Explaining Bio-coding: the Concept of Stability

Karl Javorszky

Institut fuer angewandte Statistik,
Landhausgasse 4/23, Austria. Tel./Fax + 43 1 533 47 40 (kj.sci@chello.at)

Abstract

Entropy describes one of the possible ultimate states of an autoregulated system. We contrast the entropy concept with that of a functioning homeostatic system (a system which does not degenerate into entropy). Among the many aspects of a semi-stable homeostatic system (e.g. of the system we assume theoretical genetics to manage) to discuss, in this paper we concentrate on the property of several concurrent closed random walks necessary in a model of a homeostatic system. A closed random walk in an *lnE(n)*-dimensional space (if the set under discussion consists of *n* objects; *E(n)* denotes the number of partitions of *n*) generates effects which can be quite surprising. The cells in the *lnE(n)*-dimensional matrix are ordered along properties of logical assertions (and of their combinations). We look into properties of additions and find neighbourhood relations which can help explaining some phaenomena. In this paper, we contrast the properties of a closed random walk to those of a system that degenerates into entropy. We conceptualise the circle as a special case of a closed random walk. The style is that of an essay in natural philosophy.

Introduction

This paper intends to deepen a discussion on how the interaction of regulatory interdepence in theoretical genetics works. It summarises the author's contributions to the ongoing discussion in the FIS working group on what is information. There is, in this model, an interdependence between the "actualised" and the "potential" state of an abstract cell. The actualised state is in this moment (in any specific moment), the potential state is that which has been or shall be. We discuss the interdependence between "now" as opposed to "previous" and "pursuant". In a well-regulated system, with the past influencing the present and the present influencing the future, there evolve of course rather complex questions relating to the immanence of concepts like "information" and "predictability". The connection to empirics is the observation that the genetic information is stored in the DNA. The DNA is understood to be a long *sequence* of logical markers, where each marker consists of three sequenced basic units. Each of the basic units can be any of four varieties. The DNA is then, in this paper, a sequenced collection of logical markers; we disregard the biochemical properties of the actual genetic material. We discuss rather the formal properties of a sequence and compare these to the formal properties of a nonsequenced collection. We see as the main idea of this

paper that it compares the information carrying capacities of a multitude of *sequenced* carriers with those of a multitude of *nonsequenced* carriers. The cell engulfing the DNA is seen in this abstraction as a collection of logical markers which are *not in a linear sequence*. Here, too, we disregard the biochemical properties of the abstract assembly. In short, we discuss properties of elements of a set with respect to their distinguishability once if they are lined up (sequenced) and once if they are shuffled up (contemporal).

Previous approaches

The efforts presented here have many predecessors. During some 20 years after the discovery by Watson et al. of the basic structure of the DNA, there have been dedicated efforts by mathematicians to solve the combinatorial problems connected with the mechanism of copying the genetic information from and into the DNA. These endeavors have been given up after leading figures had concluded that the biologic way of treating information can not be mapped by classical combinatorics. One of the leading figures of the quest for a rational understanding of the mechanisms involved, Adleman, said: "Whoever will solve this combinatorial problem shall necessarily have a radically different concept of numbers": a prediction which turned out to be both far-sighted and correct. A consensus seems to have been reached that one cannot massage theoretical genetics into classical combinatorics. Since then, a generation has passed.

Present schools of bioinformatics are centered on dealing with *empirical* results. In this paper, however, we treat the puzzle of genetics as a number theoretical problem, we start in the abstraction and remain in the abstraction, discussing the combinatorics of *theoretical* genetics. This explains also, why there are practically no literature references in this work with regard to recent advances and discoveries in biology and genetics. We discuss *abstract* cells, in which an *abstract* DNA interacts with its *abstract* surroundings. The idea that one wievs the action in the real cell as an abstract, combinatorical process has been evolved by the Kauffmann, Rosen, Adleman generation. New is the approach that the combinatorical process in the cell is driven by subtle differences in information theoretical properties of *sequenced* vs. *non-sequenced* collections. Classical combinatorics has solved the questions surrounding the properties of *sequences.* The Gamma distribution and the factorial are in standard textbooks of statistics. There appears, however, no literature dealing with structures on sets (multidimensional partitions). The technique called "turbo-coding", evolved by Berrou & Glavieux of the École Supérieure de Télekommunikation de Bretagne, utilises properties of *commutative* information transmission. Their turbo-coding technique utilises the same combinatorical properties of sets as the DNA does.

