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# Hegel, Concepts, and Computation

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## ABSTRACT

Gottfried Ploucquet, a teacher at the Tubingen seminary when Hegel was a student there, had been one of the few philosophers to take up Leibniz's mathematized logic, including his project of reducing logic, and thought itself, to computational processes. In his *Science of Logic*, Hegel briefly discusses this project when expanding on his own "subjective" logic. The general tenor of the response is predictable. Computational logic seeks to *mechanize* conceptual processes, but conceptuality itself distinguishes free spiritual beings from machines. Beneath the surface, however, Hegel's attitude to the relation of computation to conceptual reasoning is more complex. Here I argue that in Book I of his *Logic*, Hegel, following the approach of Plato in his late dialogues, treats a certain mathematical conception of number, the Neopythagorean triadic monad, as a model for the concept itself. In the section *Quantity*, Hegel focuses on the *incommensurability* between discrete and continuous quantities, the numbers of arithmetic and the lines, areas and volumes of geometry. This incommensurability had been discovered by the Pythagoreans and in his later writings, Plato had adopted a proposal for mediating it, attempting to generalize it to a solution of the *conceptual* incommensurability between the eternal realm of being and the transient realm of becoming. In line with Plato's attempt, Hegel presents an account of the development of mathematical practices in which the concept of number from mere counting unit to a triadic form mediating numbers and geometric continua. This structure will in turn provide a model for his own later syllogism. This role for mathematics for Hegel is to be understood as in line with Plato's later attempts to mediate being and becoming in ways in which eternal Ideas can be approximated in the form of worldly surrogates manifesting this triune structure. Conceptuality cannot be reduced to computation, but relations among computational processes nevertheless reveal much about the nature of conceptuality.

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## Introduction

In the nineteen thirties, work within the realm of pure mathematics by Alan Turing, Alonzo Church, John von Neumann, and others would lead into technical developments that would go on to define the second half of the century as the "computer age". Besides the creation of computers themselves, the computer age would promote the idea of human thought *as* computation, helping replace the cruder associationist or bahaviourist psychologies from earlier times. Such an idea of the mind as a thinking machine would add to the "scientific" challenge to the "manifest image" of what it is to be human (Sellars 1962).

In this essay I raise the largely neglected approach to such a topic of G. W. F. Hegel, one of the first in the philosophical tradition to reflect critically on a computational account of human reasoning.[1] G. W. Leibniz has been acknowledged as having taken the first steps along a road leading to Turing and the computer age (Marciszewski and Murawski 1995, ch. 3; Davis 2000, ch. 1; Isaac 2018) and Leibniz's suggestions in this regard had been adopted by Gottfried Ploucquet, responsible for the teaching of logic and metaphysics at the Tűbingen seminary when Hegel attended as a student. Hegel criticises the idea of such a project in *The Science of Logic* in his reflections on the type of "mathematical syllogism" that, for Leibniz, would effectively constitute the "software" of his envisaged thinking machines. However, Hegel's criticisms here are highly nuanced, and considering Hegel in this context may be significant in ways that outweigh the relative primitiveness of those computational proposals on which he reflects.

From the middle of the twentieth century, the development of computer science would lead to discussions as to whether cognition, intelligence, and even consciousness, could be explained as computational processes, but such discussions have generally been limited by the broadly ahistorical and metaphysically naturalist forms dominant in analytic philosophy. In such a context, emphasis is standardly on the naturalistic alternatives to seventeenth-century Cartesian dualism, while the conception of the *logic* invoked is grounded in the Frege–Russell revolution of the early twentieth. Rarely do they extend into the type of logical and metaphysical issues of Greek origin that for Hegel had been central.

Here, it is important to be reminded of the context in which Alan Turing put forward the idea of a "machine" that would come to serve as a model for the modern universal computer that would in turn provide a model for the mind. The Turing machine had not been proposed as a plan for the construction of any *actual* computer; rather, it had been offered as part of a response to a highly abstract theoretical question that had emerged in pure mathematics: Does there exist

[1] A recent exception to this neglect is Slavoj Žižek's *Hegel in a Wired Brain* (2020), in which Hegel is presented as the *most* relevant philosopher for the politics of the age of computation. In this essay I am unable to engage with this work, but note my great sympathy with Žižek's underlying interpretation of Hegel.

a general algorithmic method able to decide the validity of any statement in first-order logic?[1] As the authors of a recent textbook on the computational theory of mind indicate, *qua* its status as abstract mathematical structure, Turing machines, as well as the minds modelled on them, can be conceived as "causally inert abstract objects with no spatiolocation" (Colombo and Piccinini 2023, 21). The "machine's" relevance for a properly scientific theory of mind begs the question of the relation of such abstract mathematical systems to the world itself—here, specifically, the physical systems within which they are meant to be implemented. This is a classically *metaphysical* question, and it is a highly contested one in relation to computationalism. "Platonism" is still a popular attitude among pure mathematicians, and from such a metaphysics the question of the physical implementation of such mathematical structures remains largely unresolved.

Hegel's relevance for the computationalist theory of mind, I suggest, hangs on his unusual attitude to the Platonist's answer to the question of the worldly instantiation or implementation of mathematical structures and processes. Hegel's own approach is a form of Platonism but a form modelled on Plato's own *late* dialogues, rather than the standard other-worldly Platonism familiar in philosophy of mathematics. Ironically, it had been features of a Christianised form of *Neoplatonism* to which Leibniz had been attracted that had allowed him to be drawn into the *nominalist* orbit of Hobbes's computational naturalist conception of the mind, although interpreted within his own brand of idealism. We see in Hegel's engagement with and reaction to Leibniz, I suggest, late Platonist features of Hegel's metaphysics that have been largely neglected and obscured by the misapprehension that Hegel had adopted a variant of ancient *Aristotelianism*.[2] Such features will be relevant for Hegel's critical reactions to Leibniz's computationalist paradigm.

In section 1 below, Hegel's brief comments on Leibniz's early sketches of a computational dimension to the mind are reviewed while Section 2 looks to the role of computationally related operations on numbers within Hegel's structurally complex *concept* of number. In section 3, it is argued, via this, that Hegel's concept of *concept* draws upon an expanded concept of "monad" upon which Plato had modelled his later theory of Ideas. In section 4, Hegel's formal syllogism is then shown to manifest this *triadic-monadic* model involving a mediation of otherwise *incommensurable* conceptual determinations, with the question raised as to the role of computation in the logic of the "spiritual" dynamics of reason understood in this way. While the normativity of judgment and inference rule out any reduction of human reasoning to

[1] This was David Hilbert's so-called "*Entscheidungsproblem*" (decision problem). In this sense, Turing's approach was equivalent to that of Church's formal "lambda-calculus".

