TUPLING TRAP: UNIVERSAL LONG TERM EVOLUTION LAW TOWARDS COMPLEXITY

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ABSTRACT

Why Life complicates its life? Does Life evolves directionally to sophistication because some hidden and generic Law or it is a circumstantial appreciation due to the high&continuous level of selective pressure of the environment? Nature is blind, lazy, stingy, quick&dirty, tinkerer and do not like to invest in changes beyond risks. She has no memory or planning for the long term. If adaptative pressure would promote a more sophisticated solution, that would be reversible to the easiest response if pressure disappears. Each story of decisions will value its fitness and though immediate perceive-act will drive the success of an organism for reproduction. It do not seems to have mechanisms for the long term, but in fact, she does.

We will describe the intrinsic Tupling Trap of willing to do things not the best way, but enough, at the short term, increasing in this way the diversity of solutions, and that auto-pressures herself against her own conservationism. We will describe the Universal Long Term Evolutionary Mechanism to Sophistication and we will try to demonstrate that it is unavoidable and generic to any form of Life, or in its lax definition: to any Not Fully Isolated Adaptative Scored Complex System, Near but Out of Equilibrium.

THE QUESTION

Orthogenesis, progressive evolution, evolutionary progress or *progressionism*, is the reviled biological hypothesis that organisms have an innate tendency to evolve in a definite direction towards some goal (teleology) due to some internal mechanism or "driving force". According to this theory, the largest-scale trends in evolution have an absolute goal such as increasing biological complexity. From Darwin notebooks, p.422: "*The enormous number of animals in the world depends, of their varied structure and complexity…. hence as the forms became complicated, they opened fresh means of adding to their complexity."* Him and we ourselves take for granted a "Folk Theorem" alike "**Systems Evolve directionally to Complexity**", which is a soft orthogenetical perspective. It is an observed pattern, not a Law like the *Second Law of Thermodynamics*. Is complex directionality a conjunctural consequence of the evolutionary pressure or it is a structural Universal Law that would happen everywhere that an *Adaptative&Scored Complex System* appears? We will see here it is not innate tendency of organisms, but a consequence of short term Natural Selection itself.

Life, in this wider definition, is constructual (Bejan, 1997), "*For a finite-size system to persist in time (to live), it must evolve in such a way that it provides easier access to the imposed (global) currents that flow through it.*" Constructuallity is a perspective that implies fitness on energy flow as a driver. But it do not mean that the way to minimize expenses and maximize flow, has to be Complexity: order kidnaps free-energy. As a short term investor -self survival and reproduction scale time-, spending resources in sophistication is not an innate long term plan (records of possible futures). Investments to be selected may be minimized day to day, action to action, decision to decision, between all options for the better fitness. The paradox is while Life is looking for fitness at the short term, at the long term we observe there is a trend to complexity and diversity (branched complexity). We see it is happening, but we do not understand the why. The issue has been long analyzed with no consensus up to now: if Nature explores randomly and prefer the less, She may not plan to become sophisticated. Nature is lazy, do not like to expenses in change for free, only selective pressure move to complex solutions. Nature prefers the simplest, the cheapest,… "*The cheapest and least intensively designed system, will be discovered first by Mother Nature and myopically selected*" (Dennet, 1996). How can a myope track to the long way?

Paradox of Complexity: folk theorem taken for granted against myopic survival mechanism. E. Mayr, 1948, "*It might be well to abstain from use of the word 'orthogenesis' .. since so many of the geneticists seem to be of the opinion that the use of the term implies size and some supernatural force.*" Rensch, 1960, propose "*labor division among parts -subsystems- as an always-improvement strategy".* That is not generic and it is reversible (if expending more resources to better reproduces, when it becomes not necessary the specialization would be dissembled). Waddington, 1969, add that "*more diversity increase niche diversity and more complex niches requires more complex organisms"* (if environment get complexity, Life will do so, in a feedback cycle). Maynard-Smith, 1970 and Raup&Gould, 1974, argues it may be a mirage of a "*drunkard walk on a phase space of complexity*". If Life started as Initial Condition biased on the simplest extreme, it has had many opportunities to develop sophistication, with any need of time-arrow. Sanders&Ho, 1976, said "*additions are more likely than deletions, because they are less likely to disrupt a normal function that works, so size may increase, but… does size mean improving?*" Bonner, 1988 adds to the subdivision of systems, its merging to the more sophisticated. Arthur, 1994 collects 3 mechanisms, already postulated: *Self-Reinforcing Coevolution* (niche-species feedback); *Structural Deepening* (subsystems for subfunctions); *Software (gramma) Capture* (horizontal acquisition from other successful procedures); and he admits both first ones are reversible, even copies may be returned back. Life games simulators evolutions, develop complex solutions up to some point and stands. McShea, 1996, first said there is nothing conclusive in his simulations, "*Something may be increasing. But is it Complexity?*", later he claims that biased system will necessarily exhibit an increase of minimum Complexity. Bedau, 1997 find in their simulation models an acceleration on the sophistication time-arrow. Dawkins, 1997 was not agree with random walks or reversibility, because that is only for micro-evolutionary-scale, and become again to the *Guided Self-Organization* in the long term evolutionary scale. But which mechanism relies behind?

