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On Fuzziness and Ordinary Reasoning

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In 1685, in *The Art of Discovery*, Leibniz set down an extraordinary idea: "The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: Let us calculate [calculemus], without further ado, to see who is right." *Calculemus*. Much has been written about that celebrated expression, but if I had to remember the moment when the famous Leibnizian motto once again brought back to mind, in a way, artefacts of the present and the future, that moment would be connected with a seminar organised by Verónica Sanz at the Philosophy Institute of the Spanish Council for Scientific Research (CSIC), when she was the coordinator of the Seminario Internacional de Jóvenes Investigadores (the International Seminar for Young Researchers). At that seminar, Sergio Guadarrama presented the challenge of computing with words. It was then, if I was not mistaken and I really understood what was being explained to me, that I discovered that after all, Leibniz had something to do with a man named Lotfi A. Zadeh. I liked this, because it meant that the problem of formalising the modes of reasoning we all use was so important that many reputable researchers wanted to help the world to calculate. Alerting others to the importance of calculating and being aware of the effective realisation of a calculation when it is reasoned, is not the same as offering answers about how we can achieve this individually and even collectively, in the physical world and in the virtual one.

When it is not misinterpreted, we all tend to like Leibniz' expression; everyone likes the idea of calculating with words. Calculating by reasoning is something we normally do. A constant calculation which unites us with everyone else in a kind of endless mathematical operation, but which we accept as finished at certain moments, is an invitation to imagine ourselves as really complex creatures. Enric Trillas showed me more things about the problem of ordinary reasoning in the first "Alfredo Deaño" Seminar on Ordinary Reasoning organised by the Foundation for the Advancement of Soft Computing and the *European Centre of Soft Computing* (ECSC) in 2011. Here different research projects were discussed, relating to the challenge of Soft Computing, and the meaning of our reasoning in everyday life. The concept which I found most enthralling was the 'conjecture' which Enric Trillas spoke about.

One could say his entire discourse was imbued with the spirit of the *Novum Organon Renovatum* which led William Whewell to state that deduction is a necessary part of induction. At first glance, it is as paradoxical for a mathematician to sustain and develop a philosophical discourse based on this thesis, as it is for a

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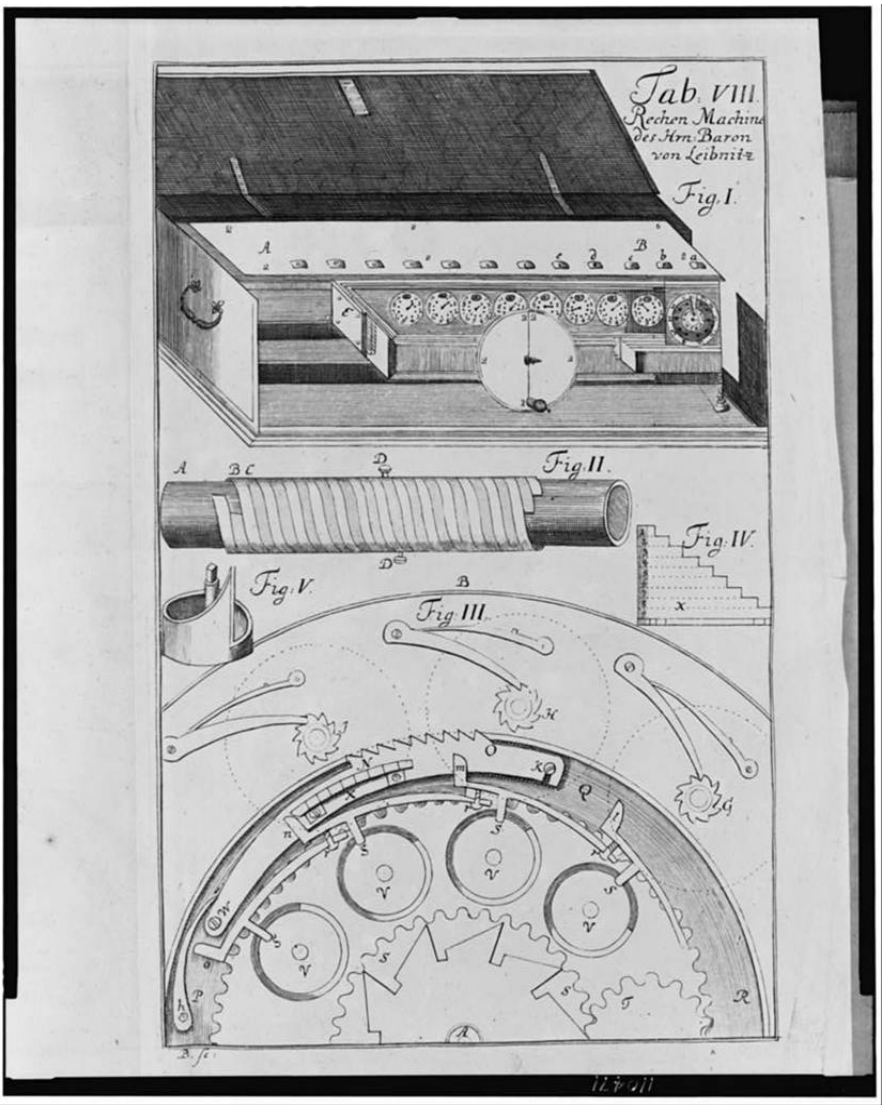

