Field Analysis for a New Research Initiative by the Metanexus Institute on ”Competitive Dynamics and Cultural Evolution of Religions and God Concepts”

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1. Introduction

The following field analysis aims to describe some distinctive theoretical approaches that commend themselves for studying the evolution and dynamics of religious systems (including concepts of God and divinity) from a perspective informed by the natural sciences.

The theoretical approaches to be presented are varieties of computational complexity studies: Cellular Automata (CA), Complex Adaptive Systems (CAS), Game Theory (GAT) including Rational Choice Theory (RCT), and Autopoietic Systems Theory (AST). In each case, the theoretical background of the approaches will be presented, and some examples of their application on religious evolution and concepts of God and Ultimate Reality will be indicated.

The purpose of this analysis is to facilitate new research programmes that either apply some already elaborated explanatory models on the empirical case of religious evolution, or develop new science-based methods for dealing with the emergence, evolution and stabilization of religious semantic systems. From the outset it should be admitted, however, that the field of “Competitive Dynamics and Cultural Evolution of Religions and God Concepts” is still in its nascence, and is by no means makes up a coherent research field. However, it is a highly promising field that commends itself to further study and calls especially for inventive scholars who are able to develop new methods and approaches, and to use methods known from the biological and economic sciences on exploring the cultural dynamics of religious systems. It should also be noted that the approaches mentioned here are far from exhaustive; other approaches are analysed elsewhere on this website, and these should be consulted as well.

Common to the approaches to be discussed below, however, is the combination of formalistic or computational aspects with a Darwinian perspective on the evolution of cultures. Thus the underlying assumption is twofold. First, it is not only possible but also advantageous to use methods known from the natural sciences in the understanding of the evolution of religious systems of meaning. Second, any cultural and religious semantics has to cope with the problem of reproducing itself, and to adapt itself to new contexts under evolutionary pressures analogous to those known from the fields of biology and economics. The computerization of the sciences since the 1970s indeed offers attractive formalistic approaches to the study of the dynamics of cultural systems. The main scientific question is here not so much “What are the constituents of culture (natural resources, institutions, communities, language etc.)?”. New questions are born, such as “How does nature and culture work?”, and not least, “How do natural and cultural systems evolve?”.

Computational Complexity (CC) theory, however, is an umbrella term for a wide variety of studies on the formation, development, and propagation of patterns, some more general, some arising under specific organizational conditions. The field builds in particular on thermodynamics, information theory, cybernetics and evolutionary biology, but also on economics, systems theory, and other disciplines. Since complexity research consistently crosses the boundaries between the inorganic and the organic, the natural and the cultural, the field is likely to influence the future dialogue between science and religion as two major cultural forces of the 21^{st} century significantly.

2. Cellular Automata (CAs) and the Cultural Dynamics of Religion

Let me begin with the study of cellular automata (CA). The idea of cellular automata goes back to John von Neumann and the program of *cybernetics* in the early 1950's. Cybernetics was concerned with the construction of control systems that are able to move, channel and combine information bits according to pre-described computational rules. For example: If situation A, then do AB; if B, then do BAB.

A Cellular Automaton is a primitive artificial world. Its "space" is a grid consisting of equal squares, usually on a two dimensional lattice. The initial conditions of CAs can be set either as specific or as random states. The "time" of CAs depends on the transition rules that determine how the cubic cells are to be changed, moved, removed or reproduced at each computational step. CAs thus use individual based modeling, that is, the "organisms" are placed in cubic cells on the grid, and their "actions" are specified by the number and features of cells in their immediate neighborhood.

In 1969 John Conway developed an efficient computer model called *Game of Life (*see Gardner 1970). The rule for this two-dimensional CA is that the state transitions depend on the states of the other eight neighbors of the cell (also the diagonal ones). The rules are so-called "totalistic" rules in so far as the rule is determined by the total number of the neighboring colors, not on their particular positions relative to the cell. Furthermore, the cells have only two states, black and white. Now the transition rules are as follows:

* If two of the neighboring cells are black, the cell is unaltered (mimicking equilibrium).
* If three are black, the cell becomes back (mimicking reproduction).
* In all other cases the cells become white (mimicking extinction).

