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"GOD DOES NOT ALGEBRA": SIMONE WEIL'S SEARCH FOR A SUPERNATURAL REFORMULATION OF MATHEMATICS

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Abstract

The article offers an analysis of Simone Weil's philosophy of mathematics. Weil's reflection starts from a critique of Bourbaki's programme, led by her brother André: the "mechanical attention" Bourbaki considered an advantage of their treatment of mathematics was for her responsible for the incomprehensibility of modern algebra, and even a cause of alienation and social oppression. On the contrary, she developed her pivotal concept of 'attention' with the aim of approaching mathematical problems in order to make "progress in another more mysterious dimension". In the Pythagorean 'crisis of incommensurables', Weil saw the possibility of defining the relationships between things in terms that are not exclusively numerical. This implies drawing an analogy between mathematical relationships and God's relationship with mankind (logos), the basis of a 'supernatural' reformulation of the entire scientific understanding of the world. The consequence is a critique of machinism and the possibility to contrast algorithmic reason with a "supernatural reason".

Keywords: Simone Weil, Bourbaki, mathematics, algebra, geometry

1. Bourbaki

There were only two meetings of the group of mathematicians known by the collective name of Nicolas Bourbaki that were also attended by Simone Weil, sister of one of the group's founding members, André Weil. We have a picture of both these meetings. In the first, Simone appears in a prominent pose, the only one standing, almost in the middle of the photo, one hand resting on the deckchair where her brother is sitting, the other on her hip, in a nonchalant attitude. In the second one she is instead in a corner, her arms behind her back, her face almost embarrassed by the choice to portray her together with a group she knows she is not part of. The comparison between these two photos plastically renders the evolution of Simone Weil's attitude towards the ambitious intellectual programme of the Bourbaki, which influenced all 20th century mathematics. At first, an attitude of profound interest, deriving from her unflagging fascination in mathematics, certainly borrowed from her relationship with her brother (Roy 2014), but also testified by all her notebooks, full of calculations and reflections on mathematical foundations. Thereafter, a gradual, inexorable estrangement, until a complete break with the very premises of the Bourbakist project, and from which some of the central concepts of Simone Weil's philosophy would derive.

To understand this, one need only open Bourbaki's *Éléments de mathématique* and read the first lines, where the objective of the mathematical collective's work is summarized. "The verification of a formalized text is a more or less mechanical process," Bourbaki say, using in the original French a term that is lost in translation, namely "*une attention en quelque sorte mécanique*" (Bourbaki 1970, E I.7). A little later they clarify the need for a rigorous formal systematization of mathematics, since in "an unformalized text, one is exposed to the dangers of faulty reasoning arising from, for example, incorrect use of intuition or argument by analogy" (Bourbaki 2004, 7-8). One can almost feel the irritation Simone Weil must have experienced when reading these lines when the first issue of the work appeared in 1939. The concepts of 'attention', 'intuition' and 'analogy', so central to her thought, are employed here with an entirely antithetical meaning to her own.

Bourbaki's programme was deeply inscribed in the mathematical philosophy of the early 20th century. The belief that a reformulation of mathematics could be realized from first principles expressed in logical formalism had already shaped Bertrand Russell and Alfred North Whitehead's *Principia Mathematica* in the 1910s and 1920s. The basic idea was that logic, i.e., the most rigorous form of human reasoning, was identical to mathematics, so that through an algebraization of logic it would be possible to merge these two fields. Borbaki's programme could be interpreted as the French response to that of Russell and Whitehead. Whereas the latter "famously filled over 700 pages of formal symbols before establishing the proposition usually abbreviated to 1+1=2," in Bourbaki's formalism it takes "about 4.5 trillion symbols just to define the number 1" (Barany 2021). One can therefore understand why Bourbaki's goal of obtaining a proof of mathematical axioms through the application of "mechanical attention," which they considered an advantage of their treatment, was, for Simone Weil, responsible not only for the incomprehensibility of modern algebra, but even a cause of alienation and social oppression. The concept of 'analogy', despised by Bourbaki, had to be placed at the center of a redefinition of science on a human scale, to the extent that Simone, in open opposition to André's programme, went so far as to conceive the drafting of a textbook for schools dedicated to the teaching of science based on analogy (see Weil 1984).