Fig. 68.1. Details of the mechanisms of the Leibniz calculator, the most advanced of its time. Illustration in *"Theatrum arithmetico-geometricum" das ist Schau-Platz der Rechnen- und Mess-Kunst...*, [1].

philosopher to exclaim "let us calculate", advising us to learn to weight our reasoning appropriately when we enter into disputes which can be resolved if we gradually find out how to present them more tangibly. It struck me that Trillas' adherence to this thesis was leading him to criticise the prejudice shared by many philosophers that all objects can be precisely defined. Trillas shares this concern with Zadeh, who

has defined himself as a fervent believer in the power of mathematics. Both for Trillas and for Zadeh, it is a mistake of classical mathematics to think you can divide objects into two sub-classes: that of the objects which are examples of the concept, and that of those which are not. If we think about the paradoxical expression which Leibniz invites us to always bear in mind (*calculemus*) perhaps it is not so strange to see two fervent believers in mathematics inviting us to look at the world exactly as we all know it to be: a reality in which there are no defined (or defining) frontiers, where we understand that a pinch of salt cannot be replaced by an exact amount, or that the meaning of *better than*, *good* or *high* cannot be defined according to the classical pattern mentioned above.

There is no precise definition dividing into two the class of all objects, nor is there a deduction mechanism based on the rules of inference operating on the meaning of utterances; only on their abstract form. This is what makes so attractive the fact that human beings, and living organisms in general, reason, aware that our conclusions are not definitive, but merely provisional. However, despite the incompleteness, not only of our reasoning but of the theories we construct with them, neither can we conclude that our inferences lack informational value. We use powerful systems to represent the world in which we manipulate our beliefs, so that many people refuse to believe that this has anything to do with logical calculation. Do we calculate? Do we rebuild information without adding new semantic content? How do semantic representations, or representations of content, affect formal mechanisms to produce inferences? Answering these questions does not look easy, but it may be an interesting strategy to ask why we do things this way.

Let us suppose our semantic representations influence the formal mechanism to produce inferences. What use to us is it to do it this way? One of the explanations which have been given is that circumstances usually oblige us to make decisions and/or to act long before we know all the relevant facts. Not all the information is available to us, because the world has not finished happening. This is the idea underlying the concept of goal-directed reasoning: we all establish reasoning which goes from the premise to the conclusion, which does not prevent us returning immediately from the conclusion to the premise. The inference rules we use justify the beliefs we select and adopt. But what for? A common answer is that it is to be able to act and live in time. In a way this is like saying it is in our interests to be able to think this way (in two directions) because our reasoning is goal-directed: it is in our interests to reason this way. However, it seems paradoxical that our interest in reasoning following a model of reasoning directed to interest makes us select an imperfect model of reasoning. This option is certainly the most consistent one if we bear in mind that, as Zadeh reminds us, we do not live in a world in which we divide objects into two sub-classes: that of the objects which are examples of the concept, and that of those which are not. If we read this idea in relation with the subject of reasoning, the result is that, through reasoning, we can live in a world where we can recant our inferences. Something so apparently simple ends up being very useful: ordinary goal-directed reasoning invites us to examine the theories of epistemic justification (externalism, internalism, contextualism, reliabilism, etc.). Perhaps this analysis of epistemic justification still does not answer the question of why (why are we normally

unable to restructure information without adding new semantic content?), but it offers different answers to the question of how.

Do all people share the same notion of inferential validity? If a self-description ('I think it's red'; 'Zadeh says yes'; 'I like eating with other people!') means the immediate production of a given context for the expression of states of consciousness – and this is the context which enables us to understand those expressed thoughts – it is pertinent to ask if we all share the same notion of inferential validity. Something may lead us to think, to begin with, that we do not. We have all experienced disagreement and misunderstanding. We often have experience as to whether or not we get things right when reproducing a given context to make states of consciousness and representational content understandable, or if we do this successfully, but then fail to infer other representational content, for example, the intentions, plans, beliefs, judgments or commitments which make up collective attitudes.

