscuramente lo sa fare ognuno, ma chiaro pochissimi. »

Galileo Galilei (1564 – 1642).

« La filosofia è scritta in questo grandissimo libro che continuamente ci sta aperto innanzi a gli occhi (io dico l'universo), ma non si può intendere se prima non s'impara a intender la lingua, e conoscer i caratteri, ne' quali è scritto. Egli è scritto in lingua matematica, e i caratteri son triangoli, cerchi, ed altre figure geometriche, senza i quali mezzi è impossibile a intenderne umanamente parola; senza questi è un aggirarsi vanamente per un oscuro laberinto. »

Galileo Galilei (1564 – 1642), Il Saggiatore, Cap. VI, 1623.

« …onde si ridusse a tanta diffidenza del suo sapere, che domandato come si generassero i suoni, generosamente rispondeva di sapere alcuni modi, ma che teneva per fermo potervene essere altri incogniti ed inopinabili. »

Galileo Galilei (1564 – 1642), Il Saggiatore, Lo scienziato e la cicala, 1623.

La ragione senza emozione: nasce l'**"Osservazione Oggettiva"** ed il **"Metodo Scientifico Classico della Realtà Immanente"**.

1. Introduction (06)

Un attento e prolungato studio, eseguito secondo il **Metodo Scientifico Classico**, ha portato alla conclusione che la **Realtà Immanente** sia basata su tre pilastri fondamentali: **Linguaggio**, **Logica (rigorosa)** e **Scienza**. Questi tre pilastri rappresentano i più elevati conseguimenti del genere umano:

1. **Linguaggio:** dal quale si possono generare ricordi collettivi e permanenti, grazie alla **Scrittura**.
2. **Logica (rigorosa):** dalla quale sono nate le grandi costruzioni di **Geometria, Aritmetica**, **Analisi**, **Algebra** e **Topologia**.
3. **Scienza:** che, con i suoi **tre livelli di credibilità scientifica**, permette di avere la certezza che il mondo (la Realtà Immanente) non è basato sul Caos, ma su di una Logica rigorosa con leggi che sono valide dal cuore del protone (un milionesimo di miliardesimo di centimetro, 10^{-17} m) fino all'orlo dell'Universo conosciuto (un milione di miliardi di miliardi di chilometri, 10^{+27} m).
   - **Primo Livello:** eventi con risultati riproducibili (e.g. Leggi Fondamentali).
   - **Secondo Livello:** eventi senza possibilità di riproducbilità (e.g. Evoluzione Stellare).
   - **Terzo Livello:** eventi unici (e.g Evoluzione Cosmica).

2. Two Examples from CICT (00)

2. Two Examples from CICT (01)

First Example
(16 by 16 pixel, 256-shades of gray image)

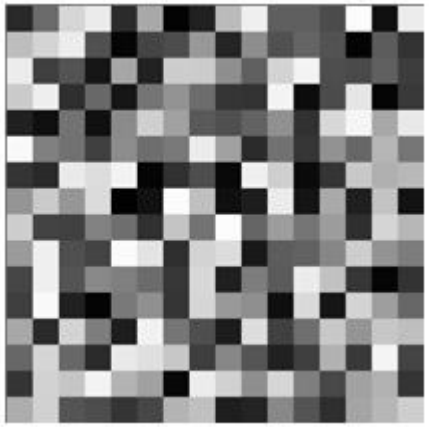
According to **Shannon's source coding theorem**, the optimal code length for a symbol is "$-\log_b P$," where "*b*" is the number of symbols used to make output codes (usually $b = 2$ for binary code) and P is the probability of the input symbol.

In case of a 256-shades of gray image, it is sufficient to use a 16 by 16 pixel image to be sure to visualize **an instance out of all** the $(2 \times 2^2 \times (2^8)!) \approx 6.65^{507}$ (clearly **a transcomputational number**) possible gray combinations generated by an ideal white noise source.

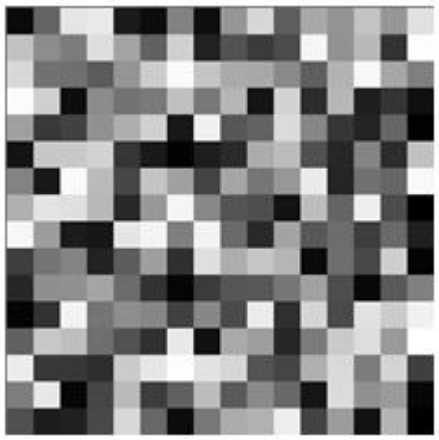
For SN combinatorial optimization, in this case SN = 257 to be sure to visualize **an instance out of all the best** $(2 \times 2^2 \times (2^8 - 1)) = 2040$ gray variation combinations, offered by this specific SN out of (2 x 22 x (28)!) $\approx 6.65^{507}$ possible ones. In this case, by design,

2. Two Examples from CICT (02)

First Example
(16 by 16 pixel, 256-shades of gray image)



$H_1(X)$ = 0.893995, in single precision arithmetic,
$H_2(X)$ = 0.893995239236685, in double precision arithmetic
$H_3(X)$ =
0.8939952392366848774964724918765288132199273122746343439319551627, with 64-digit precision arithmetic.



$H_1(X)$ = 1.000000, in single precision arithmetic,
$H_2(X)$ = 1.000000000000000, in double precision arithmetic
$H_3(X)$ =
1.0000000000000000000000000000000000000000000000000000000000000000, with 64-digit precision arithmetic.

2. Two Examples from CICT (03)

Second Example
(4,096 by 4,096 pixel, 16,777,216 true color image)

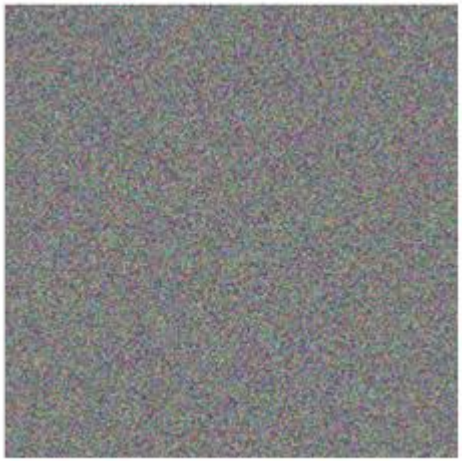
True color image by 256 shades of red, green, and blue fundamental components, for a total of 16,777,216 color variations. Traditional psychophysical experiment attained that the human eye can discriminate up to ten million colors. In this case it is sufficient to use a 4096 by 4096 pixel image to be sure to visualize **an instance out of all the possible color variations** generated by an ideal random colour source ((2 x 2^2 x (2^{24} – 1)!) = (8 x 16,777,216!) possible ones.

SN combinatorial optimization offers the best SN which allows a less-than-optimal encoding of image information in this case. In fact, the closest SN to 16,777,216, is SN = 16,777,259 to be sure to visualize **an instance out of all the best** ((2 x 2^2 x (2 x 23 x 103 x 3541)) = 134,218,064 theoretical color combinations out of ((2 x 2^2 x (2 x 23 x 103 x 3541)!) (really a very huge number) theoretical possible ones.

2. Two Examples from CICT (04)

Second Example
(4,096 by 4,096 pixel, 16,777,216 true color image)

$H_1(X) = 0.999292$, in single precision arithmetic,
$H_2(X) = 0.999292377044885$, in double precision arithmetic
$H_3(X) =$
0.999292377044885311869239847837125432063791648444
124172770067833 7, with 64-digit precision arithmetic.



$H_1(X) = 1.000000$, in single precision arithmetic,
$H_2(X) = 0.99999999993863$, in double precision arithmetic
$H_3(X) =$
0.999999999938629983275782147066555134809060385539
442715281977188 4, with 64-digit precision arithmetic.

2. Two Examples from CICT (05)

Second Example
(4,096 by 4,096 pixel, 16,777,216 true color image)

As expected, this time the ideal theoretical maximum of H(x) is not achieved. Nevertheless, its H(x) is quite close to the ideal one (less than 10^{-10} difference) and all its corresponding values of $H_n(x)$ still outperform those random noise generated, respectively. Even a less-than-optimal combinatorial entropy encoding solution can be better than a digitally random generated one.

Furthermore, according to classic information theory point of view, its Memory FootPrint (MFP) should be at its maximum value of 56,174 Kb and its information content could not be lossless compressed further. But, thanks to our knowledge of its associated combinatorial structure, its MFP can be lossless reduced to a minimum of 179 Kb code, by usual programming tools supported by MS Visual Studio development environment (≈ 314: 1 CR).

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2. Two Examples from CICT (06)

Second Example
(4,096 by 4,096 pixel, 16,777,216 true color image)

This is the final evidence to verify SN information encoding optimal efficiency. But that achieved compression ratio is the final optimal one? To answer this simple question we have to refer to algorithmic information theory and Kolmogorov complexity, named after Soviet mathematician Andrey Nikolaevich Kolmogorov (1903–1987), who first published on the subject in 1963.