2. Attention

Several studies have focused on the undeniable importance that the concept of 'attention' plays in Simone Weil's thought (Pirruccello 1995; Cameron 2003; Dall'Igna 2022). There is no such thing as 'mechanical attention'. Attention is rather the way one can access the truth, the profound understanding of the very nature of things. Attention contains within it the notion of 'intuition'. Although Bourbaki, like all mathematicians, were well aware of the importance of intuition in mathematical work (André Weil himself complains in a famous letter to his sister that in the past mathematicians were often content to intuit demonstrations rather than formulate them in precise language, to the despair of later mathematicians [see Krieger 2005]), their goal of a rigorous formulation of mathematics was antithetical to intuitionism.

In Simone Weil's thought, attention is essentially a form of prayer by which reaching the intuition of the existence of higher realities. Her closeness to Pythagorean thought, as we shall see, led her to relate attention as a form of intuition of God to mathematical attention: "If we concentrate our attention on trying to solve a problem of geometry, and if at the end of an hour we are no nearer to doing so than at the beginning, we have nevertheless been making progress each minute of that hour in another more mysterious dimension," she wrote in a 1942 draft entitled *Réflexions sur le bon usage des études scolaires en vue de l'amour de Dieu* (Weil 1951, 106). Nothing could therefore have seemed more abominable to her than to reduce mathematics to an exercise in mechanical attention, because mathematics represented for Simone Weil the first and purest method of connecting the spirit to the universe. However, as we shall see, she was bound to a geometric conception of mathematics that explicitly distanced itself from the algebraization of Bourbaki and 20th century mathematical philosophy in general. This geometric conception, of Pythagorean derivation, prompted her to inscribe on the door of her philosophy classroom at the women's lyceum in Le Puy the famous motto that stood at the entrance to the Platonic academy: 'Let no one ignorant of geometry enter' (see Pétrement, 1997).

Attention is in fact first and foremost a relationship or relation. It is a way of bridging the distance between the human and the divine: in this way it was understood by the Greeks, who saw in the relationship between quantities essentially an analogy of the relationship between human and divine. In this sense, attention is a way to enter into deeper contact with the nature of things, which would otherwise elude our understanding. Herein lies the problem of the mechanical attention proposed by Bourbaki: once reasoning is made automatic, attention ceases to exist, and so the relationship with the noumenon. In Weil's terminology, the sign replaces the spirit. Human beings become machines that manipulate signs, with no more hope of understanding the ultimate meaning of reality, as they move inexorably away from their relationship with God. We will see later the practical application of this reflection in Weil's critique of machinism.

3. Analogy

'Analogy' is another essential concept in Simone Weil's thought. While Bourbaki considered the use of analogy misleading for the understanding of mathematics, Simone Weil asserted that it is through analogy that human intelligence from childhood is led to discover the truths of nature. Analogy is first and foremost an "identity of relationships" (Weil 1978, 85), not a similarity, as is often mistakenly thought. While it is true that there is no material similarity between waves in a pond and light, still an analogy can be traced, and thanks to this analogy Hertz was able to conclude that light is an electromagnetic phenomenon. Therefore, the use of analogy is not only useful for teaching and popularization, to facilitate the understanding of scientific knowledge for laymen, but is one of the ways new types of knowledge can be acquired. Through analogy, it is possible to lead back the particular to the general, and to discover that apparently different phenomena can be explained in an analogous way: another example is the analogy by which Newton, starting from the trajectory of a projectile, guessed that the Moon's orbit is produced by the Earth's gravitational attraction.

As Weil once wrote in a letter to Alain:

> I have sometimes dreamt of a physics book for primary schools in which the interpretation of natural phenomena would be presented exclusively under the aspect of successive, increasingly exact analogies, and this starting from perception as a stage of scientific knowledge. Thus for light one would begin with a list of all the cases in which light behaves as something analogous to a movement, and then move on to the analogy with a rectilinear movement, to the analogy with waves (...). (Weil 1966, 79. Translated by the author)