[2] Almost all participants within recent Anglophone interpretations agree that Hegel task was to somehow mediate between the positions of Aristotle and Kant.

computation, computational processes, it is suggested, nevertheless have a central role in what I call the "spirit–nature–machine triad".

## 1. Hegel and Leibniz's *Calculus Ratiocinator*

Gottfried Wilhelm Leibniz is generally credited with the first modern-looking account of the idea of mechanized thinking, starting with his youthful work of 1666, *On the Art of Combination* (Leibniz 1966, essay 1),[1] although, there Leibniz acknowledges the role of Hobbes for his approach, alluding to a passage from *De Corpore* of 1656 (Hobbes 1994, 186). In Leibniz's paraphrase: "everything done by our mind is a computation, by which is to be understood either the addition of a sum or the subtraction of a difference. So just as there are two primary signs of algebra and analytics, + and −, in the same way there as it were two copulas, 'is' and 'is not'; in the former case the mind compounds, in the latter it divides" (Leibniz 1966, 3). To the idea of judgment as a type of ideational addition and subtraction, Hobbes had actually added that "if any man add *multiplication* and *division*, I will not be against it, seeing multiplication is nothing but addition of equals one to another, and division nothing but a subtraction of equals one from another" (Hobbes 1994, 186-187). This arithmetical distinction would become significant for Leibniz as he would later introduce multiplication and division of numbers as central to numerically modelling the logical relation of predication. The move from addition to multiplication and, then further, to *exponentiation* and its inverses would also become central to what Hegel called "the complete determinateness of number", which would provide a mathematical model for his *conception* of number, and in turn, for his concept of *concept*.

In his various sketched proposals for mechanized thought, Leibniz would suggest ideas found later in George Boole, the originator of "Boolean algebra" that would be fundamental to modern computing (Davis 2000, ch. 2). These included distinguishing "conceptual" from "numerical" addition in a class-based conceptual algebra appropriate to the Aristotelian syllogism and in locating this in a *binary arithmetic* reduced to the numbers 0 and 1. In contrast to Hobbes and Boole, Leibniz would affirm an "intensional" interpretation of his logic as a whole on philosophical grounds, although he would retain their "extensional" interpretations by treating extensional and intensional interpretations as translationally equivalent.[2] This, however, would be at the price of his idiosyncratic notion of the "extension" of a concept. Rather than applying to the class of worldly objects satisfying it, a concept would apply to *possibilia* existing in a totality of *possible worlds*, ultimately located in the mind of God.[3] The

[1] On Leibniz's place in the history of mechanized thought see, for example, Marciszewski and Murawski 1995, ch. 3; Davis 2000, ch. 1; Isaac 2018.

[2] On the significance and *circularity* of Leibniz's extension of a concept calculus to a propositional calculus see Lenzen 2004, section 6.1 and Parkinson, "Introduction" to Leibniz 1966, xxxv–xxxviii.

[3] For Leibniz, as more recently for David Lewis, *one* of these possible worlds is *ours*—it is the *actual* world.

atomic units of Hobbes's materialist metaphysics would thus become Leibniz's atomic non-extended "monads", the "true atoms of nature …, the elements of things" (Leibniz 1998, 268) dependent upon the *infinite* monad (God)—a view expressed in his later *Monadology* in which he dismisses the very *idea* of a *machine-based consciousness* (Leibniz 1998, 270). Indeed, the term "monad" reflects Leibniz's debt to ancient, Pythagorean-influenced Neo-Platonism (Antognazza 2016), a source reflecting Plato's later concept of "Ideas" influenced by Pythagorean mathematics that would come to play a central role for Hegel as well.

Gottfried Ploucquet had been one of the first of the few philosophers throughout the eighteenth and nineteenth centuries not only to adopt the core ideas of Leibniz's logical project, but also his project of mechanized thought. Consequently, when discussing Leibniz's "mathematical" treatment of the logical syllogism, Hegel touches on the project of the mechanisation of thought as envisaged by both figures. Hegel refers to Leibniz's youthful *On the Art of Combination* (Hegel 2010, 607) but it is not clear with how much of Leibniz's subsequent writings on logic he was familiar. However, he refers to works by Ploucquet that clearly reflect some of Leibniz's more developed views. Crucially, the issues raised by Hegel reflect some of the fundamental assumptions of Leibniz's more mature views and are relevant to the question of the placement of Hegel's *own thought* in relation to the different logical and metaphysical outlooks of Plato and Aristotle.

The particular relevance of *multiplication* for the model of predication had become clear to Leibniz in his "Elements of a Calculus" of 1679 (Leibniz 1966, essay 3), a work reflecting the increasing sophistication in mathematics acquired during his stay in Paris from 1672 to 1676 (Antognazza 2009, ch. 3). Effectively, the choice of multiplication coheres with his *intensional* way of conceiving of a judgment as a structure in which the conceptual contents of the *predicate* term are contained in that of the *subject* term.[1] Essentially, he models this on the way that a number's divisors can be considered as contained in that number, the *transitivity* of this readily accounting for the inferential transmission of truth. Thus, for a "geometric sequence" of numbers, such as 3, 6, 12, in which the ratio between consecutive terms (the "quotient") is fixed (as here, 3:6 = 6:12),[2] we know that as 3 divides 6 and 6 divides 12, then 3 divides 12. Similarly, in this "containment" model, if the concept <mortal> is contained in the concept <human>, and <human> is contained in, say, <philosopher>, we know that <mortal> is thereby contained in <philosopher>.[3]

[1] In contrast, conceived *extensionally*, this is reversed, the set-like extension of a concept containing its instances.

[2] This sequence was so-called because for the Pythagoreans, multiplication and division were fundamentally geometric operations. Thus, the product of two numbers *a* and *b* was understood as the size of the area of a rectangle with sides of lengths *a* and *b*.

[3] In its inverse *extensional* expression: if all philosophers are human, and all humans' mortal, then all philosophers are mortal, as *per* Aristotle's "perfect syllogism" of *Barbara*.

Leibniz himself had suggested that the mathematised container idea had been at least *implicit* in Aristotle,[1] and in the early twentieth century Benedict Einarson (Einarson 1936, 155–56) would point to close parallels between Aristotle's descriptions of the perfect syllogism in *Prior Analytics* and the transitivity of mathematical "measure" described in the *Sectio Canonis*, a synoptic work on the mathematics of Pythagorean music theory. There, the measure of musical intervals was dealt with in terms of the "geometric" relation of multiplicity and divisibility as found in the sequence of octaves (Einarson 1936, 155–56).[2] Leibniz, however, would take the mathematical model beyond these basic Aristotelian features. Hegel would as well, but in his case, he would preserve its specifically *musical* dimension.

