

Is a Unified Theory of Information Feasible?

A Trialogue [\(1\)](#)

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WH: Dear Rafael, in order to start our dialogue, I would appreciate your giving the first contribution by answering the following question: what conclusions do you draw from the logical trilemma in your speech at the conference?

RC: Dear Wolfgang, may I first summarize the content of the logical trilemma, or "Capurro's trilemma" as you called it in your paper "In-formatio revisited". [\(2\)](#) Information may mean the same at all levels (univocity), or something similar (analogy), or something different (equivocity). In the first case we lose all qualitative differences, as for instance when we say that e-mail and cell reproduction are the same kind of information process. Not only the "stuff" and the structure but also the processes in cells and computer devices are rather different from each other. If we say the concept of information is being used analogically, then we have to state what the "original" meaning is. If it is the concept of information at the human level, then we are confronted with anthropomorphisms if we use it at a non-human level. We would say that "in some way" atoms "talk" to each other, etc. Finally there is equivocity, which means that information in physics and information in education are wholly different concepts. In this case, information cannot be a unifying concept any more, i.e. it cannot be the basis for the new paradigm you are looking for.

Your conclusion or "solution" of this trilemma is: we go back to the etymological roots (information as "giving form") and we take an evolutionary perspective where qualities can emerge. I call this solution "dialectical informatism" (DIAINF), considering it to be a new version of dialectical materialism (DIAMAT).

I think there are several questions to be considered, which I have listed below.

1. The Kantian quest for the limits of human reason.
2. The metaphysical quest for a unifying principle (like energy, matter, spirit, subjectivity, substance, É or information) of reality.
3. Wittgenstein's quest for "language games" which are different from each other but nonetheless have a family-type relationship.
4. Gregory Bateson's definition of information as "any difference that makes a difference", this being different from information in the sense of the mental processes of "finding a difference" (information as meaning). [\(3\)](#)
5. Luhmann's distinction between information and communication or between social and psychic systems. Information is a category of solely psychic systems, it is a system-internal property that is not transferred, whereas communication means to open, on the basis of information (or meaning) a horizon of choices for other persons. Pure communication and pure information are at opposite ends of the spectrum. [\(4\)](#)
6. The question of scientific language as a question of separating (or liberating) thinking from (everyday) language.
7. The possibility of a "blind spot" in any unified theory.
8. The "practical" question of the relationship between information and money; information as something we have to pay for.
9. The quest for a networked structure of different information concepts as an alternative to a dialectical view.
10. The quest for the relationship between information and imagination. But now to your question about my conclusions from the logical trilemma in my speech at the conference. I draw one basic conclusion, namely the task of remembering the trilemma when considering the possibility of a unified theory of information; in other words, the task of remembering the differences between the differences that make a difference. This was in some way a plea for analogy and even equivocity. I believe that we can take a reductive view of

reality under the viewpoint of, for instance, an information-processing concept. We would then say: whatever exists can be digitalized. Being is computation. Such a reductive view is useful in many respects but we have to pay a high price for it, because we have to leave aside other basic phenomena which belong to different levels of reality. This is the problem faced by dialectical informatism, as I call it. Dialectical informatism, I believe, has an over-optimistic view of the capacity of human reasoning. This is why I pointed to Kant in my speech. Is there any possibility of a unified theory of information which includes "Capurro's trilemma" as a constituent element of it, and not as something to be eliminated or "solved"? Well, this is a difficult question. Maybe we should take a look at the metaphysics of Leibniz. Leibniz considers reality to have two aspects, namely "monads" and matter. There are no monads without matter (except God), and vice-versa. Monads and matter are folded into the different levels of reality in an infinitely complicated way. This means that it is not possible for us to have a "true" view of all the "steps" faced by unfolding (or "evolution"). This means, roughly speaking, that we are faced with infinite concepts of information, something which cannot be overlooked by any kind of theory. But on the other hand, when we are using different concepts of information, we can metaphysically presuppose that they are equivocal, or that our analogies are not completely false, without ever really knowing which is the real or true "primum analogatum". In other words, from the point of view of our finite reason, a unified theory of information has to learn how to "play" with equivocity, analogy and univocity, thus keeping the trilemma in mind - as a chance!

PF: Dear Rafael, in a somewhat pejorative manner you have described the concept of information which Wolfgang and I discussed in "In-formatio Revisited" as "dialectical informatism". If I understand you correctly, I think by this allusion to dialectical materialism you are saying that we persist in using the structure of DIAMAT, with just one exception, namely that we have replaced its main object, matter, by information; you seem to think that we are leaving everything else unchanged, in particular the dialectical way of thinking. I am not convinced that your argument points correctly to the core of our proposal, i.e. a methodology for perceiving information. Although Wolfgang and I share the method of dialectical thinking, we have different ideas about the possibility of a unified information-science.

I hope to be able to make my position clear. What I am looking for is not a replacement of matter by information (as you seem to assume), but the pursuit of a broader and more integrated concept, in which matter and information can coexist. Furthermore, I am looking for interconnections and linkages between matter and information. Thus, I am seeking notions which may be general enough to cope with the two alternative ways of describing reality.

In my opinion, one basic notion which can be applied generally is the term "causality". This concept is used in everyday language, in mythological thinking, and in scientific languages as well. Therefore there a chance exists to adapt it to our situation, to extend it towards our needs, and to explicate it more precisely. I think it constructive to look for information from this perspective, and to work out the differences/similarities between the causality of information processes and that of physical processes. The advantage of this perspective is the unfolding of larger range of analysis than is permitted by physics. It allows for the inclusion of completely different causal relations which cannot be viewed by the natural sciences.