In this pedagogical programme that Weil shared with a colleague, explaining her students' interest when she proposed a course on the history of mathematics (Weil 1965, 1-2), experiments should also be part of such a course, particularly the reproduction of experiments carried out in the past, so as to link the discovery to the method that produced it. This was not simply a difference of opinion to the Bourbakist programme. For Simone Weil, only in this way would science come closer to laymen and prevent the emergence of dangerous phenomena of alienation considered to be preconditions for the rise of undemocratic regimes. What would distinguish the science of the Greeks from modern science is precisely the use of analogy, which Bourbaki considered misleading. Reasoning by analogy, later replaced by the deductive method and the inductive moment, represents "the most important part the understanding plays in gaining knowledge of nature (Weil 1979, 122). When, on the other hand, data are measured separately without knowing their mutual relationship, algebra comes into play. And when the relationship between things, between people and things, between people themselves and between them and God, is broken, what occurs is uprooting, the focus of Weil's latest texts, those composed in London in 1943 before her death. In the *Prélude à une déclaration des devoirs envers l'être humain*, a sort of summary of her later thoughts, Weil writes that the uprooting of culture is probably the most profound form of uprooting: when it occurs, one can notices that in all fields of knowledge, "relations being cut, each thing is looked upon as an end in itself" (Weil 2002, 65). The example she gives is the way geometry is studied in schools: by depriving geometry of its relationship to the world, students only learn to solve problems without understanding them, automatically.

4. Geometry

It is no coincidence that Simone Weil's habilitation thesis was dedicated to Descartes. He was, from her point of view, the last of the geometers rather than the first of the algebraists, despite the fact that traditionally the algebraization of geometry was due to the introduction of the Cartesian plane. "Mathematics," Weil acknowledged in her thesis, "reigns over Cartesian physics," but in a different way than it does today, since it does not represent the language Descartes used to express himself: "It is possible to say that Cartesian physics is purely geometrical, although Descartes himself says so; the truth is that geometry, in Descartes, is itself a physics" (Weil 1966, 27. Translated by the author).

To understand the importance Weil attached to geometry as an alternative and counterbalance to algebra, we must return to Bourbaki. They continued, during the 20th century, the programme of axiomatic systematization of Euclidean geometry launched in the 19th century by David Hilbert with the *Grundlagen der Geometrie* (1889). Although this was an inevitable route to develop the new, more abstract mathematical tools that would later prove fundamental for theoretical physics, one of the side effects of the algebraization of geometry is the increasing distance from the spatial intuition that students need to grasp the ultimate meaning of mathematics in the first place. Thus, for example, the mathematician Michael Atiyah expresses in his brief overview of developments in 20th century mathematics:

> Understanding, and making sense of, the world that we see is a very important part of our evolution. Therefore, spatial intuition or spatial perception is an enormously powerful tool, and that is why geometry is actually such a powerful part of mathematics—not only for things that are obviously geometrical, but even for things that are not. We try to put them into geometrical form because that enables us to use our intuition. Our intuition is our most powerful tool. That is quite clear if you try to explain a piece of mathematics to a student or a colleague. You have a long, difficult argument and finally the student understands. What does the student say? The student says, 'I see!'. (Atiyah 2001, 658)

Simone Weil was of this same opinion. The fact that modern mathematics was founded on number, or rather on the symbol, i.e. algebra, seemed to her to be a problem: the authentic Greek science, that of Thales (the mythical founder of geometry), Pythagoras, Plato, and Euclid, was not founded on algebra, but on geometry. This is because geometric figures, being representations of nature and the order of the universe, bring men closer to God. Not only that, but the use of geometric figures, by facilitating analogies, simplifies the understanding of the underlying mathematics. Weil was amazed that her students at Le Puy ignored the link between infinitesimal calculus and geometry. She concluded that the triumph of modern algebra had obscured geometry, of which it was originally an expression, to such an extent that ordinary people had lost knowledge of their profound connection. It was a matter, then, of trying to reconstruct it, through an innovative pedagogical approach. She wrote to André: "I myself quite agree with the Pythagorean saying that God is ever a geometer—but not that he does algebra" (Weil 1965, 112). Indeed, Simone believed that for the Pythagoreans, algebraic geometry concealed religious conceptions and that "the secret religion of the Pythagoreans must have agreed with geometry and not with algebra" (Weil 1965, 113). This would explain, according to her, why the Greeks did not take up Babylonian algebra, which already included the solution of equations of degrees greater than two:

> The Greeks possessed, manipulated, and applied the notions of generalized number and function, but they never wished to express them in the form of equations; they admitted no other symbols for algebraic relations than the figures of geometry. Most probably one must see in this a taken party, connected with their general conception of science. (Weil 1966, 185. Translated by the author).