Hegel starts discussing Leibniz's "mathematical syllogism" by appealing to the idea that in it all judgments can be understood as judgments of *identity*, the conceptual links between the three syllogistic terms being "mathematical" in the sense found in Euclid's "common notion" that "if two things or two determinations are equal to a third, they are equal to each other" (Hegel 2010, 602; Euclid 1956, Bk I, common notions, 1). This can be understood as a consequence of the container model of the predicate. To assert *one* predicate of a subject is to isolate *that* predicate from all the others similarly true of that subject, such that a judgment *s* is $p_1$ will be true in as much as $p_1$ belongs to a collection of predicates, $p_1$, $p_2$, $p_3$, … $p_n$, applying to *s*, with the *complete* judgment being *s* is $p_1 \cdot p_2 \cdot p_3 \ldots p_n$. In short, the complete judgment will be reduced to a type of *equation* in which the numerical value of the subject *s* is equal to the *product* of the numerical values of all of *s*'s predicates.

A crucial feature of Leibniz's logic for his computational approach to the mind was to extend his *conceptual* "calculus" to a *propositional* one, and Hegel seems aware of this, commenting on the "intricacies that arise when the distinction of positive and negative judgment is also brought in alongside the determination of quantity" (Hegel 2010, 604).[3] However, Hegel regards Leibniz's logic as neither a simple advance beyond Aristotle's *nor* a simple degeneration of it to mathematical form, but some combination of the two—an attitude that, as we will see, expresses Hegel's specifically *late*-Platonic approach.

From the perspective of the mathematical syllogism as a *degeneration* of the classical model, Hegel treats it as depriving the syllogism of all meaningful content. Numbers in their equality and inequality are "extrinsically" related while "in the syllogism it is their [i.e., the constitutive concepts'] *connections* that constitute the essential element" (Hegel 2010, 605). But with this Leibniz has made explicit the already degenerate form of Aristotle's formal syllogism. Rather,

[1] In bringing forms of judgments "into unfailing laws", Aristotle, Leibniz had written, "was the first who wrote mathematically outside *Mathematics*" (quoted in Lenzen 2004, 6).

[2] This work is traditionally attributed to Euclid, but like Euclid's *Elements*, it is thought to have been a compilation of material from earlier mathematicians, especially from Plato's early Academy.

[3] A few pages later, he attributes this type of extension of the mathematical syllogism that reduces the syllogistic inference to "a totally empty and tautological construal of propositions" to Ploucquet (Hegel 2010, 608).

the syllogistic *unity* to which Hegel alludes is, as we will see, that found in Plato and his followers and had its origins in the unity of the three "means" of Pythagorean music theory that would provide the model for Hegel's account of the relations between conceptual determinations of "universal", "particular" and "singular". By reducing these relations to mere *mathematical* equality or inequality, Leibniz had reduced logic to "a mechanical procedure" (Hegel 2010, 607).

As Hegel notes, calculating machines already existed that could execute the operations of addition, subtraction, multiplication and division "perfectly well" (Hegel 2010, 607).[1] It had been Leibniz's extension of his calculus from concepts to propositions that promised a *logical* extension of these. Leibniz's "*characteristica universalis* of concepts" (Hegel 2010, 608) had been meant as a *meaningful language* in which propositional contents with the binary properties of true or false become subject to the mechanical manipulation of a purely syntactic "*calculus ratiocinator*". In these ways, Leibniz mathematical syllogism had features similar to *both* forms of logic that would develop in the nineteenth century, the algebraic logic of Boole and the more proposition-based quantified predicate calculus of Frege and Russell (Jourdain 1914, iii). These were the logics upon which the computer science of the twentieth century would draw for its "software", there thus being a clear path to the purported "thinking" machines that would be built in the twentieth century, and built *into* the lives of all humans in the twenty-first.

Commenting on Ploucquet's plan for "teaching logic mechanically, just as children are taught arithmetic" (Hegel 2010, 608, n. 92), Hegel comments that this is surely "the worst that can be said of an invention that bears on the presentation of the science of logic". This is because in order to be so mechanized it had to be deconceptualized and, given the link between the capacity for conceptual thought and freedom, rendering thought unfree. However, Hegel's criticism of the mechanization project is highly nuanced. As I have argued elsewhere, Hegel's *own* logic requires that concepts are able to have their meanings *redetermined*, and this redetermination will always involve a phase in which they are *stripped* of their existing meanings (Redding 2023, ch. 9). Leibniz's degenerate mathematical syllogism would surely be treated as "*aufgehoben*"—negated but nevertheless *preserved*—in Hegel's reconstituted *rational* syllogism and there should be *a place* for mathematics and the mathematical syllogism and, presumably, a place for a computational dimension *of mind* as well. What Hegel denounces is its hypostatization to being *the complete story*, but to understand how this can be we need to look further into the late Platonic mathematical origins of Hegel's own notions of concept and syllogism and the peculiar relation of concepts to their worldly implementation that flows from this origin.

[1] Pascal had designed a machine able to carry out addition and subtraction while Leibniz himself had designed one to extend to multiplication and division.

## 2. Conceptuality and Computation in Hegel's Category of *Quantity*: The idea of the "complete determinateness" of number.

According to Benedict Einarson, Aristotle had borrowed his *technical* vocabulary for logic from Pythagorean music theory (Einarson 1936), although there is no real evidence that this influence penetrated his logical theory *further*. In contrast, there is much to suggest that *Plato* had taken features of Pythagoreans music theory more seriously in relation to his later "dialectical" method.

I have argued elsewhere (Redding 2023), that Hegel had followed Plato in this regard, in his reading of Plato's *Timaeus* in his *Lectures on the History of Philosophy*, specifically appealing to the pattern of *unity* among singular, particular and universal aspects of the syllogism in a way that was ultimately modelled on the unity of three "means" of Pythagorean music theory—the arithmetic, harmonic, and geometric—in a figure called the "musical *tetraktys*". This was an arithmetical double ratio in which the numbers 1 and 2, considered as the first two members from the *geometric* sequence, 1, 2, 4, 8 … and representing the interval of *an octave*, are then divided by a pair of ratios 4:3 (the "harmonic mean", representing the interval of a perfect fourth) and 3:2 (the "arithmetic mean", representing the interval of a perfect fifth). Plato had appealed to these quantities, 1, 4:3, 3:2, 2, in accounting for the structure of the "world-soul", a structure Hegel identified with that of the *syllogism*.[1] In Plato's *Timaeus*, this structure shows the influence of Philolaus of Croton, on whose musical theory and cosmology, Plato had drawn.