Kolmogorov randomness, also called algorithmic randomness, defines a string (usually of bits) as being random if and only if it is shorter or equal than any computer program that can produce that string.

So, our short answer is: that was our first attempt to compute a lossless compression ratio and, according to previous considerations, it is possible to do better than that, if you like!

3. CICT (00)

3. CICT (01)

Shannon entropy (usually denoted by **H(X)** or **Sh(X)**) is **the average unpredictability in a random variable**, which is equivalent to its information content. Therefore **Shannon entropy is a stochastic measure of probabilistic information uncertainty.**

The concept was introduced by Claude E. Shannon in his 1948 paper "A Mathematical Theory of Communication".

Shannon entropy provides an **absolute limit on the best possible lossless encoding** or compression of any communication, **assuming that the communication may be represented as a sequence of independent and identically distributed random variables**.

Information Concept is Quite Recent

- **Claude Shannon** (1916–2001) – Binary Code Uncertainty Probabilistic Evaluation.
- **Gregory Bateson** (1904–1980) – The Difference that Makes the Difference.
- **Heinz Von Foerster** (1911–2002) – Observator Plays the Key Role.

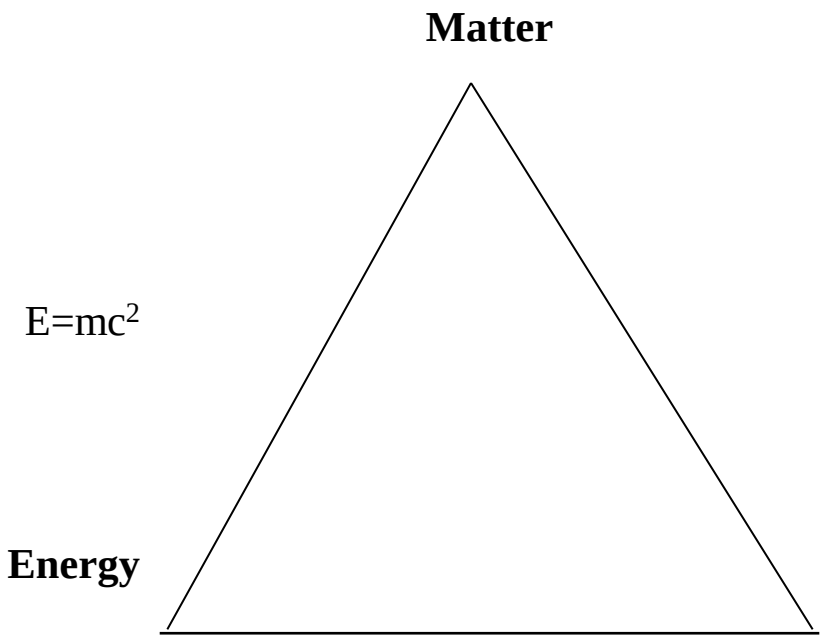
3. CICT (02)

Information Concept Operative Links

- **Albert Einstein** (1879 –1955) – Matter and Energy in 1905, ($E = mc^2$, light speed c superior limit).
- **Leo Szilard** (1898 –1964) – Energy and Information in 1929, (Maxwell Demon).
- **Hans-Joachim Bremermann** (1926–1996) – Matter and Information in 1962, ($E = mc^2 = hf$), (Bremermann Limit → Transcomputational Numbers).

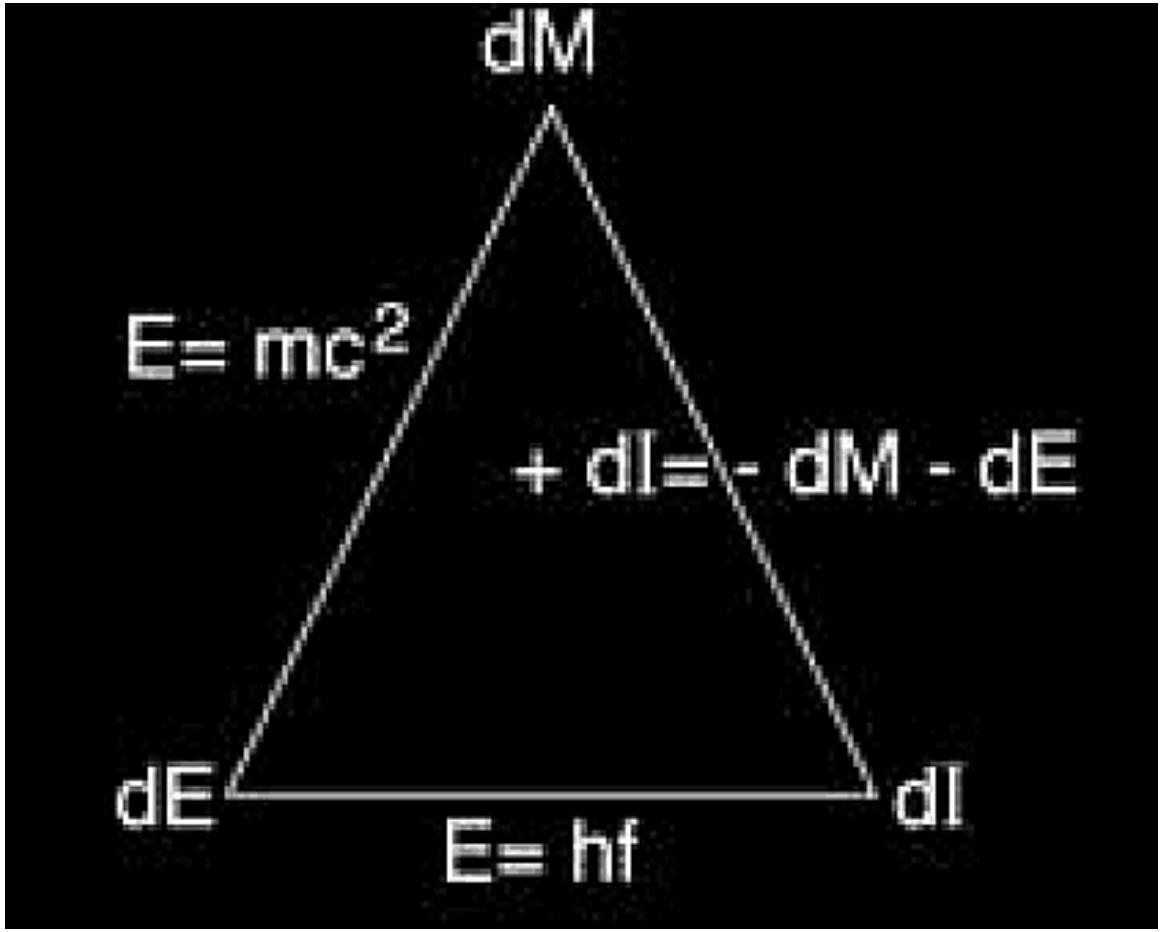
3. CICT (03)

Triangular Relationship (Bio-Quantum Physics of SpaceTime)



3. CICT (04)

Evolutionary Principle
(Bio-Quantum Physics of SpaceTime)



Matter and Information

In 1962, according to Quantum Physics, **Bremermann** shows that there is a speed superior limit even for operative symbolic computation by Matter. Maximum Operative Computational Speed (Ce) < **1,047** bit/gram/second.

In 2004, University of Michigan physicist **Mark Newman**, along with biologist **Michael Lachmann** and computer scientist **Cristopher Moore**, has extended the pioneering 1940s research of Claude Shannon to electromagnetic transmission. Specifically, they show that if electromagnetic radiation is used as a transmission medium, **the most information-efficient format** for a given message is **indistinguishable from blackbody radiation**.

So, paradoxically if you don't know the code used for the message you can't tell the difference between an information-rich message and a random jumble of letters.

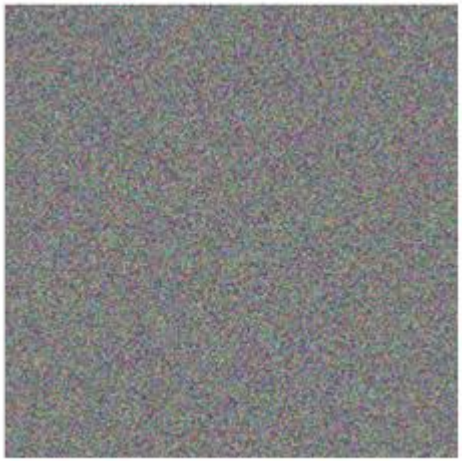
Operative Pattern Recognition Limitations

- **Ross Ashby** (1903 –1972) has showed that a few symbolic computational strategies are practically unachievable.
- E.g. A 20 by 20 LED grid (you can turn them on and off) is associated to 2^{400} different patterns, i.e. > 10^{100} different combinations.
- A brute force approach strategy to find a specific pattern is going to fail: an "Earth-sized computer", computing since our contemporary estimated Universe creation, (according to our best measurement of the age of the universe, as of 22 March 2013 (13.798 ± 0.037 billion years ($4.354 \pm 0.012 \times 10^{17}$ seconds) within the Lambda-CDM concordance model), would be unable to achieve the desired result (to find our desired pattern).