5. Algebra

This idea stemmed from her own interpretation of the so-called "crisis of incommensurables," which is completely antithetical to historical tradition as well as Bourbaki's version of the history of mathematics. The crisis of incommensurables refers to the famous discovery of irrational numbers by the Pythagoreans in the 5th century BC. Applying Pythagoras' theorem, we observe that the diagonal divides the square into two congruent right-angled triangles, of which the diagonal *d* is the hypotenuse and the two sides of the square (*a* and *b*) the cathexes. We therefore obtain the measure of the diagonal by considering that, according to Pythagoras' theorem, $d^2 = a^2 + b^2$, that is $d = \sqrt{a^2 + b^2}$. Assuming a square of side 1, the diagonal will be the square root of 2: an irrational number, i.e. neither an integer nor an exact fractional ratio, but only an approximation, between two numbers. Legend has it that the Pythagoreans were so shocked by this discovery that they forbade spreading it, since the incommensurables called into question the entire edifice they had built on proportions and ratios between integer numbers.

In a letter on the subject to his sister, André Weil asserted that the crisis consisted in the fact that approximation did not exist in Pythagorean thought, so that the discovery of incommensurables ruined Pythagoreanism (Weil 2013).

Simone retorted with her idea of "a progressive development whose continuity is at no point interrupted by any drama due to the incommensurables" (Weil 1966, 115), because the Pythagoreans, perhaps with the exception of first-degree initiates, "were certainly capable of conceiving the real number" (Weil 1966, 116). This stance of hers is explained by the need to reject the Bourbakist approach according to which the crisis of incommensurables would have demonstrated, even after Eudoxus' solution, the impossibility of handling mathematics by resorting to geometry alone, and the necessity of switching to algebraic language starting from Diophantus (Bourbaki 1974). In contrast, Simone Weil stated:

> This game must have seemed profane, or even impious, to the Greeks. Otherwise, why should they not have translated the treaties on algebra, which must have existed in Babylonian, at the same time that they transposed them into geometry? The work of Diophantus could have been written many centuries earlier than it was; but the Greeks attached no value to a method of reasoning for its own sake, they valued it in so far as it enabled concrete problems to be studied efficiently. (Weil 1966, 117)

It is in this sense that Simone Weil conceived the concept of 'ratio'. According to her hypothesis, the Greeks' profound interest in proportion depended on the fact that they considered the study of relationships between things (between numbers, but before that between shapes, as in the case of triangles and circles) an analogy with the relationship between human beings and God. On this basis Simone Weil attempted to reconstruct the entire history of Greek mathematics, although she will not go beyond a brief sketch probably dating from 1942 (she sent it from Casablanca, where she had moved with her family to escape Nazism before leaving for America).

Weil suggested that the Greeks had discovered incommensurables, even before the calculation of the diagonal of the square, by observing that there is no proportional mean between two numbers of which one is twice the other. Pythagoras' discovery of the right-angled triangle could already have been based on the search for a proportional mean between two known quantities, since two similar triangles with two unequal sides represent a proportion between three quantities a, b and c, where c (the side in common with the two triangles) is precisely the proportional mean between a and b ($a / c = c / b$). Even Menaechmus's discovery that the problem of doubling the cube (a classic problem in Greek mathematics) could be solved by the intersection of two parabolas[1], could be traced back to the search for the proportional mean between a fixed and a variable quantity: the proportional mean x between a fixed quantity a and a variable quantity y must in fact respect the relation $a / x = x / y$ from which the equation of a parabola $y = x^2 / a$ derives. Such a reconstruction would show that the Greeks, while consciously deciding to ignore algebra, were able to handle higher mathematical notions through geometric forms.

6. Ratio

According to Simone Weil, the great discovery of the Pythagoreans consists in the understanding that the diagonal of a square exists even though it cannot be expressed by an exact number that is the ratio between two numbers. This relationship, on the contrary, "demands an exercise of the intelligence that, compared to that required by any relationship between numbers, is much purer and devoid of any help from the senses" (Weil 1966, 174. Translated by the author). Here we can introduce the important concept of λόγοι ἀλογοι (*logoi alogoi*), that is, incommensurable, or 'unspeakable' or indeed 'irrational' relations. In Simone Weil's historical reconstruction of the crisis of incommensurables, the emotion of the discovery of irrational numbers was joy, and not anguish, because instead of being astonished by the fact that there were relations that could not be defined by numbers, the Pythagoreans must have been "intensely happy to see that even what cannot be defined by numbers continues to be a relation" (Weil 1966, 174. Translated by the author). Such a discovery would have represented the defeat of the "blatant nonsense" that "everything is number" (Weil 1966, 174. Translated by the author). Rather, for the Pythagoreans, the λόγοι ἀλογοι would have represented the only-at-first-sight contradictory relationship between the infinite distance and the absolute unity between man and God: this is why for Greeks mathematics would have been, according to Simone Weil, a "form of mysticism".