In the passages of the *Timaeus* to which Hegel alludes, Plato describes the demiurge as forming the world-soul out of a "mixture" of "the *Being* that is indivisible and always changeless" and "the one that is divisible and comes to be in the corporeal realm", to which he adds a *further* mixture of "the same and the different", the resulting mixture confusingly being described as between "the same, the different, and … being" (Plato 1997, *Timaeus*, 36a). Immediately after this, Plato goes on to divide up this dough-like mixture first in proportions according to the sequence 1, 2, 3, 4, 9, 8, 27—a sequence which is clearly formed from listing the *squares* and *cubes* of the natural *numbers* 1 to 3 (i.e., 1, $2^1$, $3^1$, $2^2$, $3^2$, $2^3$, $3^3$)—*then* interpolating between the terms of these sequences, amounts according to the ratios 3:2, 4:3, 9:8, and 256:243. The first two ratios are, as we have seen, the two fundamental inter-octave concords that feature in the musical *tetraktys*, the means that *divide* the geometric interval 1:2.[2]

As noted above, the geometric mean or "mean proportional" is the mean of any three consecutive terms, *a*, *b*, *c*, in a *geometric* sequence, which advances according to the general proportion, *a*:*b* :: *b*:*c* such that, *numerically* expressed, the square of the geometric mean will

[1] To render these less confusing, I will sometimes render *ratios* as *fractions* despite the fact that, strictly, the Greeks did not possess the concept of a fraction. Nor did they possess *any* of the symbols used above.

[2] 9:8 and 256:243 represent the values of a full tone and semitone in this system, respectively. For our purposes they can be ignored.

equal the product of the extremes ($b^2 = ac$), and the mean itself the square root of the product ($b = \sqrt{ac}$). The geometric mean had been considered as an ideal proportion and of intrinsically higher value than the other two, but relying on the square roots of numbers, it could be indeterminate in the system of Pythagorean *natural* numbers and unable to be represented by a ratio of whole numbers. Thus, there was no geometric means *between* consecutive terms of a geometric sequence. The arithmetic mean (or average) is simply half of the sum of the extremes ($b = (a + c)/2$), while the harmonic is its *inverse*, $(\frac{a^{-1}+c^{-1}}{2})^{-1}$, which simplifies to $\frac{2ac}{a+c}$, and these are both ratios of natural numbers and so, for the Greeks, numerically *determinate*. The two intra-octaval means thus came to be seen as numerical representatives of the geometrically determinate but numerically *indeterminate* geometric mean of the octaval interval between 1 and 2, when these were considered as belonging to of a geometric series, 1, 2, 4, 8 ….

Arranged as inverse double ratio, 1 : 3/2 :: 4/3 : 2 (Barbera 1984), the *pair* of the arithmetic and harmonic means in the musical *tetraktys* are now understood to divide the interval, standing in for the geometric mean which cannot, and provide a range of calculable numerical approximation for the impossible geometric mean (Brown 1975). It is known that Greek mathematicians had access to algorithms from Babylonian mathematics for producing rational approximations of such "impossible numbers" (Zellini 2020), and it is clear that the musical *tetraktys* itself provides such a mechanism. The pair divides the interval in such a way that the range of approximations can in turn be narrowed by *iterating* the procedure—that is, taking the harmonic and arithmetic means *of* the obtained harmonic and arithmetic means themselves. This recursively applied operation thus results in two *infinite* series of numbers that converge on the "irrational" target value in a way that would be developed in the mathematics of the early modern period.

Here I will approach what is essentially an analogous mathematical structure to the musical *tetraktys* but from a different direction—that of Hegel's conjectural history of the development of *actual computational processes* within the historical practice of mathematics, as sketched in the section of *The Science of Logic* (Book I, Section 2), headed "*Quantity*". With this we start to gain a sense of the role played by computation in Hegel's logic and, thereby, his metaphysics.

In the second chapter of this section, "*Quantum*", Hegel charts the evolution of a structure from the simple Pythagorean *monad* to what he calls the "complete determinateness" of number,[1] a *concept* of number that, with its internal differentiations, goes beyond the earlier concept of the monad *qua* atomic unit of counting. Later *neopythagorean* Neoplatonists such as Theon of Smyrna and Proclus had treated the monad on the harmonic model as an absolute unity yet with *incommensurable* internal parts, and this had become a model for certain

[1] Hegel refers to the "*vollkommenden Bestimmtheit*" (Hegel 2010, 193) and the "*vollständigen Bestimmtheit*" (Hegel 2010, 211) of number.

Christian conceptions of the holy trinity (Louth 2011, 140–142). Hegel's own "concept" with its triadic syllogistic articulation would have this same contradictory shape, one allowing him to avoid Leibniz's fully transcendent monadic God.[1] The basic features of this structure are already on display in the "complete determinateness" of number.

Hegel resists calling this structure a *concept* of number, noting that his presentation "cannot be said to be a philosophical treatment of them … it is not, in fact, an immanent development of the concept". He continues, here "the concept can make its way forward only externally, and its moments also can be only in the form peculiar to their externality, as here equality and inequality" (Hegel 2010, 177). This "external" realm is that of the spatio-temporal realm of the *mathematical* practices of actual communities, and is not one in which one can expect to find something that is *in itself* properly conceptual in the Hegelian sense, because, for Hegel as for Plato following *Philolaus*, such ideal entities are not directly manifest *in the world*, in the way they are, for example, in Aristotle's idea of teleological *essences* or *substantive forms*. Rather, what we can expect to find here are pairs of imperfect *surrogates* or *paradigms* (*paradigmata*) of such concepts—surrogates with the status of primitive Philolaic "mixtures" of the ideal and the corporeal. The "complete determinateness" of number will provide an initial model of such a surrogate, and while such conceptual surrogates are not "concepts" in the Hegelian sense, they are (for Hegel, improperly) *known* as conceptual as understood within the *Verständeslogik* of which Hegel is critical—that is, (pseudo-) concepts thought of as both *inhering in* objects themselves and grasped by knowers as *abstracta* in order to subsume those objects into classes. Furthermore, as with Plato, this "complete determinateness" provides us with a type of imperfect mathematical model for the *proper* concept of number. A *less imperfect* model will be the "proportion of powers", as I have examined elsewhere (Redding 2025) and, after this, Hegel's own *formal* syllogistically structured model of *concept* itself, found in his account of the syllogism in Book III of *The Science of Logic*. All are imperfect surrogates of the concept itself but they can be regarded comparatively as rankable from worse to better approximations.