3. CICT (07)

Image Lossless Compression Test (4,096 by 4,096 pixel, 16,777,216 true color image)

$H_1(X)$ = 0.999292, in single precision arithmetic,
$H_2(X)$ = 0.999292377044885, in double precision arithmetic
$H_3(X)$ =
0.99929237704488531186923984783712543206379164844412417277006783 37, with 64-digit precision arithmetic.



$H_1(X)$ = 1.000000, in single precision arithmetic,
$H_2(X)$ = 0.99999999993863, in double precision arithmetic
$H_3(X)$ =
0.99999999938629983275782147066555134809060385539442715281977188 4, with 64-digit precision arithmetic.

3. CICT (08)

Operative Pattern Recognition Limitations

Patterns in natural systems abound, from the stripes on a zebra to ripples in a river bed. In many of these systems, the emergent appearance of an ordered state is not unexpected as the outcome of an underlying hidden ordered and folded process. Thus crystal growth, honeycomb manufacture and floret evolution generate regular and predictable patterns.

On the other hand, intrinsically apparently and stochastically computed "noisy and disordered" processes such as thermal fluctuations or mechanically randomized scattering generate surprisingly similar patterns.

3. CICT (09)

Computational Information Contemporary Double-Bind

Our computational information contemporary classic systemic tools (developed under the positivist reductionist paradigm) are totally unable to capture and to tell the difference between an information-rich message (optimal coded message) and a random jumble of signs that we call "noise".

It is a distressing dilemma in computational communication…
(and in the overall contemporary scientific community too.)

How come we scientists (statisticians) are still in business without having worked out a definitive solution to the problem of the logical relationship between experience and knowledge?

(Piercesare Secchi, 2013)

3. CICT (10)

Computational Information Contemporary Double-Bind

We need to extend our systemic tools
to solve this double-bind situation.

HOW?

We must discover
a creative solution
in our contemporary systemic paradigm!

4. Creativity and Learning (00)

4. Creativity and Learning (01)

Creatività ed Apprendimento (MPE)

Il funzionamento della mente umana è basato su **due processi fondamentali**, secondo il Modello Pragmatico Elementate (**MPE**):

Processo A: Costruzione di un Modello Finalizzato (MF) al perseguimento creativo di una meta.

Processo B: Accettazione (verifica + eventuale aggiornamento MF) razionale del Processo A.

Il **Processo A** viene alimentato dal dubbio, dalla mediazione ed ha assoluto bisogno del supporto di una ridondanza caotica ambientale: (**emozione→costruzione modello ottimo finalizzato→sensazione→azione**).

Il **Processo B** si alimenta dell'opposizione e della dittatorialità e richiede invece una chiara definizione per operare attivamente: (**emozione→percezione→articolazione logica di persorso risolutivo→verifica→apprendimento**).

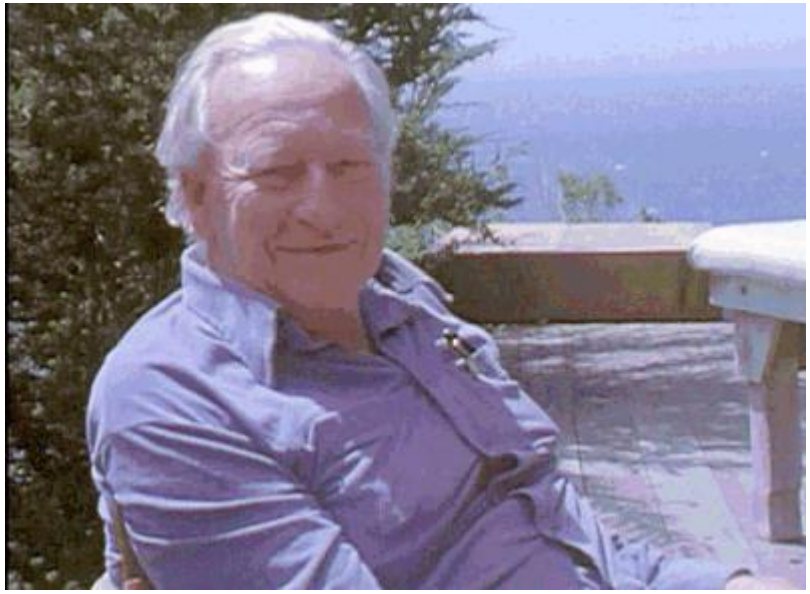
4. Creativity and Learning (02)

Apprendimento secondo Confucio

Se ascolto dimentico.
Se vedo ricordo.
Se faccio capisco.

4. Creativity and Learning (03)

Apprendimento secondo Bateson e von Foerster



Ricerca della differenza che fa la differenza, **procedendo per tentativi...**

Gregory Bateson (1904-1980)

… dove il punto di vista dell'**Osservatore** gioca il ruolo **determinante.**

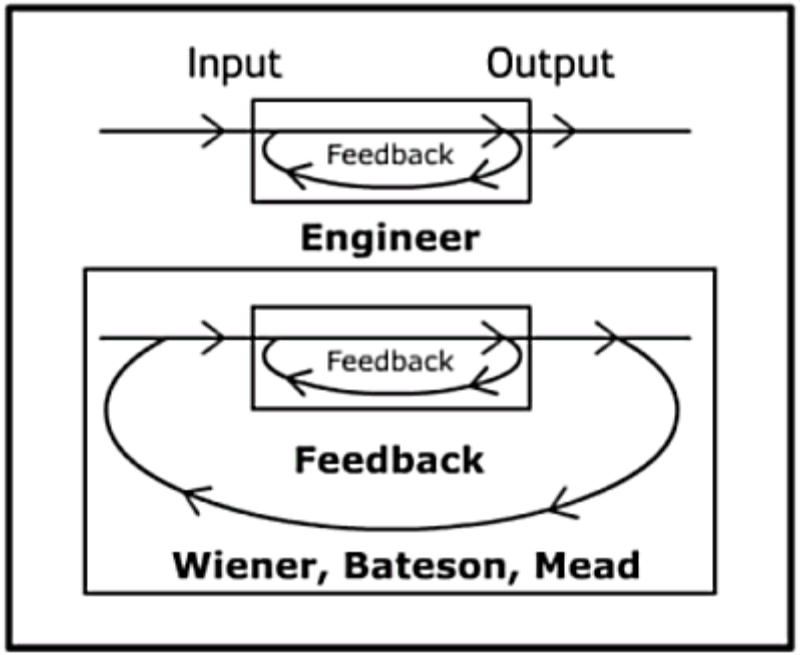
Heinz von Foerster (1911-2002)

4. Creativity and Learning (04)

Bateson Learning by Widening Your Panorama...

« . . . essentially your ecosystem, your organism-plus-environment, is to be considered as a single circuit. »

Interview with Gregory Bateson and Margaret Mead, CoEvolution Quarterly, June 1973.



4. Creativity and Learning (05)

Remembering that "The map is not the territory"

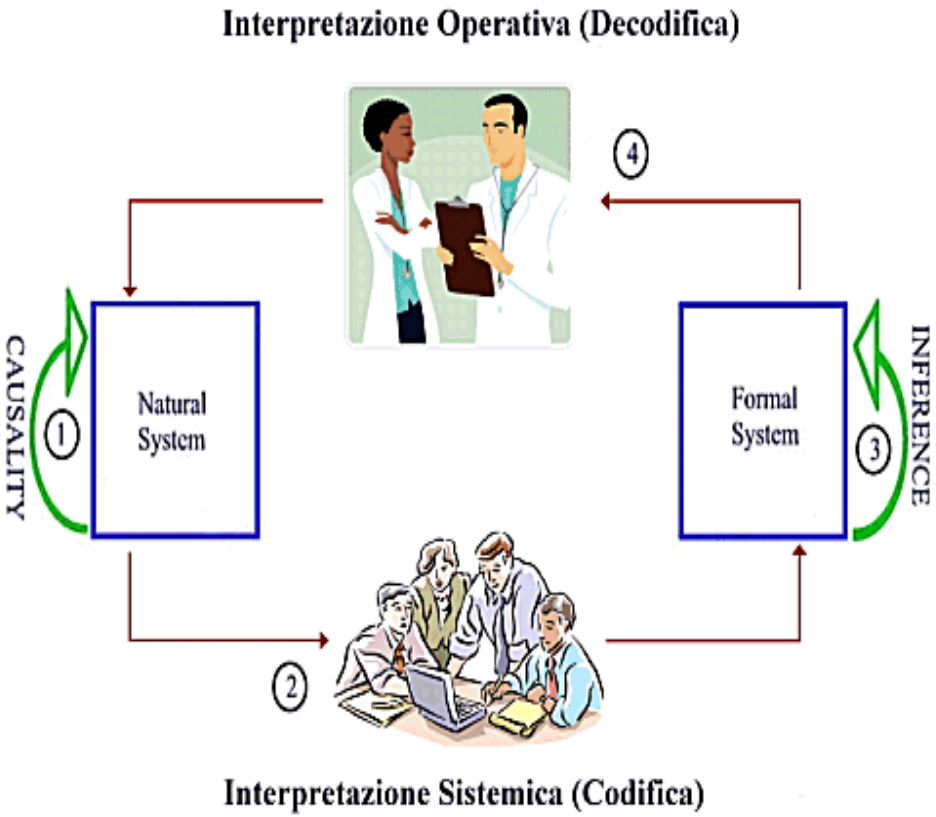
Gregory Bateson (1904-1980), in "**Form, Substance and Difference**", from **Steps to an Ecology of Mind** (1972), has elucidated the essential impossibility of knowing what the territory is, as **any understanding of it is based on some representation.**

