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THE RIDDLE OF PREDICTABILITY

Knowing the future

Humans have always been eager and anxious to know the future and rather often have looked for the satisfaction of this desire through the intermediation of privileged persons who were supposed to be in contact with the gods (such as oracles) or which were simply endowed with the gift of "reading the future" (such as fortune-tellers of various sorts that can be found in every culture and are still present in our "advanced" societies). Modernity has found in science the secularized replacement of that old belief and it is well known that the precise prediction of the appearance in the sky of the Halley comet in the years 1758–1759 greatly contributed to the intellectual and social prestige of natural science in the 18th century. Even in times closer to us, the prediction of the gravitational deflection of light observed in 1919 was a decisive factor in the acceptance of Einstein's general relativity theory.

Prediction and determinism

The general intellectual background of these conceptions was a rigid deterministic view not only of physical nature, but also of human existence and historical events. This view seemed to be overcome when the new natural science was conceived as the ground for technological *applications* in which the exact knowledge of the deterministic natural mechanisms allowed for the design of *artefacts* that could be put at the service of humankind and efficiently contribute to the solution of its different problems. This fruitful combination of natural determinism and human creativity in projecting and inventing machines was seen as the justification of the thesis that advancements of science and technology constitute the essence of *progress*. This idea is the core of the positivist outlook which feels itself justified in proposing this view as a perspective on the future of humankind precisely because the concept of *prediction* was structurally entailed in the pattern of technological *machines*.

Indeed in a machine nothing is mysterious because its structure and way of functioning were known *before* the

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construction of the concrete machine itself, being the consequence of of the skilful application of scientific knowledge that could explain how and why the machine had to function according to its *project.* This explains the fascination that the idea of machine enjoyed during the 18th and 19th century: if we are able to propose a machine-model in order to interpret and explain a particular physical process, we have the impression of having understood it completely and the same attitude can be extended also to the comprehension of non physical processes (like the psychic or the social ones), when we are able to read them as the manifestation of certain idealized "mechanisms". It is clear that such readings are possible by ignoring a lot of features of the system so modelled, but it is often said that such features are not essential and can be removed by further refinements of the mechanism proposed.

The limits of the mechanistic models

These mechanistic models certainly produce an intellectual satisfaction because they contribute to the *understanding* of a given domain of reality thanks to an *analogy* with more familiar domains or simply through an abstract idealization. Their limitation, however, quickly appears when they are used in order to offer *predictions* regarding the domain under investigation. The reason usually adduced for such limitation is of a quantitative nature: it is pointed out that any such model only contains a small number of parameters, whereas the concrete domain contains many more, and if we tried to take them also into account, we would have to do with a great deal of equations whose simultaneous control would imply a huge computational task. There is perhaps a little grain of truth in this alleged explanation but its inadequacy becomes patent if one considers that the advancements in computer technology have put at our disposal computational tools that can certainly afford such difficult tasks. In the popular literature it is often said, for instance, that a good modern computer can do in a couple of minutes a calculation that had required the uninterrupted work of hundreds of well trained human mathematicians during some centuries. In the same vein one could find in the popular literature regarding artificial intelligence in the 1970s the claim that the human brain, with its billions of neurons, is a computer that (according to the computer technology of those times) would have the material dimensions of the Empire State Building, requiring for its functioning an energy supply equivalent to that produced by the dozens of the most advanced plants for the production of electricity functioning at that time.