We do not have a perfect definition of Entropy -or Syntropy-, but we have agreed a logarithmic scale to measure it, both in the statistical or in the informational dialects (options or ways to reach to the same). Beyond that, we do neither have a perfect definition of Complexity, but even less consensus about its measurement. As Complexity definition is not generic, its measure may refer to specifics: *Blum axioms, Code Sophistication, Cell diversity, Morphology, Halstead, Cyclomatic, Processor Time, Parametrization, Forecasting, Effectiveness, Self-dissimilarity, Fluctuation, NP-Complete, U-Rank, VC dimension, Rademacher*,… Margalef, 1972 and Chaitin, 1979, got the *Information Theory* to define Diversity and Complexity in Biology through *Shannon Entropy*. Bonner, 1988 proposed to measure the number of type cells, as Kauffmann did in 1991, with biochemical paths. There are "lower" organisms with higher indoor diversity,… best code is not the longest, but the shorter for the same result, while the longer provide a better path to future essays from Machine Learning point of view. To be longer is against laziness or/and Second Law of Thermodynamics. McShea, 1991 insists but from types of functionality levels between unicellular and multicellular organisms, and defines *Hierarchical Complexity Classes*. Adami et al, 2000, proposed the operative DNA length (minus junk-DNA to deal with the *C-Value Paradox*) and compare it with *Shannon Entropy* per program (useful code, but we do not know how to identify useless in DNA).

In prokaryotes there is, in general, a linear relationship between genome size and the number of genes. The smallest genomes are found in symbionts and parasites and this do not mean to be less sophisticated, but maybe better programmed. However, in eukaryotes there is no correlation between genome size and the complexity of the organism. Gene number is less worse approximation, but what really matters is that more complex organisms have more gene functions. Although there has been an increase in the maximum level of complexity over the history of life, there has always been a large majority of small and simple organisms and the most common level of complexity appears to have remained relatively constant. As we just said, no relation between complexity and size in different clades. Simple life is not with us anymore, while there is a gap between the no-life to life… and low biochemistry loops (minimum sophistication), seems has been forgotten by Life. Maybe we do not have a proper definition on what to look for.

When modeling with short-term adaptative rules, systems gain complexity, but remain reversible and this is not what we observe in Nature. Chaisson, 2011, approach it in another way, back to constructuallity: energy flow increases with Complexity, the better organization, the quicker energy drain. So, at this moment it is an open question, with no clear definition, diverse measurement and not a clear relation with Entropy –"*Modularity*" in Networks jargon, as a reference $Q > 0.7$ it is considered strong clustering- or level of surprise on respect to random.

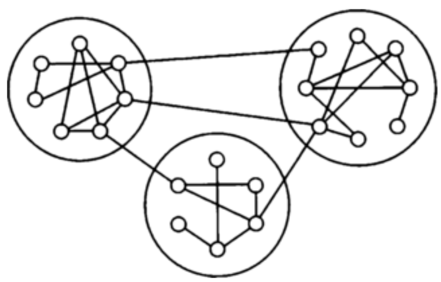
They all were right, but each perspective holds a piece of the cake and all of them are compatible. The arrow to specialization in tissues, in functions, in jobs, in cultures,… is a fact around us, but it is a consequence of a Universal Law or it is pushed by the environment? Is it reversible? Which mechanism rely below the connection between Short and Long Term Natural Selection?

THE ANSWER

While there is not a consensus on the definition/measure, experiments are fed either by hypothesis of mechanisms implemented on simulators, and/or measuring sophistication in Nature in several ways. Models simulates the mechanisms that they previously proposed, and hide an implicit *Confirmation Bias.* Direct measurements may have also a bias due to the lack of consensus measuring several items, while every experiment measures parameters that confirm the thesis. Assuming all previous perspectives, due to those limitations, let us start barely from scratch, just to watch all those ideas from another modeling approach... decision networks: a *Dynamic Multinode Network Game* way, with evolving nodes, links, payoff matrices, rewiring, beating for time limitation to decide the path to minimize energy flow. Time processing scores the inverse of information processing capability.

We all are the history of our decisions about an uncertain environment. They are a bridge between the biological recipe and the environment. Fitness of any organism to survive and reproduce is driven by its bridge-decision history, and to collect and process information with some criteria to decide, may have better results than to decide randomly in a martingale trip. When environment propose same situation again and again, it is cheaper to have implemented the same proven solution than to essay randomly each time. To have criteria means a cost in memory and process (it may be cognitive, cultural or just genetical, even chemical or physical). The organism has to invest resources to remember a criteria of perception-act repetition. This do not mean to have even a genetic code or a brain, just a mechanism to store and process information as a loop in a set of chemical reactions (in a higher level related ideologies).

At the very beginning there were not an specialized information codification system -RNA / DNA-, just the better constructual chemical path reaction automatizes cumulative maps, or reinforced recipes, or tuples. In computing "tupling" is a program transformation by packing some recursive functions, to eliminate multiple traversals over the common data structure. The major difficulty in tupling transformation is to find what functions and how are to be tupled for the best efficiency: several results are returned from a single traversal of a data structure. They compete and collaborate at the short term. In the same sense, recursive physical&chemical loops -clusters- would be more efficient to drain free energy than random reactions, but those tuples may be reversible when its cost losses its trade off. Tuple-loops develop a memory through cumulation of its better efficiency, and that reinforces some ways better than other if environment propose recursive situations. A topical example may be the *Krebs Cycle* or an analogy we can think on is *Hebbian Reinforcement*: "the cleaner is the road, the quicker is for pedestrians, that cleans the road when walking". In tupling jargon, it would not be a matter of membrane, code and metabolism, but of sequential coarsening, cumulative memory into the structure itself and reaction automatization. We already can build computers based in BZ reactions, water surface tension with nanomagnets,… allowing process and memory. The way to internally store a reinforced structure is overfitting: the relative weight of a new microstate decreases among experience and the improvement in tuple efficiency, results a minimum in inputs and outputs on subroutines or coarse loops (or let's say specialized subnetworks for a quick and dirty decision automatization).