There can be no literature relating to the mathematical properties of sets in their understanding as carriers of symbols, because the underlying phenomenon, multidimensional partitions, has been by tradition left undefined. The logico-mathematical problems of categorising meanings of symbols on

sets are too deep to unfold en passant in a formal fashion. No ontological explanation is attempted regarding the terms „object“, „set“, „matter“ and „forces“. These words are used in their everyday, common sense meaning.

In the approach presented here, we use generally the *density* aspect of meanings, relations, symbols, similarities and differences, even objects and therefore space, translating the concepts in *degrees of probability*. In the everyday lexicon, the connotations of „certainity“ connect the terms used throughout this treatise: both of the solidity of a hard fact (a material object) and of the certitude of something surely happening as the consequence of things being so in the moment as they are (a prediction). The condensation of a probability into a certitude and the condensation of symbols, logical relations, predecessors of matter, energy, forces and space into a solid, hard fact appear in introspection as creations of our brain that were produced by using thinking steps along similar lines. The probability aspect carries a concept of an inner coherence. The sentences describing „Usually, it is <so>“ and „Usually, it is <there>“ have obvious grammatical similarities, and this is the property we make use of. We generate every possible (formalised) scientific sentence, find the most usual subsets and discuss the most probable varieties of „Usally, it is <whatever>“. The method is then *statistical linguistics*, applied on the collection of natural numbers. We use the natural numbers as idealised words in an idealised language, relying heavily on work done by Wittgenstein, Carnap and Frege. The concept of semantic markers has been evolved by Chomsky.

Dual interdependence

The central idea is that of a duality. In the model, that what is the case is not contained in one system of references but in two. Even this “two” is not a very strict mathematical term but the cerebral concept of recognising the difference between “known” and “not known” in the mental development of the child. As we build our basic understanding of the world we have to take into account the experiences we gained as we developed our first idea of the world. In that system of references there is a first bifurcation of the memory-cum-experiencing black block, segmenting inner experiences into known and new. Neither the known nor the new consist of each one delineated experience, therefore it is not a mathematical concept of “two” into which we first distinguish that what is the case and that what can be the case.

In a somewhat more grown-up rediscussion of the subject-matter, we can imagine a co-regency of a system, where there are two regulating systems and each is itself a regulated system by the other system’s consequences. The dual interdependence is well-known from social psychology and may get overevolved into a *folie-á-deux*. There, each of the participants experiences and presents his own actions and impulses as being reactions and reflexes caused by and effected on behaviour of the other participant. The error in reasoning of the parts in a *folie-á-deux* is that they perceive themselves as not being active freely or free to act at all, an intellectual pretence which has its own influencing aspects on the strategy of communication. The unusually high consistency among the views of the participants

of a folly appears to be bought by an unusually diverging set of beliefs if compared to views held by the general public. They somehow create an inner truth which has more similarities than expected among strangers, but on the other hand, they have more deviation to the general truth shared among members of the public. There is, obviously, a capacity in humans to create dis-entropic densities, to increase the polarisation between two subsets: in this case "within" and "external". There appear to be *two* ways of organising inner realities which can get rather dissimilar or even opposing. The *two* in this way of painting an inner process is only a distant relative of the 2 we know from 2+2=4, yet we observe that there is congruence, cooperation, similarity and dissimilarity among the parts of the *two* sets of predispositions.

In a more mainstream model of interdependence, both actors experience parts of their impulses as being originated by their own needs and drives and other parts as being triggered or originated or regulated by instances other than their individual self.