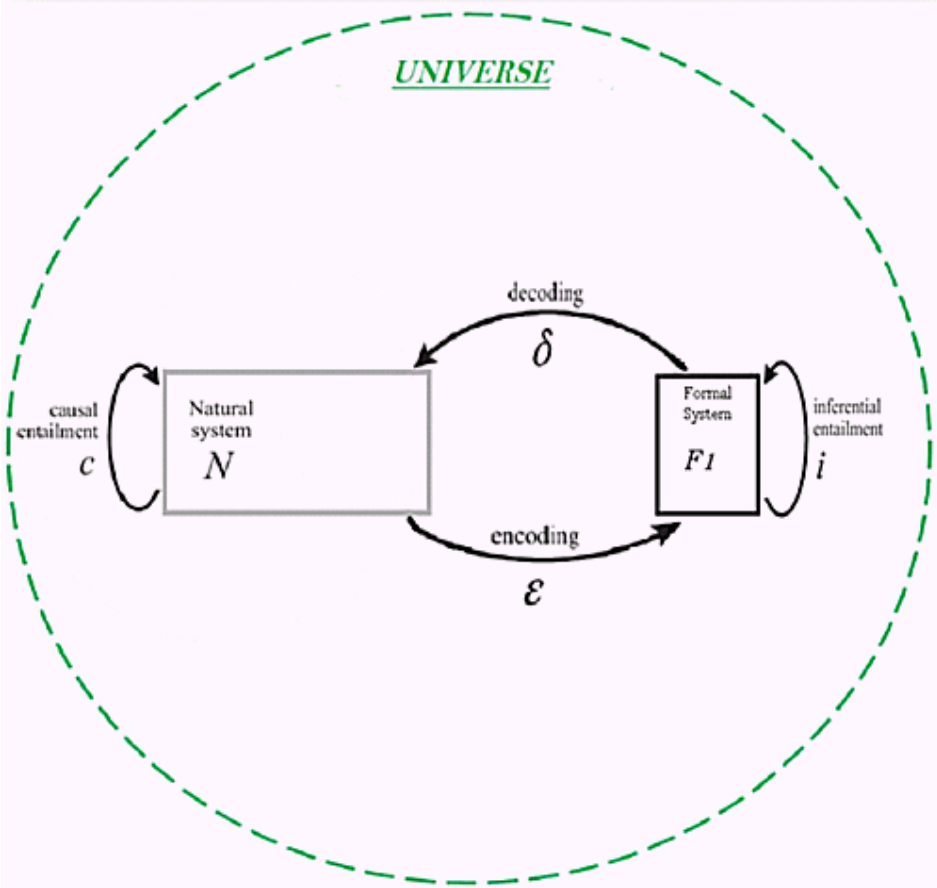
Polish-American scientist and philosopher **Alfred Korzybski** (1879-1950), developer of the "**Theory of General Semantics**", coined the dictum "the map is not the territory", encapsulating his view that **an abstraction derived from something, or a reaction to it, is not the thing itself.**

Another basic quandary is the problem of **accuracy**. **Jorge Luis Borges**'s (1899-1986) "**Del rigor en la ciencia**" (1946) describes the tragic uselessness of the perfectly accurate, one-to-one map.

4. Creativity and Learning (06)

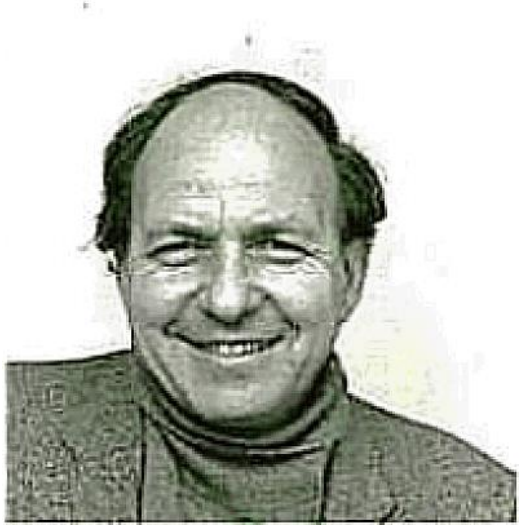
Creatività Sistemica secondo Robert Rosen (1934-1998)





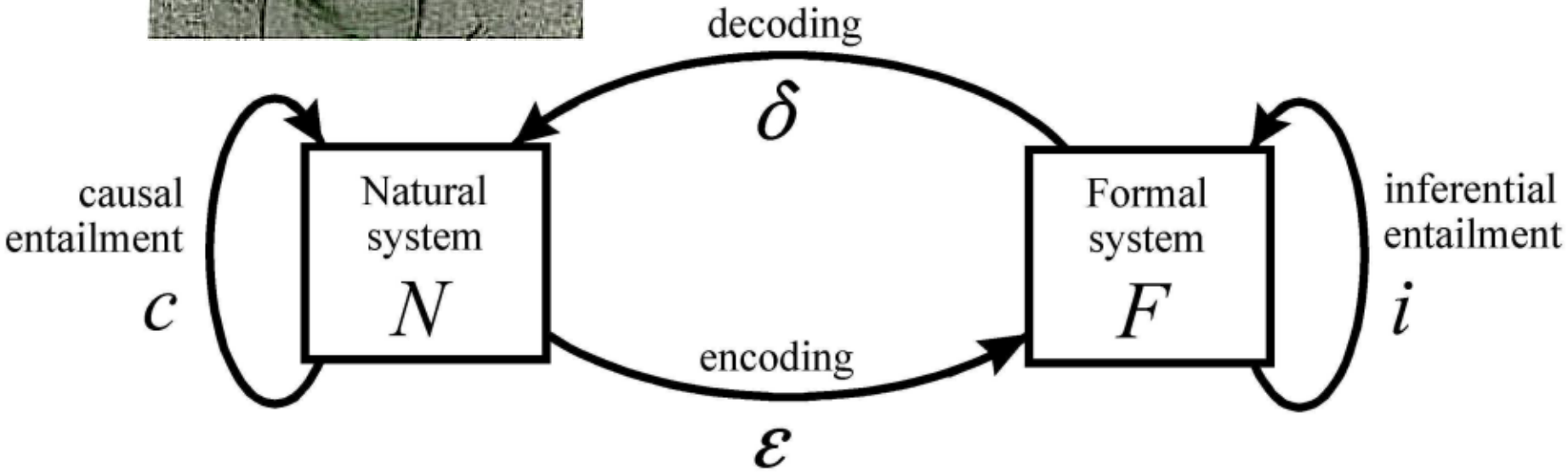
4. Creativity and Learning (07)