To understand more about what 'inferential validity' means and why this process is susceptible to every kind of cognitive bias, we must refer to the discoveries in the psychology of reasoning of Peter C. Wason. The results of Wason's experimental research are a paradigm of how concepts of inferential validity do not satisfactorily account for the phenomena of ordinary reasoning. In 1960 some experimental psychologists began to take an interest in the nature of human reasoning. A series of experiments led them to conclude that most human beings ordinarily make basic mistakes in deductive order in their inferences. This research led to the emergence of the concept of 'inferential competence'.

The definition of inferential competence proposed by the experimental psychologists was not shaped by all the principles and rules of classical logic. This research would later be enriched by the application of a tentative hypothesis according to which the experiment subjects made more formally consistent inferences when presented with a concrete version of the inferential tasks, i.e., when they were asked to resolve these tasks while still using natural language, and not through formalisations in an object language.

The research of these experimental psychologists chimes with the discovery of cognitive bias or systematic errors when making inferences. From the point of view of cognitive psychology, cognitive biases are one of the core concepts of the psychology of reasoning, because they let us infer that there is a certain type of context, conditions and situations in which a cognitive mechanism (with inferential or inductive effects) produces cognitive results which are not correct.

This cognitive heuristic itself represents an example in which we see that inferential and representational processes are dealt with in ordinary reasoning based on interpretive components and processes. Thus, in the case of epistemic biases, the previous interpretation of the contexts in which cognitive mechanisms (e.g., an inference, a representation) is what guides the subject when producing justified or acceptable cognitive mechanisms.

In their studies on defeasible inferences authors such as Keith Stenning and Michiel Van Lambalgen have drawn our attention to how little importance is usually given to the three dimensions present in interpretation (the logical, semantic and pragmatic dimensions) in the mastery of logic and the philosophy of language.

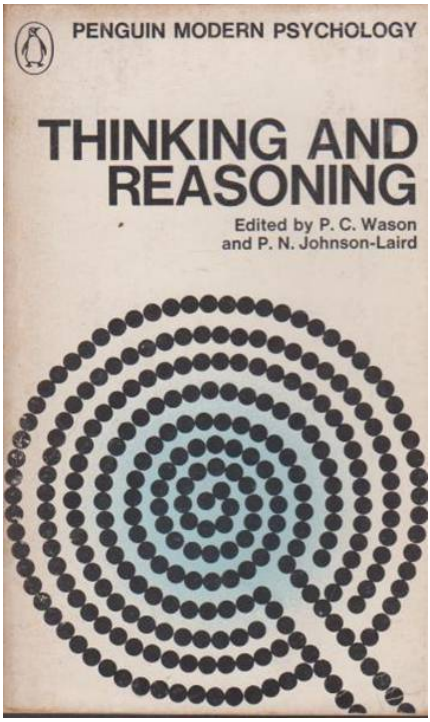

Fig. 68.2. Cover of the book edited by Peter C. Wason and P. N. Johnson-Laird, [2]

Defeasible inferences are the opposite of deductive arguments, which are not defeasible. If a conclusion follows deductively from a set of premises P, it can never be valid if P is increased, or in other words, an inference cannot be valid if, among other aspects, more information is obtained based on the inference.

For example, defeasible inferences are constantly used in historical research and reasoning. In fact, the functions which some historians who call themselves reconstructionists confer on historical reasoning are not in agreement with the nature of the inferences used in developing the reasoning: they construct historic reasoning based on a deductive conception of this reasoning. However, we find that in history, there is no place for deduction; history is an eminently defeasible space.

In everyday life too, our inferences are defeasible inferences. We can see this, for example, in some of the most important revocable or defeasible inferences, such as conditional inferences, within which we can highlight so-called conversational implicatures, as well as abductive inference, which I regard as the logical pattern inherent in the cognitive process called 'interpretation'.

Ordinary reasoning enables us to have a closer relationship with reality (because it is eminently fuzzy), and fuzzy logic - as far as I have been able to understand until now - establishes the conditions of possibility to carry out the sophisticated calculation through words with which Lotfi A. Zadeh invites us to contemplate ourselves.

References

1. Leupold, J.: “Theatrum arithmetico-geometricum" das ist Schau-Platz der Rechnen- und Mess-Kunst... Christoph Zunkel, Leipzig (1727)
2. Wason, P.C., Johnson-Laird, P.N. (eds.): Thinking and Reasoning. Penguin, Harmondsworth (1968)