In the model proposed for theoretical genetics, there are two collections of constraints and restrictions on the possibilities that can be the case. This concept is also easy to point out in everyday life: a child has a phase where it can figure out that some actions on his part shall be considered "allowed" and some are "not". The boundaries delineating the collections of future actions into "no trouble" and "don't do it" have been made understood by Mom and Dad, and the child discovers quite naturally, which of the elements of his set of future actions S are appropriate in the presence of Regulatory Agency M or D or both or neither. In cases of interregulation and in the model proposed for understanding genetics, only M and D act, doing things together which are suitable for both of them and each keeping a part of the individual resources to realise individual plans of action. If they were completely and fatally fallen for each other, we could observe an automaton-like imitation and highly motivated efforts to experience everything in double, sharing to the advantage of symbiosis, to the detriment of individuality. Cultural frames of reference are of course not uniform, but generally, there is a common sense agreement within a culture whether a *dyad* (a system consisting of two interacting, interregulating agents) is over- or underdoing its mutual dependence.

We have no semantic references for the abstract picture to be told in the language of numbers. Traditionally, mathematics has had a monopolar power of situation definition. There was the concept that there is *one* right way of looking at measurements, *one* set of numbering units, keeping *unit* distance to each other. The general idea of *duality* has been re-introduced into modern Western thinking by Hegel's dialectics[1]. The concept of *synthesis* arrives at a result, solving the polarisation of standpoints. The synthesis and the *entropy* concept appear closely related, first of all by being *one* state, solution, result, instead of two opposing. The polarisation is more radical with Wittgenstein, who dissects the world into about what can be talked meaningfully and the rest. In that concept, there is no tension between one set of requirements and the other, he comes down squarely and firmly on the

[1] after Parmenides' polarisation of thoughts vs. feelings

cortical side, simply ignoring e.g. the communicative validity of nonverbal signals, and the role emotions play in influencing the system of logical thoughts.

From a psychological viewpoint, duality is something the customers suffer from. They usually refer to this by talking about "inner conflicts" and "the body-soul-antagonism". The over-polarisation and letting both representations organise into opposing sets of values and beliefs blows up some congruence and similarity-dissimilarity questions outside any reasonable importance. Usually, it seems helpful to find a synthesis, be it by letting the philosophical system of beliefs of the subject get more instinct-oriented, tolerant against the body and biochemistry (hormones), or be it by letting the biochemistry, the urges and needs from the hormonal standpoint, get their way in a danger-free surroundings.

The concept of a well-regulated system roots solidly in a duality in which the biochemistry (the collection of bodily fluids, the urges and needs expressed as hormone concentrations) and the consciousness (the patterns of electrical discharges of the brain, the so-called logical, insightful persona) co-exist and co-operate. This concept is also a well-known part of one's acculturation, with some slight differences on emphasis among biologists and mathematicians, whether one discusses things as they are or rather as they should be. In psychology, one uses the terms "cortical" for ideas that are thought up and do not exist if one sleeps and "cerebral" for more instinct-driven and animalistic, body-oriented processes which usually do not officially take place if one is well-mannered.

One of the main ideas behind the contributions in the FIS chatroom was that what distinguishes cerebral and cortical productions is their way of being packaged: while intuition, feelings, urges and needs, emotions in general are conceptualised as *liquid* states, the logical, rational, cortical productions are seen as *electric* processes. The main difference between a *liquid* and an *electric* representation of any one element of the repertoire is that the carriers of the biochemical compositions are (in fact, in a liquid surroundings) *commutative* while the electrical discharges (also known as thoughts) are *sequential*. We have a great many varieties of hormones that can be present in an abstract cell, but we have only one kind of unit burst of the ganglion, where *the temporal distance* since the last burst is the carrier of the information (at least in this abstract simplification). In the idealised system of *mens sana in corpore sano*, the way one's hormones are presently made up does influence how one thinks about the world and oneself in it; and similarly, the way one thinks about oneself and the world around one does massively influence that what one feels and which hormones one produces. In everyday life, we undoubtedly see, experience and use this interlock, both directions.

Having now presented the general picture of *two* sets of logical restrictions which interact with each other, one being the *target value* for the other's *actual value*, we see that such a system cannot remain stable in any *one* of its possible states. The model has an intrinsic tendency of to-and-fro, never finding the ideal state which could satisfy both regulatory requirements. The built-in dynamism – or instability or quasi-stability – of the system leads us to discuss in a critical way the concept of *entropy* and to propose an alternative to that time-honoured concept.