Robert Rosen's (1934-1998) Modelling Relation



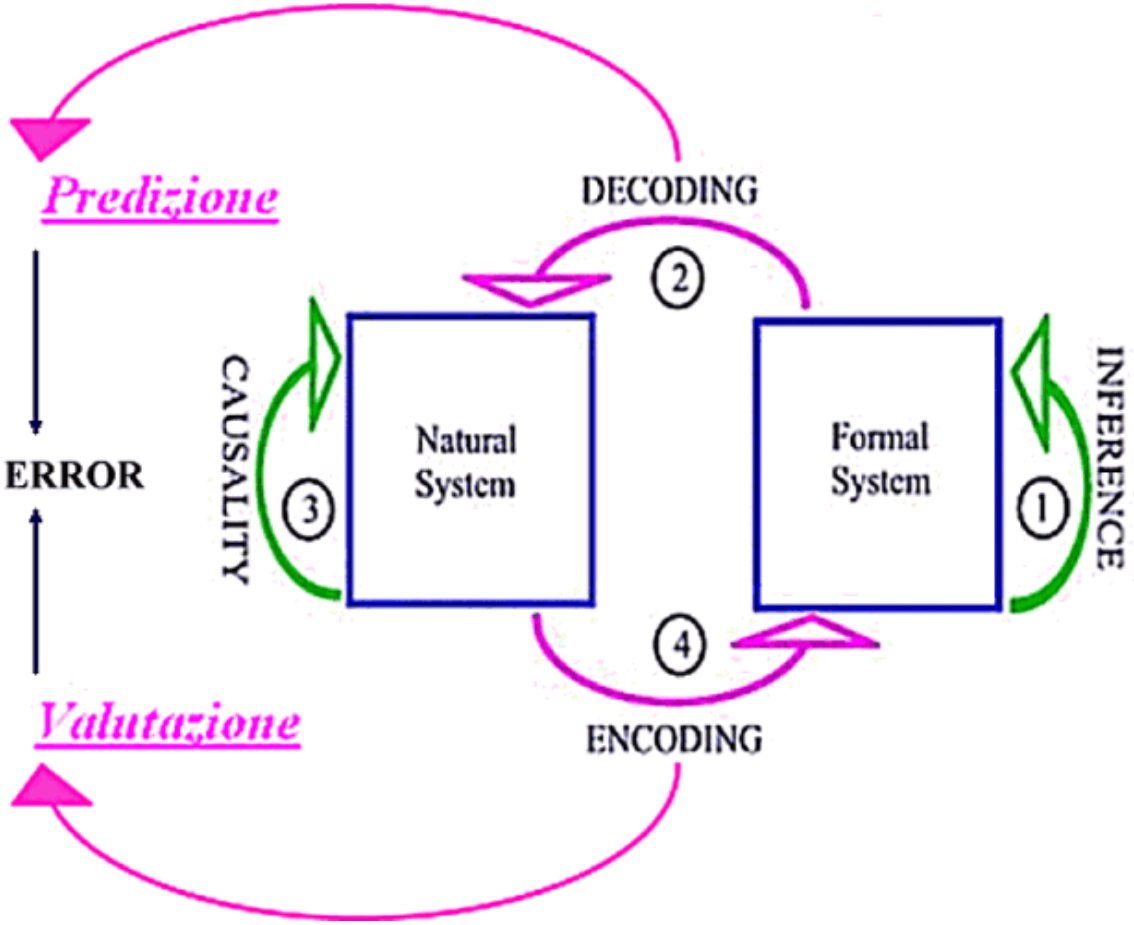
« …any material realization of the (M,R)-system must have noncomputable models. »

Robert Rosen (1934-1998)



4. Creativity and Learning (08)

Creatività Sistemica secondo Robert Rosen (1934-1998)

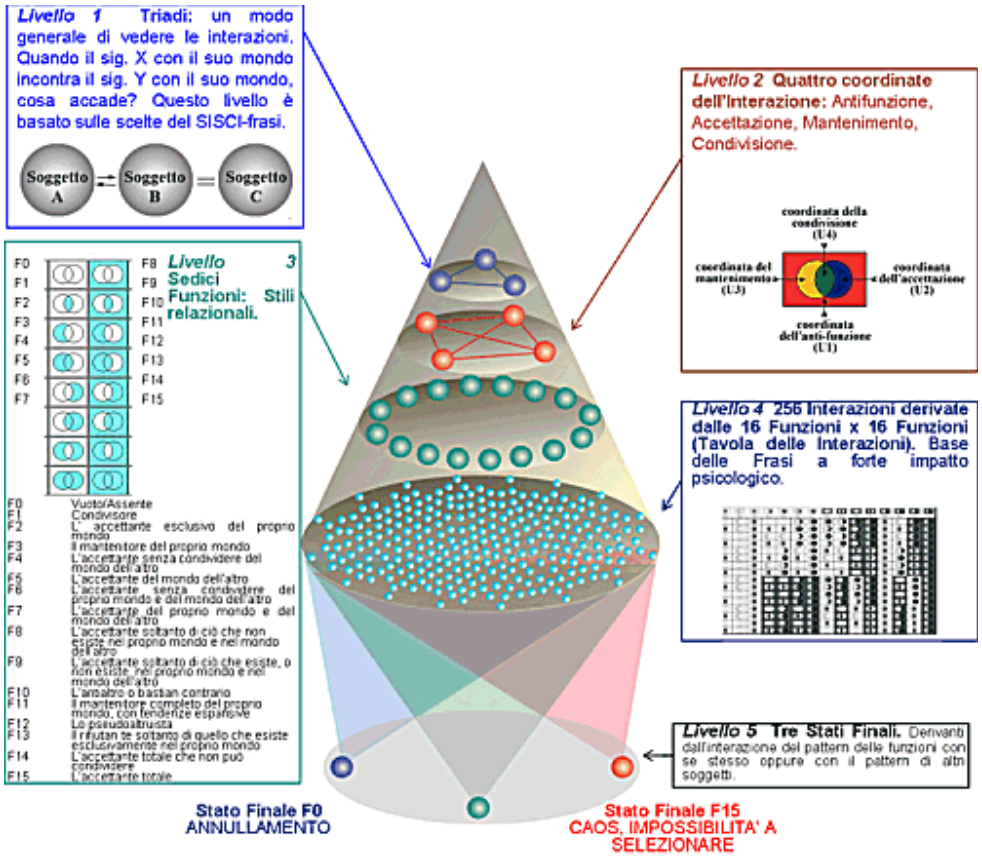


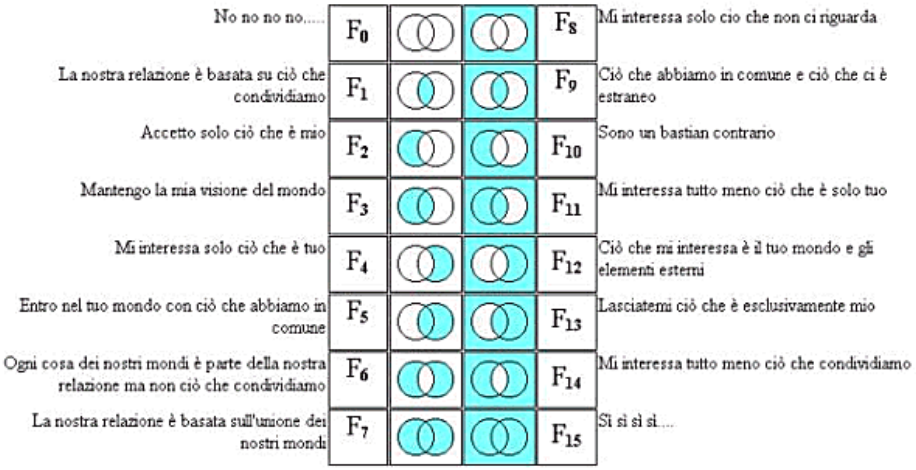
Anticipatory System:
« A system containing a predictive model of itself and/or its environment, which allows it to change state at an instant in accord with the model's predictions pertaining to a later instant. »

(Robert Rosen, 1985)

4. Creativity and Learning (09)

Ausilio alla Creatività Sistemica, tramite Apprendimento Logicamente Articolato (MPE)





(Piero De Giacomo, (1999)

4. Creativity and Learning (10)

Articolazione Logica di una Ipotesi di Percorso Risolutivo

La ragione senza emozione: è alla base dell' **"Osservazione Isolata"** e del **"Metodo Scientifico Classico della Realtà Immanente"**.

Tutti gli attuali approcci formali della Teoria dei Sistemi ingegneristici sono ancora basati sul « **Divide et Impera** » (Julius Caesar (100 b.C. – 44 b.C.)), su sistemi chiusi, con notevole dissipazione di informazione.

Una simile dissipazione di informazione è anche alla base dell'operazione di **Divisione** dell'**Aritmetica Elementare**, di cui si utilizza ancóra la sóla informazione dominante (**Quoziente**), senza nessun impiego dell'informazione riposta nelle componenti minoritarie (**Resti**).

Riuscire a sostituire « **Divide et Impera** » con « **Divide et Relate** », ovvero mettere in relazione i Resti con il Quoziente della Divisione Aritmetica Elementare, porterebbe alla definizione di una **"Osservazione Relazionale"** e ad un metodo di **"indagine condivisa"** chiamato **"Metodo Naturale"** che, a livello sistemico permetterebbe la conservazione dell'informazione e, metaforicamente, la realizzazione di sistemi in grado di ricavare **la "ragione" dall'emozione**.

4. Creativity and Learning (11)

The Verification of New Creative Result

Elementary Arithmetic long **Division** minority components (Remainders, R), for long time, **concealed relational knowledge** to their dominant result (Quotient, Q), not only can always allow **quotient regeneration** from their remainder information **to any arbitrary precision**, but even to achieve **information conservation** and **coding minimization** (optimal coded message), for dynamical systems.