From quantity to complexity

The weakness of the perspective that lies behind those popular images was that it focused only on *quantity* and ignored *complexity.* Purely quantitative problems can be mastered (perhaps) by more and more powerful computing apparatuses, but complexity introduces the great novelty of the *interactions* between the different parameters that can be represented in the model, and this notoriously creates a whole spectrum of hard problems that exist already when the parameters at stake are very few. This is the phenomenon mathematicAlly denoted by the notion of *non-linearity* whose first announcements were developed n a famous paper by Henri Poincaré on the "Three bodies problem" (1889–1890). The problem is conceptually simple and clear: the only physical interaction considered is the mutual gravitational attraction between material bodies expressed by the Newtonian law which is *deterministic* and allows for good predictions if the system considered consists only of two bodies. Starting with three bodies, however, the application of this deterministic law does not lead to a general solution permitting to predict the dynamical behaviour of this system in time, because after a short initial time interval in which the behaviour is sufficiently "determined", it rapidly gives rise to a highly unpredictable trend (this is often qualified as "chaotic" behaviour). This does not prevent that certain "regularities" be found in this chaotic development. All these sophisticated and skilful mathematical developments cannot obscure, however, the fact that complexity drastically prevents predictability even when only deterministic actions are present.

Roads, maps and compass

The notion of linearity can be intuitively expressed by saying that, in case we can determine the status S_0 of a system at time $t = 0$ with an order of precision ε, we can predict the status S_n of the same system at time $t=n$ with an order of precision ε too. Non-linearity, on the contrary, occurs when the real status S_n of the system at time $t = n$ not only greatly differs from the one which could be predicted in the linear case, but cannot even be predicted through a different mathematical procedure.

The moral of the above reflections is that the most rational and efficient strategy for planning personal and collective actions cannot rely on the dream of looking for exact predictions secured by the creation of skilful deterministic "mechanisms". The increasing awareness that the situations of real life are always *complex* has destroyed the optimistic (and naïve) confidence in this methodological approach whose tacit implicit presupposition was that everything in the physical world as well as in human affairs is already pre-determined, so that what matters is to detect the roads and the maps of this enormous territory. According to this view, if we want to achieve a certain goal, we must be able to find in the map the suitable itinerary able to carry us to that goal. Unfortunately, as we have seen, no such maps are available.

Hence, what shall we conclude? Are we lost? Are we reduced to simple guessing and hope to have good fortune? Not necessarily: we simply need to change our image. Instead of dreaming of a non-existent map, we should better consider how one can explore a still unknown territory. An instrument that could be of help for him is certainly a compass, that indicates a *direction* in which he could move, an instrument particularly useful if he knows, with a sufficient degree of confidence, where is the goal he intends to reach. In such a situation he could correct his itinerary from time to time, make detours if necessary, in order to circumvent obstacles or impracticable routes, but always having some *orientation* regarding the direction of his walking.

Orienting values

The image of the compass suggests us the way for overcoming the intrinsic limitations of predictability: what we need are certain criteria of *orientation* and these can be identified with certain *fundamental goals* or *values* that can inspire the

personal or the collective action, depending on the situation we are considering. The fundamental characteristic of such goals is that they are not "chosen" because they are instrumental to the achievement of something else, but are considered valuable *in themselves*.

Any concrete human action, be it individual or collective, is characterized by the fact of pursuing a consciously adopted principal goal and using strategies or courses of action considered as suitable means for attaining the goal in the conditions and circumstances in which the action takes place. Normally this course of action is articulated into several "segments", each one having basically the same structure as the global action, but with the characteristic of being "subservient" to the overall goal, in the sense of being instrumental to the attaining of this goal. This entails that there is a significant margin of contingency and flexibility in these segments, whose possible modifications and arrangements are rationally justified by the change of conditions, the unexpected appearance of obstacles or facilities encountered "on the way", that impose or suggest changes with the view of keeping the *orientation* towards the overall goal. Therefore, the stability of this goal is the precondition for the rationality of the flexibility of the different courses of action involved, and this means that the overall goal is in a certain sense *unconditional*, whereas the partial goals of the single segments are intrinsically conditioned.