In this figure we can see a node with a single input and single output which may gain efficiency 6 to 1 if it is considered as a node. Each cluster, defined and measured through "maximum betweenness", had been automated with a reinforcemed recipe of paths.

Maybe in the future we will be able to apply it to Life Emergence if we could identify "fossil" loop reactions inside biochemistry (maybe as difficult as identifying specific emotions maps inside a brain through neuron firing). This is not a paper to describe how pre-Life becomes Life, -how chemical loops cumulates automatization, through *Tupling Mechanism*-, stored as traps in chemical maps of recursive constructual responses with better fitness. Communities of reactions will compete and collaborate for the efficiency of the solution. Beyond those hypothetical chemical maps storing memory of the better energy drain, we may describe the mechanism in a better known Life Evolution from genetics, taken as initial condition, and even from brain spiking and epicultural maps. So, we will jump in this description of the *Tupling Trap* to the better known first living organism, with a basic specialized and stored aside coding system -genetical code- that allows him to decide to action the same, when perceiving similar recursive configurations of the environment.

Darwin in 1859: "*As natural selection acts solely by accumulating slight, successive, favorable variations, it can produce no great or sudden modifications; it can act only by short and slow steps*". *Theory of Punctuated Equilibria* (Eldredge&Gould, 1972), questioned Darwin's gradualistic account of evolution, asserting that the majority of evolutionary change occurs at or around the time of speciation. Tupling Trap is also the deep mechanism behind this widely observed phenomena.

From a narrower definition, *Life* is the emergence of an specialized information decision code for transcendence in time to drain energy through. It is an economic concept: atoms decides crystallization from a fixed coded, like traditional computing, changing inputs and outputs, not the program. Neurons decides to spike including a trade off scoring, somehow similar to ML computing, changing the program parameters, and this permits to adapt and overfit to stability. Classical programing, organic chemistry are "*Deterministic Polynomic"*; but Life, as evolutionary, network, distributed, neural, deep learning or games theory, computing is "*NP Complete"*. Value scoring is what bridges recipes and adaptations and turns no-Life to Life. Here there is a hint of which chemical loops we may look for.

ENTROPY

We can factorize any number of circumstances perceived D, necessary for taking the very best decision to act, but most times not dually ($D = 2^N x 3^M x 5^P x 7^Q x$… as N decisions between 2, M decision between 3 options,…). We do not know even the exact translation between "information" contained into reality to Mb. Because prime numbers, digital simulation can only approximate D to its nearest $d=2^N$, being N the number of questions Yes/No. The number of simple basic Y/N parameters that are considered in a decision may represent its phase space by nodes related in a network. Generically it may produce a rest from a number D to a low prime factorization d, which is not unique, as it depends also on the optimal path used to decompose ("*Kolmogorov Complexity*" and/or distance to the "*God's Algorithm*"). Eventually a number can be factorized only by high prime numbers, decomposing a very difficult decision into some less but still difficult decisions. Applying $\log_2$ to the number of possible dual paths to arrive to the same factorization of D (not d), approximates an Entropy D-d. So, in the definition of the decision network -when there is more than one variable to consider-, we can identify a relation between that first level of entropy and complexity.

To life, to think, to evolve is to decide. Decisions are forecastable if we set the values of the scoring matrix. Free Will and Adaptation are a matter of values, they are not about decisions, but they help us to visualize. Decisions which are not factorizable into (Y/N, 0/1, -1/1, even/odds,…) 2^N ways to decide (or even could be possible to consider other very low prime numbers), may increase entropy, (i.e. to decompose a decision in a 13-parameters phase space, can be approx. 2^3+5, 3^3+4,2^1x5^1+3, 11^1+2, 2^2x3^1+1, 2^1x7^1+1, 3^1x5^1+2, 2^4+3,… we can also decompose in 2x(2+2+3)-0.5 or $2+2+2+(2+2+2+2+2+2+2+1)x10^{-1}$, or $2+2+2+(2+2)x10^{-1}+ (2+2)x10^{-2}$ +… and we have several ways -"microstates"-, with several efficiencies –"rest"- to do). They will not have the same processor expenses and entropy. A decision noted by 11 or 7 no factorizable options would not be easy, and may need to approx. again. 2, 4, 8, 16, 32,… they dilute among other and the "bigger" decisions, leave intrinsically the bigger gap to error, ashes and risks. In computing languages N-tuples are vectors into which their N elements are somehow related and those relations distinguish 2 vectors with same values, and a vector can be factorized in different tuples changing or not the properties of the set as an object (an object build by objects). Same N-vector can be configured in many N-Tuples, but if they are related every configuration will have different properties. When N is an integer with no rest, decision process is homopathic; when N is a decision approximation, with a rest, is heteropathic (Stuard Mill). In both cases this is only for the highest possible N that the organism could process in a limited time available, not the best N for the very best constructual solution.