The section "Quantity" is itself divided into three chapters, "Quantity", "Quantum", and "Quantitative Proportion" (*das quantitative Verhältnis*), and the path through quantity to proportion will progressively show how a more "atomistic" conception of number that was characteristic of the early Pythagorean *monad* becomes replaced by a more holistic or "structural" approach in which numbers come to be at least partially defined by their functional roles in different, but linked, computational processes. This leads to the "complete determinateness" of number.

[1] Hence Hegel would show considerable sympathy for the views of the Catholic writer Franz von Baader, who associated the trinitarian idea of three persons in one God with Pythagorean number theory, and who criticised what he took to be the pantheistic views of both Schelling and Hegel (Redding 2023, 4–6, 232).

Thus, in the chapter "*Quantum*", Hegel alludes to the *origins* of numbers in simple counting procedures, in which since "the ones are external to each other, they are pictured in a sense image, and the operation by which number is generated is a reckoning on the finger tips, dots, etc." (Hegel 2010, 172).[1] Here, these material units of reckoning, the finger tips and dots to which we might add pebbles or beads on an abacus, can be assembled into "amounts" and could effectively function as the tokens of Leibniz's conjectured "machine language", when understood from *Hobbes's* extensional and nominalist point of view. Here, exemplifying a number in a group of fingers or dots allows the determination of number *itself* to become independent of the identity of *what* is being counted, hence independent of their *concepts*. While one counts the size of a herd of goats by counting only *goats*, by pairing each goat with a finger, say, the *number* counted in each case becomes *indifferent* to the particular identities of the *things* (goats, fingers) counted. Here it is important that for the Pythagoreans, the monad was itself *not* a number, but the principle from which all number is generated. Such an "indifferent unit" of counting is what, according to Aristotle, Plato had modelled his "Ideas", in each case the relevant relation holds between a subsuming *one* and a *many* subsumed under it (Aristotle 1984, *Metaphysics* 987b7-13). On such a model, the single "Idea" of something, justice, say, was conceived as standing to the *plurality* of its purported actual instances in the way that the *monad* stands to the plurality of different numbers. This model, however, as various interpreters have argued,[2] would be the target of criticisms by the character Parmenides in Plato's later dialogue *Parmenides.* In the dialogues following it, Plato would thus seek to modify (or perhaps clarify in the face of misinterpretations) his *original* theory of Ideas expressed in the language of "one and "many", and to do this would draw on the musically expressed theories of Philolaus. Hegel's conjectural history retraces this evolution of the monad from simple unit to internally and *contradictorily* differentiated model for Platonic Ideas.

In Hegel's account, such enumerating activity leads to the more complex calculating practices that start with simple mechanically rule-governed (or *algorithmic*) processes involved in basic arithmetical procedures such as addition and multiplication, as when from memory or the use of a table of numbers, one learns to mechanically replace the sequence "2 + 3", say, by "5", or "4 + 5" by "9". While the idea of the "unit" that abstracts from the identity or "concept" of what is counted will be ultimately shown to have been *intrinsically* conceptual all along, there nevertheless remains a way in which cognition might be thought of as built up, Hobbesian style, "bottom-up" from purely computational processes within nature to higher, "emergent", conceptual ones.

[1] One might add, of course, the *pebbles* allegedly used by the early Pythagoreans to construct diagrammatic numbers, whence the term "calculus".

[2] These works include, for example, Sayre 2005, Gill 2012, and Kahn 2013.

In his earlier discussion of quantity, Hegel had begun with "pure quantity" as having emerged as the sublation of the final category of *quality* from the section preceding it, quality as "being-for-itself" (Hegel 2010, 154). As such, quantity is first determined as the monadic "unity" of its two moments, the *continuity* of geometrical magnitudes, and the *discreteness* of arithmetical numbers, a unity first expressed "in the *form* of one of them, of continuity" (154-155). Throughout this chapter, however, considerations of *discreteness* as relatively independent from those of continuity emerge, with the *difference* between continuity and discreteness coming to be understood as in fact their *incommensurability*. Historically we might think of this in terms of the Pythagorean discovery of the incommensurability of discrete numbers and continuous geometric magnitudes (lines, areas, volumes), thought to have been made sometime in the fifth century and to have disrupted the earlier Pythagorean assumption that *all* ratios of continuous magnitudes could be rendered in ratios of natural numbers—a discovery Plato seems to have considered especially consequential (Novak 1982–1983; Negrepontis, Farmaki and Marina Brokou. 2020). Philolaus had responded with his primitive "mixtures" of the "unlimited" and "the limit", the underlying principles of continuity and discreteness.[1]

Throughout the chapter on *quantum*, discreteness comes to be considered fundamental, but of course, the *implicit* qualitative difference between continuous and discrete quantities still remains (Hegel 2010, 169), with Hegel treating some of these overtly arithmetical structures as having an implicit "geometrical" dimension, as indeed they had been originally so treated.[2] Then, in the third chapter, "Proportion (*Verhältnis*) or the quantitative relation", the two qualitative and quantitative moments of quantity will be shown to exist in a type of unity in the form of an equality between explicitly differentiated ratios of numbers on the one hand, and of the otherwise incommensurable continuous magnitudes on the other, the mature form of this, the "proportion of powers", showing a relation between discrete and continuous quantities that is isomorphic with the bond that characterizes the world-soul in Plato's *Timaeus* that Hegel identifies with the *rational syllogism* (Redding 2025). Within the category of *quantum*, all this is approached from a fundamentally *numerical* standpoint in which numerical quantities, subject to quite complex but mechanically conceived and so *non-conceptual* manipulations, eventually bring to the surface a type of *mediation* of the underlying opposition of discrete and continuous. Thus, Hegel discusses "modes of connection" that are brought about by "*species of calculation*" (Hegel 2010, 171), of which there will be basically *three*—addition, multiplication and exponentiation—that are to be counted together with their *inverses*, subtraction, division,

[1] These claims were contained in a work, *On Nature*, thought to have been in Plato's possession. For the surviving fragments see Huffman 1993.