I will try to sketch the main argument: For human beings it is essential to understand the world; the reason for understanding it is the need to control it, the reason for controlling it is the necessity for survival. According to Kant, the principle of causality is the a priori of how we talk about this possibility of control (although we have to modify its precise content). Cassirer taught us that the content of this principle is not only applicable in physics, but in everyday modern (and, as I see it, post modern), and mythological thinking as well. Nevertheless the understanding of the principle has changed considerably over time. Here we will not deal with the variations of the content of causality throughout the history of physics, but prefer to look for the difference and the implications of the causal principle between the physical and informational processes.

So, on each level of investigation (e.g. in physics or in biology or in social sciences) we will try to answer the following question: "How is this part of reality handled/controlled by internal or external forces?". The answer which is given by physics is evident: it is possible because of the Causal Principle which is the basis of laws of nature. One has to control the cause to bring about any effect. Laws of Conservation in physics (of energy, of matter, or of impulse) reduce the "freedom of choice" (i.e. diversity) of possible effects. Some kind of automatism is applied. "If I do this, nature answers like that". Mechanical materialism believes in the unique effect of any cause (Laplace's daemon was the metaphor used to characterize the omniscient status of a scientist who knew the status of the entire world at any one moment). Today causality in physics represents a general, immediate, and local relation between physically measurable variables which are non-symmetrical with respect to cause and effect.

Information, on the other hand, is able to mediate between cause and effect without having to obey the

Laws of Conservation as such. There is no need for uniqueness of the effect. More than that, not even the type or quality of the effect needs to be predictable. One of the main differences between physics and information sciences can thus be seen here. While physics is oriented towards forecasting effects based on some explicated premise, information sciences have to deal with the structure of the unpredictable. At first glance this seems to be a very fuzzy enterprise, but it is in fact the complement of the unique predictability of the physical world. The new cannot be grasped theoretically by physics. If everything were uniquely predictable in a physical environment, no development of the world would be possible.

A second difference can be found between physical and informational processes. Physical units (in particular in classical mechanics) are based on the metaphysical principle of some factor (like mass, force, energy) while the substantialism gets lost in the realm of information. Information in its reified aspect is like a symbol, a metaphor. It is more a pointer to some kind of interpretation process than an object per se. It does not always point to any object of so-called reality. If there is some conscious process needed to interpret the pointer, and thus to create a new piece of reality, the substantiality of information is no longer needed. By the same argument, uniqueness of interpretation is no longer assured; on the contrary, in information processes there must be freedom of choice, on some level there must even be unpredictability, there must be the opportunity for creativity, and producing something new. Here Leibniz's monads could come into the picture. They could be interpreted as an early concept to explain the half of the world which was left out by mechanical materialism, such as processes of the human mind, the soul and creativity. In my opinion there is no need to stick to Leibniz's interpretation of the monads as being divinely created. The concept of information processes would allow for a materialistic explanation.

So far I have tried to show the differences between information and physical processes. But there are similarities as well. While the physical process in the history of science originates from uniqueness and predictability, more and more uncertainty has come up in physics during the last few decades. Quantum mechanics has shown that we have two options. The first is to stick to the uniqueness of causality as in traditional mechanical materialism; this has the disadvantage that one has to restrict the realm of "reality" to the world of the systems, not to the elements themselves. Alternatively, one could bring randomness into the picture, thus widening the notion of causality, weakening the uniqueness of the link between cause and effect. I prefer the latter interpretation as a suitable solution to this dilemma. However, the distinctiveness of processes of information then shrinks.

From another point of view, information processes resemble physical processes. It is the lack of a strict Law of Conservation of Energy in Einstein's general theory of relativity. Another source of indeterminism is the notion of mathematical chaos which was found in a huge number of models that describe the physical world. Although we could forecast the future and the past of our world if we knew the state of the world at one single moment, chaos theory has taught us that processes exist which depend so heavily on initial conditions that small changes in the latter can radically alter the former.

On a completely different level, a second example of resemblance can be given. As Einstein showed, the Law of Conservation of Energy does not hold for his General Theory of relativity.

The similarity of physical process to information processes can be found as well. If information, with its syntax, semantics, and pragmatics is used in a reified and fixed manner, the information process can play a very similar role to that of a physical link. All industrial automation processes are of this type. The unique and predictable reaction to a certain situation is the core feature of any automated assembly line, of a computerized, numerically controlled machine tool, or a PC. Because of their high independence from any laws of conservation, engineers prefer them to physical feedback systems (e.g. the centrifugal-force regulator or mechanically controlled automated looms).

I hope that these statements will destroy your suspicion that our goal would be the mere replacement of matter by information, whilst retaining a dialectical concept.

RC: Dear Peter, I am glad that the pejorative undertone of my criticism has become an incentive for, not an obstacle to, our dialogue. I see, indeed, some similarities between the interpretation(s) of reality provided by dialectical materialism and the view of a general information science with an evolutionary perspective. Of course, we cannot fully discuss here the questions of what dialectics, materialism or informatism in all their historical and theoretical complexity are. With the term "dialectical informatism" I was trying to put a marker on the discussion. But you are right, "isms" always indicate something pejorative in the sense of an exaggeration. My question is "Where are the limits of such an information science?" or "Where are the limits of the notion of information as a basic concept for understanding reality?"

You suggest that the concept of causality should be applied not only to matter but also to information, and you mention "the differences/similarities between the causality of information processes and that of physical

processes". This proposition is, I think, a clear denial of informatism as such; everything is information, or physical processes are to be understood basically in terms of information, or the like.

