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HEURISTIC VALUE OF SIMULATION MODELS IN PSYCHOLOGY

Alberto Greco

Institute of Philosophy, University of Genoa
4 via Balbi, 16126 Genova

Summary

Starting from some remarks about the use of models in psychology, Human Information Processing (henceforth called H.I.P.) models which sometimes use computer simulation will be examined. An attempt to show that simulation in psychology does not necessarily imply an H.I.P. approach is then made.

The Use of Models in Psychology

The lack of unity in psychology is commonly acknowledged: the division among specialties is so emphasized that it has been said that there exists no longer "the" psychology but only "many" psychologies. In particular, it must be recognized that there is a break between experimental (or academic) and clinical (or applied) psychology, both because of the difference of problems and interests (of "objects" it could be said), and the difference in the way of theory making. It is common knowledge that clinical psychology tends to construct great theoretical systems, whereas experimental psychology, dominated nowadays by the cognitive trend, prefers to use models. This usually means that experimental psychology today prefers theoretical constructs that are applied to a limited range of phenomena. In other words, the subdivision of research is stressed since these "models" frequently regard a single cognitive process or even some particular aspect of a cognitive process instead of the old general issues such as the relationships between perception and motivation or memory and intelligence.

To say that psychologists, at least experimental or cognitive ones, today prefer to construct "models", however, means also another thing: that is, not only that the objects of their theoretical constructs are limited or not very general, but also that in order to speak of psychological objects they make a "change of system", namely they refer to a conceptual system whose components are not psychological concepts. This is, besides, the traditional meaning of the concept of "model". It must be added on this subject that some correspondence between those components and the modelled psychological reality is necessary; for an epistemological audience it will be enough to mention that this "correspondence" between model and reality is usually named with a single word: analogy.

Statistical Models in Psychology

If the "models" that a large part of recent psychology presents are considered in this sense, it must be recognized that in this theoretical activity there is nothing new and rather that models are a necessary tool for research. Moreover, they are to be found in all psychological approaches: psychoanalysis dealt with psychic energy using (perhaps misusing) the model of physical energy, and coined many other metaphors; Lewin's psychology with models inspired by the physics of electro-magnetic fields and by topology; psycholinguistics for a long time used the model of communication theory (emitter - receiver - channel, etc.).
The use of statistics too may be considered in one sense the use of a model. In this case care must be taken because this use is not always an "analogic" one. There are uses of statistics that certainly help the model construction: they are those which, by "analogy", attribute to psychic processes a probabilistic, stochastic, aleatory, samplable way of working (e.g. Signal Detection Theory, probabilistic learning theories, etc.). These uses of statistics tend to "model" our representation of psychic processes and to impose a statistical structure on them. So when we ask if some psychological events are measurable on a nominal, ordinal, interval or ratio scale, we are somehow "thinking of" them as different in those various instances; and this is also true when we ask whether the "distribution" of certain psychological events corresponds or not to some parameters like the normal distribution.
On the other hand, there is one use of statistics that does not intend to say anything about the nature of objects or psychic variables but is simply applied to hypotheses made by psychologists in order to explain certain phenomena. Part of this second aspect is the classic use of statistical "significance", which is essentially the application of the theory of probability to observational or experimental results. For instance if, having in mind some hypothesis, we have constructed an experimental design on the grounds of which in condition A we should not have a certain effect whereas in condition B we should, when we obtain our results, we must ascertain whether these are really due to our manipulation of independent variables and not to chance. So in statistical inference we can generalize to the population the results obtained from a sample only if the differences found in the sample are not due to chance.

H.I.P. Models and Simulation

We have dwelt upon statistics because of its considerable use in experimental psychology. But it is certain, as said above, that the most topical models are those inspired by H.I.P. philosophy. These models suppose that man is an information processor and that his psychic processes, in particular "cognitive" ones, are comparable to computer programs. On this metaphor or analogy many micro-models of this or that process have been constructed, putting some transitory memory or buffer here or some store there, using diagrams very similar to flow-charts and enlivening everything with the magic word: information. It has been said (Weizenbaum, 1976) that if the behaviorists put a black box between stimulus and response, the cognitivists have replaced it with a computer. In this context some models are being proposed that make the analogy between man and computer so explicit as to get the very processes reproduced by the computer.TThese are the simulation models. It would seem

that these models are tied by a double thread to H.I.P. presupposition because of the use of the computer, the explicit analogy between program and process, and the use of the information concept. We will try to show that this is not necessarily the case.