Most would agree that this is simple. Very simple indeed. It is "die" or "divide". Nonetheless the evolving features of these systems can be highly complex. One can try out different initial conditions, and see how the system proceeds. When the program is played, one notices clusters of cells ("populations") and pulsating processes of near-extinction and sudden regeneration; one also notices how populations meet and reinforce one another. All this is beautiful in itself. But the most astonishing feature is the emergence of "gliders", that is, localized structures that develop in one general direction and create exciting self-organizing structures that are far from simple. The *Game of Life* thus also models historical lines of descent, some of which continue to grow endlessly and continue to elicit new structures, new forms of order.

The question is now whether these computer-generated systems can be said to follow a few more general patterns. The seminal work of the physicist and computer scientist Stephen Wolfram has been devoted to this question since the early 1980's (summarized in Wolfram's *A New Kind of Science*, 2002). In order to be able to investigate the world of CAs systematically and unbiased, Wolfram chose the simplest possible CA, a one-dimensional CA with only two colors (black-white). Any step forward is then determined by only the three cells in the row immediately over the cell, which has to make a "decision". The three upper row cells thus have only 2 x 2 x 2 = 8 possible combinations of color. Now with only two colors, the possible rules for deciding the next step for any cell are 2^8 = 256 possibilities. During his systematic search, Wolfram discovered the universal feature that all CAs fall into four main classes.

Class I consists of those CAs that simply die out very quickly. It is not difficult to predict that if the rules do not allow for enough reproduction of black cells, the screen will soon be all white, and vice versa. Formally expressed, the system fades away into a single "limit point" attractor.

Class II rules are a little more lively, but eventually they begin to oscillate repetitively between a few states. Even though we see no evolving logic, we can nonetheless discern distinctive nested structures, where smaller patterns are part of wider patterns. Formally expressed, they form a dynamical system as a two-point attractor.

Class III rules are more interesting in that they develop chaotic systems, though again with some self-similar structures appearing all-over, but in this case not repetitively. Class III systems thus display randomness, and look like some of the systems found in the mathematical chaos theory: The spontaneous evolution of CAs is *neither derived from the initial conditions nor from a specific tuning between initial conditions and the mathematics of chaos*. Rather, the random patterns are *intrinsic* to the class III rules.

Class IV, however, contains by far the most interesting features, which appear at the creative edges between the regular patterns of class II and the random patterns of class III. These are rare indeed, but quite significant, because they show that highly complex and 'interesting' behavior can be produced against the background of very simple rules. Patterns here grow without coming to a fixed point attractor, without repeating the same structures, but also without displaying the randomness that characterize class III.

The amount of systems in each class, however, seems to correspond inversely with their interesting features. That is, around two-thirds of the 256 rules produce the infertile class I states, but around one-third of the patterns continue to grow, as we see it in class II, III, and IV. Only 14 % yield the more interesting patterns (Wolfram 2002, 57). However, in an evolutionary arms race, these were the ones to whom the future belonged!

Now the question is, Can CAs be used to model and understand religious evolution? Let me just mention two examples from the more recent literature. The British mathematician John Puddefoot (2002) has applied Wolfram's Four Class typology to different forms of religious discourse. As he points out, the exclusivist claim of salvation within some religious traditions has the formal structure of a single point attractor of Class I: By contrast, religions seeking a sort of cognitive equilibrium with its environmental culture follow the oscillating patterns of Class II systems. More individualistic and eclectic forms of religiosity, such as New age, follow the pattern of chaotic systems, whereas the strongest candidate for a highly competitive religions may be found in Class IV, where we find that novelties in religious discourse emerge at the critical edge between Class II and Class III phenomena. Thus the recurrent pattern of internal (maybe even "doctrinal") stability and continuous dissipation under the constant pressure of cultural inputs from other religions and culture may be seen as the strongest candidate for religious self-development.

My second example is the so-called "Jihad Model" (René Thomsen, Peter Rickers, Thiemo Krink, and Christian Stenz 2002). This is a consistent attempt to use a cellular automaton model on religious evolution. The model is a so-called multi-agent system (MAS) based on individual agents. More specifically the artificial world consists of five general features:

(1) A *world* (represented as a sufficiently large, but finite two-dimensional lattice),
(2) 2 times 200 *individual agents* with the following four attributes:
- (a) An individual *location* in space, by which each individual agent is surrounded by the eight neighbors in their immediate environments.
- (b) An *energy level* between 100 as their upper limit and 20 as the lowest hunger limit, below which any agent has to prioritize the search for food.