D is limited by *qualia*; d is limited by primes. A full perception in all scales needs infinite resources to invest in information capture, but the time to decide is given by the environment (the wild pig will not wait for decision to fight or flight). Collecting data trades off on the perception tools: senses and scales (*sentience*). Sentience may be a broker recommendation to invest in collecting information, only if there is option to action as a consequence with better fitness. Senses are structurally limited but the attention to the information they can process is also limited by opportunity. There will have to add more decisions about which parameters are not worth of to be perceived and which actions are available. This level of rest between D's and d's (parameters needed for decision and parameters considered into an elapsed time), increase diversity in ways to get the same solution, complexity/entropy, maximizing flow, minimizing the rest, between the optimal D and the useful enough factorization d, (d<D). What is not known because perception limitation, what is not considered because action limitation, is pruned from an optimal decomposition and increase again entropy/complexity, due that any decision cannot wait until collecting full information (exploring all microstates or in this case, N-Tuples). Tupling automatize and thought prescribe a recipe of optimal D and reduces time to decide, increasing d.

At the next approach level, even if there is an accurate perception and availability to act, and the parameters are homopathic, eventually there may be too much nodes to process and we have to classify hieratically them by relevance to acquire, remember, process and project… analogously as "*SD-Maps*" A.I. simulations (Atzmueller & Puppe, 2006): "*FP Trees*" pruning the less relevant nodes by the time availability set by the situation. We can collect many information to buy a car, but we do not have the same availability to decide if we run or wait, if we hear the car acceleration when crossing the street (in this case we do not mind about color, power or price). The normalization in the code to do such a "qualia pruning" (chemical, genetic, but also can be educational, grammatical, software,…) creates a "Umwelt" (Uexküll, 1957), which defines each species through the trimming of their niches perception and action scope.

Each not known variable, not perceived, pruned by approximation, rejected for irrelevancy subjectivity or out of scope to act, reduces time but increase entropy sequentially by levels and diversify the possible ways to process the same decision decomposition path as a solution, increasing the gap between the best and the better because all limitations. The better selection, the more efficient use of processor time. A root has to decide to invest its resources to grow in some direction depending on pH, humidity,… maybe more relevant than temperature or salinity, so it is better for the use of limited resources to have information about pH and humidity, than to grow randomly in any direction, or also than spending time in collect and process perceptions, that may not be relevant for fitness in "normal" situations. The optimal decision for Life is not the best solution, but the better profit relative to its trade off.

It can be done by many ways to get the same solution. To decide is a trade off algorithm: besides solution scoring, the system has to adapt to the time, data caption possibilities and information processing capabilities. Approximating and trimming, leaving in each level an ashes path of "rests". Rest increase the options on how to fill the gaps -exploring microstates- to get the same flow enough satisfactory solution. We simulate the micro-evolutionary scale with the decision fight-or-flight factorization (would be the movement of a bush a wild pig? or a rabbit? Is the wind? or a relative? Do I have in my hand a gun? Am I alone? Where are my kids?....), in a network where nodes are perceptions and actions -i.e. a brain-. There will be some nodes not perceived, some not considered (high primes decisions), some nodes may not be possible (i.e. a worm cannot fly to scape), some nodes and links judged by the code as not relevant, some misunderstanding, some links that are not optimal, and limitations about the memory and process capacity, for an outside-given time to decide. Even if some nodes are not considered, as far as there will not be any criteria to select interactions, it will be a Uniform Network in which every approximation, every misunderstanding, every hierarchical categorization of relevance,... Uniform network is not efficient and will prune and evolve to some structure where recurrence of successful paths would be reinforced and thought memorized in the network structure itself.

So the simulator needs to trim the initial random hedge of nodes and links again up to this limitations, while N is in each strategy downsized, 2^N will be further and further away from the initial number, that may produce wider and wider rest and entropy to adjust time processor. Structures compete and collaborate to be the reinforced path. If we do so in a Random Network, that correspond to the wiring parameter, it just adapt randomly but not gain efficiency. In a Uniform-Random structure, incentives would be also uniform, but payoff matrices will neither be optimal or adaptable to any outside circumstance. They are set for repetition of the most common situations and not every situation is uniform. To have some kind of selection between fitness, the decision network has to have some kind of persistent way to score: some rewiring/revaluing criteria, some code with memory and processing capabilities, some backpropagation process. That gives another level of rest, which is statistical, biased and depends on distribution that generically an organism do not know (black box): from modified to exceptional circumstances of the environment, that are not selected because its cost.

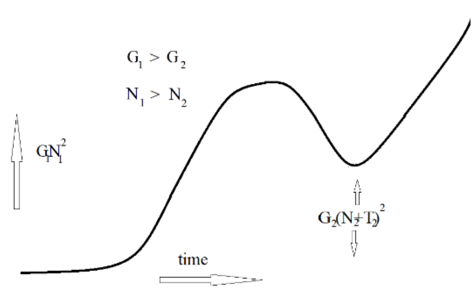
Structure, degrees, distances, densities, clustering, payoff matrices, layers,… evolves biased by a criteria recorded by memory of success (and we insist, memory can rely in the inner structure of the decision network, rather than a specialized codification system). If there is not a near solution to explore "cheap" enough in a specific situation perceive-act, that do not mean that with another structure or size, it could eventually become selected by fitness from another approach. (Maybe for an organism would be interesting to measure photon density, but until the development of an "eye", this will not be useful enough. Romans invented the steam machine but by then it was more expensive than slaves and was not a fitness-innovation until centuries later). So an evolutionary network simulator may need a dynamic scoring rewiring and backpropagation weight options, if the link is not optimized to give the best solution.