Entropia and eurhythmia

The presentation of the idea of this section carries some formidable rhetorical challenges. We wish to put forward the point that entropy as a concept has no inner meaning, that the concept of entropy needs to be deconstructed. The new alternative to take its place, eurhythmy, can better be understood in the polarisation against the old concept of entropy, being its opposite in important ways.

Writing in a *Journal of Entropy* about entropy being a superstition may appear ambitious. There is, however, a nice precedent of deconstructing a central principle which had traditionally been seen as a Principle. Bruno de-personified God and spoke of the Affecting Cause. Nietzsche explicitly renounced that organising principle by saying "God is dead". Wittgenstein simply ignored any possible discussion about an underlying organising force, implicitly excluding God by talking only about communicable concepts. There is a Viennese figure of speech for dealing with an embarrasment: "don't even ignore it", and his cavalier negligence of not even negating something which his predecessor found necessary to make dead, appears to use this rhetorical tool, he doesn't even discard the concept of a humanoid Cause out in nature.

Facing my own windmill, entropy, I cannot yet muster so much courage as to completely ignore it. It is necessary to de-mean it, de-construct its usage in contexts and de-interpret an idea the time of which has passed.

The main objections against entropy are as follows:

- it describes *one* idealised state of the world;
- it ascribes *one specific* collection of properties to the world;
- no one has ever seen it happen.

The linear concept of evolution, or indeed time, is far from biological reality. There is no *one* specific state in living organisms towards which they would tend. It would be in questionable taste to propose a natural philosophy, in which a projected linear trend of biologic organisms would be towards death. Aside the formal point of Wittgenstein, that death is *not* a part of life, there is a semantic difference between the stable and continuous state of death and that what we call self-organisation and self-reproduction. The very concept of biology is a sequence of states, where periodically a state which is more or less the same, returns. The organism should be seen as essentially the same after a complete cycle of heart pulse, breathing, swallowing, peristaltics, feeding and hunger, activity and sleep within the day and during a year's passage. In fact, the generational reconstruction of what has been is a striking argument towards an understanding of Nature's processes as repeated in cycles of differing lengths. The point against entropy is that it paints a trend towards an ultimate state, in which then everything remains. Such a concept does not hold in a picture of Nature in which things live. If it lives, it is recurring. Even our non-living surroundings, the Earth, offers us a much more politically correct, green, basic understanding of the world by impressing on us the changes between day and night, high and low tide and the seasons. A philosopher living is such a rhythmically changing

environment must heavily abstract from the surrounding reality to create a linear concept of trends towards one final state.

The aspect of homogenity is the second serious shortcoming of the idea of entropy. If it lives, it consists of parts that are different to each other. It is inconceivable to extrapolate a biological property to pervade all and remain in one essential sameness. The idea of decomposing is tantamount to the idea of fertilising: Having reached one optimised solution to a procedure, the system has at the same time realised a highly extreme critical situation in the other regulating body. The procedure during a repetition has an end in one system of references: this end is at the same time a beginning in an opposing system of references. Having come to an entropy state in one describing language means that the units partaking in the entropy have become equalised. In the termo-dynamic sense, all units are cold to the same amount. The sameness of the units is a highly improbable state in the language describing the world as a collection of differing units. The de-individuation of the arguments of a logical sentence is not a usual occurrence. In the collection of all sentences that describe the results of scientific investigations, there are a very few only where the arguments are all alike. It seems a natural property of the world around us that it consists of differing parts. A philosophy that paints a world where everything assumes a kind of all-invading sameness has left a very basic common ground. The probability for the relevance of such an approach is rather marginal. The usual case the language describes does have repetitions and similarities but not much above two thirds. There is about a third of dissimilarity in the typical sentence describing what is the case. In the statistical concept of linguistics, there is a quasi-random walk in a matrix of possibilities. The neighbourhood relations are based on formal properties and with regard to densities, there is a theological assumption that what is the case will have been most probably the case and will most probably be the case again. Then, the thickness of the frequencies in the matrix's cells will determine what will happen next. The next moment is different in that respect to this moment, that it has a differing attribute in any of the categories: points to size n on N, contains k arguments, among which different i, disjunction class m, truth class d, etc. The property of having arguments (summands) that are of i differing kinds is extremely stable. One leaves the mainstream, if one postulates the case to be to be the subject of a description with a disproportionately low number of differing arguments of the logical sentence. The consistency cannot be that much derailed from the center of gravity of the system, around which it peregrinates. There is no credible path for a walk from the center to such an extremely unlikely case that there is no difference among the arguments. As the result of a scientific sentence, this state is highly unlikely to be encountered among that what is probably the case. We may distinguish between what is the case and what we can say about it. Wittgenstein has put forward the idea that we can only recognise well that about which we can speak (exactly), and it shall remain forever mysterious whether what is indeed the case but we cannot speak about. For all practical purposes, he says, the reasonable approach is to regard the two collections as identical (if we can't talk about it, it isn't a subject of reasoning). In light of this, the question whether entropy shall ever appear anywhere, is not so much senseless but rather irrelevant. Even, if there would evolve a situation in which all arguments of a