Then traditional ***Q* Arithmetic** can be even regarded as a highly sophisticated **open logic**, **powerful and flexible LTR and RTL formal numeric language of languages**, with self-defining consistent word and rule, **starting from elementary generator and relation**.

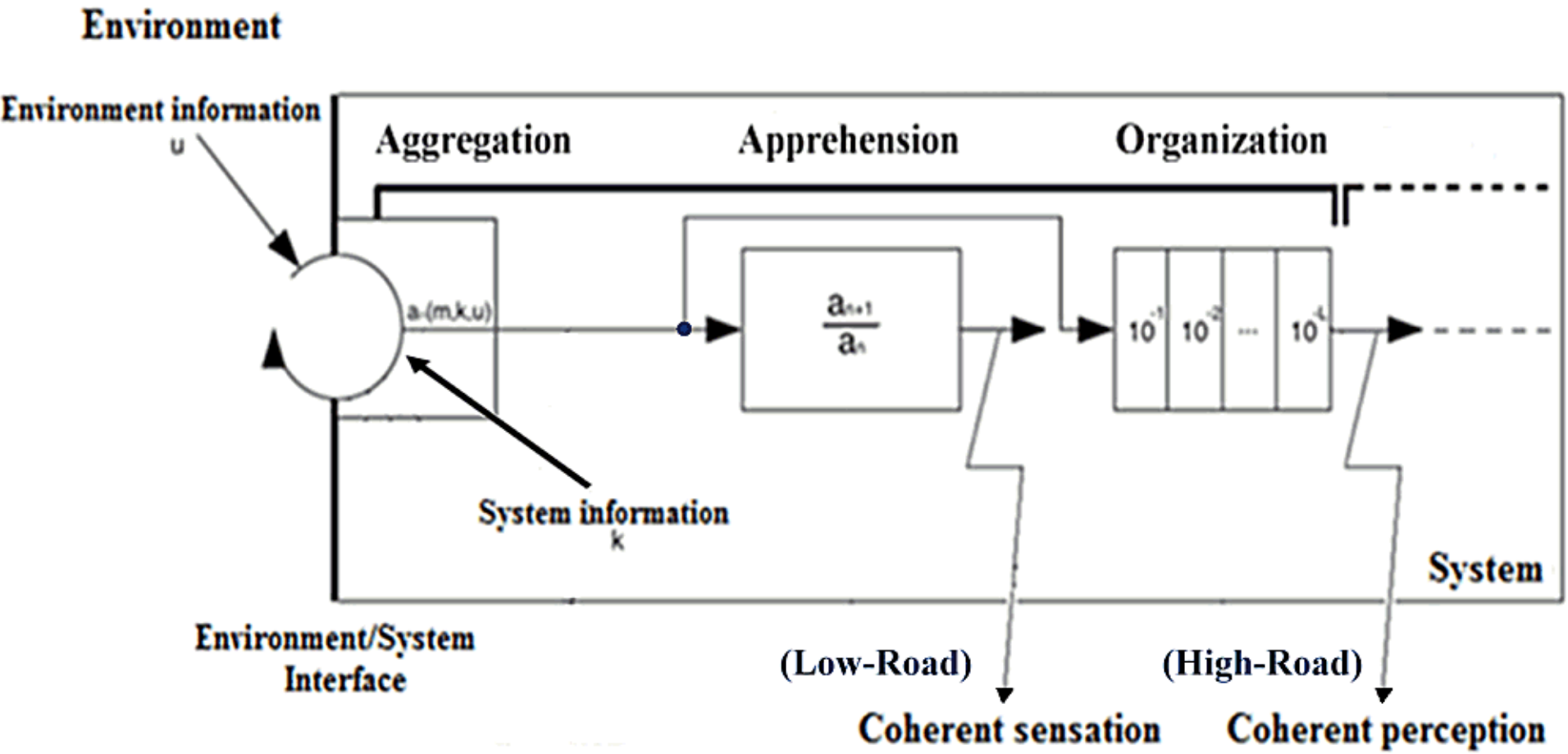
This **new awareness** can guide the development of successful more convenient algorithm, application and powerful computational system.

(Fiorini & Laguteta, 2013)

4. Creativity and Learning (12)

An Example on Systems Theory

(Low Road and High Road LeDoux's Amygdala Pathways Systemic Model)



4. Creativity and Learning (13)

An Example on Algebraic Irrational Number Mapping

k_1 \ k_2	0	1	2	3	4	5	6	7	8	9	…
0		$\frac{1+\sqrt{4}}{2}$	$\frac{1+\sqrt{8}}{2}$	$\frac{1+\sqrt{12}}{2}$	$\frac{1+\sqrt{16}}{2}$	$\frac{1+\sqrt{20}}{2}$	$\frac{1+\sqrt{24}}{2}$	$\frac{1+\sqrt{28}}{2}$	$\frac{1+\sqrt{32}}{2}$	$\frac{1+\sqrt{36}}{2}$	…
1	$\frac{1+\sqrt{1}}{2}$	$\frac{1+\sqrt{5}}{2}$	$\frac{1+\sqrt{9}}{2}$	$\frac{1+\sqrt{13}}{2}$	$\frac{1+\sqrt{17}}{2}$	$\frac{1+\sqrt{21}}{2}$	$\frac{1+\sqrt{25}}{2}$	$\frac{1+\sqrt{29}}{2}$	$\frac{1+\sqrt{33}}{2}$	$\frac{1+\sqrt{37}}{2}$	…
2	$\frac{2+\sqrt{4}}{2}$	$\frac{2+\sqrt{8}}{2}$	$\frac{2+\sqrt{12}}{2}$	$\frac{2+\sqrt{16}}{2}$	$\frac{2+\sqrt{20}}{2}$	$\frac{2+\sqrt{24}}{2}$	$\frac{2+\sqrt{28}}{2}$	$\frac{2+\sqrt{32}}{2}$	$\frac{2+\sqrt{36}}{2}$	$\frac{2+\sqrt{40}}{2}$	…
3	$\frac{3+\sqrt{9}}{2}$	$\frac{3+\sqrt{13}}{2}$	$\frac{3+\sqrt{17}}{2}$	$\frac{3+\sqrt{21}}{2}$	$\frac{3+\sqrt{25}}{2}$	$\frac{3+\sqrt{29}}{2}$	$\frac{3+\sqrt{33}}{2}$	$\frac{3+\sqrt{37}}{2}$	$\frac{3+\sqrt{41}}{2}$	$\frac{3+\sqrt{45}}{2}$	…
4	$\frac{4+\sqrt{16}}{2}$	$\frac{4+\sqrt{20}}{2}$	$\frac{4+\sqrt{24}}{2}$	$\frac{4+\sqrt{28}}{2}$	$\frac{4+\sqrt{32}}{2}$	$\frac{4+\sqrt{36}}{2}$	$\frac{4+\sqrt{40}}{2}$	$\frac{4+\sqrt{44}}{2}$	$\frac{4+\sqrt{48}}{2}$	$\frac{4+\sqrt{52}}{2}$	…
5	$\frac{5+\sqrt{25}}{2}$	$\frac{5+\sqrt{29}}{2}$	$\frac{5+\sqrt{33}}{2}$	$\frac{5+\sqrt{37}}{2}$	$\frac{5+\sqrt{41}}{2}$	$\frac{5+\sqrt{45}}{2}$	$\frac{5+\sqrt{49}}{2}$	$\frac{5+\sqrt{53}}{2}$	$\frac{5+\sqrt{57}}{2}$	$\frac{5+\sqrt{61}}{2}$	…
6	$\frac{6+\sqrt{36}}{2}$	$\frac{6+\sqrt{40}}{2}$	$\frac{6+\sqrt{44}}{2}$	$\frac{6+\sqrt{48}}{2}$	$\frac{6+\sqrt{52}}{2}$	$\frac{6+\sqrt{56}}{2}$	$\frac{6+\sqrt{60}}{2}$	$\frac{6+\sqrt{64}}{2}$	$\frac{6+\sqrt{68}}{2}$	$\frac{6+\sqrt{72}}{2}$	…
7	$\frac{7+\sqrt{49}}{2}$	$\frac{7+\sqrt{53}}{2}$	$\frac{7+\sqrt{57}}{2}$	$\frac{7+\sqrt{61}}{2}$	$\frac{7+\sqrt{65}}{2}$	$\frac{7+\sqrt{69}}{2}$	$\frac{7+\sqrt{73}}{2}$	$\frac{7+\sqrt{77}}{2}$	$\frac{7+\sqrt{81}}{2}$	$\frac{7+\sqrt{85}}{2}$	…
8	$\frac{8+\sqrt{64}}{2}$	$\frac{8+\sqrt{68}}{2}$	$\frac{8+\sqrt{72}}{2}$	$\frac{8+\sqrt{76}}{2}$	$\frac{8+\sqrt{80}}{2}$	$\frac{8+\sqrt{84}}{2}$	$\frac{8+\sqrt{88}}{2}$	$\frac{8+\sqrt{92}}{2}$	$\frac{8+\sqrt{96}}{2}$	$\frac{8+\sqrt{100}}{2}$	…
9	$\frac{9+\sqrt{81}}{2}$	$\frac{9+\sqrt{85}}{2}$	$\frac{9+\sqrt{89}}{2}$	$\frac{9+\sqrt{93}}{2}$	$\frac{9+\sqrt{97}}{2}$	$\frac{9+\sqrt{101}}{2}$	$\frac{9+\sqrt{105}}{2}$	$\frac{9+\sqrt{109}}{2}$	$\frac{9+\sqrt{113}}{2}$	$\frac{9+\sqrt{117}}{2}$	…
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱

5. Dreaming and Creativity (00)

5. Dreaming and Creativity (01)

Although it has been described since ancient times, dreaming remains a somewhat mysterious mental process, and scientists around the world continue to study its mechanisms and meanings.