Niche feedback –*"backpropagation"*-, will inevitably concentrates and reinforces and select some organization into the decision network, just because some of the more expensive informed decisions, eventually may have better fitness than random cheaper responses (others are not worth of). That means cumulative clustering of the recurrent decisions subnetworks and with enough time, investment in specialized memory and process functions for recursive decisions. Nature is stingy, if it works do not changes, so it is still reversible at this point if there is a less scored way or lower environmental pressure, while reversion remain as an option among others to be selected by its trade off. With this clustering mechanism, Natural Selection have cumulative and overfitted memory of the past, but not of the future. A random walk to go, most of times would not be the random walk back to the lowest energy same gate. If selective pressure disappear, the reversibility can bring the system to the previous or even to another simpler solution. With memory printed in the network structure, Life will gain complexity only from some level of adaptative pressure circumstantially. Up to here memory of a tuple or feedback reinforced way to decide the better, vanishes if scoring better for a lazier solution, with more entropy and similarity to a Uniform or Random organization.

Overfitting and the advantage of being the first solution to succeed, stabilizes the tuple with the outside pressure. Simulations often shows networks to coarse when there is feedback reinforcement, creating overfitted homogeneity inside communities (because it is so coded through reproduction of the successful recursive solutions). Paths with better flow will reproduce more because they arrive earlier to the low energy level than slower paths and because its speed, they can be more used by the system into a time interval. At this very first level of recording, the system do not use any specialized software to reproduce the successful recipe. If a path uses a better energy/time than other, there will be more quick than slower paths at the same time, but the first has the hill position advantage and other solutions needs to jump that gap.

The capacity requirement to process the network evolution to equilibrium between minimum energy and maximum flow, would be GNN (being G, *mean degree/2 < 0.5*; and N the factorized *number of nodes* perceive-act). The first enough action to adapt a situation, will require minimize processor time α GN^2: the less nodes, the less time to fight or flight. Links increase or decrease linearly the time to decide and they hold the structure, but parameters considered in a decision are to the square. In the short-term evolution sometimes reversion of the quantity of nodes will have more fitness, always better than link structure erasing, that will remain with less pressure in evolution of the simulation. Adding a node, a perception, an information to manage and produce an action, (a dimension on the phase space, a variable in the decision), is a very expensive step-forward, because <u>its value in time is to the square</u>. (If Nx10, GN^2x100).

The alternative mechanism to reducing N better than G to minimize investment in information process, will be to collect and process information and may select a priority for pruning nodes N vs links G: maintaining structure and better decision for action. But the trap is that the tupling competes with other tupling for the same solution to drain costless energy and will be hysterical -inelastic- (structures coopetition within herself for the lazier). With success of less cost but better linked decomposition of the decision, linked substructures or clusters may be selectively optimized, reinforced if useful for being often applied and tends to isolation in a subset of the vector: a tuple T. This is an energy optimization process that do not need environment pressure: its driver is the minimum expense. A *black box* with low input&outputs. Niche feedback and eventually because the better fitness in time processing for re-useful code than process each repetition, can be substituted by that single T-input-output process -automatized- which collects recursive N related parameters. This process would be still reversible (simulation by iteration) when environment pressure bias decrease, but if create *black boxes* T lower than N, Nature would prefer the lower path. Evolving networks simulations show that several nodes N strongly linked because repetitions, may be stable (not changed by a small changes in its nodes, edges, distances or weights) and can be replaced by a lower number of communities T with strong inner "*Connectivity*", (as a reference this can be measured in a network with the parameter "HCS" which edge connectivity exceeds half the number of nodes in a subgraph T), that intrinsically contains particular rules of interaction inside T and collectively with other nodes N.



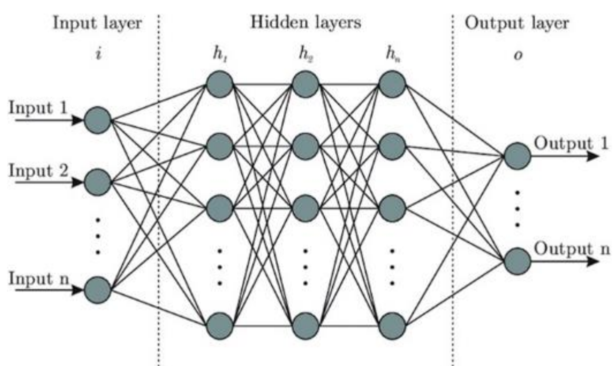
Improvement Cycle increasing N to compete into an elapsed time a reinforced solution; followed by Tunning Cycle improving structure to do the same with as less expenses as possible.

THE ARROW

Nature do not know about those backstage subtleties and matters about energy flow, resources, information, time and cumulative memory process limitations for a satisfactory decision to act in the very best short elapsed time: reducing $N_{ini} > N_{fin}$+T. Under competition for scarcity, G pruning is set for a better drain solution, to improve the information processing for a better decision fight or flight increasing N in an elapsed time. During reinforcement, even if pressure downlow, competition is into the solution phase-space for lowering investment, decreasing N trough T clustering, setting a local minimum and no easy way back in terms of energy optimization and that is the arrow. Analogous Product Life Cycle has been deeply analyzed and modelized in Economics.

Rules to link has increased in the process to be used only if so, and sometimes maybe in a better constructual benefit than reversion. This has a cost in available process capability at the long term scope, while not in short-term process demanding, so in time to decide to fight or flight. It is very possible that store a tuple have a lower cost in a Hebbian structure, than increase N by disassembling tuples. If fitness is better through this alternative option, it will be better also when that code will be evoked in the future. It is a trap! It is enough to happen once, to print a time-arrow in the evolution of the network structure that will not be easily reversible from this point. Optimizing time to decide with memory of recursive situations, will be cheaper in the short term, but holds expensive structural code inside the system definition. Here is a Darwinian mechanism for the long term!