logical sentence describing this situation would be alike, we would not be able to talk about it in a sensible fashion. The language in which we speak about Nature does not allow for such an eventuality. We could not relate (connect) this idea to the main body of ideas.

The third point in deconstructing the concept of entropy deals with its real, common-sense nonsensical nature. We have so far shown that a concept of natural philosophy cannot be valid if it points out *one* specific state in which Nature is then supposed to remain, or, if a state is pictured to consist of elements which each and all have *one* common property. These attributes of the entropy concept have been discredited by their contradiction of our axiomatic knowledge of the world being a repetitive and diverse one. Now we want to discuss the idea of entropy from a semantic, sensual viewpoint.

One learns about entropy at school as they demonstrate something hot cooling off until it shares the temperature of the surroundings. They extrapolate this observation and discuss what would happen if what we observed – the dissipation of heat and the leveling off of temperature differences into a general, uniform, common temperature – would be a universal phenomenon. Then, of course, the whole universe with Sun, Earth and all the other furniture would have such a common, uniform temperature and there would be no more differences at all. This strikes a child as a superstition of the, again, completely crazy grown-ups. This is a long, sad, folkloristic element of the repertoire, to be sung on evenings around the campfire. The idea is an overdose of melancholy which has nothing to do with reason and common sense. The conclusion from a local observation into a general law is usually brought forward as a rhetoric tool, a rather simple and cheap one. The intellectual process is the same like in the conclusion "You would jump out of the window also, if your friend would find it cool, wouldn't you" with which young people are often clobbered rhetorically, if they insist that they like something and a friend is brought up as a witness to the sanity of the choice. Disregarding common sense for a grammatical-rhetorical point to be gained is often observed with rather insecure people. Concluding from the fact that a cup of hot tea cools off at room temperature should not give rise to anxiety phantasies about the Universe slowly loosing all its properties and becoming a dead matter – the over-analogy has nothing to do with reason and a sense of proportions.

The fact is that no one has yet demonstrated the actual existence of the so-called entropy. I have not seen the school building becoming as cool as the temperature in the physics lab, nor have the winds ceased nor the Sun stopped and the next Winter was cold but next Spring warmed up again. In the social network I know personally, I cannot imagine a serious, sober, thinking person would stand up these days and argue that there is a natural tendency of temperature to homogenise on Earth or in this galaxy[2]. And one would not want to waste his time by speculating about physical effects that, maybe, happen in other galaxies but not in this. Entropy as a concept will soon join rain dances, mumification, werewolves, communism, ethereal fluidum, flogiston and many other concepts that were in use by

[2] We rather fret these days about the Earth *warming up* and the Sun *exploding into a supernova.* Entropy is very much against the Zeitgeist.

thinkers of their respective socio-historical cultural niche. The time has not yet come to not even avoid ignoring this nonsense, so it seemed necessary to state that the concept of entropy is a superstition devoid of any real importance. Maybe, next generations will save themselves the trouble of rejecting the idea of entropy, like we don't even bother to ignore the planetary constellations while extracting gold from industrial or medical waste. To be fluent in matters of astronomy was considered to be a basic requirement towards understanding the Causes and Principles of Alchemia. It may have been a methodical-didactical tool to train the intellect with. There is no more need of the tool of linear extrapolation *ad absurdum*, because our axioms about the world have massively changed. The unidirectional linear extrapolation of decomposition has lost credibility, it needs coagulation or crystallisation as its opposite. Entropy is an idea, just like infinity, of which the time has passed.