(c) An *age* which is determined the remaining life-span, co-determined by the technological level of the culture of which the religion is a part.
(d) A *religion* with certain variable characteristics as defined below

(3) Two (or more) religious populations are simulated in each experiment, and each *religion* is again characterized by four parameters,
(a) The *enlightenment level* influences (i) the maximum age of the agents (by 50 %), (ii) their combat strength and (iii) their likelihood of converting others to their religion.
(b) The *aggressiveness level* simulates the likelihood of combating a neighboring individual from another religion.
(c) The *belief intensity* determines the likelihood of converting other, or being converted to another religion.
(d) The *birth rate* is defined by the religious disposition either to mate and create offspring, or not to mate.

(4) The individual agents have the following five *choices of action*,
(a) *Mating* (requiring two neighboring individuals of the same religion)
(b) *Eating* (consuming available food resources scattered around in the CA, thus upgrading the energy level of the individual agents)
(c) *Attacking* (thereby converting the other in case of superiority *and* downgrading the energy level of the former enemy)
(d) *Converting* (changing the religion of the other)
(e) *Random walk* (when no other rule applies)

These actions, in term, are constrained by *threshold values* that represent the costs involved in the activities of mating, eating, converting, attacking and being injured. These threshold values are the variables that can be redefined from one computer experiment to another. One could say, for instance, that mating (and getting offspring) costs 50 energy units, eating 1, converting 5, injury 35 and attacking 2 energy units. On these assumptions, of course, attacking is modeled as a relatively risk-free strategy, which is hardly realistic on a battlefield, where the actors do not know the strength of the other part, and where wounds are not healed as fast as on the computer screen.

Much is debatable about the perhaps all too theoretic set-up of this "Jihad"-model (as it unfortunately is called). But still some unexpected insights came out the study. For example, it turns out that a religion with a belief intensity of 100, which at the same time also forbids reproduction (birth rate = 0), can still piggyback on the major control religion by way of continuous conversions. A pattern of population cycles emerges, very much like the pattern we see in the co-evolution of biological host-parasite relationships. In fact, the parasite religion here grows in periods of decline of the bigger religion, and vice versa. This looks very much like *Class 2* CAs in Wolfram's typology. - It would be interesting to see, if one could here further explore the model in order find examples of class III and IV.

Another interesting feature of the "Jihad model" is that relatively segregated geographic regions are continuously produced between two competing religions. Out of "individual" actions, clusters of religious communities are formed. The formation of ghettos, on this model, is a natural expectation.

I have discussed this model at some length here, because it shows that "hard" formalistic approaches are indeed applicable to more "soft" areas of study, such as religious evolution. Suffice it to say that there is a long route from observations to computer models and to the complexities of the real interconnected systems. An improved model should therefore be able revise itself in the stress tests of being applied to real-world complexities. The process of computer modeling involves a long process of reality checks. Computational models will include a design cycle of observation, informal description, formal model, computer model, simulation, and least but not last: model verification by reiterated observation.

3. Complex Adaptive Systems (CAS)

What is missing from the CA approach is the function of *learning* that is characteristic for *Complex Adaptive Systems* (CAS), and no less for religious traditions. Many Simple Adaptive Systems have an internal program which controls the system-environment exchanges. Think of a thermostat, which directly adapts to the environment by controlling the input-output relations of temperature. A thermostat is certainly an example of organized adaptive complexity; however, it is not an example of *self*-organized complexity. The program of a thermostat does not develop itself under the influence of the environment. It connects directly, in a prefigured way, to the relevant aspects of its environment ("now too hot, now too cold").

In the case of CAS, by contrast, a self-selective process takes place within the system. Inside the organism, an internal schema of the environment is carved out which is then -- by trial and error processes -- adjusted to the subsequent experiences of that system.

Wouldn't this idea of complex adaptive systems be a confirmation of Neo-Darwinian selection processes? Yes and no. Yes, because a mechanism of selection is certainly at work in these quasi-cognitive processes; one could here argue (with Karl Popper and other proponents of evolutionary epistemology) that if an organism's schema of reality is fundamentally misleading, it will soon begin to starve, have difficulties in finding a mate -- and over time it will be outselected. But No, CAS also transcends standard Neo-Darwinian theory. For the interesting claim of CAS is that *adaptation is something that happens at all levels of reality*: at the level of the ecosystem (think of the emergence of the earth atmosphere of oxygen etc.), at population level (think of foxes surviving in cities), at the level of the individual organism (learning processes), at the cell level (think of the neurons in the human brain), and at the gene level (the prioritized unit of selection and reproduction in the received view of Neo-Darwinism). CAS thus transcends the standard biological view of adaptation, according to which adaptation is "a property of an individual organism, not of an ecosystem", as John Maynard Smith has pointed out (in Pines 1994, 580).