You speak about causality of matter and causality of information. Maybe we should recapitulate some of the questions connected with the concept of causality in general. As you know, causality is a concept deeply rooted in Western philosophy. The so-called "Pre-Socratic" philosophers used the concepts of "arche" and "aition" in trying to understand nature from a non-mythical viewpoint. It was Aristotle who, based on his interpretation of the Platonic "forms" as well as what we could call the "pottery model" of production or causation established a four-part distinction of causality. Since the Middle Ages, these four kinds of causation have popularly been known as "causa materialis", "causa formalis", "causa efficiens", and "causa finalis".

"Arche" and "aition" were translated into Latin as "causa" and "ratio" and were sometimes used as synonyms, although being the "real" cause of something is different from the "reason" why something happens. According to Leibniz, everything that exists must have a "sufficient reason" for its coming into being. Therefore, according to metaphysical argumentation, there must be a fundamental reason why there is something at all, rather than nothing, i.e. something that has its reason for being in itself: God as "Causa sui" as Spinoza called it.

Plato's "demiourg" in the "Timaios", a kind of "pottery god", became (under Christian metaphysics) a transcendent creator as "causa efficiens" and "finalis" of nature, separated from immanent causality. This can be seen, for instance, in Thomas Aquina's distinction between "creatio" and "informatio". Causality "per informationem", or immanent causality, presupposes that something already exists on (or in) which the cause produces an effect, for instance the processes of life or understanding. Causality "per creationem", or transcendent causality, is God's prerogative and means the capability of producing something out of nothing ("ex nihilo").

Metaphysics also made a distinction between two forms of immanent causality: a "transitive" immanent causality, where a cause can change or even disappear in the process of (in)formation, and another immanent causality where the cause remains the same although changes may take place. The latter is the case for e.g. human or animal souls. The transcendent cause must be "higher" than immanent causality.

The idea of a transcendent cause was criticized by modern natural scientists who looked only for the immanent empirical laws of nature. This is, I think, what you are referring to when you talk about causality of matter, which was supposed, at least until the quantum physics debate, deterministic. Modern causality is conceived not only in terms of the immanent causality of the laws of nature but also as an evolutionary or "transitive" causality. The question is now whether evolution can be seen as an "information" process following rules or laws or, as you suggest, a deterministic causality of matter and an indeterministic causality of information must be distinguished. I think you are giving, against the modern conception, the primacy to the latter.

The modern philosophical debate on causality was influenced by Empiricism as well as by Kant. According to Kant, the concept of cause is on the one hand something we do not get out of the phenomena, but it is something that belongs to our understanding of them (contrary to what empiricists such as Hume believed). On the other hand, the rule of human reason, i.e. "every effect has a cause" remains empty until we apply it empirically. Whether or not reality or nature as a whole and "in themselves" obey this rule is something that goes beyond the capacity of our theoretical knowledge.

Kant also inherited and transformed the distinction between immanent and transcendent causality. His "practical reason" acts according to a "causality of freedom" that can be considered from a naturalistic point of view as a contradictory concept or at least as an oxymoron, a verbal contradiction. Kant's solution of this "contra-dictio" ("Widerspruch") is his dual view of two separate levels of reality, freedom and necessity, causality of freedom and causality of matter, that are not in (logical) contradiction, but in an existential (or ethical) "struggle" ("Widerstreit") with each other, as they belong to two different ontological dimensions. For Kant, freedom was a fact that could not be explained by theoretical reason and natural causality.

This is, of course, a very uncomfortable situation for modern natural science, which is looking for "solutions" ("Lösung") in terms of deterministic causal explanations and not for the Kantian philosophic "dissolution" ("Auflösung") of his antinomies through causality struggles. Nowadays there is therefore the question of whether Kant can be naturalized, for example given an evolutionary conception of the "a priori" structures of reason or an emergent explanation of human freedom. In such a conception the immanent deterministic principle "causa aequat effectum" is being superseded, or at least delimited or complemented, as you say, by a non-symmetrical but immanent relationship between cause and effect. Explaining reality means in this case dealing not only with deterministic material causation but also with non-deterministic informational causation.

It is in this sense, I believe, that you speak of a new kind of causality, a causality of information. The question is, whether this different type of causation gives rise, as you say, to a new distinction between the sciences and in what way this distinction could be interpreted, namely as two complementary ways of understanding the whole of reality, as a formal or methodological distinction, or as a distinction that arises from different phenomena, a "real" distinction ("cum fundamento in re"). The latter alternative would be a new version of the difference between natural and social sciences or between the "Geisteswissenschaften" and the "Naturwissenschaften" according to the 19th century German terminology. The first alternative would imply some kind of naturalization of the concept of information, considering all natural processes as open to new and unpredictable "information". This is, I think, what Tom Stonier was talking about and what Carl Friedrich von Weizsäcker is also considering when he connects the concept of information to its philosophical origins in Plato's and Aristotle's forms.

This would fit with your interpretation of Leibniz's dualism of matter and monads, which can also be interpreted as a monism as far as matter is an "expression" of the monads or, what comes nearer to your view, as an original twofold "pre-established harmony", not of two substances, but of two dimensions unfolding themselves through infinite possibilities. Your examples from relativity and chaos theory show that we are becoming aware of indeterministic processes in nature and this leads to the present challenge of the primacy of deterministic causation of matter.

This makes possible your turning over (if I might call it that) the modern view that tries to explain all processes under the deterministic premises of the causality of matter. Within the deterministic view, time is a homogeneous succession of instants. Our causal explanations are supposed to be in the order of the before (cause) and the after (effect). Time in itself, being a homogeneous frame, is reversible. You point to this by saying that according to determinism, we could forecast the future (and describe the past) of our world if we knew the state of the world at one single moment (Laplace's daemon).