Instead, let us use a concept which is more in line with this generation's beliefs and cultural attitudes. It is much less pessimistic and rather more influenced by Eastern thinking of rebirth and wheel and reincarnation. The idea needs some fancy dressing-up because it is so everyday as a turning wheel. Yet, one cannot call it "circular" or "elliptic" or "geoid" or "egg-shaped" philosophy, because these names have less pep and would suggest a sort of mechanical perfection which living organisms lack. In fact, even non-living organisms are not perfect and exact like geometry would idealise them to be: to my knowledge, there is a slight unpredictability even in the behaviour of the Heavenly Bodies with the Sun erupting sometimes more sometimes less, in a quite rhythmic fashion, and the Earth woggling ever so discreetly like a person who is not sober to the point of having become a robot.

A repeated periodic re-attainment of a state which more or less is identical to a state previously attained at the beginning of this period shall be called a *rhythmic* process or procedure. The difference between periodic and *rhythmic* is that the latter does have some stochastic influencing attributes by being sometimes a bit later, usually about punctual and sometimes a bit sooner that in the idealised case of the former. The rhythmic pattern is the periodic pattern encountered under practical circumstances. This is a very statistical approach and accepts the existence of the measurement and the sampling errors, and may also de-abstract from the idealised concept. If the expectation values of the measurements yield a periodic process, then it is a rhythmic process.

The same tolerance and statistical attitude applies to the distribution of attributes in the cross-sectional description, too. If one's blood has a set of idealised parameters every morning, then the distribution of the actual parameters shall demonstrate the rhythmic nature of everything biologic.

The prefix *eu* makes a well-pulsating or lovely-pulsating system of a pulsating system, which sounds nicer. It should also signify that in an *eurhythmic* pattern, at least *two* stochastic influences eventuate. The interregulation may be compared to the frequency and the amplitude dimensions of a swing. If both the time and the quality aspects of a collection's descriptions are rhythmic, we speak about an *eurhythmic* process. ("This morning I feel more refreshed than last morning" shows that both the objective times of the subjective term of morning, and also the extent of the regeneration are subject to a stochastic component.) The co-variance of two rhythmic processes influences the random walk among (describing sentences about) what is the case now and what shall be the case next. At

every step along the random walk, we encounter something new and different, but the collection (and succession) of describing sentences, each different to each other, we have stepped though in the course of the random walk, yields in its entirety an overall sameness, by returning to square one of the (next) random walk. Several concurrent circular random walks constitute the skeleton of an eurhythmic procedure. We appear to recognise noises coming from a natural cause, and these noises are eurhythmic.

So, instead of a mental picture of everything becoming sort of coolish and uniform, ending in a stable state, in the proposed basic concept everything turns and vibrates and oscillates and cycles and swings and vacillates and revolves and pulsates, not too mechanically but with recognisable patterns. Experiments show that the human nervous system is optimised for dealing with background noise of the eurhythmic nature. By some inborn knowledge, we recognise and filter out noises coming from a natural source the easiest. Eurhythmy is then the essence of the self-regulation of our inner, biologic, clocks, by describing their co-chronocity.

References and Notes

1. Wittgenstein, L.: Tractatus logico-philosophicus, Suhrkamp, Frankfurt, ^{9}1973
2. Carnap, R.: Logische Syntax der Sprache, Springer, Wien/New York, ^{2}1968; [English: The Logical Syntax of Language, London, 1937]
3. Carnap, R.: Einfuehrung in die symbolische Logik mit besonderer Beruecksichtigung ihrer Anwendungen, Wien, 1954; [English: Introduction to Symbolic Logic and Its Application, Dover, New York, 1958]