The sub-mechanisms of a *Horizontal Loop Combination* will be recursive in each step: backpropagation; rewiring optimization (creating a “functional program” about organization and structure of the subnetwork); normalization and rules (standardizing and coding interactions, reusing and increasing its “*weights”* on the collective); concentrating the links to input and output information (specialization and isolating the subsystem); erasing no-relevant nodes (trimming low degree); automatization (coarsening into layers of nodes and clusters substituted by tuple-nodes); to sum less overall size of the network N with more hidden and optimized by repetition links G, and eventually as the organization has increased, with less processor requirements $G_{fin}(N_{fin}+T)^2 < G_{ini}N_{ini}^2$ at each immediate decision, but not as a whole set. Code only use a part of the processor capacity in each short term decision, reducing the time for this specific, but needs more memory to run the objects coded inside the full cumulated program, which is critical for the long term fitness because processing time is critical to fight or flight.



That will happen into an autofeedback recursivity cycle between levels, creating layers of clusters, layers of layers of clusters, clusters of layers,… and so on. Interacting horizontally and also vertically, and they will eventually reuse subroutines from other tuples, tuples of metatuples,… The lazy Nature would select to use the minimum node number network, not minding that much if they are N or T. That may or may not be the old way, but hidden in the backstage paying a price in entropy (alternatives to manage variables), cumulatively the network contains more rules and links but less N+T,… more information and organization for less processing needs if there is a coarsening of the more used. Links and rules increase their weights to be reused in similar circumstances in longer terms because an immediate criteria of Nature, and She minds mostly about the apparent reductions of the number of parameters needed to decide with enough fitness. Code inside tuples will only run when needed, supporting a lower short-term time processor, but emerges a higher long-term code complexity because the storing of subroutines and objects directories in overfitted weights.

This short-term view to minimize time processing, would spend free-energy in programming the tuples in “Hebbian language”, decreasing local entropy while increase the global. To store recipes in code is a metatuple -a meta black box- itself (*Baldwinian Evolution*). Eventually it will increase the processor-time at the long-term view -to use again the rule when appliable-, and increasing order will be compensated with more efficiency, passing through energy and information. If there is wind and the bush moves, it could be an automated decision to consider not relevant fight-or-flight (but the organism focus on this situation, not on reproduction, or socialization, or whatever other code not useful at this moment). Near-but-out of equilibrium, life will investigate and select either reversibility in the short-term evolution scale -survive or reproduce-, random walk back to lower N, or to invest in organization G -software writing to substitute a large number of N for a small T-, at the hidden cost of code only used when necessary. Nature evaluates which option is cheaper at short term in $G(N+T)^2$, not what is better for his reproduction success in the long term.

To collect and manage information through the automatization codification would improve recursive decisions, eventually the balance can be better than recovering the old way -or another more random way-, increasing the availability to include more nodes for a decision, while leopard attach will gives the same processor-time requirement for a better short-term decision. *Baldwin Effect* has often been considered some kind of Lamarckism, but is in fact a Darwinian selection about fitness in time to decide, quicker if automated. Each step dilutes the reversible and simplest alternatives to reduce N just pruning, among an increasing number of alternatives improving G to reduce N through T coarsening and substitution.

Diversity will delete homopathically with enough time the old way because its higher cost in each situation, or at least leaving it as just another decreasing probable option. Some plants and other eukaryotes lose meiosis when the evolutionary benefits no longer outweigh the costs. Deuteromycetes fungus lose even sex. By the other side, eventually the fitness of the automatization will improve sometimes the information management, adding variables considered before as irrelevant. Two steps forward, one step backward in the *Hierarchical Network Decomposition*. Energy drain demand increases with concentration. Tribes concentrated in sedentary towns. Antique civilizations concentrated on cities, which needs to be more structured and diverse to process much more energy, ideas, decisions, ways to do, paths,… in higher density with more complexity in the scoring value matrix. A civilization needs more energy than a tribe, but drain a much higher energy flow. After romans the dark ages deconstruct cities, but with new ideas history improve the energy flow again in bigger urban concentrations, because the tupling trap is itself a memory of the arrow, collaborates and compete with other tuples, but not with random sets of less structured single nodes of higher entropy.

Even in equilibrium, because the best is not the better, network tupling optimization has not a unique “*polynomial path”* to a unique solution. In a “*gradient descent*” process on the “*Tunning Cycle*” for the local minima, the more out of equilibrium, the more stressing situations; but also the more diversity, the more stress, both in a feedback loop. Diversity of auto-created options drives the systems to a new coopetitive pressure between those improvements (logarithm of the number of ways to get equivalent solutions). External selective pressure may produce exponential evolution (if it were linear, we would need to change to log-scale), but even without it, diversity is a niche itself where to compete or collaborate to decrease N increasing T. “*Greedy algorithms*” decrease processor-capacity for a short term decision -because in every situation the decision manages a lower N resumed in T-, but may need memory processing at the long term, sharing or copying solutions,… Even between equivalent solutions, the longer and not maybe more optimized because neutral or non-optimal reinforcements, would be a "blank tape" available for future explorations (size can be good, or bigger is not always better, but it helps).

There is not an algorithm to find the solution in a "*polynomial time*". If a God would design an organism *NP-Complete*, it would be optimized to 2^N, optimally coded, with no misestimation or overestimation of relevance, fair payoff matrices,… but in Nature each fudge for the short-term is patched quick&dirty with a satisfactory solution, usually not the best, while there is not availability to check all options with the full code and all optional microstates of ways to get them. When solution is recursively used, adapts itself to efficiency and stands through time overfitting the path.