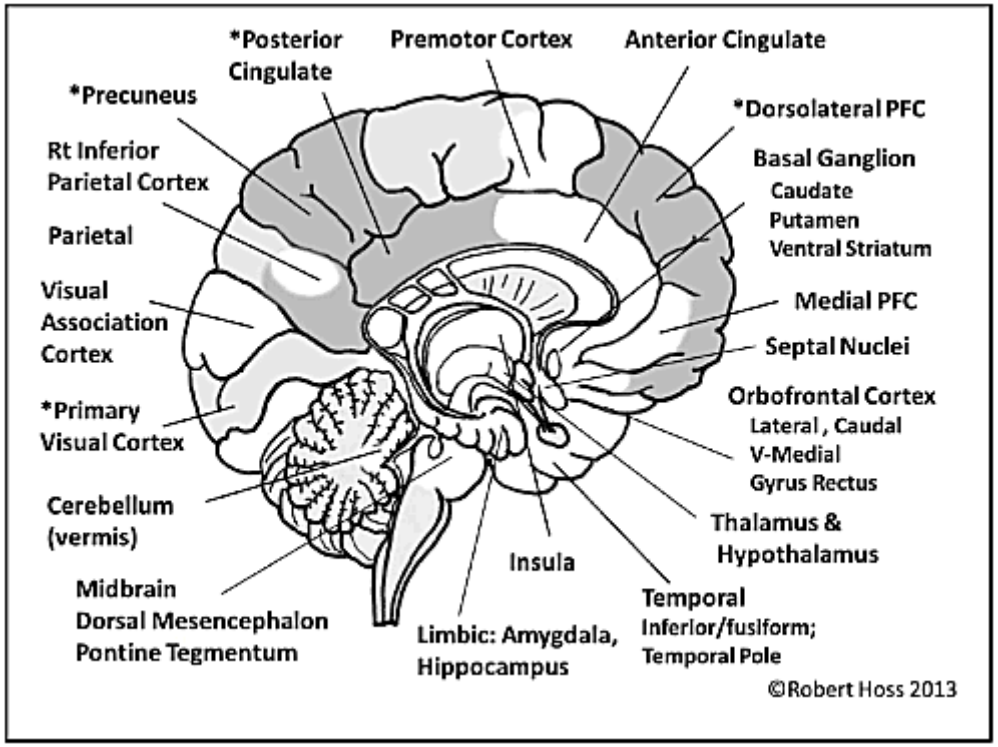
The interesting question is "**what happens to the experiential subject during the dream state?**"

To answer that question, over the past 20 years, Evolutionary Psychology (EP) has emerged as a major theoretical perspective, generating an increasing volume of empirical studies and assuming a larger presence within psychological science.

EP is an approach to the study of the mind that is founded on Darwin's theory of evolution by natural selection. It assumes that our mental abilities, emotions and preferences are adapted specifically for solving problems of survival and reproduction in humanity's ancestral environment, and derives testable predictions from this assumption.

5. Dreaming and Creativity (02)

Active (white) and *inactive (dark gray) centers of the brain in REM sleep



John Allan Hobson (1933-), well-known for his research on REM sleep, states that the combined activity of these brain centers appears to account for not only the **unusual characteristics of dreams**, but also **some of the functions** that psychologists and theorists have **attributed to dreaming in the past**, (Hobson, 2003). Based on this assumption, Hobson has developed his approach "**towards a theory of protoconsciousness**", (Hobson, 2009).

Derived from neuroimaging studies (Maquet, Braun, Nofzinger et. al. in Hobson 2003)

5. Dreaming and Creativity (03)

Active (white) and *inactive (dark gray) centers of the brain in REM sleep

High activity is seen in the **limbic regions** involved in **emotional processing** (amygdala and hypothalamus) and short-to-long term memory consolidation (hippocampal regions).

This high activity in the **limbic system** or "**emotional brain**" has led researchers to believe that «dreams selectively process emotionally relevant memories via interplay between the cortex and the limbic system» (Seligman & Yellen, 1987).

Interaction of the **hippocampus** and **amygdala** supports that dreams weave new material into established memory guided by emotion, organizing that memory, based on what is emotionally important to us (Hartmann, 2011).

More Evidences from Neurophysiology

« Dreaming is a sensitive system that tries to pay much attention to the threatening cues in our environment. Their function is to protect and prepare us » (Revonsuo, 2011).

Neuroscientist Joseph E. LeDoux (1949-) finds two amygdala pathways in the brain of the laboratory mouse by the use of fear conditioning and lesion study. He names them the "**high road**" and "**low road**". (LeDoux, 2002)

The **low road** is a pathway which is able to transmit a signal from a stimulus to the thalamus, and then to the amygdala, which then activates a fear-response in the body. This sequence works without a conscious experience of what comprises the stimulus, and it is the fast way to a bodily response (a more primitive mechanism of defense).

The **high road** is activated simultaneously. This is a slower road which also includes the cortical parts of the brain, thus creating a conscious impression of what the stimulus is (a more advanced and sophisticated mechanism of defense).

Amygdala Hijack

Amygdala hijack is a term coined by psychologist Daniel Goleman (1946-) (Goleman,1995). Drawing on the work of Joseph E. LeDoux, Goleman uses the term to describe emotional responses from people which are immediate and overwhelming, and out of measure with the actual stimulus because it has triggered a much more significant emotional threat.

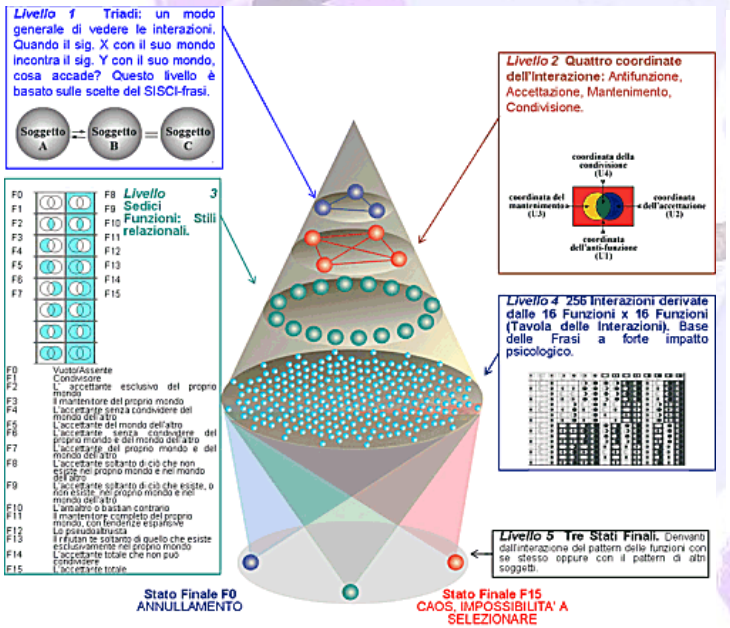
From the thalamus, a part of the stimulus goes directly to the amygdala (**low road**) while another part is sent (**high road**) to the neocortex (the "**thinking brain**"). If the amygdala perceives a match to the stimulus, i.e., if the record of experiences in the hippocampus tells the amygdala that it is a fight, flight or freeze situation, then the Amygdala triggers the HPA (hypothalmic-pituitary-adrenal) axis and hijacks the rational brain.