[2] As noted earlier, the Pythagoreans had thought of the operation of multiplication as geometric as opposed to addition, which was properly arithmetic.

and, in relation to raising to a power, the *two* inverses of the taking of *roots* and the taking of *logarithms*.[1]

Despite the *externality* (to the concept) of these numerical units and the computational processes into which they are drawn, the numbers become interrelated in such a way that the *implicit* concept of number as "indifferent unit" becomes transformed. For example, over the centuries, the implicit reciprocity of addition and subtraction would lead to the concepts of *negative* numbers while root-taking as the inverse of raising to a power would lead to that of *irrational* numbers, and so on. Neither negative nor irrational numbers had counted *as* numbers from the original "monadic" Pythagorean point of view and would only become recognized *as numbers* in Europe in the early modern period. It is something like this "bottom-up" arithmetical construction of the dynamically changing system of numbers that is often presupposed by advocates of a *computationalist* approach to mathematics itself, holding *conceptual* activity to somehow "emerge" from these underlying implementable computational processes.[2] Hegel's approach is meant to show that such computational, quasi-conceptual processes can only be *ultimately* understood from the point of view of his own idiosyncratic concept of concept. Nevertheless, understood from the *conventional* concept of a concept, Hegel appears to anticipate something like the computational account of mathematics and, perhaps, of the mind itself when considered in its *natural embodiment*, that is, from within the scope of natural science. The inverses of exponentiation will especially be crucial to this process in which the early Pythagorean notion of the monad is eventually transformed into the neo-Platonic monad with its internal differentiation, as they will draw into the otherwise "pure" realm of mathematics a rule for imperfect surrogates of otherwise "impossible" numbers.

In this sequence, addition introduces hierarchical relations between the "units" collected into "amounts", as when numbers are bundled up into classes of ten in decimal systems of counting. With this, the process of counting becomes extended from counting individual entities themselves to counting the "amounts" into which those entities have been grouped, leading to the operation of multiplication (c.f., Euclid 1956, Bk. VII, def. 18). For example, "by adding to one seven another seven and by repeating the operation five times" (Hegel 2010, 172).[3] Next, in a similar way, *multiple* multiplications introduce the operation of *exponentiation* or the raising to a power, such that the multiplication of a number *n* by itself can also be thought of as raising that number to the "power" of 2 ($n^2$). This in turn allows the *powers themselves* to be

[1] The "logarithmic function" is one *inverse* of the exponential function (Hegel's "raising to powers") in that for any number $x$, its logarithm $y$ is just the power to which some specified constant $b$ (called the base) must be raised so as to equal $x$. In short: $y = \log_b x$ if and only if $x = b^y$.

[2] On the current debate between computationalist and conceptualist approach to numbers, see for example Fillion 2019.

[3] Later Hegel would, in the Greek way, link quantities raised to higher powers to the *qualitative* magnitudes of geometrical areas and volumes.

*added* in ways that correspond to multiplication among the base numbers raised to those powers. For example:

$$2^2 \text{ x } 2^3 = (2 \text{ x } 2) \text{ x } (2 \text{ x } 2 \text{ x } 2) = 2^{2+3} \text{ or more generally, } a^m \text{ x } a^n = a^{m+n}.$$

Here, the originally *incommensurable* implicitly arithmetic and geometric operations—addition and multiplication—come to exist within a mediated unity which, in fact, had provided the mathematical basis of a computational aid that, in the early seventeenth century, greatly facilitated the emerging physical sciences—the logarithmic tables that allow complex long multiplications to be approximated by much simpler additions.[1]

This "concept" of number, arrived at *via* Hegel's conjectural history of early mathematics, like the later *formally similar* "proportion of powers", has features we can recognize in Plato's "musically" conceived structure of the world-soul in the *Timaeus* alluded to above and that Hegel identifies with the rational syllogism *qua* "completely posited concept" (Hegel 2010, 588). It is a unity that, like the Neo-Platonists' monad, has an internal complexity in which a non-instantiable "ideal" number comes to be represented by a pair of opposing *approximations*, as in the way that the non-instantiable *geometric mean* of an octave had been represented by a pair of *computable* approximations, the arithmetic and harmonic means.[2]

## 3. From Hegel's "Complete Determinateness" of *Number* to his Late-Platonic Concept of *Concept*

In his *post-Parmenides* dialogues, Plato explores various attempts to find properly *conceptual* analogues of Philolaus's musical *tetraktys*. For example, in the *Philebus*, without naming Philolaus, Plato has Socrates introduce Philolaus's distinction of "unlimited" (*apeiron*) and "limit" (*peras*), associating the *apeiron* with the continuity and relativity of the continuous *geometric* magnitudes: "Whatever seems to us to become 'more and less', or susceptible to 'strong and mild' or 'too much' and all of that kind, all that we ought to subsume under the genus of the unlimited as its unity" (Plato, *Philebus*, 24e-25b). In contrast, what is *not* found in the unlimited, he goes on, includes "the equal" and "equality", and "things like 'double', and all that is related as number to number or measure to measure". All these belong to *limit* and help us to put "an end to the conflicts that are among opposites, making them commensurate [*symmetra*] and harmonious [*symphona*] by imposing a definite number on them" (25e).[3]

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[1] Thus, from $a^m \text{ x } a^n = a^{m+n}$ it follows that log to the base *a* of the *product* of *m* and *n* equals the *sum* of log *m* and log *n*, both considered to the base, *a*. That is, $\log_a n{\cdot}m = \log_a m + \log_a n$. Hegel possessed a treatise on the mathematical basis of logarithms (Mense 1993, 680).

[2] It should be noted that when the irrational numbers became available, the octave was soon divided internally in a way that is the inverse of the geometric series of octaves themselves. This is the modern "equal temperament" tuning in which the twelve semitones of the octave advance according to the ratio of $1:\sqrt[12]{2}$.