EVOLICITY

Log scale is inverse to exponential functions. Let us call "**Evolicity**" to the evolution speed ("*gradient optimization*"). Increased diversity will always accelerate *evolicity* because N is to the square, even if environmental pressure declines. Processor-time is proportional to GN^2, so requirements for information management, because the exponential growth of alternatives coopiting, will increase with size in some "*Power Law"*. In a narrowest context of neurosciences, Changeaux, 2009, call the process of increasing options, *Generator Of Diversity* (and use representations coopiting for attention -relevance, feedback reinforcement-, demanding more memory per decision in his simulations). More than this, while several nodes may be discretely automatized -coded- and outsourced to a single or lighter new tuples, changes in N_{ini} – (N_{fin}+T), will not be generically smooth (again, because the time to solve is that rest to the square), because it is not a change of an N but a T, or a T of N&T's.

Evolution has to decide itself for the fitness of divesting in processing, pruning no-relevant N, or invest in code to substitute an *homogeneous* set of N's by a lower number T by automatization. While at the short-term fudged invest in automatization may be better to reduce N than to be back to the old way, that implies a rest, more diversity of paths, so more entropy, and margin to organize with need of more processor time and memory, to run code to the long term to a higher diversity of perceive-act situations. Fudges seem cheap at the short term, but reveal to be expensive in structure maintenance at the long term, when we consider full code. Fudges over fudges decrease efficiency respect a well-designed mechanism, but increase dramatically ways to stack fudges. The more optimized in its process capabilities, the more recurrent. Environment changes and diversification of codes is a niche itself and maybe by then it is better the fudge than the well-designed. Reversibility to random options instead of informed selection has nothing to do to be selected, because the recurrence. Llinás, 2001, perspective see the perception-action subsystem for multicellular organisms, as a specialized hardware to decide where to move, and from there it has gain complexity up to our brain. (From a similar point, DNA is a memory-processor subsystem of chemistry for life). An ant has to decide where to step forward in 2D, but a fly has to decide in 3D, so she needs more automatized codification, so more processing capability. Allman, 1999, describe correlation between cognition of leaf and fruit monkeys because the need to appreciate colors, sweetness and more parameters (N^2).

Damasio, 1995, "*Perhaps it is accurate to say that the purpose of reasoning is to decide and that the essence of decision is to select an option*." A selection among 2^{N+T} + rest. For a developed brain like ours, he called *Somatic Maker Biasing* what we would identify as a type of high level cognitive tuple, and they can be not only inherited into the lineage, but also shared -reproduced- from other brains. He also describes the code as dispositions of incentives, which is here the key. Tuples as spike maps. Black boxes we call anger, intuition, pain, ideas,…

Quick and recurrent decisions may require to be coded in a very optimized N/T value and stable payoff matrices, -i.e. genetically coded in incentives and punishments-. Automatization in tuples has the cost of adaptability if the situation is new or not the same as usual (a not perceived, misperceived or perceived but not well scored perception-action, becomes relevant, and previous approximate factorization of the decision walk away from reality). Genes, chemes, memes, nemes, temes, demes, are tuple-code (let concentrate tuple's definition into scored dynamic subnetworks). Neural patterns of spikes simulating perceptions are tuples. Hunger is a tuple, when the perception of low level of sugar in blood plays a game with the availability of food. Common sense is a black box: a tuple of tuples of tuples and so on; a symbol is a recursive tuple of tuples; a flag, a slogan, an accounting system, a constitution, emotions, love it self is just a system of recursive tuple of tuples. Automated decision black boxes inside black boxes naturally selected for better decision processing… automatized auto-replicator code of incentives between hidden layers for preprogrammed "*low-cost-quick&dirty*" decisions. The more black boxes, the more evolution complexity.

Processor speed or its inverse, time enough to process, allow to have not strictly optimized the code, making possible to either submit random or driven new version, include patches, or use other's *quick&dirty* innovations. In between Quick/Slow decisions becomes a niche itself where decisions coopete and may require recursively learned tuple-codes as rules, traditions, histories, methodologies, software,… Non closed programs to be fulfilled into uncertainty, case by case, and do not have high requirements of hurry, are the gap to fill with "ad oc" programming, by Scoring Matrices on which decisions are processed, we call Free Will (a matter of Value Scale). The more locally concentrated, *syntropic*, highly layered, structured, clustered and organized, the more sophisticated societies, will be more efficient in the drain of energy and information, and with enough time, dilute homopathically the old way. To become paleolithic again is not an option for ourselves, while facts seem to appear this is our way now a days.

UNIVERSALITY

"*Evolution is economic and addicted to DIY (refurbishing).*" Nature pays the karma of her fudges and contradictions. The masquerade of the recursive tuples with hidden cost in sustaining syntropy and diversity increasing of solutions to solve inner gaps between pruning for the better and the best decision, microstates and niche-classes: being lazy and stingy at the short-term selection, makes Nature to work harder because Her myopia. Being lazy, increase diversity and codification hidden in tuples. The more black boxes they are, the more complexity. The more complexity in tuples networking, the more complexity in score matrices. The more lazy and the more fudged, the more diversity of solutions. The more diversity, the more pressure for Natural Selection, even with no environmental limitations. The more auto-pressure, the more no desirable sophistication at the long-term and the more stable overfitted memory; and this **Tupling Drive Mechanism Towards Complexity** is generic, not circumstantial, intrinsically unavoidable and would happen everywhere an *Adaptative Scored Complex System -Life-*, would emerge, even with pseudo-stability of the environment, near but out of equilibrium.