Thus it seems that the idea of complexity may enlarge our standard picture of adaptation significantly. If learning processes take place at many levels (see also Weber and Depew eds., 2003), there are also many 'agents' of evolution, for whom the enviromental influence 'makes a difference'. We are here approaching a *biosemiotic* view of evolution, according to which something (the environmental influences at large) means something specific ('light', 'food', 'mating') for somebody (an organism with internal, preferential schemas for orientation). Thus the idea of complex self-adaptation is structurally in accordance with the pragmatist Charles Sanders Peirce's definition of a sign: A sign means something (reference) to somebody (the interpreter) in a certain respect (the context).

Now imagine that one were to regard specific religious systems as examples of CAS. One would then be able to identify certain internal programs that serve to stabilize the code of this or that religion, such as holy scriptures, recurrent liturgies, rituals (re-enacted at individual or communal level), and doctrines. In very strict religious communities, these programs will be used very much like a pre-set thermostat, that a priori determines what should be included, or excluded, among the environmental inputs. Imagine again, however, that the element of evolutionary learning or adaptation came into the focus of some specific religious community. In this case, the communal *interpretation* of the holy scriptures would come into focus alongside a reflection on the *style*, in which liturgies are performed, and on the *use* of rituals in given context. The words and concepts used in scripture, liturgy, and rituals may thus find different applications, including concepts of God and community.

Seen from a linguistic perspective, this would mean that the lexical terms (e.g. ‘God’, or ‘Buddha-Nature’) no longer possess a fixed semantic value, but are functioning like indexical pointers, the content of which will have to be specified within larger semantic discourse systems (“stories” or “myths”), the meaning of which again are co-determined by their use by specific groups or individuals. Semantic flows will begin to take precedence over against stable meanings. Since lexical terms no longer flow unsupported by discourse systems, and discourse systems gain their meaning from their particular contexts of usage, it is highly probable that scholars will be able to identify many examples of “mixed discourse”, that is, a discourse by which, say, Christian concepts are made fluid and understandable by concepts from other religions (often called “syncretism”), or elucidated by reference to secular sources of knowledge such as science (often referred to as “secularization”). In the light of the theory of CAS, such flows of religious insight would be more the rule than the exception; furthermore, the same patterns of evolution of religious concepts are likely to take place both in more “liberal” and in more “conservative” interpretations of faith.

Against this theoretical background, one could think of two distinctive types of research that may complement one another in the study of the cultural dynamics of religious evolution. One task is to show how the dynamic of religious evolution actually has taken place in historical communities, and how this dynamic is at work in present-day religious communities, where no religion is protected from external influences. One could here imagine important new studies of the history and sociology of past and living religions. Another research task will be to study, whether these actual processes of inter-religious and inter-cultural exchange will benefit the rationality and inner coherence of a religious tradition, or not. This type of research will demand a much more theological approach to the cultural evolution of religious traditions. It may well be the case that certain forms of rationality can be identified in the very process of passing on a religious tradition and communicating it to others. For in every communication, which involves human arbiters, there will be certain performance-based selection from the rich resources of religious tradition; some traits of traditional religion will be reinforced, whereas other traits will sink into oblivion.

However, both the concise historical or empirical analysis of the linguistic flows of religious discourse, and the philosophical or theological reflection thereupon will be able to learn from the formalistic approaches of computational complexity theory. Theoretical resources can be found within neighboring fields such as computational linguistics and cognitive science.

4. From Prisoner’s Dilemma to extended Game Theory (GAT)

One way to formalize such studies is game theory. Game theory is, like the theory of CA, based on individual agents, who (in a sort of contrived thought experiments) are imagined to perform specific strategies of choice vis-à-vis other actors. Game theory often shares the assumption of Rational Choice Theory, according to which actors make their choices by following the supposedly most beneficial (and hence “rational”) strategies for themselves.