In support of this assertion, the philosopher noted how the ancient Greeks did not make machines because they would have realized the risks of an instrumental (technical) use of mathematics. The few exceptions, such as that of Archimedes, would confirm this thesis, as the machines produced through the

[1] Weil used Menaechmus's solution as a proof that the Greeks already knew the notion of a function, but they preferred not to use it.

application of first principles were put at the service of war, particularly in the siege of Syracuse. We thus begin to come closer to understanding the 'political' significance of Weil's mathematical philosophy. Her idea consists essentially in identifying, or rather rediscovering, the possibility of a mathematics that is not sired to technique, i.e. to purely instrumental reason. In what we might call the "cosmology of technique" (Campagna 2018), that 2+2=4 is a truth placed within an arithmetical interpretation of reality where the sum serves the purpose of calculating and measuring quantities, which represent the essential entities in the world of technique. In an alternative conception, such as the one Weil ascribed to the Pythagoreans, 2+2=4 is instead a relationship through which Unity (that is, the supernatural entity from which reality derives) spreads in a similar way to the work that God does in the universe through the Word (*logos*). Indeed, the term *logos* in John's Gospel that we translate as Word (John 1:1), stands for 'reason' (Weil also translates it as 'relationship'): a reason that makes the universe intelligible, but in a different way from what technology does, which does not recognize numbers as having any essence but only an instrumental position. This is why Weil considered the discovery of incommensurables attributed to the Pythagoreans to be revolutionary: the possibility that it is not possible to find a relationship between two numbers that can be expressed in terms of quantity, but that such a relationship nevertheless exists, represented for the French philosopher a proof of the existence of a logic that surpasses the purely mathematical one.

The problem, in Weil's view, arose when, with Greek society wanting to base every relationship on number, the discovery of incommensurables led Gorgias and the Sophists to question everything, plunging them into relativism ("Being does not exist: even if it did exist, it would not be knowable; even if it were knowable, it would not be sayable or communicable to others"—a statement, that of Gorgias, which seems to spring directly from the crisis of incommensurables). According to Weil, this would have favoured the rise of Pericles' dictatorship and the loss of freedom for the Greeks.

7. Quanta

From her writings on quantum physics, based on her readings of texts by Louis de Broglie and Max Planck, it appears that Simone Weil did not have a full understanding of the significance of the quantum revolution, something her brother André also reproached her for (see Cosgrove 2008). But she certainly recognized the importance of making quantum discoveries understandable to everyone. If classical physics can be explained by easily repeatable experiments, quantum physics must be made comprehensible by translating algebraic language into a language at everyone's doorstep. An idea that did not convince André, but which she perceived as a necessity. As she wrote in her short essay *Réflexions à propos de la théorie des quanta* (1941):

> There are even some physicists who tend to make algebra the sole language, or almost, so that in the end, an unattainable end of course, there would be nothing except figures derived from experimental measurements, and letters, combined in formulae. Now, ordinary language and algebraic language are not subject to the same logical requirement; relations between ideas are not fully represented by relations between letters; and, in particular, incompatible assertions may have equational equivalents which are by no means incompatible. When some relations between ideas have been translated into algebra and the formulae have been manipulated solely according to the numerical data of the experiment and the laws proper to algebra, results may be obtained which, when retranslated into spoken language, are a violent contradiction of common sense. (Weil 1968, 54)

In order to understand the meaning of these statements, one must first look at the analogy drawn by Weil between the consequences of the crisis of incommensurables in the 5th century BC and that of the quantization of physics from the early 20th century onwards. She did not deny the truths of quantum physics, just as the Pythagoreans did not deny the incommensurability of the diagonal of a square: yet she believed that these truths could be expressed in some other way, and that to this end a reformation of mathematics analogous to what Eudoxus had done after the discovery of irrational numbers should be undertaken. The difficulty of translating concepts formulated in mathematical expressions, such as Planck's constant, into physical terms, led her to see quantum physics as a further drift of the abstractionism that had infected modern algebra. Essentially, it was a matter of preventing quantum physics from making the algebraization of nature inexorable and irreplaceable, widening the divide between the scientific elite and the layman due to a formulation inaccessible to ordinary language. Otherwise, science would have become increasingly distant from society and specialization would have increased, making the advancement of the scientific enterprise and the acquisition of new knowledge increasingly difficult:

> If one has studied the books of scientists for twenty years but is not a professional scientist one is still a layman from the point of view of science; and lay opinions have no credit in the village, no one pays the slightest attention to them, unless it is occasionally to borrow some pleasant or flattering expression. A cultured reader, an artist, a philosopher, a peasant, a Polynesian, are all of them to the same extent, that is to say absolutely, outside science; and scientists themselves are outside, with respect to every specialty except their own. (Weil 1968, 57)

The risk inherent in such elitism, in this division of knowledge into mutually incommunicable watertight compartments, was very clear to her: the disappearance of truth and its replacement by utility. In the *Cahiers*, Weil copied a passage from a manuscript by Evariste Galois, where the young and ill-fated mathematician lamented the high degree of complexity that algebra had reached at the beginning of the 19th century (Weil 1970, 13). According to Galois, only through a reformulation of mathematics by geometers would it become possible to advance mathematical research, thanks to a necessary simplification of calculations. This idea was emphasized by Weil in the *Cahiers* as an "essential idea". In fact, on this basis Weil proposed a reformulation of modern science that would also involve quantum physics and allow for a redefinition of the proportions between things, starting with that between human beings and machines, and then moving on to the rediscovery of the relationship between mathematics and geometry, between symbols and numbers, between these and the world, and between the spirit and the universe.

8. Machinism

Simone Weil's choice of a sabbatical from teaching in order to directly experience working life in the factory, between the end of 1934 and the first half of 1935, was aimed at verifying whether her theses on worker uprooting, set out in the *Réflexions sur les causes de la liberté et de l'oppression sociale* (1934), were true. In opposition to the Marxian theory of alienation, the ultimate causes of labor alienation and thus social oppression are to be found for Weil in the drifts of modern science, in the replacement of the relation with the sign, of number as the representation of the link between the human mind and nature with the algebraic symbol. In the *Cahiers* we find a brutal synthesis of this reflection:

> in modern work: substitution of means for end
> in modern algebra: substitution of sign for things signified
> (Weil 1970, 24)

And a little further on:

> machine: the method is in the thing, not in the mind
> algebra: the method is in the signs, not in the mind
> (Weil 1970, 27)

The sense of these notes, well expressed in the 1934 text, come from one of the discoveries Simone Weil made in her year in the factory: that the workers did not know the purpose of the machines they used. Workers see in the machines they employ nothing more than an incessant series of meaningless tasks to be performed, since they do not understand the relationship between the physics and the world. All they care about is figuring out the best way to make the parts faster, without any interest in either the purpose of those parts or the operation of the machine, which could have been improved to simplify the work, since those who design the machines are often not aware of the real needs of those who use them (a concept not very different from the distance of the programmer from the needs of the end user of a software). To this end, Simone bought several industrial design books to understand how machines are designed.

Algebraization finds its most detrimental consequence in machinism: machines, that is, technical applications of mathematics, are transformed into instruments incomprehensible to human beings; this produces exhaustion, alienation and, indeed, uprooting[2]. If we had paid more attention to the lesson of the Greeks, who did not want to build machines by refusing any immediately practical application of mathematics, we would have prevented algebraization from promoting a new season of extreme relativism of science, on the basis of which first the civilization of machines and then the oppression of totalitarian regimes were built, in Germany as in the Soviet Union (but whose preconditions can be found in every industrial country). Conversely, as Simone Weil wrote to a student as early as 1937, "I believe, like you, that science is entering into a crisis more serious than that of the fifth century and that, as then, it is accompanied by a crisis of morality and a yielding in the face of purely political values, that is, in the face of force" (Weil 1966, 83. Translated by the author).

[2] By the way, this incomprehension of the relationship between machinic labor and physics was analogue to what Weil had observed in her students regarding the relationship between mathematics and geometry.