Decisions are not the issue, but scale values that define them. The decision for a seed to grow has a relatively easy scoring, but the collective behaviour of citizens have just more complicated, even chaotic, dynamic scoring functions. The more complex scoring in each node, the more options to solve a pseudoequilibrium and the more speed in gradient descending. As the "*Folk Theorem of Guided Self-Organization*" is true, Natural Selection is driven to a pattern "*quod erat demonstrandum*". That means that Universe is plenty of complex life, high cognitive organisms, martians of all kinds and the acceleration of the recursive process approach ourselves quickly to *Singularity* (punctuated jump in our evolution as Homo) and others, in other planets, may have been and will be already there… because the long term exponential evolution to complexity happens to be a Universal Law.

This has tried to be a description of a generical mechanism at any place on the Universe where locally concentrated organization for the scored efficiency of draining energy emerges, homeostasis stabilizes the system and its complexity and evolicity will exponentially increase: this means it is a must and we are not alone. But we do not know how are other macrostates or which is the pattern to converge… There is a pattern: Complex Life unsuccessfully botching with dynamic trade off for the equilibrium in draining energy, to reach what we call Death.

REFERENCES

(1949) Shannon, C.E. & Weaver, W. *The Mathematical Theory of Communication*. Univ. of Illinois Press, Urbana, IL

(1957) Uexküll, J. von *A Stroll Through the Worlds of Animals and Men: A Picture Book of Invisible Worlds*. In Schiller, C.H. (ed.). *Instinctive Behavior: The Development of a Modern Concept*. New York: International Universities Press.

(1960) Rensch, B. The laws of evolution. The Evolution of Life, Tax, S (ed), pp. 95–116, University of Chicago Press, Chicago, IL

(1969) Waddington, C.H*. Paradigm for an Evolutionary Process (Towards a Theoretical Biology)*. Aldine.

(1972) Maynard Smith, J. *On Evolution*. Edinburgh Univ. Press.

(1972) Margalef, *R. Homage to E. Hutchison, or why is there an upper limit to diversity*. Transactions of the Connecticut Academy of Arts and Sciences 44: 21-235.

(1972) Eldredge, N. & Gould, S.J. *Punctuated equilibria: an alternative to phyletic gradualism*. In: Schopf TM, editor. Models in palaeobiology. San Francisco: Freeman Cooper; p. 82–115.

(1974) Raup, D.M. & Gould, S.J. *Stochastic simulation and evolution of morphology-towards a nomothetic paleontology*. Syst. Zool. 23(3), 305–322.10.2307/2412538

(1976) Dawkins, R. *The Selfish Gene*. Oxford University Press, London.

(1976) Saunders, P.T. & Ho, M.W. *On the increase in complexity in evolution*. J. Theor. Biol. 63, 375–384.10.1016/0022-5193(76)90040-0

(1979) Chaitin, G.J. *Toward a Mathematical Definition of "Life"*. In Levine, R.D. & Tribus, M. *The Maximum Entropy Formalism*, MIT Press, pp. 477–498

(1987) Katz, M.J. *Is evolution random? Development as an Evolutionary Process*. Raff Ed. R. Liss NY

(1988) Bonner, J. *The Evolution of Complexity*. Princeton Univ. Press

(1991) McShea, D. *Complexity and Evolution: What everybody Knows*. Biology and Philosophy, 6, 303-324

(1991) Ray, T.S. *Evolution and Optimization of Digital Organisms*. Scientific Excellence in Supercomputing, Baldwin

(1991) Kauffman, S. *The Sciences of Complexity and Origins of Order*. Santa Fe Paper 91-04-021

(1993) Holland, J. *Echoing Emergence: Objectives, Rough Definitions, and Speculation for Echo-class Models.* Univ. of Michigan

(1994) Arthur, B. *On the evolution of complexity. Complexity Metaphors Models and Reality*. Addison Wesley Reading M.A.

(1994) Gould, S.J. *The evolution of life on Earth*. Sci. Am. 271(4).

(1995) Damasio, A. *Descartes Error*. Computer Science.

(1996) McShea, D.W. *Evolution*. Lawrence, Kans. 50, 477-492

(1996) Dennett, D.C. *Kinds of Minds: Toward an Understanding of Consciousness*. Basic Books, NY

(1997) Bedau, M. & Snyder, E. & Brown, C. & Packard, N. *A comparison of evolutionary activity in artificial evolving systems and in the biosphere*. Proceedings of the Fourth European Conference on Artificial Life. MIT Press

(1997) Bejan, A. *Advanced Engineering Thermodynamics*, 2nd Edition. Wiley.

(1999) Allman, J. *Evolving Brains* Scientific American Library.

(2000) Adami, C. & Ofria, C. & Collier, T.C. *Evolution of biological complexity*. PNAS April 25, 97 (9) 4463-4468

(2001) Llinás, R. *I of the Vortex: from neurons to self*. MIT Press

(2009) Yaeger, L.S. *How evolution guides complexity*. HFSP J. 2009 Oct; 3(5): 328–339.

(2009) Changeux, J.P. *The Physiology of Truth: Neuroscience and Human Knowledge*. Harvard University Press.
(2011) Herrera, F. & Carmona, C.J. & González, P. & del Jesus M.J. *An overview on subgroup discovery: foundations and applications.* Knowl Inf Syst 29:495–525 Springer-Verlag
(2011) Chaisson, E.J. *Energy rate density as a complexity metric and evolutionary driver*. Complexity 16(3):27-40.