Game theoretical analysis has often been formalized in the context of the *Prisoner’s Dilemma*, in which we have only two actors that are forced to share the same scarce resources within a closed setting, and have the choice between collaboration or competition. Since W.D. Hamilton’s foundational work on “The Genetical Background of Social Behavior” (*Journal of Theoretical Biology* 1964), we have seen a suite of sociobiological studies aiming to explain collaborative behaviour as based on the sharing of genetical material (Hamilton 1964), or on reciprocal altruism *without* a genetic kinship (Trivers 1971, Axelrod 1990, 1997), or on an indirect reciprocity *without* a direct payoff for the individual (Alexander 1987; Nowak & Sigmund 1998).

What has come out of these well-known studies is a renewed emphasis on the importance of *reiterated experiments* so that one's first choice may be altered under influence of the choices of the other agent(s). Thus if a collaborative behaviour is met by non-reciprocation from the other agent(s), it may be more advantageous to change strategy and defect the next time, *or* to expand the time horizon so that the other agent(s) are given new chances of collaboration. The shared assumption is that cooperation will benefit all actors, especially if one can find a strategy for stopping or punishing cheaters. Life and morality may be "non-zero sum games", to put it with Robert Wright.

Reiterated Prisoner's Dilemma's thus give us a chance to model evolutionary learning processes on a relatively simple model. Even more interesting from a theological perspective, however, are the attempts to model collaborative behavior at the more complex level of social groups. One of the most influential and convincing studies in this respect are Eliott Sober's and David Sloan Wilson's *Unto Others The Evolution and Psychology of Unselfish Behavior* (Harvard University Press 1999). The convincingly show, first, that biological and economic research should separate the *motivational* issue of benevolence or malevolence at the psychological level from the *functional* issue of how to stabilize a social collaboration at the higher level of complex societies. Thus, they point out that social co-existence may stabilize the emergence of new moral codes by simply expelling or punishing individual cheaters within the systems. In so far as the keepers of moral systems (such as police and judges) are legitimized by the society at large, they incur, each individually, only modest personal risks in exercising justice; however, their job is quintessential for the functioning of the society as a whole. Second, Sober and Wilson have proposed simple mathematical models that show, why one must transcend the realm of genes and individuals in order to understand the cultural dynamics of human societies. At the same time, empirical psychologists have shown, that human persons, as a matter of fact, disgust cheaters, and rather want to sacrifice own benefits than allowing social cheaters to win their game. Both at group level as well as at the psychological level, there seem to be inclinations towards doing the good rather than just that which is of direct or indirect benefit to oneself.

As is evident so far, sociobiology and evolutionary psychology has been concerned about explaining moral behavior, especially the possibility of altruistic and generous behavior (Stephen Post & colleagues; Nørretranders 2002). Why not extend this research program into the field of religious evolution, including the notion of God and Ultimate Reality? First steps have already been done. David Sloan Wilson has applied his method on the issue of religious evolution, using the development of Calvinism as his historical test-case (Wilson 2002), and also many empirical studies of the psychology and spirituality of forgiveness have been presented (e.g., Worthington 2002). However, both the biological and the economic communities are divided on the issue, as to whether the individualistic perspective is sufficient to explain social behavior, or one would need to understand cultural and religious evolution at the more complex level of group behavior and religious semantics. The field of "Competitive Dynamics and Cultural Evolution of Religions and God Concepts" is an invitation to take part in this scholarly debate, if possible at more complex level than has been reached so far.

5. The Theory of Autopoietic Systems (APS)

Allow me to end with a note on the perspectives coming from *autopoietic systems theory*, or the theory of self-productive systems, which seems to me especially applicable for reconsidering religious notions of God, and of the human participation in divine creativity.

The general idea of self-organizing systems is sometimes prematurely equated with the notion of autopoietic systems. The difference is that while self-organizing systems combine great variability with internally regulated mechanisms or programs (as we see in CAS), autopoietic systems produce new internal components and thus continuously create new system environment-interactions. While the concept of *self-organization* still retains the idea that systems are organized out of pre-established elements, the concept of *autopoiesis* more radically contends that the components themselves may be created only inside organized super-structures. Self-transformation extends not only to the organization of the system but also to the elements specific for that system. It is only in a cell, for instance, that we meet the special arrangements of molecules that make up its membrane. Or, again, consider, the how the carvings of the brain (like physically engraved schemata) are produced in a kind of "topobiological competion" (Edelman 1992, 83), that recurrently reshapes the neurons and their interacting networks. Selection processes thus take place also in the brain, to the benefit of the brain's over-all plasticity.