[3] I suggest that this pair of *archei* as found in Plato's late dialogues is best understood as they appear in the context of a table of ten homologous oppositions attributed to the Pythagoreans by Aristotle in *Metaphysics* Book 1, chapter 5, one of the earliest extant accounts of their views. There Aristotle describes the Pythagoreans as

In these later dialogues Plato starts to talk of a method for determining what in the world should be considered "second best" (Plato 1997, *Statesman*, 300b; *Laws*, 739e) (or awarded "second prize" (*Philebus*, 22d)), between a pair of opposed and contending imperfect worldly surrogates or "paradigms" of Ideas.[1] In the *Laws*, for example, he describes an ideal distribution of goods as determined by the *geometrical proportion*, in which is granted "much to the great and less to the less great". Such a determination would be *more just* than that which, in *arithmetical fashion,* equal amounts are distributed to all (*Laws*, 757b-c). But Plato also emphasises the practical impossibility of the geometric distribution, which would require "the wisdom and judgment of Zeus" to enact. For practical purposes, he thus suggests that a "*harmonic*" compromise between the *just* geometric and the *practical but unjust* arithmetical distributions—a solution involving the *tetradic* relation between the three means, such that the harmonic is regarded as the surrogate of the geometric in an environment dominated by arithmetical relations—i.e., the actual world.[2]

We have already noted an allusion to a type of Philolaic "mixture" of the *indivisible* eternal one and the *divisible* corporeal entities, as well as an analogous mixture of "the same" and "the different", in the *Timaeus.* In these places we can think of Plato as anticipating and addressing Leibniz's problematic opposition between *finite* monads and the divine *infinite* monad separated by a, in practice, unbridgeable gap. (Kant had made Leibniz's gap *in principle* unbridgeable by invoking the dichotomy of concepts and intuitions as effectively incommensurable representations.) Given Hegel's clear intentions to *mediate* Leibniz's (and Kant's) gap, it is clear how Plato's late approach could have appealed.

We might now start to get a grip on the role that computational processes in human cognition can be thought to work among those "imperfect surrogates" standing in for properly *conceptual operations* conceived *as* ideals that cannot be themselves directly implemented. This is all part of Hegel's critical reinterpretation of what he calls the logic "of the understanding" and in which he includes both ancient logics, as found in Aristotle, and modern, as in Leibniz and Kant (and that would effectively apply after Hegel to Boole, Frege, Russell). That is, these are *all*, effectively, degenerate forms of the logic of Plato's later dialectical thought—his *rational*

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considering number to be "the principle both as matter for things and as forming their modifications and states … the whole heaven, as has been said, is numbers" (Aristotle *Metaphysics*, 986a16-21), and prefaces his mention of the table of the Pythagorean principles with a specific discussion of the first two pairs that "hold that the elements of number are the even and the odd, and of these the former is unlimited, and the latter limited" (Aristotle, *Metaphysics* 986a18-20). These two fundamental oppositions, the limited and the unlimited and the odd and even are then listed as the first two of a list of ten pairs of principles arranged in two columns.

[1] Clearly, it would be the Idea itself that was worth of first prize *were* it instantiable.

[2] Attempts to demonstrate the *unity* of these three otherwise incommensurable mathematical ratios had remained an issue for the Greeks for some time after Plato's death, as suggested by the fact that, a century later, Eratosthenes of Cyrene (276–194 BCE), would apparently compose a work, the *Platonikos*, on the role of mathematics in Plato's philosophy, and another, "On Means", seeking proofs for the interrelation of the three musical means (Heath 1921, vol II, 156).

syllogism in which Ideas are represented in the world by worldly surrogates that can aim at being awarded "second prize". Nevertheless, such surrogates have crucial roles to play in a rationally directed life when regarded *as* surrogates of the real thing. It is this conception of logic that can be found in Hegel's "Subjective Logic" of *The Science of Logic*, and the question we must ask is, what form of logic *there* is to be awarded second prize as the best *approximation* of the logic of concepts *properly conceived*?

## 4. The Neo-Pythagorean Triadic Monadism of Hegel's Syllogism.

In his "Subjective Logic" Hegel traces a series of judgment forms that eventually transitions into the *syllogism* which is "the truth" of the judgment (Hegel 2010, 593). The series starts with "judgments of existence", the first form of which is a simple *extensionally understood* subject–predicate judgment in which the predicate "adheres" in a singular concrete subject ("the rose is red" in the sense of some specific rose)—the containment of the predicate in the subject broadly coinciding with the judgments of Leibniz's extensionally interpreted concept calculus in which properties belong to objects (albeit *possible* ones). But *negative forms* of such judgments lead to more abstract judgments, "judgments of subsumption", which are closer to the structure of the judgments of Leibniz's *intensionally interpreted* calculi, and these eventually become incorporated into the more complex "judgements of reflection",[1] which repeat the subject–predicate form of judgments of inherence but now with a *generic* subject (e.g., "the human being is mortal, things are *perishable*" (569). The series continues through "judgments of necessity" and eventually issue into "judgments of the concept" which will transition into the syllogism.

The judgment of the concept is a distinctively *evaluative* judgment concerning the goodness or badness of some action or action-product. From the conventional point of view of the "*logic of the understanding*", the potential for disagreement over value judgments most often leads to discounting their "objectivity", but Hegel reverses this attitude in taking disagreement as pointing to the *normativity* of the act of judgment itself. Judging, as a *public* linguistic activity, is something that can be done, and *judged* to be done, well or badly, the act of judging itself dragged into the domain of what is being judged.[2] Hegel's point is that assertions will only achieve the status *of* judgments in virtue of their ability to face dialogical contestation (the essence of "dialectic" in both Plato and Hegel) and thus gain or fail to gain rational support by the giving of *reasons*. This is the passage to the formal syllogism in that a judgment such as "this house is good" can expand into one in which the singular subject–universal predicate relation becomes mediated by a "particular" middle term which effectively contains the

[1] Negation raises the notion of false but *possibly true*, judgments—that is, judgments true is other possible worlds.
[2] Famously, Hegel stresses the essentiality of linguistic expression to concepts in the Preface to the second edition of *The Science of Logic* (Hegel 2010, 12). C.f, Žižek's comments on Elon Musk's envisaged neuralink project which envisages bypassing language in human communication (Žižek 2020, ch. 2).

justification of that initial judgment: "this house, as so and so constituted, is *good*" (Hegel 2010, 585), a mediated judgment in which one can recognize a syllogism of the type "this *S* is *P*, such *P*s are *U*, therefore this *S* is *U*.[1]

A crucial feature of Hegel's formal judgments and syllogisms which contrasts with Aristotle's is his explicit distinction between the determinations of *singular* and *particular*, which can be aligned with Plato's distinction in the *Timaeus* between the "Different" and the "Same", the mixable principles into which everything is divided. That is, to grasp an individual *as* a particular is to grasp it in terms of what it *shares* with a range other things, but to grasp it as *singular* (as in "this house" of the judgment of the concept) is to grasp it in its raw "*haecceity*", in its *difference* to other such things. Indeed, Proclus, a neo-Platonic author with whom Hegel was familiar, had linked these to the musical means describing the "harmonic proportion" that "connects all the samenesses" as "establishing a common ratio and yoking together things that are naturally similar" while "the arithmetic mean … binds together the various Differences", adding that "the geometric mean is the monad of the harmonic and arithmetic ones" (Proclus 2009, 175–176).