It is evident that, in order to play such a high role, the overall goal must be really *unconditional,* that is, it must have the quality of a solid *value* worthy of being pursued *in itself*, as we have said and, because of that, capable of *giving a sense* to the individual or collective action under consideration. Such values cannot be found in science and technology, whose internal logic and structure are typically *hypothetical* and this fact suggests an analysis of the crisis in which finds itself modern civilization, that seems to have given to technoscience the full confidence for the solution of all human problems. Technoscience has given to humankind a tremendous power, but no orientation regarding how to make use of this power. Today we feel that more intellectual energy and commitment is needed in order to complement the technoscientific progress with an ethical, social, spiritual reflection from which we could derive some orientation concerning the way of making that progress profitable for the benefit of humankind. This conclusion is by no means unexpected: it is simply the consequence of having sufficient awareness of the *complexity* of the "World of Life", that entails that no single aspect of this world can offer the right solution for the global problems. They require a cooperative interrelation of all the dimensions of this complex world.

Emergence

There is another deeper reason for the difficult confluence of predictability and complexity. As is well known, a fundamental notion intimately related with the concept of a complex system is that of *emergence*. It consists in the awareness that a complex system is constituted by several interrelated subsystems, each of which is characterized by specific properties and functions. The global system, however, has properties and functions that are different from those of any subsystem though they "depend", on the other hand, from the good functioning and the good interrelations among the subsystems. A living organism is a clear example of this interdependence and emergence, and emergence is really something new that cannot be neither logically derived nor causally produced by the simple juxtaposed actions of the single subsystems but requires the special arrangements and subsistence of the intersystemic interactions. This, however, is only half of the story, because the existence, the qualities and functions of the global system also depend on its relations with its *environment*, relations that we can call extrasystemic with respect to the particular system considered, but are normally also intersystemic from a higher point of view.

Emergent features are, strictly speaking, unpredictable. Nevertheless, there is another sense according to which they are predictable, This happens when a system has its own dynamic *development*, that is, when the system goes through successive steps in which it preserves its own identity but at the same time acquires (or loses) certain properties, capabilities, functions. Living organisms are again the most familiar example: the "metamorphosis" of an insect that begins as an egg, then spends a few weeks as a larva (similar to a worm), then remains some more weeks in a closed isolation as a chrysalis and finally comes out as a "perfect insect" in the form of a beautiful butterfly is an eloquent example of a combination of emergence and predictability. The abundance of such examples in the domain of living organisms, however, does not capture the most radical sense of predictability that concerns something that did not occur yet but is expected to occur. In fact, the case of successive steps in the individual development of an organism can be considered as "observed regularities" in which certain emergent features appeared in a given sequence during the development of the organism. Therefore, it is simply a matter of scientific induction to "predict" that a certain living organism that we are observing now will show certain specific features after a certain temporal interval. Hence the genuine case of prediction concerns future events of which we do not have similar examples in the past and which we believe either that they have a serious probability of spontaneously occurring, or that we think that we could more or less efficiently produce.

Producing the future

Especially in this second case predictability receives a great importance, because it can entail a *responsibility* for the consequences of the actions we intend to realize. In fact, when we operate on a given complex reality, it is theoretically certain that our action will have effects on the whole system and we are unable to know in what measure this could determine unexpected changes in the system and even contribute to the *emergence* of unpredictable situations. The introduction of technological novelties is paradigmatic in this sense and for this reason requires *prudence* which does not coincide with the most common sense of "carefulness" but has the deeper philosophical meaning of a complex judgment in which different aspects, values and constraints are evaluated and a wise choice is proposed. The interesting fact is that in this prudential judgment the maximum level of predictability must be looked for, and this usually relies upon scientific and technological knowledge (considered in a suitable broad sense), whose principal contribution should first consist in the indication of ac-

tions that *ought not* be realized because the technoscientific knowledge available clearly indicates the negative effects that would follow. Secondly, on the ground of technoscientific knowledge it would be *recommended* what actions with positive affects and small negative side-effects could be promoted, remaining conscious, however, that unexpected emergent situations could occur.