In autopoietic systems, therefore, there is no separation between producer and produced. A cell's being is given only by virtue of its internal dynamical operations and the system is not a substance definable prior to its operation (immune systems therefore vary significantly in genetically identical twins). It is the internal functioning of the system that both determines *whether* or not the cell should build up new elements, and *how* the cell picks up (or ignores) specific elements of the external world (Maturana/Varela 1992 (1987), 43-52).

Taking the feature of complex adaptability seriously means taking seriously the pluralistic order-and-disorder of nature. The world has many centers of control, and to each is assigned a certain *process autonomy*. Like other types of complexity theory, the theory of autopoietic systems presupposes a *constitutive materialism* ("there exist no other elementary particles than those known by the physical sciences -- or in principle knowable by them"). However, what are important are not the singular objects (e.g. atoms or molecules), but the work cycles they perform within holistic, yet highly specialized networks. What matters is not the generic amount of matter's physical energy, but the specific physical organization of matter.

The pluralistic order-and-disorder has its ontological basis in the *operational closure* of the different systems themselves. That is, a system is not acting at the mercy of the environment, but is itself determining what is relevant, and what is not relevant in the surroundings. Accordingly, there does not exist one objective environment, common to all systems, but there exist as many environments as you have adaptive systems. Autopoietic systems may react to their environments on all grades from negative feedback (balancing each other) to positive feedback (mutual enhancement). Eventually we face a continuous *criss-cross interpenetration* of different kinds of operational systems. Evolution seems to be driven by type-different autopoietic systems, sometimes competitive, sometimes symbiotic, sometimes in synergetic resonance, then in dissonance with each other.

Elsewhere I have tried to formulate some of the basic principles of autopoietic systems as follows (Gregersen 1998, 338):

1. Autopoietic systems are *energetically open systems,* dependent on external supplies.
2. While autopoietic systems are energetically open, they are *operationally closed*. The closure of the system is even a precondition for the way in which the given system handles its openness vis-à-vis its environment. The cell, for instance, is open for energy supply only so long as the energy input does not break down its own membrane and internal structures.
3. The self-reproduction of autopoietic systems is *not necessarily tied to specific physical structures*, since the structures may change as the dynamical system operates. The immune

> system, for instance, does not always protect the frontiers which are under attack but may, rather, reproduce the system by forming new strategies of survival through structural self-transformations. Self-*re*production often happens through self-*production*.
> 4. Also the *elements* of the autopoietic system are constituted by the system itself, by way of (selective) inclusion or exclusion. The membrane, for instance, only lasts as long as the cell-system lasts.
> 5. *Interpenetration* between differently structured systems takes always place on the basis of the given system itself. In one system, the intrusion of a new chemical element makes no difference; in yet another, the consequences can be enormous. The causal effect is always co-determined by the system itself.

Let me just mention one example for, how concepts of God can be elucidated through the idea of autopoietic processes: the Jewish and Christian concept of the "Kingdom of God". It is generally acknowledged in New Testament scholarship that the kingdom of God is not conceived as a place nor as a separate realm, but is simply the exercise of God´s reign in the world of creation in such an intense manner that God is perceived to be both present and revealed in mundane processes.

Now, what are the similarities between the inherited idea of the kingdom of God and the theory of self-producing processes? First, there is a common awareness of the self-creative powers of nature. In the teaching of Jesus, the kingdom of God is likened to the scattering of a mustard seed on the ground which grows and sprouts while you are at sleep, you don't know how: "The earth produces of itself" (Mark 4:29, *automatiké*). The reign of God is compared with the mustard which in antiquity was considered as weed. If this is so, it is the relentless will to existence that is compared with the kingdom - - the same inconsiderate insistence that we see in beggars, or in the woman who lost a penny and went on searching until she finally found what she wanted (Luke 15:8-10).