In contrast, the causality of information allows only a prediction in a non-homogeneous time. Past, present and future are not reversible. This does not just mean that we can make any kind of "predictions" or that "anything can happen", but that informational explanations are probabilistic and no "daemon" can give us a firm knowledge about future effects.

My question is now whether on the basis of your distinction we are dealing with a) a difference between physics and information sciences (you are using the plural!), or b) with physics (and chemistry and biology and...) as information sciences, with different (infinite?) information concepts. Is the principle of causal information "just" a formal ("transcendental") frame for the study of different effects under the premises of their informational causes? In what sense can we say that informational causes have at least partly unpredictable effects ("causa informationis non aequat effectum")? In what sense does this principle of non-equality give rise to the information trilemma? I mean, in what sense does that which is considered to be an information process (for instance at the biological level) give rise to the non-equivalent emergence of consciousness, whose information processes, being non-equivalent with the ones that caused it, are now the cause of societal ones etc.?

It seems to me that as in the case of matter, the concept of information changes (analogically? equivocally?) in the different levels (and what remains is "only" a void or formal causality of information). When we study matter in physics, biology, and the social sciences, the meaning of this concept changes dramatically. The concept of matter is a "polymorphic" one. We have no "science(s) of matter", the "matter" of physics is far away (how far?) from the "matter" of, say, literature. What (natural) sciences have had in common with each other is (until now) the causality of matter as a formal principle. Dialectical materialism gives, I think, a primacy to the causality of matter. But here again we are facing the trilemma! This was the reason for my "warning" about "dialectical informatism"; as far as it remains deterministic, it gives the primacy to a specific level of reality, and it is supposed to say something about reality in itself" or as a whole (mixing, in Kantian terms, the "ontological" with the "transcendental"). It seems to me that instead of extending the causality of matter (and determinism) to a "non-material" dimension of reality (history, literature etc.), we are now trying to do the contrary, taking the causality of information as a basis .

But if, according to Kant, in the case of causation of information we cannot say either that all reality is "informed" or capable of being "informed" (God being, metaphysically speaking, the "forma formarum"), and, more basically, if the concept of causality (being a "transcendental" concept) is one way of interpreting nature (in an objective deterministic and/or indeterministic way), then we have to ask ourselves whether the model of nature that gave rise to such a concept is the only legitimate one. This is the point stated by Heidegger when he analyzes the experience of "nature" ("physis") in Pre-Socratic philosophy.

According to Heidegger, "physis" was primarily seen as a process of "unconcealment", where something emerges, becoming "unconcealed", whereas at the same time there remains a basic dimension of "concealment", which can not be adequately grasped in terms of causation, and particularly of production. The process of "producing" (or of "bringing something forth") has an affinity to the imagery of pottery. What

metaphysics does is, roughly speaking, project the pottery model back into the experience of nature as "unconcealment". The concept of causality being, according to Heidegger, a metaphysical concept, "forgets" or takes for granted the twofold dimension of the given of nature, or tries to explain the given-ness of the given with the help of a transcendent cause. According to a non-metaphysical experience, nature has no ground, and this "having no ground" is shown (and concealed) as "unconcealment". Gratitude, the given-ness of the given, is more basic than causation. This is something, I think, that goes beyond the question of determinism or indeterminism, and therefore beyond the primacy of the causality of information with regard to causality of matter. But at the same time, your concept of causality of information seems to question the imagery of pottery as well as the idea that the whole of reality is a kind of hardware and software pool, where all kinds of "information" can be produced, stored, manipulated etc., although this is, I think, an almost obvious interpretation of the causality of information within the metaphysical background of today's information processing systems. Nature would then be considered to be a gigantic information network instead of a gigantic clockwork mechanism.

WH: Dear Peter, may I enter the discussion here, please? We are talking about a distinction we draw in causality, namely between causality of informational processes and causality of material processes, of matter - as you put it, Rafael -, that is causality without informational aspects.

Before I deal with your question, Rafael, (as to whether this means a distinction in science as well), let me point out that I do not think that this distinction is a question of being either a formal, methodological distinction or a material, real one. In my view these two aspects are not independent of one another. We use the method of drawing the distinction because we suppose that there is such a difference between the two kinds of causation in reality.

But, having said this - and here I come to the crucial point -, this by no way entails the prolongation of the divide between natural sciences and social sciences. You know, Rafael, that I am a strong advocate of the unity of all science. Differences in what different disciplines are investigating do not automatically imply that they are obliged to use different methods exclusively. There are common features as well, mutual facets lying in the objects to the same extent to which the objects differ from each other. We have good reasons to assume that the universe, though constituted of a probably infinite number of different parts, does not fall apart. The universe is one and many fold at the same time.

So, the distinction between several kinds of causation is not primarily a structural distinction between disciplines in the system of sciences. It's rather a historical distinction - a distinction between an old-fashioned world view in which all processes are deterministic and in which there is no room for indeterminism, on the one hand, and an emerging new world view which allows for conceiving deterministic processes as a special case of the intrinsic non-deterministic character of the unfolding universe on the other. We are facing a paradigm shift so fundamental that it entangles not only science but also our everyday views. And what is very important: it does not do away with the former findings but includes them in setting limits to them. That is: under certain circumstances we find deterministic causation, but this is not the usual case.