Two basic considerations support the above reflections. The first concrns the fact that, in the last analysis, future is the only temporal space available to us, one in which we can bring about something, simply because the past has already occurred, is no longer at our disposal, cannot be modified, and the present is just a fugitive instant that goes away quickly and is simply "open" towards the future. Hence, the future is the only proper dimension of our actions. The second ground concerns predictability. We have stressed the limitations of predictability, linked in particular with the non-linearity of complex systems dynamics. Nevertheless it is logically impossible to envisage actions in the future without some measure of prediction, hence, prediction is also indispensable. A partial solution of this difficulty comes from the consideration that, in the initial stages of a dynamic complex process the development is rather close to linearity, and this means that we can rely upon certain observed *trends* in order to make predictions endowed tith an acceptable plausibility. This is why we need and are also entitled to avail ourselver of scientific and technological knowledge in projecting the future, though remaining vigilant towards the decreasing reliability of our predictions with the increase of the time span of our prognoses.

Globalization

What remains little known, however, is the impact of the extrasystemic conditions, that we can call *environmentsl* in a broad sense, that is, not only in the most familiar sense of the ecological natural environment, but in the more comprehensive sense of the increasing *globalization* that entails a growing ethnic and cultural pluralism directly affecting precisely those general views regarding high level "unconditional" values that preside over the orientation of human conduct and on overall judgment.

We are obviously referring to that great contemporary phenomenon that is known under the term "migration" When we speak of migration today we mean something different from the traditional fact that certain persons abandon their native place of residence and go "abroad" with the aim of finding a more suitable place to live for a variety of reasons, that could go from the search of a good job to the condition of being forced to go into exile for political reasons. This phenomenon has always existed in history and regarded single individuals or small groups of individuals, who were qualified as "emigrants" from their country of origin and "immigrants" in the new country of residence. When we speak of migration today we mean the displacement of entire populations that enter the borders of an already settled population and want to find in that territory their final destination. This phenomenon is not totally new, having occurred some times in human history, and has produced deep changes in it. The best known example is perhaps that of the so-called "Barbarian invasions" that eventually produced the end of the Western Roman Empire in the 5th century, an event that is usually indicated as the beginning of the Middle Ages. Such old migrations usually concerned nomadic populations that for centuries had been accustomed to make violent incursions, raids, plunders and then returned to their nomadic way of life, but in that final stage they became stable occupants of a part of the invaded territory and gradually mixed themselves with the original population. Today nomadic populations are almost inexistent and migration concerns people who are inhabitants of a given territory or even citizens of a given state and leave their country in order to settle in a different one.

This substantial novelty requires a pertinent study of the nature, the causes and the forms of contemporary migration which in the last decades has become, so to speak, more "spectacular" due to its magnitude: hundreds and hundreds of people have come daily especially to certain European countries and their presence has produced a great amount of political, social, economic and diplomatic problems, tensions and debates that have impressed the public opinion.

An important element in the characterization of contemporary migrations is the fact that big groups of migrants belonging to a single ethnic population have a certain *cultural identity* constituted by a variety of customs, moral rules, family structure, social conventions, religious believes, general conceptions concerning the natural environment, the nature of humans, the status of men and women, the nature and structure of society, the sense of life, the authority of tradition and so on. These groups are not only culturally different from the culture of the country where they arrive, but also from that of other migrant groups and this fact easily produces a "clash of cultures" whose depth and effects are unpredictable and vary from country to country depending on several factors. There are countries that, for historical reasons, have already a certain experience of "multiethnic" composition and have tried to cope with it according to different "models", whereas for other countries this situation is new and, therefore, more difficult to manage, because it has direct impact on *concrete actions* and conducts that inevitably emerge also on the public stage.

The spirit of tolerance and dialogue appears as the only means for attaining a satisfactory solution for this *emergent* problem of our time, a solution that cannot consist neither in an uncommitted relativism, nor in the pretention of finding in a single model of rationality and morality the right solution. This, however, is the most serious challenge for our time, that must find the way of putting reason as the only alternative option to the use of violence.