Secondly, the kingdom of God is related to open-ended possibilities. In Matthew, the kingdom of God is also called the kingdom of the heavens, whereby heaven is a symbol of those aspects of creation that are beyond our control, and yet determine our existence. Speaking of the heavens as belonging to the kingdom of the God articulates the trust that even the powers of irruption and irregularity ultimately belong to God. The powers of disorder are not free-floating powers of an animistic sort (Welker 1999, 36-40). Thus, the notion of the kingdom of heaven both encapsulates the unity of the world of possibilities (heaven not being divine, but an integral part of God's reign) and the multiplicity of new relevant possibilities (what the biologist of complexity Stuart Kauffman refers to as "adjacent possibilities").

Thirdly, the idea of God's reign addresses the fact that the world is construed as a series of openings, or invitations. However, an invitation has to be received in order to reach the goal aimed for. The symbolic world of the parables is full of people who either accept the invitation, or do not. Think of the parable of the king who invites to a wedding banquet, but his friends refuse to come, and the king then extends the invitation to the destitutes on the street (Matt 22:1-10). Or think of those who burry their talents rather than using them (Matt 25:14-30). The choice of accepting or not accepting (or using the options or not using the options) exemplifies the formal features of autopoietic systems in so far as these are bound to adapt to their environments. To adapt, or not to adapt, that's the question.

Yet *one has to adapt to oneself in order to adapt appropriately to the environment*. As we know from the theory of autopoietic systems, operational closure precedes openness. Self-adaptation precedes adaptation to the environment. Accordingly, the one who is addressed by the parables, will have to change his or her mental framework in order to catch the novel adjacent possibilities of the Kingdom of God.

For the same reason, the ontological status of the God's reign is not, and cannot be, easy to determine. We hear that the kingdom is not a reality which can be observed, and yet it is said to be amongst us (Luke 17:21). The reason is simply that the adjacent possibilities of the Kingdom of God have to be caught and taken up. If taken up, however, the internal structure of the human person is necessarily changed. The Kingdom of God is an objective-relational reality, in so far as it only *occurs* at the very moment when one enters into the relational networks elicited by the approaching kingdom. Accordingly, when Christians pray, "Thy Kingdom come", they presuppose that the reign of God is not already here. There is not a ready-made design, a fulfilled reality imprinted on the structures of reality; the reign of God is in the process of coming to us. The kingdom is not of this world, and yet its efficacious presence can be depicted in scenes from everyday existence. As argued by the German theologian Michael Welker, "the reign of God is in a process of emergence". As such it is similar to a surprise: "a surprising change of configuration is delineated that ...requires new powers of self-organization" (Welker 1992, 509).

Accordingly, the parables of Jesus consistently intertwine the awareness of the goodness of creation and the need for readjustment and redemption. The grace of God is graspable only in the creative zones between that-which-is (creation) and that-which-is-not-yet (the kingdom of God) by the exclusion of that-which-destroys creaturely co-existence (sin). The kingdom of God therefore presents itself in the fragile yet potentially fertile regimes between order and disorder. We thus find cross-fertilisations and co-adaptations on every scale:

> (1) We have the interrelation of *nature and culture* (on the spatial axis). Nature is not perceived as enslaved by laws but is consisting of autonomous agents in a constant process of co-ordination. Neither are human beings seen as exercising freedom at its fullest scale. Human beings are blind, unless they adjust their mental frameworks to the new possibilities of the kingdom.
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> (2) We also have the interrelation of the *world of actualities and the world of possibilities* (on the temporal axis). Unexpected chances for self-development emerge in the always critical system-environment interactions in which a re-structuring of the human person is made possible.
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> (3) Finally, we have the interrelation between the *finite realizations of order and the divine wellspring of unprecedented novelties* (on the vertical axis). The concept of the kingdom of heaven specifies, within a highly complex network of images, the difference between self-productive processes that are resonant with God's will and those who are not. A divine-humane economy of superabundance is articulated where more comes out of less in the highly ordered yet fragile zones of collaboration.

The sudden emergences of the kingdom of God are like seeing God in the fluids of a waterdrop. You both need to have the curved structure of the fluid drop "out there", and you need to adjust yourself "internally" to seeing God in that fragment of reality. Nothing goes without the other. For in the world of autopoiesis, no adaptation happens without self-adaptation.

The case of the semantics of the "kingdom of God" is but one example that shows how inherited religious concepts may be re-evaluated through the insights of evolutionary thinking. Perhaps is nature not quite as brute as we have become used to think. And perhaps is cultural and religious evolution not as separated from nature, as we have learned through a three hundred years of history of compartmentalization.

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