This is because what cannot be made comprehensible to everyone can become an instrument of social oppression: from industrial machines to algebraic number theory. This is why the dream of those who believe that in the future it will be possible to definitively replace human labor with intelligent machines is destined to fail, according to Weil, at least as far as the hope that by freeing human beings from labor it will be possible to free them at all is concerned: for as long as the operation of machines is not within everyone's reach, it will always be possible for a small inner circle to use them for their own ends, which will easily diverge from the common good; and the same machines, if made truly intelligent and autonomous from humans, will be able to pursue ends other than our own, which will similarly diverge from what we consider the common good. If we allow the goal of increasing labor output through machines to go hand in hand with a social structure founded on the "reversal of the means and the end," then we will face with "the strange spectacle of machines in which the method has become so perfectly crystallized in metal that it seems as though it is they which do the thinking, and it is the men who serve them who are reduced to the condition of automata," as Weil wrote in her *Réflexions* (Weil 2001, 87-88).

Simone Weil's habilitation thesis on Descartes' science already indicated a possible way out. Weil defended the goal of Cartesian physics to "replace the things we feel with things we understand" (Weil 1966, 15. Translated by the authors). With Descartes, physics was still comprehensible on a geometric level and not exclusively replaced by algebra, as would happen with the introduction of infinitesimal calculus. Cartesian physics thus shows that it is possible to redefine physics in terms of relations to the world, of analogies that can be understood by anyone with due attention. From here, in the years that followed, Weil would continue to develop her thought, with the aim of opposing a utilitarian science marked by technical application alone with a "new science," the foundations of which should instead aim to restore to science its role as an instrument for the unveiling of truth. The worker who uses the machine should always be able to understand how the machine works, the physical laws that govern it, the method that expresses it. The student solving a division should always keep in mind the theorems that govern this operation, beyond the means employed to solve it. Eventually, one should be able to grasp, just by observing a circle, the set of underlying mathematical laws. The technique will then have to be perfected not to maximize the profit or the performance, but to make it "more conscious and more methodical" (Weil 2001, 99): in this way, the improvement in performance will come of itself, according to that evangelical principle "seek first the kingdom of God and his righteousness, and all these things will be added to you" (Matthew 6:33; see Weil 2001, 99).

9. Supernatural

The growing and spontaneous fusion of the philosophy of mathematics and mysticism that is evident in the evolution of Simone Weil's *Cahiers* is the natural fruit of her thought. The many calculations in the notebooks can also be seen as an alternative way of reaching an understanding of the divine, just as she believed the Pythagoreans did. This idea shapes her entire conception of a "supernatural reason". It is not to question the validity of the scientific understanding of the world, but to reconnect science with the higher reality that Weil's mystical conception held to be the true cause of being. From her point of view, even the truth of the Gospel is scientifically exact, and it makes no sense to speak of miracles and the supernatural: divine providence is not arbitrary or capricious, but the ordering principle of the universe, what defines the relations between the parts that compose it (Moser 2011). The entire Greek science may have developed from the idea of incarnation, represented by the proportional mean. This was the idea that allowed Simone Weil to transform science into mysticism. Force, which seems to be the law that dominates the world down here, is countered by grace, which is the law of the kingdom of God. The phrase that Archimedes uttered when discovering the principle of a lever ("Give me a point of leverage and I will lift the world") conceals, *in nuce*, the Cross: "The silent presence of the supernatural here below is that point of leverage" (Weil 2001, 166). The principle of the lever is that a descending movement is matched by an ascending movement. Thus, God's grace enables the salvation of mankind.

Not enough attention has been paid until now to how prophetic these thoughts are in relation to our times. It is impossible not to notice the connection between today's debate on the algorithmic regulation that reduce human beings to numbers and data, promoting new forms of social oppression based on the opacity of the algorithms themselves (the 'black box' that hides within it the assumptions and political biases of programming), and Weil's theory of alienation based on the drift of modern mathematics and science. "Science is a monopoly, not because public education is badly organized, but by its very nature; non-scientists have access only to the results, not to the methods, that is to say they can only believe, not assimilate" (Weil 2001, 40). Her proposal for an alternative conception of science involves unhinging the pivot around which modern science revolves: acting in view of an end. Weil intuited this perfectly, noting in her notebooks that the attitude most antithetical to the continuous effort of the will is "waiting," expressed by the Christian idea that one is not saved because one does good but because God comes to save Man gratuitously, not because of our merits. This, according to Weil, responds to a "logic of supernatural reason more rigorous than that of natural reason" (Weil 1970, 109). Simone Weil's entire conceptual effort was directed towards this goal: since a reformulation of mathematics aimed at bridging the gap between natural and supernatural reason would eventually allow to "envisage a technical transformation which would open the way to a different civilization" (Weil 1970, 39).

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