The emerging information science is part of this paradigm shift. It is not all of the new paradigm itself. The new paradigm says: we live in a self-organizing universe in which the future is open, though there are certain constraints. As to me, information science says: information comes into play where self-organization takes place. Here I want to draw your attention, Rafael, to another point. There is no sharp difference between matter and information. The latter arises from the former. That is, if matter transcends the limits of determination, if it begins to organize itself, then information is generated. The philosophical background of this is emergentism. Emergentist philosophy, as developed for instance by Lewis Morgan and summed up by David Blitz in a recent book on Emergent Evolution, holds that effects which do not "result" from causes, that is, which are not "resultant" but "emergent", cannot be "reduced" to their causes. In this case *causa non aequat effectum*, causation is only a necessary constraint, but not a sufficient one as it is in mechanistic causation. Thus, standing on the base of the concept of emergence, you have on the one hand the opportunity to stick to the concept of causality, which means that there is nothing which was created out of nothing (let's leave the question of the coming into being of the universe out), and on the other hand there remains enough openness to let novelties arise which did not exist before. So there is also a continuum between matter (which is self-organizing) and information (which is bound to self-organization and therefore bound to matter as a necessary precondition), though there is a discontinuity between the two.

In other words, I want to stress that there are no absolute differences. Thinking distinction and oneness in one - something like that is maybe dialectical thinking. Stating that there are only distinctions to be drawn and no common ground to be detected belongs to the positivistic way of thinking which is overcome nowadays by the paradigm shift towards taking the whole into account. But - what counts even more - it would be a sad and dull world in which we had to live, if the concept of equivocity were right. This would

indeed be like the work on the tower of Babel. Aren't human lives self-organizing systems which construct their paths decision by decision? And is it unthinkable to drop a view which sets formal logic absolutely, and to adopt another one which better fits the flexible developments around us?

What I want to state is that your trilemma, Rafael, is also due to a very special view of the world. If, instead, I postulate an emergentist view, a view of evolutionary systems which organize themselves, I can avoid extending one level of reality to another as well - there is no need to have a *primum analogatum*, because the systems are not thought to be analogous, but related to each other, depending on each other, arising from each other, and therefore establishing common features and different features. If I postulate this view, I can think the general and the specific together, and then there is no dilemma whatsoever anymore.

I admit that there is no possibility of gaining absolute knowledge of what is going on in the universe (including ourselves). But you have already admitted - if I didn't misunderstand you - that we obviously continually succeed in gaining relative knowledge and even better, comprising knowledge. We have to be pluralistic just in order not to overlook a possibility of attaining another piece of knowledge and to go one step further. In this sense, a unified theory of information cannot be designed as a closed dogma. But we may take into account that every time we in the scientific community reach an agreement on some hypothesis, we are producing some bricks for the build-up of the theory.

PF: Dear Wolfgang, dear Rafael, just a few comments on Wolfgang's last excursion into matter and information. I think I can agree with most of your arguments. There is only one paragraph that I find somewhat misleading. It is linked to the relationship between matter and information.

Wolfgang, you wrote: "there is also a continuum between matter (which is self-organizing) and information (which is bound to self-organization and therefore bound to matter as a necessary precondition), though there is a discontinuity between the two."

Although I agree with you, Wolfgang, on your statement that matter is a precondition of information, I wonder whether the term "continuum" is an appropriate characteristic for the relationship between matter and information. In my opinion these two belong to different ontological categories. Wolfgang, you describe the relationship as if there were a development of matter towards information. But the notion of development means a qualitative and quantitative change of some entity which stays the same over time. While matter in physicists' terms is inseparably linked to energy and mass (both properties of matter are conserved, except the general theory of relativity), information is a different concept.

I could agree with you if you stated that information is, or may be, an aspect of matter or a property of it, but it would be misleading to say that information is nothing but transformed matter. In my opinion, information has a special symbolic aspect; we want to stress that its materiality is not the essence of it, although of course reified information cannot be exchanged without a materially mediated process. Under the material aspect of information there have to be some structures, be they transient or invariable over long periods of time. But these structures do not refer to themselves, but to other phenomena (this is the semantic level). In my opinion the basic difference from physical relationships is the principle of exchangeability in the process of information creation. It is not fixed by the symbol which represents some sequence of actions or some physical objects or subjects. And in the more recent developments of evolution, in particular in human beings, the constructivist feature of information is of particular importance. New views may come up, and may change essentially the behavior of the interacting partners (pragmatic level).

I would summarize my argument as follows: information emerges at a certain state of development of matter, but is not matter itself. It has some material aspect, but this is not essential. It needs a symbolic representation, referring to other objects, processes or thoughts. Symbolic representation implies that there is no unique determination of the symbol. Symbols could be taken from existing objects, but they could be invented and created anew as well. Sometimes implicitly or explicitly construction processes, bargaining processes and power are involved in the information process.

WH: Dear Peter, let me give just a short answer. My intention was to argue against dualism. There are no two substances like matter and information which are absolutely independent of each other. The laws of physics are valid and hold for all phenomena insofar as they have physical aspects. Insofar as they have emergent properties which go beyond physical properties, laws of physics do not tell us very much. They give only constraints, but do not determine the specific nature of the new quality of the phenomenon in question. We have material systems which do not show informational qualities, and we have material systems which show informational qualities. But in my opinion, there is no information

generating/processing system which does not have a material basis.

RC: Dear Wolfgang, I think we are now discussing the content of my first remark (under Nr. 4) concerning the difference, as Lars Qvortrup puts it, between Bateson's definition of information as "any difference that makes a difference" and information in the sense of the mental processes of "finding a difference", the latter being the concept proposed by constructivists such as Heinz von Foerster and, according to Qvortrup, by Niklas Luhmann. However, Luhmann does not attribute meaning to all biological systems, but only to psychic and social ones.

You say, "Éthere is no sharp difference between matter and information. The latter arises from the former", and you explain "arises" by saying "if matter transcends the limits of determination". How is this possible? How can indetermination "arise" from determination? And does this mean that you speak of information only at the level of self-organizing, i.e. living beings? Otherwise you would have to consider the difference between self-organizing non-living matter and self-organizing living matter. What can this difference mean? If you say that the universe (whatever you imagine this concept to be!) is "per se" non-deterministic, then it is not necessary to say that information "arises" from matter. We (!) always have to deal with informed matter.