To simulate means to reproduce by means of suitable programs certain psychic activities (intelligent but not necessarily so). Sometimes simulation in psychology is confused with artificial intelligence: the latter nevertheless is more general on the one hand and more limited on the other. It is more general because its main purpose is to obtain the performance of a task which, if made by man, would require intelligence. What is important, then, is that the program leads to the same results that man achieves, possibly more quickly and accurately. Artificial Intelligence (henceforth A.I.) is the basis of robotics, since it aims (and is financed) to construct robots' "minds". For instance, it is interested in the construction of problem solving programs (the "blocks world", in which solid bodies are moved or stacked up, is classic). In principle, however, it is not important that these problems be solved just as man does. Anyhow, A.I. researchers happened to realize that, after all, the best source of ideas about how these processes could take place was man himself; so they started writing programs that imitate the way all this is supposed to take place in man. Here we are within the field of simulation and the interests of computer science happen to coincide with those of psychology. Yet it must be repeated that psychologists are interested only in simulation, not in general A.I., in that they ask the program to reproduce as faithfully as possible psychic processes and possibly to make typical human mistakes.

We have claimed that, in another sense, A.I. is more limited than simulation: it does indeed put some constraints on the nature of studied processes by speaking of "intelligence": is it not possible to simulate something which is not intelligent (e.g. affective processes, stupid behaviour...)? With regard to "what" can be simulated, it must be made clear that the object of the simulation is not really behaviour (even if psychological simulation is sometimes called "behavior simulation") because a computer program that makes some effector organs (e.g. a robot) perform imitations of human behaviour would simply be robotics. In the same way a program which produces on a video linguistic answers to questions, like those a man could, is not reproducing only behaviour but also the mental activities that are behind it. Another definition is "cognitive simulation" because these mental activities are often cognitive processes. We would prefer to speak of "psychological simulation", including all computer programming made in order to reproduce processes or phenomena which are studied by psychology.

Two Senses of Simulation

So defined, simulation, like statistics, can be understood in two different senses: analogic (in this sense it gives rise to models) and hypotheses validation.

In the analogic sense, the writer of a program which will reproduce psychic processes, attributes to these processes, arguing from analogy, structure analogous to that of the program, that is the steps run by the computer as it follows the program, are analogous to psychic operations or activities. In this case, what does associate the model to the modelled phenomenon (what Mary Hesse would define the "positive analogy")? It is the concept of information: namely it is said that the information flow undergoes

analogous vicissitudes in both cases. But, in the other sense, simulation can be understood as a simple tool for theory proving, almost to "set theory in motion" in order to reach the extreme consequences that its hypotheses involve. In other words, if it is granted that certain hypotheses about a given psychic phenomenon (e.g. neurosis or paranoia, to take what Colby, a well-known pioneer in this field, has simulated) are true, some consequences should come from it (e.g. on the behaviour side): these consequences can be deduced using paper and pencil as well and the computer is not strictly essential. However, by using it in an interactive way, one can modify very quickly many parameters and then verify what it happens. The hypotheses of a theory can be considered as a set of "rules" about the object and therefore they are translatable into a program.
This is certainly not the only way to do so and there is no guarantee that it will always work. The important thing here is that simulation does not constitue in this case an H.I.P. model, because it does not suppose that there is an analogy between the way the computer works and the way the human psyche does and it does not claim that simulated psychic matter is necessarily equivalent to processes of information manipulation. For instance, the Freudian theory of defence mechanisms, which does not use the language of information but of energy, has been simulated (Moser et al., 1969).
The language of information, therefore, is not a strict consequence of the adoption of a simulation perspective. (Why then has cognitive psychology been taken in by this language? The reasons are complex and it is not possible to go into them in detail in this paper: however it can be said that this language helped to conceptualize certain psychological variables in a useful way in order to overcome behaviouristic difficulties about the study of "inner processes").

Cognitive Science

A proof of the fact that a contribution to the study of cognitive processes by means of simulation is possible without H.I.P. presupposition can come from some ideas that have been developed within a very young science, Cognitive Science, which studies cognitive processes unifying the points of view and contributions of Cognitive Psychology, Psycholinguistics, Computer Science, A.I., and Philosophy.
In Cognitive Science, for instance, one can find programs that state in a new way the problems of linguistic comprehension and of the conceptual representation of knowledge. New representation systems that have been devised have nothing to do with information theory or with H.I.P. hypotheses, going from the mere (and automatic) application of predicate calculus logic to structures such as semantic networks, frames, scripts. Schank's Conceptual Dependency theory, and Wilks's, which is very similar, can rightly be called psychological theories. These authors have tried to enucleate some semantic primitives (for instance Schank attempted to connect all normally used verbs with only eleven primitive actions), independent of any natural language. On the basis of this theory, programs have been constructed which not only can represent knowledge but can thence generate inferences. Moreover, since primitive concepts are independent of natural languages, this theory has made possible decisive steps towards automatic translation. Other important contributions have been made with regard to problem solving strategies. All these ideas can give a great heuristic contribution without necessarily sharing the H.I.P. approach. (Obviously, many cognitive scientists do share it, but this is a question

of personal belief, not a necessary consequence of the theory).
In conclusion, simulation is not a panacea but neither is it what some of its opponents would like to make out: it does not necessarily imply an analogy between human beings and computers or the reduction of man to a computer; on the contrary, the trend is to model the computer more and more in the likeness of man and to help understand man.

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