Proclus's interpretation neatly captures Hegel's syllogism. *Qua* component of the *rational* syllogism, the universal term, "the good", itself refers to a directly unrealizable concept (Plato's "Idea" modelled on the "geometric mean")—any *actual* house will at best be a second-best *surrogate*, but potentially able to play the role of this-worldly *paradigm* of the ideal house. On the basis of such paradigms, a community will come to share norms of excellence against which all individual instances can be judged. But such judgments are fallible, and the experience of some new house may come to challenge the conventional paradigm. Here the roles of measure and measured can be reversed, the new house establishing a standard according to which all others must live up.

For Hegel, such patterns of human reasoning belong to the realm of spirit—here *objective* spirit (*der objective Geist*) which while unable to be reduced to *nature* is embodied in historically dynamic communal practices which are in turn embodied in natural human beings. Here Hegel's *spirit* in general plays a somewhat analogous role to that of Leibniz's infinite monad, God, within which all the finite monads exist but neither Hegel's God, nor the general sphere of *Geist* itself, can be conceived as simply transcending nature, as with Leibniz.[2] In recent decades there have been many attempts to ground Hegel's concept of spirit in patterns of intersubjectively based "recognition" (*Anerkennung*),[3] and such an intersubjective dynamic

[1] Hegel's evaluative judgment of the concept has similar features to Kant's judgments of *aesthetic* value, as found in the third *Critique*. On some of these parallels and their significance see Redding 2007, ch. 6.

[2] Nor, of course, can it be reduced to it, as with Hobbes, nor as somehow immediately identifiable with it, as with Spinoza.

[3] This notion is most commonly discussed in relation to Hegel's practical philosophy, but in Redding 1996 I have attempted to give it a more general role.

is clearly instantiated in Hegel's pragmatically conceived rational syllogism. Subjects engaged in dialectic clearly do so as both natural and spiritual beings. *Qua* natural beings, they exhibit immediate but correctable responses to the affecting objects of their environment. The *redness* of this rose or the *excellence* of this house produce immediate "gut-level" responses, but these responses are subject to processes of self-correction given their expression within *normative* communicative relations to others, relations within which each "recognizes" the other as *capable* of holding his or herself *to* the socially existing norms and as even as capable of rationally *challenging* them.

Here Hegel had followed and generalized the role given to recognition by Fichte who, in his *Foundations of Natural Right* of 1796, had treated humans as "being-determined to be self-determining" in the face of "a summons [*eine Aufforderung*]" to "resolve to exercise their efficacy" (Fichte 2000, 31), summonses directed to them from other rational beings. But while Fichte's recognitive "spiritual" legal sphere of right stood in unmediated opposition to nature as embodied in the family, Hegel, in his *Philosophy of Right* (Hegel 1991, Part 3, section I), extended spiritual recognition to the family itself considered, as the immediate form of "Ethical Life" (*Sittlichkeit*). In all this, Hegel's approach to normativity can be regarded as exemplifying the late-Platonic point of view, in that we might regard Kant's *Categorical Imperative, qua* criterion of morality, as playing the role of a directly *unrealizable* Platonic "Idea", *indirectly* represented in the actual world by two opposed imperfect approximations—the forms of recognition involved in the family and in civil society respectively. In conclusion we might ask: how might the computationalist idea be seen as functioning in this context?

## Conclusion: Recognition and the Spirit–Nature–Machine Triad.

In contrast to common approaches in which the *rule-following* of human practices is abstractly contrasted with the *causal* process of nature, Hegel's approach starts from a type of "mixture" of *incommensurable opposites* as found in Plato's late Philolaic approach. In the family, there is a unity in which the dimension of incommensurability of the two principles is yet to be made explicit, this then coming to the surface in the particularizing forms of subjectivity created in the civil sphere. The unity of these two opposed spheres is conceived as achieved in *the state*, but this is not a *return* to the false unity of the starting point, *the family*. Hegel's unity is not the "totality" of tradition and his notion of *state*, which "readers of Hegel usually perceive as a normative description of a model rational state" is more one on which "dusk is falling" (Žižek 2020, 33). That is, the state is better conceived as *second-best* "harmonic" option,[1] the best that can be achieved in an actual world infused with the injustice of the "arithmetic" mean.

The role given by Hegel to the family as the immediate realm in which products of nature—i.e., infants and children—are inducted into spirit, raises the question of what it is *about* their

[1] Or perhaps with Žižek, the *least bad*?

natures that allow *them*, but not other natural beings, to be so induced, and eventually into the "impersonal" recognitive processes of civil society and then the state proper.[1] In the *Philebus* Plato had addressed the claims of both pleasure and knowledge to the status of the *good life*, showing that *neither* could be considered to unilaterally instantiate it. A life of *pleasure* demanded exercise of reason, while the exercise of *reason* could only occur in a being able to take *pleasure* in reasoning. Nevertheless, via the dialectical method, knowledge was awarded the prize (of course, the second prize, the first being reserved for the Idea of the good) over pleasure. We might think of opposed realms of *Sittlichkeit* in much the same way. For Hegel, civil society had added a dimension to human forms of life in which a form of freedom unable to subsist in a generalized way could now do so. But civil society generates its own pathologies and must enter into a mediation with forms from the family. Moreover, in order to be induced into the realm of civil society, individuals have had to have been already induced into the more mechanically rule-governed order of the family. But what is the "nature" of the original "natures" so able to be incorporated in these interlinking processes into spirit? Here the way that numbers are eventually transformed into concepts in the interlinking computations of mathematics stands as a model. Might not more generally such computational dimensions of nature so contribute?

"Computers" *were*, of course, in the first decades of the twentieth century, human beings—almost exclusively women carrying out computations under industrialized conditions in which mathematical rules had to be applied in speedy, mechanical ways. These humans would come to be replaced by *computing machines* that were developed on the basis of the discoveries of Turing and others, as machines effectively meant to *mimic* the original rule-following of humans. *In turn*, this would lead to the computational conception of human reasoning and intelligence *itself*. In this historical configuration, might we not, rather than be forced to chose between the alternatives of a *reduction* of the concept of reason to computation and its blunt denial, rather recognize an underlying recognitive process involving spirit, nature, and machines, in which humans *qua* rule-following beings are able to recognise themselves in the *otherness* of the natural processes otherwise constituting them and the machines within which actual rules are able to be implemented? In short, might we not better approach the "computational theory of mind" in terms of the spirit–nature–machine triad understood according to the Late-Platonic dynamic structures adopted by Hegel that have been broached here?

[1] I explore these relations in Redding 1996, chs 8–11.

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