This question was discussed by Plato in the "Timaios", as well as in the "Sophistes". May I recommend the book by Serge Morel, "Le tombeau du dieu artisan" (Paris 1995), whose interpretation of Plato I will now briefly recapitulate. The "demiourg", the pottery god, "convinces" matter and its concomitant necessity to orient towards the ideal form; or, as Plato puts it, "intelligence dominates necessity" (Tim. 48a). The world begins with a "mélange" of mechanical determination and intelligent order. It remains oriented towards perfection, but it will never reach it. But what happened, asks Morel, at and after the beginning? There must be something "there" (!) which makes possible the relationship between the material or sensible and the intelligible. This "third genus" is called "chora" by Plato. It is invisible, without form ("amorphon") and indestructible (Tim. 52b). You say, "Let's leave the question of the coming into being of the universe out". I think this poses more conceptual difficulties than if we try to get a coherent view, where even the most difficult elements are not left out, but are included as questions (!) in the intelligence search process. This is of course a philosophical attitude, but it may also be useful, in the long run, for scientific hypotheses.

"Chora" means something capable of reception, in as much as it is capable of nutrition and protection. Plato thus compares it with a "mother" (Tim. 51a). "Chora" is something prior to matter, and to information. According to Morel, the protective function of "chora" is neither that of causality, nor of a primordial substance, but it is a "representative" one, i.e. it (or "she"!) protects the genesis of material things with an orientation (otherwise they would disappear). The concept of "impression" ("typos") used by Plato in this context was translated into Latin with "informatio". "Chora" is what makes configurations (or in-formations) possible. Plato also compares it with a "riddle" (which is a kind of network) (Tim. 52d-53b). "Chora" is the difference that entails all differences or forms with their potentialities; otherwise the "demiourg" would not have been able to mix them according to their proper structure, being confronted by elements with total instability. Before I break off this Platonic discourse for a moment I would like to quote a sentence from the "Sophist" (in a rough translation):

"The Guest: We are of the opinion that all these [living and non- living beings on earth, RC] were generated successively from a former non-being by the effect of a god ("theou demiourgountos")? Or shall we hang on to the common opinion as well as the general gossip?

The aitetos: What do you mean?

The Guest: ... that nature ("physin") produces all these things with blind causes ("apo tinos aitas automates") generating without intelligence ("dianoias"); or is there reason ("meta logou") and divine knowledge ("epistemes theias") from a god producing them?

The aitetos: I really fluctuate again and again between these two possibilities, maybe because of my youth." (Soph. 265c-d)

The reason why I have brought Plato into our discussion is that we should be careful when we speak about paradigm shifts. "New" and "old" are very relative! But I agree with you that the deterministic paradigm has proved untenable and that the "old" idea, as Plato says, of "blind causes" (or, as we can literally translate, of "automatic" or self-organizing causes) is now "the common opinion".

I would like to be a little provocative now. What if the universe is more like a Tower of Babel than, if you remember Popper's metaphor, a cathedral? (5) You say "there is a discontinuity" and that the systems have "common features and different features". Well, this is the definition of analogy! According to the "new"

paradigm we should take the word "difference" seriously, because we cannot reduce "reactio" to "actio". Equivocality means that we are using the same words for different things. We do this for instance as a joke, or when we are looking for a rhetorical effect. My question is: are we talking equivocally when we say that cells exchange information and that human beings exchange information? Why should the universe be incoherent, given that it is pluralistic, i.e. where different phenomena arise that cannot be reduced deterministically to former causes? Indeed, as you say, "there are no absolute differences". Why? Because if something were absolutely different from anything we may know, then it would be impossible for us to understand it! This was the problem posed to Christian theologians for whom God was supposed to transcend all mundane reality. One way to talk about him without falling into the traps of analogy was the "negative theology" ("theologia negativa"). We find a kind of "philosophia negativa" in Kant's negation of a reasonable talk about "things in themselves", and also in present constructivist theories. I think it is Konrad Lorenz (and Karl Popper) who uses the word "fulguration" when he talks about the (highly) improbable evolution from non-living matter to life, and from life to consciousness. There is, I believe, no "continuum" between these "fulgurations". We can understand animals only "ex negativo" i.e. in as much as they are not like us. And we do not know what death (and being born) means. The continuum-hypothesis belongs to what you call the "old" deterministic paradigm. The consequence of the idea of causality "per informationem" is "natura facit saltum". We could also say that nature is not completely transparent. According to Heraclit, "nature likes to conceal itself" ("physis kryptesthai philei"). We cannot plainly (deterministically) explain (and foresee) how differences "arise", but not know about other possible "fulgurations" in the universe. Does this mean we live in a "paranoic" situation? I do not think this is necessarily the case, at least as far as we are able to find differences and to understand them as such. We are, in the second sense of the word, informational beings, and not only beings with differences that "make" differences. Non-rational animals do not inform each other, i.e. they cannot grasp, as far as we know, something "as" something, seeing it in its proper context. This is only possible through language. This human prerogative is, of course, not a licence for species chauvinism! In this sense, we are the "primum analogatum" of the information concept and we therefore have to be careful about the limits of analogies. The irreducibility of "fulgurations" opens the chiasm of equivocality. Of course, there is the question of whether we "see" the chiasm of qualitative differences, or whether it is just a product of a paranoid imagination. The only way out of this dilemma is again through a common delimitation, i.e. through the patient work of mutual information. Our "logos" is conditioned and biased by the process of having to tell each other what we believe is the case. Human "dia-log" is an informational process, entailing the possibility of finding differences together, as well as of giving a (partially) different sense to the fulgurations, beginning with the primordial fulguration of being itself. As we are not the primordial origin (and end) of being(s), our "demiourgical logos", or our world picture, is not only a delimited but also a biased one. Future generations will be able not only to question it with regard to its correctness, but also to design new drafts or perspectives (from what has until then been concealed), thus giving the possibility of new kinds of relationship between man and world. This is the idea of truth as "un-concealment" (in contrast to truth as *adaequation* or correctness) suggested by Heidegger, going back to Greek "a-letheia".