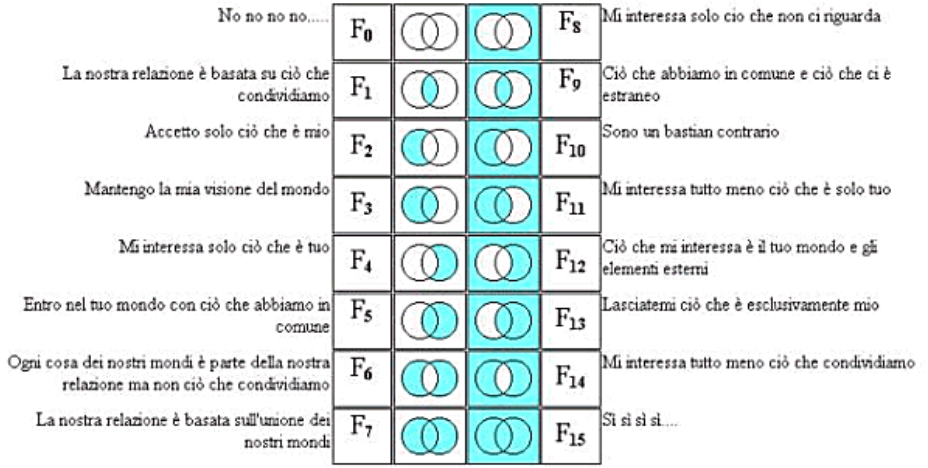
This emotional brain activity processes information milliseconds earlier than the rational brain, so in case of a match, the amygdala acts before any possible direction from the neocortex can be received. If, however, the amygdala does not find any match to the stimulus received with its recorded threatening situations, then it acts according to the directions received from the neo-cortex. When the amygdala perceives a threat, it can lead that person to react irrationally and destructively.

5. Dreaming and Creativity (06)

EPM Clinical Brain Profiling and Therapeutic Aid

Dreams have long been understood to be a valuable tool in therapy. External intervention using dreams begins with dream recall and then applies what was discovered within the dream in a logical articulated manner. This might include exploring deep emotional issues the dreamer is dealing with.





(Piero De Giacomo, 1999)

5. Dreaming and Creativity (07)

More Questions

Dreams, once recalled, are found to consistently have a personal "meaning" for the dreamer, but has dreaming evolved to serve an important internal function?

Is the dream simply the projection or our brain's interpretation of unconscious processes taking place, or does the dream experience itself play and active role in bringing about some restoral or adaptive learning function?

Might the dream be the meaningful internal communications of information within the unconscious regions of our brain, taking place in its natural visual form picturing connections and associations?

Dreaming Creativity Evidences

Dream researchers have known for centuries that dreaming helps problem solving, but they still do not know why.

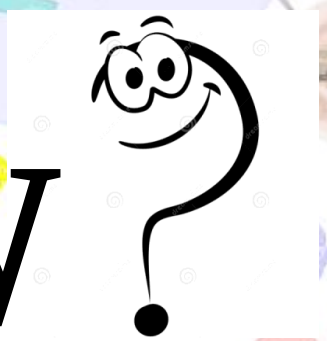
But problem solving may be a side effect of a simulation system. The mere fact of running scenarios over and over may inevitably generate new solutions. That's why when we have an important decision to make, we like to "sleep on it" first.

Robert Stickgold, sleep researcher, points, for example, to the ability of sleep to allow us to integrate and consolidate knowledge. During sleep, our brains are making sense of the world, discovering new associations among existing memories, looking for patterns, formulating rules. "That's how we create meaning," says Stickgold. "Our brain puts things together" (Wamsley & Stickgold, 2011).

Dreaming Creativity Evidences

It's also known that we get better at tasks just by dreaming about them. Stickgold found that if you time people as they tap out the sequence 4-1-3-2-4 with their fingers, then ask them to do it again later that day, they are no better.

But highly motivate them and let them sleep in between and their performance improves, literally overnight. The implication seems obvious: Sleep provides practice.



HOW ?

5. Dreaming and Creativity (10)

EPM Logically Articulated Problem Solution Path Hypothesis

EMP present logically articulated problem solution path hypothesis is:

Given the availability of a **high-level** logically articulated problem **solution path hypothesis**, by dreaming, our mind networked resources ("**the software**") try to find **the best low-level model** that solves our problem, by scenario simulation, according to our stored elementary knowledge tokens.

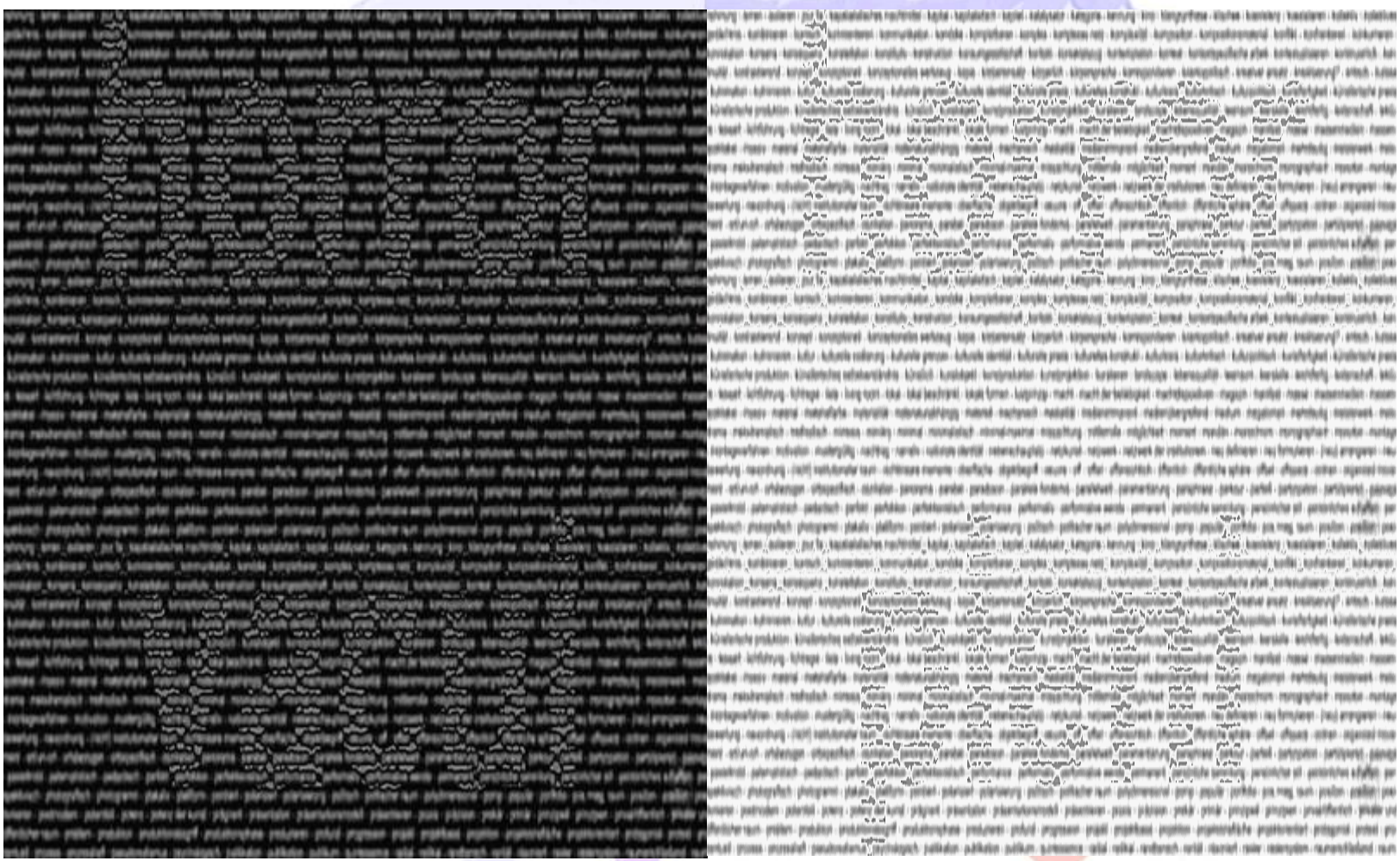
If a solution is found, it is stored as new networked relations between elementary tokens and made available as a new resource. The overall system performance improves, according to usual neural plasticity constraints.

If a solution is found, and it is needed for our immediate survival, it is plastically implemented in a neuronal sub-network ("**the hardware**") as soon as possible.

If a solution is not found, then we'll have recurrent dreams, looking for it.

5. Dreaming and Creativity (11)

The Verification of New Creative Result



6. Summary and Conclusions (01)

- Per inquadrare correttamente la presentazione si sono illustrati i paradigmi sistemici di riferimento oggi disponibili per una ricerca scientifica senza confusione paradigmatica, con i dovuti riferimenti storici ed operativi.
- Si sono presentati due esempi di un problema di double-bind attualmente presente nell'area di ricerca della tecnologia dell'informazione e della comunicazione computazionale (CICT) e l'ipotesi di percorso risolutivo che ha portato al superamento del problema, grazie ad un approccio creativo supportato da MPE.
- Sulla base dei successi applicativi di MPE illustrati e di evidenze neurofisiologiche, si avanza una ipotesi originale di ricerca sulla verifica della funzione neurofisiologica del sogno e della creatività dei sogni in applicazioni di problem-solving complesse.

Main References (01)

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Thank You for Your Attention