According to Peter, information "needs a symbolic representation". This is very similar to what Plato says when he talks about "chora" as a medium for the protection of the representations. According to Margel, "chora" is shapeless, but entails "figures" ("schemata"), i.e. the specifications of the transformations of the elements. There are still some very specific (and difficult) distinctions in Plato's theory, such as the original representations ("mimemata") leaving an impression, or "typos" (the "forma impressa") representing a form ("apotupoma" or "imago expressa" or the ideal content), and finally the "morphai" or the defined schemes. The "schemata" build a kind of relationship between the sensitive and the intelligible world. In this context I would like to remember that for Kant in his "Kritik der reinen Vernunft", the "schemata" play a key (and obscure) role connecting the categories with the sensitive data.

My question now concerns the differences, and similarities, between the process of the "in-formation" of matter and the meaning of this process to the "demiourg"... and to today's information scientists! I think we can agree with Plato in as much as the intelligent activity of the "demiourg", his informational activity, is different from the informational process that took place before his intervention, where the world was "without proportion and measure" ("alogos kai ametros") (Tim. 53a). In other words, if we are now dealing with an organized universe, it is because the informational activity of the "demiourg" exists, which was based on a pre-given symbolic draft. It is interesting to consider that for Plato, the human soul undertakes the task of the "demiourg", namely to "save" the world or to give it a reason ("logon didonai"), to be responsible for it. We have to learn to distinguish both informational processes (before and after the intervention of the "demiourg"). In my study on the etymological roots of the information concept, I defined information as the determination of form (genitivus subjectivus and objectivus). (6)

Yes, "the latter arises from the first", but not in the sense that it could be reduced to the first or explained by it, but in the sense that the first makes responsible informational action possible. According to this view, the field of information science is the field of responsible intelligent action in order to "save" the world. It is a complementary, and qualitatively different action to the one performed by the forms. We are dealing with

a field of open possibilities, and no pre-formation tells us what we have to do in order to do the right things. But at the same time, we live in an age when the gods, and with them their rational "logos", are gone. The "demiourg" has lured us, according to Margel's interpretation, with the impossible promise of transforming the real world into the ideal one. For Plato, the world has thus become "the tomb of the pottery god" (Margel's title: "le tombeau du dieu artisan"), in the same way as our bodies are the tomb of the soul (we are born in a woman's body) which loses the connection to the gods and the ideal numbers. At the same time, as the soul takes the place of the "demiourg", it must take care of the connections between the world and the "logos", being capable, as a finite being, of failing the "logos" and ending in "myth" and dissolution. Our informational activity would basically be one of learning to die, Socrates' definition of philosophical activity. That means learning to understand that the stories we tell each other about ourselves and our world are supposed to be "logos", but that they are constantly in danger of becoming a myth, especially when we believe the world (in one of its "in-formations") is the fulfilment of the ideal, instead of keeping the dimension of announcement of an unattainable expectation. I would like to link Margel's concept of "expectation" ("attente") with the non-Platonic mythical concept of announcement ("angelia") that plays a key role in Greek tragedy. Maybe we should define ourselves not as "logical" (and mortal) beings ("zoon logon echon", "animal rationale et mortale"), but as "angelical" or informational ones. "Angelia" is, as far as we are concerned, more basic than "logos". Information is the dimension that enables "logos" and "myth" to be communicated. Dealing with these two ends, it contains something from both, and can fail on either side. The information age is our age; this is why we are looking for an information science. But we would fail ourselves, and would bring the world into dissolution, if we understood ourselves as a fulfilment of the expectation. Learning to die is our way of opening up to the "logos" and to its fragile transmission.

Excuse me for this long mytho-logical discourse!

WH: Dear Rafael, I agree with you that it is very hard to imagine how indeterministic relations could have arisen from deterministic ones. Therefore it is more convenient to imagine a universe which has been indeterministic (or more precisely, not strictly deterministic) from the very beginning. I prefer to view the evolution of the cosmos - the universe - as a sequence of stages which differ from each other in that later stages show qualities which did not exist in earlier stages. It's like an unfolding of perpetually new qualities, a self-organizing universe in which the self-organization itself is developing from one kind of self-organization to another kind of self-organization. Ebeling and his colleagues differentiate a dozen phases in the development of the cosmos since the Big Bang. And these phases are seen by numerous scientists as interlinked via symmetry-breaking phase transitions.

Surely there are non-living material things which are capable of organizing themselves ? Think of the famous Bénard cells and other dissipative structures. And it is precisely because in self-organization processes the result does not equal the starting point, and 'reactio' is unequal to 'actio' (for there is novelty emerging), that I feel a deep connection between self-organization and information. And I would like to interpret the saying 'information is a difference that makes a difference' in the following way. In self-organizing processes there appears to be a difference between the input and the output of a system; this difference is due to a difference between some inputs to the system; so to say, the difference in the environment is taken by the system to be something which makes a difference to the system. And this difference which is offered by the system can be taken by other systems in the environment to be something which makes a difference to them, and so on.

Let me state this clearly. I do not believe that what emerges at a certain time was pre-existent somewhere else before that time. It could not have existed except as potential. So, at the beginning of the universe, the potential for life, humans and consciousness must have been there as a disposition, as a chance which could be realized by actual development (or not). I myself do not believe in anything like god. That's a personal conviction, and I respect other convictions. But I see in emergentist philosophy a proper tool for tackling such problems, like such as how a new thing comes into being; matter itself does it, all material systems do it, when far away from thermodynamical equilibrium conditions, by having the ability to organizing themselves.

I agree with you fully when you describe emergence as something which is not a reduction, and not an explanation in the full sense of the word, that is, in the sense of a complete reduction of effects to their causes. I suspect that, logically speaking, emergent phenomena cannot be explained fully in as much as the conclusio has to contain more than is given by the premises, because the conclusio must designate a new quality. Such deductive reasoning is logically impossible.

And so we have a mix of continuous aspects and discontinuous ones - in the course of evolution and in the structure of the universe. I don't think you doubt that the phases of our unfolding cosmos are linked together, because it is the same cosmos which is unfolding. It is a deep insight to say that humans are made of the same stuff as, for instance, trees and stones. There is continuum between fulgurations. Why

should we not be able to grasp both the differences and the similarities? Okay, we do this by communicating. No problem. I would add that it's not a mere construction; constructions are made for mapping, they have to prove realistic in confrontation with the objects, and they are supposed to help in solving problems which arise from social practice. Today, the survival of humanity is at stake, and therefore we see the problems of mankind's evolution on the one hand as problems which are usually faced by evolutionary systems during their process of maturing, and on the other hand as problems which have specific features owned only by this specific system, mankind. This is the very problem, and in trying to find solutions, we recognize the similarities of all systems in the universe, despite their particularities, and we are developing a new information theory which is aware of this.

RC: Dear Peter, dear Wolfgang, if we consider the definition of information proposed by Lars Qvortrup as "any difference that makes a difference", and "finding a difference" (Bateson), then we could add a new definition by saying that information consists not only of "making" differences (as in the case of nature) or of "finding" differences but also of "designing" differences. This last possibility can be a most general one, as in the case of philosophical ontologies. My friend Michael Eldred uses the English term "casting" meaning the German "Entwurf" (as in the case of the Heideggerian "Seinsentwurf"), which is usually translated as "project". It is a weaker term that does not give the impression of anthropocentrism. In other words, our "castings" are conditioned by an "a-morphical" dimension we call matter (and Plato calls "chora"), as well as by the fact that we are facing a non-deterministic universe. Aristotelian physics is a way of casting being, as was the Newtonian one, and as is the present perspective of looking at things as bytes! This does not mean that there is a "real" thing "behind" the phenomena, but that we can cast their being under different perspectives. Without doing any kind of casting we see nothing... the difference between being and beings is like the one between beings in their appearance under a particular casting, and the given-ness of the potential for casting beings in different ways. Corresponding to this possibility, i.e. our corresponding to the mere possibility as such, is something very related to what Buddhists call nothingness. We always cast in the form of language, i.e. with other human beings. The casting of being (and of beings) in the digital form is something we owe to e.g. Quantum Theory, as well as to Turing (both lines going back to Descartes, Pascal, Leibniz etc.) As co-casters we are more a passage than a substance, more an announcer ("angelos") than a subject.

PF: Dear Rafael, I certainly agree with you when you bring the perspective of casting and designing to the concept of information. But a lot of other questions arise immediately. Is there any substance which is casted? If so, on what level of ontology is it located? If not, what are the conditions for bringing casting and designing into existence? Is the "passage" of casting predictable or does it produce something completely new each time? In my opinion, the application of your casting theory to real events in real life has a lot of additional prerequisites. For me, at this point, you have to make your understanding of the world clear, otherwise the concept of shaping will remain somewhat fuzzy. If we could start with an evolutionary concept which does not contradict our findings in science or history, I think we would be better off, and on a more real pathway of understanding.

I cannot subscribe to your general notion of casting as being digital. Although it seems to be correct that there is a current technological trend towards computerization and networking, contemporary authors exaggerate its importance. I, however, prefer a view where digitalization is seen as a particular kind of shaping or coding of a phenomenon, be it based on matter or energy. Although the digital computer is prevailing at this time, and is dominating fashionable discourse, other types of coding procedure exist as well (eg. analogue and physical).

WH: Well, let's bring it to a close there. To sum up, Rafael und Peter, I would like to ask you to answer one question briefly. You already know how I feel about this issue; do you think it is possible to conceive and elaborate on a unified theory of information?

RC: Yes, but with the reservation that every viewpoint, be it Newtonian or digital or whatever, has its own blind spot, which restricts our vision, and we have to be aware of this.

PF: I agree, but don't want to go as far as Rafael when he claims that all theories are as good as each other. There are differences, and so some theories are better than others. Newtonian thinking has been

replaced by e.g. the superior Theory of Relativity. The former contains restrictions which are absent in the latter; thus future theories will uncover today's blind spots.

References:

- (1) This is the unshortened version of an email discussion the three of us had in the aftermath of the conference. The short version is published in World Futures 1997, Vol 49.
 - (2) P. Fleissner, W. Hofkirchner: In-formatio revisited, Wider den dinglichen Informationsbegriff. In: Informatik Forum 3/1995, 126-131
 - (3) L. Qvortrup: The Controversy over the Concept of Information. In: Cybernetics & Human Knowing, vol. 1, N. 4, 1993, S. 3-24.
 - (4) See D. Bounoux: La communication contre l'information. Hachette 1995
 - (5) K. Popper: Objective Knowledge. Oxford 1973, S. 121: "We are workers who are adding to the growth of objective knowledge as masons work on a cathedral."
 - (6) R. Capurro: Information. München 1978
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